PREDICTORS OF NEURODEVELOPMENTAL OUTCOMES AMONG ACUTE MALNOURISHED CHILDREN UNDER FIVE YEARS, IN NAIROBI INFORMAL SETTLEMENTS

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DECLARATION AND APPROVAL

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This research thesis is my original work and has not been presented for a degree in any other university at any other award

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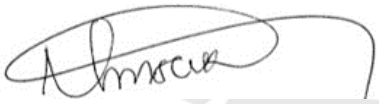
Signature 

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ABSTRACT

Background: Acute malnutrition rates remain high in sub-Saharan Africa, including Kenya, particularly in Nairobi's informal settlements. These areas are characterized by inadequate access to clean water, poor sanitation, limited health services, and sub-optimal living conditions, all of which increase the risk of malnutrition among children under five years of age. This study examined the predictors of neurodevelopmental outcomes in cases of acute malnutrition relapse among children under five living in Nairobi's informal settlements.

Methodology: A comparative, cross-sectional, hospital-based study was conducted in Viwandani and Korogocho informal settlements in Nairobi. The study compared three groups of children under five: those who had never experienced acute malnutrition, those with a first episode, and those who had relapsed. Both quantitative and qualitative methods were employed, utilizing purposive sampling. Neurodevelopmental outcomes were assessed using the Malawi Developmental Assessment Tool (MDAT). Quantitative data were collected through structured and semi-structured questionnaires and analyzed using STATA version 17.0. Qualitative data were collected through Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and In-depth Interviews (IDIs), and analyzed thematically using NVIVO software.

Results: The prevalence of acute malnutrition relapses in Korogocho and Viwandani during 2024 (January to December) was 41.01% (n=260) out of 634 acute malnutrition cases. The prevalence of Moderate Acute Malnutrition (MAM) and Severe Acute Malnutrition were 31.55% (n=200), and 9.46% (n=60) respectively. Significant predictors of relapse included household food security [AOR=1.817; CI: 0.868, 3.802; $p < 0.05$], wealth quintile [AOR=2.051; CI: 1.077, 3.903; $p < 0.05$], handwashing practices [AOR=0.993; CI: 0.526, 1.876; $p < 0.05$], decision-making on small purchases [AOR=3.445; CI: 1.174, 10.112; $p < 0.05$], antenatal visit coverage [AOR=1.830; CI: 0.996, 3.363; $p < 0.05$], dietary diversity [AOR=1.393; CI: 0.752, 2.584; $p < 0.05$], and breastfeeding initiation [AOR=3.425; CI: 1.620, 7.244; $p < 0.01$].

The prevalence of poor neurodevelopmental outcomes among children under five years was 44.57% (n=119). Children with acute malnutrition relapse had the highest rate of poor neurodevelopmental outcomes, 53.93% (n=48). Relapses were significantly associated with poor neurodevelopmental outcomes and were 2.082 times at risk of poor neurodevelopment than children without relapse or with normal nutrition [COR=2.082; CI: 1.113, 3.895; $p < 0.05$]. Maternal postpartum depression and child maturity at birth also predicted neurodevelopment [AOR=3.618; CI: 1.860, 7.038; $p < 0.001$] and [AOR=2.930; CI: 1.205, 7.123; $p < 0.05$], respectively.

Conclusion: Acute malnutrition relapses are prevalent in Nairobi informal settlements and significantly predict poor neurodevelopmental outcomes. Targeted interventions addressing identified risk factors are crucial to improving child health and development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS /ACRONYMS

ADHD: Attention Deficit/Hyperactivity Disorder

ANC: Antenatal Care

APHRC: African Population and Health Research Center

CI: Confidence Interval

ERC: Ethics and Research Committee

FANTA: Nutrition Technical Assistance Project

FGD: Focus Group Discussion

HFIAS: Household Food Insecurity Access Scale

HOME: Home Observation for Measurement of the Environment

IDI: Indebt Interview

IYCF: Infant and Young Child Feeding

KDHS: Kenya Demographic and Health Survey

KII: Key Informant Interview

LBW: Low Birth Weight

LMICs: Low and Middle-Income Countries

MAM: Moderate Acute Malnutrition

MDAT: Malawi Development Assessment Tool

MUAC: Mid-Upper Arm Circumference

OR: Odds Ratio

SAM: Severe Acute Malnutrition

SE: Standard Error

SES: Socio-Economic Status

SD: Standard Deviation

UN: United Nations

WASH: Water and Sanitation Hygiene

DEFINITION OF TERMS

Malnutrition	A condition when the body lacks enough of the required nutrients or has an excess of the required nutrients. Malnutrition in children includes wasting, being underweight, stunting, and deficiencies of micronutrients (minerals and vitamins) or excess nutrients.
Acute malnutrition	Acute malnutrition is a form of undernutrition that results from decrease intake of protein or/and energy or/and loss due to illness, resulting in bilateral pitting oedema and/or sudden weight loss. It is defined by the presence of bilateral pitting oedema or wasting [low Mid Upper Arm Circumference (MUAC) or low Weight-For-Height (WFH), Weight-For Length (WFL)].
Moderate acute malnutrition (MAM)	Is defined by a weight for height/length (WHZ) indicator between -2 and -3 z-scores (standard deviations, sd) of the WHO international standard cut off, or by a mid-upper arm circumference (MUAC) between 12.5 cm and 11.5 cm or both (Fiorentino et al., 2016).
Severe acute malnutrition (SAM)	This is a type of acute malnutrition where the MUAC < 11.5 CM or WHZ < −3 SD or the presence of bilateral pitting oedema (nutritional oedema), or both (Fiorentino et al., 2016).

Mild acute malnutrition Mild	malnutrition is a less severe form of nutritional deficiency where the body shows initial signs of inadequate nutrition but without significant functional or structural effects. It is characterized by a WHZ of between -1 and -2 standard deviations below the WHO median growth standards and a slightly reduced MUAC, but it is not indicative of critical malnutrition (Fiorentino et al., 2016).
Marasmus	A form of SAM with visible wasting, which is severe as a result of the body breaking down body fat and muscle for energy.
Kwashiorkor	A form of SAM with bilateral pitting oedema in the lower legs that progresses to the hands, arms, and face.
Marasmic-kwashiorkor	A form of SAM with a combination of bilateral pitting oedema and severe visible wasting.
Acute malnutrition relapse	Wasting within 6 months after exiting treatment, as per the recommended discharge criteria (Council of Research and Technical Advice for Acute Malnutrition, CORTASAN).
Chronic malnutrition	An irreversible, long-term effect of protein-energy deficiency where an individual fails to attain the expected height at a given age.
Neurodevelopmental disorders	Neurodevelopmental disorders (NDDs) are conditions characterized by impairments in communication, cognition,

behavior, and/or motor skills resulting from abnormal brain development.

CHAPTER 1: INTRODUCTION

1.1. Background

Malnutrition in children under five years old remains a persistent global health challenge, particularly in informal settlements, which are typically low-resource settings. Globally, malnutrition contributes to more than three million deaths annually among children under five (Kassaw et al., 2021). Sub-Saharan Africa (SSA) alone has approximately 13 million children suffering from acute malnutrition (Owolade et al., 2022). In Kenya, malnutrition is responsible for 35,000 deaths annually among children under five (Fanzo et al., 2022). Between 2018 and 2019, the prevalence of acute malnutrition in Nairobi's informal settlements was classified as medium but was approaching a high threshold at 9.93% among children under five (De Vita et al., 2019). According to the United Nations, this rate of wasting is classified as medium (Johnson, 2016).

The United Nations has also warned that unless global inequality and poverty are addressed, approximately three billion people will be living in slums by 2050 (Bhalla, 2023). Currently, 965 million people live in slums in Asia, while SSA is home to approximately 230 million slum dwellers (Ramani & Hettiarachchi, 2022). Nairobi has around 40 slum areas, where an estimated 56% of the city's population resides (Wamukoya et al., 2020). These settlements often lack clean water, adequate health services, and proper sanitation, creating an environment where children under five are highly susceptible to malnutrition due to limited access to nutritious food and suboptimal living conditions (De Vita et al., 2019).

Globally, the relapse rate of acute malnutrition in children under five after treatment for severe acute malnutrition (SAM) ranges from 10% to 37% (Stobaugh et al., 2019). Relapse most frequently occurs within six months following treatment (Burza et al., 2016). In Ethiopia, the relapse rate within six months post-treatment is reported at 36.2% (Alyi et al., 2023). In Kenya, relapse rates up to four months post-treatment is 3% for children previously treated for SAM and 11% for those treated for moderate acute malnutrition (MAM) (Lelijveld et al., 2021).

Acute malnutrition among children under five is often driven by inadequate dietary intake, frequent infections, and poor maternal and child care practices (Alyi et al., 2023). Limited access to nutritious food during critical growth periods results in energy and nutrient deficiencies (UNICEF, 2023). Repeated illnesses, such as diarrhea, respiratory infections, and measles, further exacerbate the situation by impairing nutrient absorption and increasing energy requirements (Alyi et al., 2023). Additionally, factors like poor sanitation, lack of exclusive breastfeeding, and insufficient health services contribute to a vicious cycle of undernutrition and illness, increasing the risk of both initial episodes and relapse of acute malnutrition (De Vita et al., 2019).

Acute malnutrition has devastating effects on a child's growth, physical health, and neurodevelopment. Efforts to combat acute malnutrition have primarily focused on therapeutic interventions, including nutritional rehabilitation, management of medical complications, and close monitoring of the child's recovery. However, relapse after initial treatment remains a significant challenge, undermining sustained recovery and optimal neurodevelopmental outcomes (Lelijveld et al., 2021).

Key vulnerabilities such as food insecurity, limited healthcare access, and poor sanitation are strongly linked to relapse following treatment (Alyi et al., 2023). In communities with limited nutritious food and inadequate healthcare follow-up, children are at higher risk of recurrent malnutrition (Lelijveld et al., 2021). Low socioeconomic status and limited caregiver education further intensify these challenges, perpetuating the cycle of malnutrition and negatively affecting neurodevelopmental outcomes (Lelijveld et al., 2021).

Neurodevelopmental outcomes include fine motor skills, gross motor skills, cognitive and social skills, and language abilities (Komutambo et al., 2022). Fine motor skills involve the movement and control of small muscles in the hands, fingers, tongue, lips, toes, and wrists. Gross motor skills refer to the use of large muscles for crawling, sitting, running, walking, and head movements. Social skills enable children to interact with others and include abilities such as expressing frustration, smiling responsively, recognizing themselves in a mirror, and preferring primary caregivers (Komutambo et al., 2022). Language development encompasses receptive and expressive language, as well as articulation. Factors influencing neurodevelopmental outcomes include maternal education (Konkel, 2018), birthweight (Sato et al., 2022), family composition (Bush et al., 2020), and household food security (Komutambo et al., 2022).

A study in France reported that the rate of moderate to severe poor neurodevelopmental outcomes was 28% (Pierrat et al., 2021). In Eastern Uganda, 12.7% of infants exhibited poor neurodevelopmental outcomes in at least one domain (Namazzi et al., 2019). In Kenya, among children with normal weight-for-length/height, the prevalence of poor neurodevelopmental outcomes was 4.47% in 2022 (Abuga et al., 2022).

The early years of life (0–5 years) are critical for brain development. Studies conducted in the Philippines, Brazil, and Jamaica demonstrated that malnutrition during this period can cause irreversible developmental delays (Grantham-McGregor et al., 2007). Previous community-based studies in African countries, including South Africa and Tanzania, have shown a significant association between malnutrition and poor neurodevelopmental outcomes in children under five (McCormick et al., 2020). In Uganda and Malawi, children who did not recover from wasting had poor neurodevelopmental outcomes (Babikako et al., 2022). In western Kenya, malnutrition was identified as a significant predictor of delayed developmental milestones, with an adjusted odds ratio of 13.9 (Gudu et al., 2020). Despite this evidence, there is limited research exploring the relationship between acute malnutrition and neurodevelopmental outcomes among children under five in Nairobi's informal settlements. These settlements present a unique context due to their high prevalence of acute malnutrition and the presence of multiple risk factors (De Vita et al., 2019).

Even after treatment and initial improvement, a considerable number of children experience relapse, often resulting in deteriorating health and increased vulnerability to infections. Malnutrition has been shown to cause lasting changes in brain structure, neural connectivity, and cognitive processing, leading to long-term developmental impairments (Gudu et al., 2020). Nairobi's informal settlements, characterized by adverse household, community, and individual factors, present an appropriate setting for examining the relationship between relapse of acute malnutrition and neurodevelopmental outcomes (Faye et al., 2019). The complex challenges faced by children in these areas emphasize the urgency of understanding how relapse impacts neurodevelopment. Given the limited

research on this topic, this study aims to contribute valuable insights into the broader consequences of malnutrition and recovery trajectories in resource-constrained environments.

1.2. Statement of the Problem

Adequate nutrition and good health are essential for children's physical and neurodevelopment (UNICEF, 2022). However, nutrition deficiencies remain among the top 20 causes of disease in Kenya, as measured by Disability-Adjusted Life Years (DALYs) in the Global Burden of Disease (GBD) study (Hannah Ritchie, 2019). The Kenya Demographic and Health Survey (KDHS) 2022 reported that the prevalence of wasting among children in Kenya is 5%, which represents a 1% increase from the previous KDHS 2014 findings (Kenya National Bureau of Statistics [KNBS] et al., 2023). In Nairobi's informal settlements, the prevalence of acute malnutrition among children under five was classified as medium, at 9.93% (De Vita et al., 2019).

Despite ongoing efforts by the government both county and national and the private sector, acute malnutrition remains a critical public health concern among children under five years old living in informal settlements (Codjia et al., 2022). The high rates of malnutrition in Nairobi’s slums can be attributed to several factors, including food insecurity, poor sanitation, lack of access to clean water, and inadequate healthcare services. These conditions expose children to heightened risks of malnutrition due to insufficient intake of nutritious food, nutrient loss from diarrheal diseases, and poor living environments (De Vita et al., 2019).

Although timely treatment interventions are provided, a significant proportion of children experience relapse after initial recovery. Studies conducted globally report relapse rates in acute malnutrition ranging from 10% to 37%, which is a significant public health concern (Lelijveld et al., 2021). However, there is limited data on the prevalence of neurodevelopmental outcomes among children under five years old in Kenya (Abuga et al., 2022).

Investigating the relationship between relapse incidents and neurodevelopmental outcomes is crucial, as it addresses a critical issue affecting a vulnerable population. While existing research has demonstrated the negative impact of malnutrition on neurodevelopment, there is a gap in understanding how relapse episodes may further influence these outcomes (McCormick et al., 2020). This study seeks to contribute to closing this evidence gap by exploring whether relapse leads to more adverse neurodevelopmental trajectories compared to a single episode of acute malnutrition.

Previous studies have examined the association between acute malnutrition and neurodevelopmental outcomes at the global, African, and national levels. However, there has been limited focus on informal settlements a unique and particularly vulnerable setting that warrants specific attention and targeted research.

1.3. Research Questions

1. What is the prevalence of acute malnutrition relapse among children under five years old in Nairobi informal settlements?
2. What are the factors associated with acute malnutrition relapse among children under five years old in Nairobi informal settlements?

3. What is the prevalence of poor neurodevelopmental outcomes among children under five years old in Nairobi informal settlements?
4. What are the individual and household factors associated with poor neurodevelopmental outcomes among children under five years old in Nairobi informal settlements?
5. What is the association between acute malnutrition relapse and neurodevelopment outcomes among children under five years old in Nairobi informal settlements?

1.4 Study Objectives

1.4.1. Broad Objective

To determine predictors of neurodevelopmental outcomes in acute malnutrition relapse among children under five years old in Nairobi informal settlements.

1.4.2 Specific Objectives

1. To determine the prevalence of acute malnutrition relapse among children under five years old in Nairobi informal settlements.
2. To identify factors associated with acute malnutrition relapse among children under five years old in Nairobi informal settlements.
3. To determine the prevalence of poor neurodevelopmental outcomes among children under five years old in Nairobi informal settlements.
4. To determine the association between acute malnutrition relapse and neurodevelopment outcomes among children under five years old in Nairobi informal settlements.

1.4. Justification

For children to reach their full potential, they require five essential and interconnected components of nurturing care: adequate nutrition, good health, responsive caregiving, safety and security, and opportunities for early learning (UNICEF, 2022). Acute malnutrition poses a significant threat to child health and development, particularly in informal settlements, which are classified as low-resource environments (Segre et al., 2023).

Acute malnutrition rates in Korogocho and Viwandani informal settlements are notably higher compared to other areas in Nairobi, such as Kibera, which reported a wasting rate of 2.5% (De Vita et al., 2019). These areas are also characterized by the frequent absence of primary caregivers, who are expected to care for malnourished children at home (Mao et al., 2020). The elevated malnutrition rates in these settlements are often accompanied by increased rates of relapse after treatment, which is likely to have a detrimental effect on neurodevelopmental outcomes.

This study focuses on children under five years of age because this is a critical developmental period across all domains—physical, cognitive, social, and emotional. In Kenya, previous studies have reported varying prevalence rates of poor neurodevelopmental outcomes among children under five: 6.1% in 2006 (Mung'ala-Odera et al., 2006), 2.06% in 2016 (Hannah Ritchie, 2019), and 4.47% in 2022 (Abuga et al., 2022). These findings suggest that poor neurodevelopmental outcomes have been increasing over time.

Children who fail to reach their developmental milestones are less likely to grow into productive adults (Smythe et al., 2021). Reduced productivity in children is often associated with decreased learning efficiency, which can prolong the number of years required to complete school. This delay has economic consequences not only for the government but also for families who must bear the additional financial burden (Psacharopoulos, 2014).

Nairobi's informal settlements were selected as the focus of this study because, despite the significant progress Nairobi City County has made in child health care, these settlements continue to be hotspots for malnutrition. Notably, Nairobi City County is the only county in Kenya that has established a breast milk bank, located at Pumwani Hospital.

1.5. Significance of the Study

The findings of this study contribute to the growing body of evidence that can inform the development and improvement of policies and practices that specifically address the needs of children who experience relapse after acute malnutrition treatment. A comprehensive approach that integrates both nutritional and developmental considerations may lead to more effective and sustainable outcomes.

These findings offer practical guidance for health care delivery at the facility, community, and household levels, particularly regarding the treatment and follow-up of children enrolled in outpatient acute malnutrition management programs. The study's significance is aligned with the increasing recognition of the need for holistic approaches to child health and development, as emphasized by frameworks such as Nurturing Care and precision medicine. It underscores that a child's well-being extends beyond physical recovery and

highlights the complex interactions between physical health, neurodevelopment, and socio-environmental factors.

By examining the association between relapse incidents and neurodevelopmental outcomes, this study contributes to the understanding of the holistic well-being of children affected by acute malnutrition in resource-constrained settings. The findings may inform the design of more comprehensive intervention strategies that not only address the immediate nutritional deficits but also focus on relapse prevention and the promotion of healthy neurodevelopment.

Furthermore, by exploring this association among children under five years old in Nairobi's informal settlements, this research provides critical evidence to support improvements in existing policies and practices. Such improvements have the potential to break the cycle of malnutrition and enhance the developmental trajectories of these vulnerable children, enabling them to reach their full potential.

1.6. Scope of the Study

The geographical scope of this study focused on Nairobi’s informal settlements, specifically targeting selected areas with high rates of malnutrition. The findings are intended to be applicable not only within the context of informal settlements in Nairobi but also in similar low-resource settings outside Nairobi.

The study population included children under five years old from Viwandani and Korogocho informal settlements. The study considered three groups: children who had never experienced acute malnutrition, those experiencing their first episode, and those who had relapsed after treatment for acute malnutrition.

The study specifically examined individual and household factors associated with neurodevelopmental outcomes. Broader community and systemic factors were not the primary focus, as existing literature has already documented these aspects, particularly given that children in the two settlements share similar environmental conditions.

The neurodevelopmental assessment in this study focused on outcomes potentially influenced by variables such as the assessment environment and rater bias. While integrating neuroimaging techniques, such as magnetic resonance imaging (MRI), would have provided greater precision and objectivity, logistical constraints made the use of such techniques unfeasible in this study. Nonetheless, the literature review provided supporting evidence from MRI studies that have demonstrated associations between malnutrition in children under five and neurodevelopmental outcomes.

1.7. Assumptions of the Study

1. Homogeneity of Treatment: The study assumed a relatively uniform approach to the treatment of acute malnutrition within the informal settlements. This implies that the treatment protocols, nutritional interventions, and healthcare services provided to children with acute malnutrition are consistent across the study population.
2. Causation Inference: The study assumed that the observed neurodevelopmental outcomes are solely influenced by relapse incidents and the associated acute malnutrition. While efforts were made to control for other factors at the design stage and during analysis, it is acknowledged that various environmental and social factors may contribute to developmental trajectories.

3. Consistency of Neurodevelopmental Assessment: The study assumed that the chosen neurodevelopmental assessment tools were reliable and applicable to the cultural and linguistic context of the informal settlements.
4. Children under five years old who never healed of acute malnutrition had the same neurodevelopmental outcome trajectory as those experiencing relapse after treatment.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

A growing body of research evidence indicates that poor neurodevelopment in young children has significant long-term effects on adult well-being. This section reviews existing evidence on the influence of individual, household, community, and systemic factors on neurodevelopmental outcomes in children. The findings from this review emphasize the importance of understanding the determinants of neurodevelopment, particularly among children who have experienced acute malnutrition relapse after treatment in informal settlements.

2.2. Theoretical Frameworks

This study is built on two theoretical frameworks: a theoretical framework for relapse to severe acute malnutrition (Schaefer et al., 2021), and Bronfenbrenner's bio-ecological systems theory of early childhood development (Perron, 2018).

2.2.1. A Theoretical Framework for Relapse to Acute Malnutrition

This study is grounded in the theoretical framework of post-treatment relapse in malnutrition. According to this theory, factors influencing the risk of relapse extend beyond contextual conditions associated with the incidence and recurrence of severe acute malnutrition (Schaefer et al., 2021). A child's health and nutritional status are key determinants of relapse. These factors influence the likelihood of achieving full recovery, the child's immunological resilience, and their overall nutritional well-being. Together, health and nutritional status are critical predictors of acute malnutrition relapse following treatment.

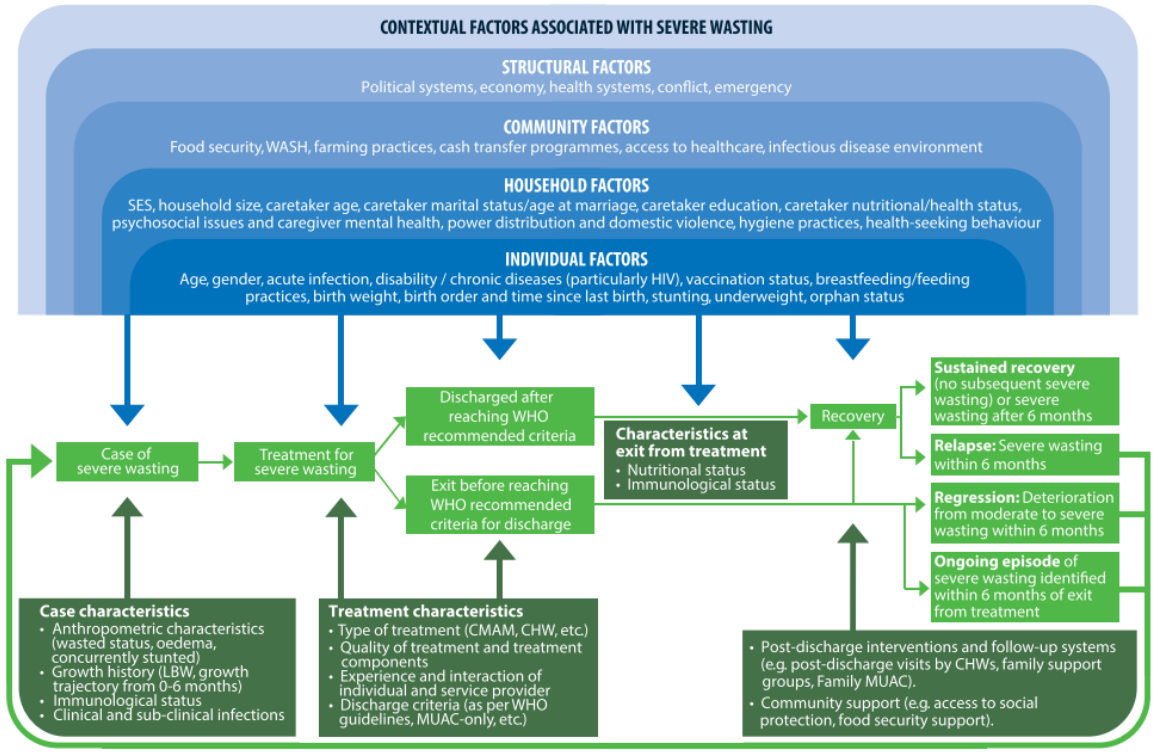

Figure 1: A Theoretical Framework for Relapse to Acute Malnutrition

2.2.2. Bronfenbrenner's Bio-ecological Systems Theory of Early Childhood Development

This study is strongly grounded in the bio-ecological systems theory of early childhood development (Perron, 2018). The theory posits that interactions between environmental and biological risk factors can lead to poor neurodevelopmental outcomes. It emphasizes that children's development is shaped by the relationships and experiences within their surrounding environments. Various systems within the environment influence neurodevelopment, including individual factors (such as maternal and child characteristics), household factors, community factors, and systemic factors.

The dynamic interaction among these factors contributes to poor neurodevelopmental outcomes in three groups of children: those who have never experienced acute malnutrition, those undergoing their first episode, and those who have relapsed following treatment for acute malnutrition.

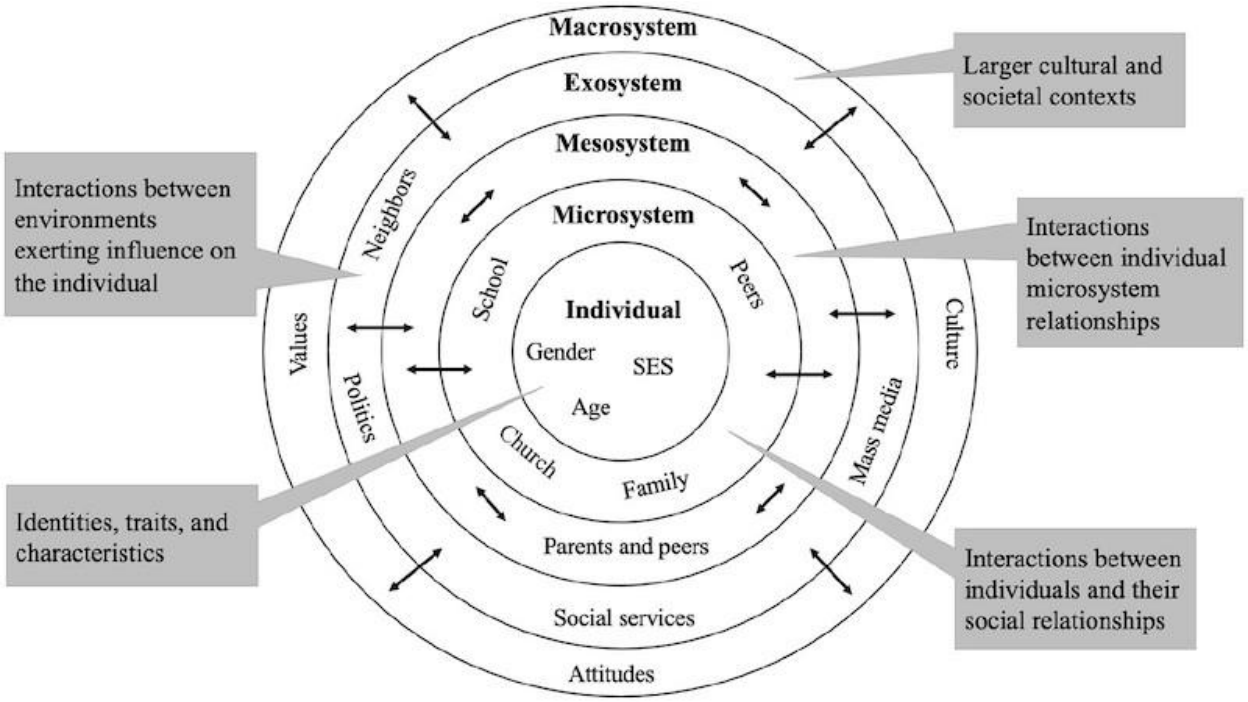

Figure 2: Bronfenbrenner's Bio-ecological Factors Interaction on Child's Neurodevelopment

2.3. Review of Related and Empirical Literature

2.3.1 Maternal Factors

Various maternal factors influence a child's neurodevelopmental outcomes. These include maternal education level, maternal age, maternal nutritional status, maternal substance use during pregnancy and breastfeeding, as well as contributors to maternal health such as antenatal care (ANC) attendance, delivery care practices, and postnatal care practices.

Maternal education (literacy levels) is a key determinant of children's neurodevelopmental outcomes. A study conducted in Iraq found a significant relationship between maternal education level and children's neurodevelopment (Alkhazrajy & Aldeen, 2017). In Uganda, primary caregivers with college education were more likely to have children who reached fine motor skill development thresholds compared to those whose caregivers only had a high school diploma (Komutambo et al., 2022). Additionally, career training has been linked to improved parenting behaviors, better stimulation practices (Habibi et al., 2018), and enhanced problem-solving skills in children (Asztalos et al., 2017).

Maternal age is also associated with neurodevelopmental outcomes in children (Asare et al., 2018). However, this relationship is non-linear and influenced by multiple factors. Higher maternal age is often linked to reduced direct involvement in childcare (Duncan et al., 2018), while younger parents may be preoccupied with career development, limiting the time and attention devoted to their children (Duncan et al., 2018). Older mothers may also be less likely to follow healthcare providers' recommendations, which can negatively impact child neurodevelopment (Komutambo et al., 2022). Compared to younger mothers, older mothers are often associated with poorer neurodevelopmental outcomes in children, potentially due to differences in caregiving styles (Falster et al., 2018).

Children whose caregivers are between the ages of 21 and 30 years are more likely to meet developmental thresholds in personal social skills compared to those whose caregivers are between the ages of 51 and 60 (Komutambo et al., 2022). On the other hand, older motherhood is sometimes associated with higher education levels, which can positively influence children's cognitive development (Falster et al., 2018). Very young mothers may

lack the knowledge, experience, resources, and social support necessary to adequately support their children's neurodevelopment.

Maternal nutritional status and substance use during pregnancy also significantly impact cognitive and neurodevelopmental outcomes (Cortés-Albornoz et al., 2021). The developing brain is especially vulnerable to nutritional deficiencies between 24 and 42 weeks of gestation (Cortés-Albornoz et al., 2021). Poor maternal nutrition during this critical window can result in long-term neurodevelopmental impairments at various stages of a child's life. Nutritional deficiencies during early pregnancy particularly affect the development of the cortex, auditory system, and hippocampus, often leading to delayed speech, poor cognitive function, and impaired motor skills (Kadosh et al., 2021).

2.3.2 Child Factors

Several child-specific factors influence neurodevelopmental outcomes. These include the child's age, gender, birth weight, length-for-age, health status (infections), diet quality, vitamin A supplementation, vaccination history, breastfeeding patterns, and post-neonatal complications such as poor feeding, unconsciousness, hypothermia, convulsions, high body temperatures, and intrauterine growth restriction.

Infants generally show significant improvements in motor development between three and four months of age (Hadders-Algra, 2018). However, a study conducted in Ireland found that children's neurodevelopmental outcomes did not always improve as expected with age (Gaul & Issartel, 2016). According to Komutambo et al. (2022), children aged between two and six months had a higher likelihood of achieving optimal neurodevelopmental milestones compared to those aged 19 to 23 months.

The influence of gender on neurodevelopmental outcomes remains somewhat contradictory in the existing literature. However, some studies suggest that girls tend to have better neurodevelopmental outcomes than boys when controlling for nutritional status (Moore, 2024).

Diet quality has a strong positive association with neurodevelopmental outcomes. Fortification of food with essential micronutrients, vitamins, and proteins has been linked to improved cognitive development in children (Prado et al., 2019). Conversely, a lack of dietary protein may hinder or delay neurodevelopment (Sato et al., 2022). Recent evidence highlights the importance of animal protein supplementation in preventing malnutrition and enhancing cognitive abilities in children (Pimpin et al., 2019).

Low birth weight (LBW) is a known predictor of delayed neurodevelopment, particularly by the age of one year (Sato et al., 2022). Although the short-term association between LBW and neurodevelopment at six and 24 months is well-documented, long-term effects remain inconsistent across studies (Prado et al., 2019). Preterm infants are particularly vulnerable to the adverse effects of malnutrition, which can severely impair later neurodevelopment. Addressing early protein-energy deficits in these infants can promote healthy brain growth (McCormick et al., 2020).

Stunting is another critical factor, as stunted children often have compromised immune systems, underdeveloped brain structures, and delayed organ development, all of which contribute to neurodevelopmental delays (Falster et al., 2018; Komutambo et al., 2022).

Breastfeeding is widely recognized for its positive impact on both the nutritional quality of breast milk and the strengthening of maternal-child bonding (Krol & Grossmann, 2018). There is a well-established association between the duration of exclusive breastfeeding and improved developmental scores across all age groups and geographical locations (Onyango et al., 2022).

Newborns who experience conditions such as asphyxia, infections, preterm birth, low birth weight, and pathological jaundice are at an elevated risk of poor neurodevelopmental outcomes (Sato et al., 2022). These risks are often exacerbated by the "three delays" in accessing medical care: delays in decision-making, delays in reaching healthcare facilities, and delays in receiving quality care upon arrival (Shah et al., 2020).

Furthermore, post-neonatal complications such as poor feeding, unconsciousness, hypothermia, convulsions, high body temperatures, and intrauterine growth restriction have been shown to contribute to poor neurodevelopmental outcomes in children (El Rafei et al., 2021).

2.3.3 Household Factors

Various household factors affect a child's neurodevelopmental outcomes. These include family composition, household food security, socio-economic status, Water, Sanitation, and Hygiene (WASH) indicators at the household level, household parental practices and decision-making, and intimate partner violence within the household.

Family composition differences have been associated with varying neurodevelopmental outcomes, whereby children raised in two biological parent families perform better compared to children raised in single-parent families across all age groups (Bush et al.,

2020). Child birth order is also a significant factor in neurodevelopment. Firstborns tend to demonstrate higher intelligence compared to their siblings but may also be at a higher risk of developing disorders such as attention deficit hyperactivity disorder (ADHD) (Bush et al., 2020; Kampouri et al., 2018). Family size contributes to children's neurodevelopment, although this is often influenced by other factors such as the child's gender, parental conflict, parenting behaviors, and parental mental health (McCormick et al., 2020).

Children from food-secure households generally have better neurodevelopmental outcomes than those from food-insecure households (Komutambo et al., 2022). Neurodevelopmental progress in children aged 6 to 23 months has been partially explained by improved household food security (Frongillo et al., 2017). Household-level food security has also been directly linked to the timely achievement of motor developmental milestones (Geletu et al., 2019; Komutambo et al., 2022).

Low socio-economic status is associated with poor neurodevelopmental outcomes, particularly among undernourished children (Galler et al., 2021). However, the home environment plays a critical role in determining a child's neurodevelopment, often beyond the influence of socio-economic and health-related factors (Nampijja et al., 2018). Poor indoor air quality, particularly from the use of substandard heating and cooking sources that emit harmful particulate matter and combustion by-products, may contribute to poor neurodevelopmental outcomes (Akteruzzaman et al., 2023). Burning coal inside homes is specifically associated with increased exposure to harmful fumes, which can lead to adverse neurodevelopmental effects (Akteruzzaman et al., 2023). Additionally, low-quality structural materials used in home construction are linked to negative neurodevelopmental consequences (Bush et al., 2020). Many building materials contain heavy metals and other

toxins that may increase the risk of neurodevelopmental disorders such as ADHD and autism (Gallo & Posner, 2016). Harmful chemicals commonly found in household items include polyvinyl chloride (PVC), which is used in pipes, ceiling coatings, and flooring, as well as compounds present in fabrics, furniture, and carpets that can volatilize at room temperature (Prasittisopin et al., 2023). WASH indicators are significantly associated with child health and nutritional outcomes (Mshida et al., 2018). However, a review of the literature did not establish any direct evidence linking WASH indicators to children's neurodevelopmental outcomes.

The early developmental stages of a child's life are crucial for their future well-being. Parental practices and decision-making at the household level are important predictors of a child's cognitive abilities (Malhi et al., 2018). For example, parental involvement in introducing solid foods at seven to eight months of age is associated with increased caregiver-child interaction during feeding, which positively influences neurodevelopment (Malhi et al., 2018).

Exposure to intimate partner violence within the household can have long-lasting adverse effects on a child's neurodevelopment. This is because children's stress-response systems and developing brains are particularly sensitive to environmental stressors during early childhood (Mueller & Tronick, 2019).

2.3.4 Community Factors and Systemic Factors

Since every child (normal or malnourished) live in the same community and has a shared environment, the community and systemic factors affect them equally. There are other

potential variables that are worth discussing. Information on how community and systemic factors are associated with neurodevelopmental consequences is discussed below.

Community Factors

There is an interaction between environmental and biological risk factors that can lead to poor neurodevelopmental outcomes in children (Perron, 2018). A child's immediate environment and limited social interactions are among the key risk factors that contribute to this outcome (Bush et al., 2020). Children primarily learn through social observation and interactions with the people around them (Perron, 2018). Positive relationships, loving care, and adequate stimulation enhance a child's ability to communicate and build relationships with others, which in turn supports healthy neurodevelopment (Perron, 2018).

Exposure to community noise has been associated with poor neurodevelopmental outcomes in children (Raess et al., 2022). Similarly, children exposed to violence within their communities may suffer long-lasting neurodevelopmental impairments, as their developing brains and stress-response systems are particularly sensitive to such environmental stressors (Mueller & Tronick, 2019).

Low-quality structural features in school environments have also been linked to negative neurodevelopmental outcomes (Bush et al., 2020). Materials used in the construction of school buildings often contain heavy metals and other toxins, which may adversely affect children's neurodevelopment (Gagnon-Chauvin et al., 2020). In addition, lack of access to clean drinking water at the community level increases the risk of ingesting harmful contaminants, such as heavy metals, which can further impair neurodevelopment (Lewis et al., 2017).

Socio-cultural factors play a significant role in shaping neurodevelopmental milestones in children. Cultural beliefs and practices, such as the misconception that diarrhoea is caused by teething or the reluctance to seek conventional medical care, can negatively impact child health and contribute to poor neurodevelopmental outcomes (Nampijja et al., 2021).

Systemic Factors

Lack of contact with healthcare providers can deprive mothers of essential knowledge regarding child development (Aldayel et al., 2020). This gap in awareness may stem from low socio-economic status (SES), which can limit educational attainment and subsequently impact child neurodevelopment (American Psychological Association [APA], 2017). Access to well-maintained roads and well-equipped healthcare centres is critical in shaping neurodevelopmental outcomes among children under five years old (Shonkoff, 2016). Furthermore, healthcare providers who receive training in human growth and development gain a deeper understanding of developmental milestones, which enables them to offer better guidance and support to caregivers (Shonkoff, 2016).

The literature clearly demonstrates that multiple factors at both the system and community levels influence children's neurodevelopmental outcomes. These factors impact both malnourished children and those who experience relapse after treatment for acute malnutrition. This study was based on the assumption that these system and community factors represent a shared environment that affects all children across the study groups, although the degree of impact may vary. Therefore, the primary focus of this study was on individual and household-level factors.

2.4 Identification of Knowledge Gap

There is substantial research evidence on the impact of malnutrition on neurodevelopment; however, a critical gap remains in understanding how relapse incidents specifically influence these outcomes (McCormick et al., 2020). This study seeks to address this gap by exploring whether relapse results in a more adverse neurodevelopmental trajectory compared to a single episode of malnutrition. While there is existing evidence demonstrating the association between malnutrition and neurodevelopmental outcomes at the global, continental (Africa), and national (Kenya) levels, there has been limited focus on informal settlements a uniquely vulnerable context that warrants specific investigation. This study recognizes the importance of addressing not only the immediate physical health concerns of malnourished children but also the potential long-term consequences on neurocognitive development.

2.5 Conceptual Framework for the Nutritional and Related Drivers of Child Neurodevelopmental Outcomes

This study is grounded in a conceptual framework that examines the influence of child factors, maternal factors, and household factors on the pathways leading to acute malnutrition, relapse in acute malnutrition, and neurodevelopmental outcomes among children. The household factors assessed include household food security, socio-economic status, Water, Sanitation, and Hygiene (WASH) indicators, family composition, and parental practices. The maternal factors examined include maternal education level, age, health status, and substance use. The child-specific factors considered include age, gender, birth weight, infections, vitamin A supplementation, diet quality, vaccination status, and breastfeeding practices.

In addition to these primary factors, the framework acknowledges that modifying influences, such as cultural beliefs and adherence to medical prescriptions, can also play a significant role in determining neurodevelopmental outcomes, regardless of the presence or absence of the assessed child, maternal, or household factors (Figure 3).

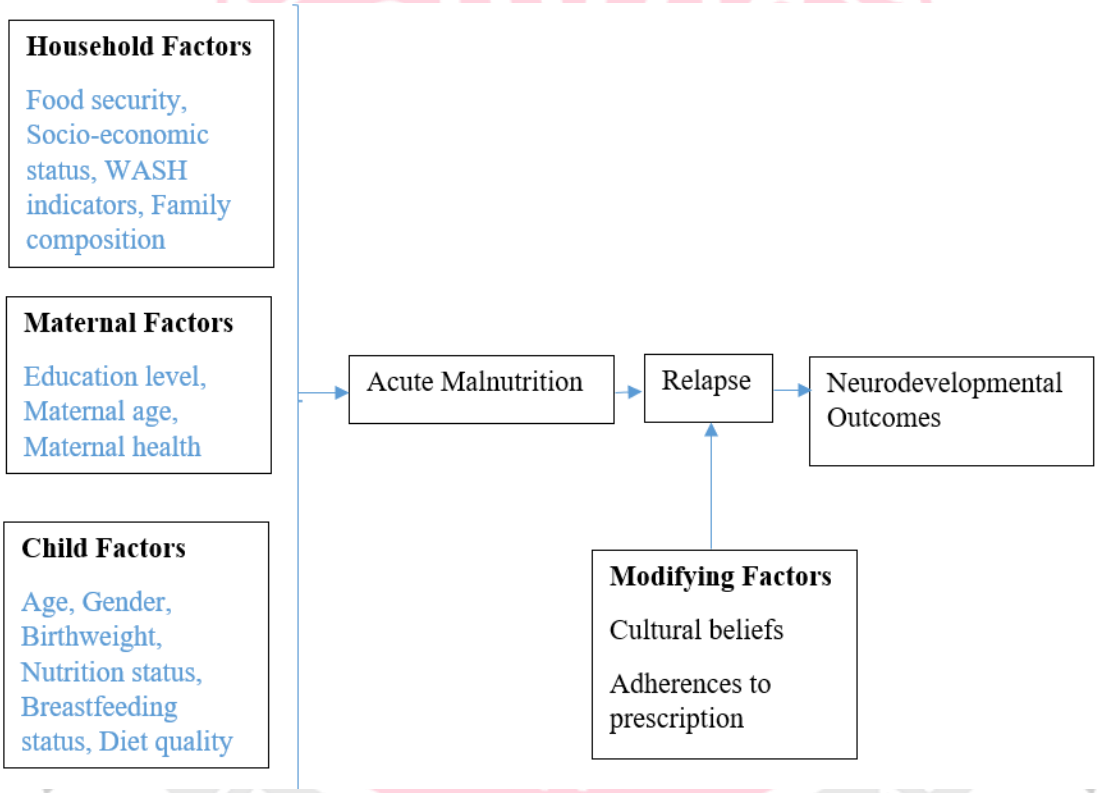

Figure 3: Conceptual Framework for the Nutritional and Related Drivers of Child Neurodevelopmental Outcome

CHAPTER 3: METHODOLOGY

3.1. Introduction

This section highlights key data collection approaches that guided the study's development and attained the needed research outcomes based on the underlying research problem. The key research aspects that are presented in this section include study setting, target population, research design, sampling, data management, and considerations of research ethics.

3.2. Research Design

This study used a comparative (analytical) cross-sectional design that was hospital-based (Wang & Cheng, 2020). The exposure and the outcome were assessed simultaneously. The study design was chosen because of the limited MSc timelines and relatively short duration required to complete a research project. A comparative cross-sectional study was chosen because of the need to infer the causes of poor neurodevelopmental outcomes in children under five with acute malnutrition relapses. We used both qualitative and quantitative approaches in data collection.

3.3. Study Setting

The study was conducted in four health facilities within Nairobi informal settlements: two hospitals and two health centers (Viwandani -Mareba Hospital and Kwa Reuben Health Center; Korogocho- Korogocho health center and Ngomongo hospital). The hospitals were purposively selected as they are the largest hospitals within the study sites. They also have nutrition clinics for managing acute malnutrition. The four hospitals were selected because they are located within the slums and serve residents of the slum areas. The rates of acute malnutrition in Korogocho and Viwandani slums are higher compared to an informal

settlement like Kibera which had 2.5% wasting rates (Kimani-Murage et al., 2015). These slum areas are among the areas with the highest rates of acute malnutrition in Nairobi and the high rates of malnutrition can be attributed to inaccessibility to clean water, high levels of food insecurity, poor sanitation, and healthcare services, creating an environment where the under 5 children have high chances of becoming malnourished (Kimani-Murage et al., 2014).

3.4. Target Population

In determining the prevalence of acute malnutrition relapses in Viwandani and Korogocho informal settlements, the number of children who had either acute malnutrition or relapse was extracted from the hospital records between January to December 2024.

The study participants were in three comparative groups from similar socioeconomic backgrounds. By comparing the three groups, it is possible to infer the causes of poor neurodevelopmental outcomes. The study's target population was children under five years old living in the two informal settlements who had never suffered acute malnutrition, those who had acute malnutrition for the first time, and those who had acute malnutrition relapsed.

3.4.1. Inclusion Criteria

1. Children under five years old who had been living in Korogocho and Viwandani within the past year.
2. Severe acute malnourished children under five years old who had first episode of acute malnutrition.
3. Children under five years old who had acute malnutrition relapses.
4. Children under five years old who had never suffered from acute malnutrition.

3.4.2. Exclusion Criteria

1. Children under five years old who had conditions such as cerebral palsy, genetic syndrome, congenital heart disease, malabsorption cerebral palsy, etc. This information was obtained by asking the mother and/or confirming from the mother-child booklet.
2. Clinically unstable children under five years old during the assessment test.
3. Acute malnourished children under five years old who had never received treatment.

3.5. Operationalization of the Variables

Appendix III shows the different variables, their types, and the types of raw data to be collected, as well as the scale of measurement of the raw data.

3.6. Sample and Sampling Procedures

3.6.1. Sample Size Determination

Data extracted for determining the prevalence of relapses was obtained through the census of all children seen at the study location's healthcare facilities during the review period.

Fischer's formula for comparative cross-sectional studies was used to determine the sample size for primary data collection (Charan & Biswas, 2013). The sample size was calculated based on the assumptions from a study done in Kenya, which found that the citation-given prevalence for any neurodevelopmental impairment was 12.7 % (Experimental group) and 1.00% (Comparison group) (Dwivedi et al., 2018). Most studies reported the overall aggregated prevalence of neurodevelopmental impairment as a single outcome and not as separate domains.

$$n = \frac{\left[z_\alpha \sqrt{(1+1/m)\bar{p}(1-\bar{p})} + z_\beta \sqrt{p_0(1-p_0)/m + p_1(1-p_1)}\right]^2}{(p_0 - p_1)^2}$$

$$\bar{p} = \frac{p_1 + m p_0}{m+1}$$

$$n_c = \frac{n}{4}\left(1 + \sqrt{1 + \frac{2(m+1)}{nm|p_0 - p_1|}}\right)^2$$

α alpha, β, 1 - power

nc is the continuity-corrected sample size

zp is the standard normal deviation for probability p. n (It is then rounded up to the nearest integer)

Power= 80%, Alpha =5%

N per group =72

Applying the correction for continuity, since in my question, a continuous distribution is used to approximate discrete distributions.

Sample size, N per group = 89

The total sample size for the three groups = 89×3= 267

3.6.2. Sampling Technique

Quantitative interviews with caregivers- A purposive sampling technique was employed where participants were selected on availability and eligibility to either group. This sampling method involved recruiting participants who met the inclusion criteria as they presented themselves until the sample size was attained.

Qualitative interviews with caregivers, healthcare providers, community health volunteers, and community health assistants- Quota sampling was used, and sampling stopped once the required number of subjects was attained. The population was divided into groups based on specific characteristics (Nurses, nutritionists, doctors, clinical officers, primary caregivers, community health workers, and community health assistants), and then the participants were selected from each group based on the predetermined quota.

3.7. Data Collection Instruments

Data extracted for determining the prevalence of relapse was obtained through a census of all children seen at the study location hospitals during the review period. The extraction was done manually and recorded in a data extraction form.

For the quantitative component of the primary data collection, both structured and unstructured questionnaires were used for data collection. The questionnaire was uploaded on the Survey CTO mobile data collection platform to ensure accuracy, validity, and completeness.

Qualitative data collection was done using a focus group discussion guide (FGD), an in-depth interview (IDI) guide, and a key informant interview (KII) guide. Quantitative interviews were done using a structured and semi-structured questionnaire. The questionnaire and the guides were developed in English and translated into Swahili as well. Validation prior to data collection was done through pre-testing in another informal settlement with similar settings to check for clarity and consistency. The tool underwent further modifications based on the feedback from the pilot. Data were collected by five research assistants for a period of three months, and they underwent a one-week training prior to data collection. Qualitative data were programmed in the Survey CTO mobile data

collection platform, and relevant quality checks were included. For quantitative data, the quality checks that were put in place include constraints and data validation prompts to minimize invalid or incomplete entries. For quality control, the data was reviewed daily after collection.

Prevalence of Acute Malnutrition Relapse Among Under-5 Children in Viwandani and Korogocho Informal Settlements.

The data on the prevalence were collected quantitatively by extracting data of children with relapse from the hospital records.

Factors Associated with Relapse

Data on the factors associated with relapse were collected both qualitatively and quantitatively using appropriate tools. The mothers were interviewed using a structured questionnaire (Quantitative data). Purposive sampling was used to select the mothers. Qualitative data were obtained using KII with healthcare workers (Hospital-based healthcare workers, Community Health Assistants (CHA), and Community Health Volunteers (CHV)). IDIs and FGD with the mothers. The selection of qualitative participants was through quota sampling.

Individual Factors (maternal and child factors): Individual factors were captured using the quantitative tool that was administered to the mothers. The section on maternal factors focused on ***maternal social factors*** (Education and income), ***demographic factors*** (Age), and ***maternal health factors*** (postpartum depression, maternal nutrition status, and antenatal care coverage). The section on the child factors focused on the ***child health and morbidity factors*** (diarrhoea, hospitalization, child maturity status at birth, and

birthweight), ***child feeding practices*** (dietary diversity, initiation of breastfeeding, and exclusive breastfeeding)

Household Factors: Data on household characteristics was obtained by administering the questionnaire to the mother (primary caregiver). The questionnaire captured data on the ***household socio-economic determinants*** (Food security, poverty line, wealth quintile, number of biological parents, decision on income usage, and urban farming), and ***environmental health and sanitation factors*** (access to drinking water, effective water treatment methods, good handwashing practices, solid waste disposal, and improved sanitation facilities).

Cultural Practices and Beliefs: Qualitative interviews were used to explore cultural practices and beliefs related to the child's feeding, care, and health behaviours of the mothers and opinions from the other groups of respondents.

Anthropometric Measurements: Data on the child's height or length, weight, and MUAC measurements to determine nutritional status. Height/length was measured using an infantometer while weight was measured using a weighing scale/salter scale. The weight and height/length were then be changed to the z scores (WHZ) using the WHO WHZ reference chart to classify the severity of the malnutrition. Child MUAC was measured using infant MUAC tapes and measurements were taken halfway between the acromion and olecranon process at the midpoint. The tape was checked so that it was not too tight or too loose. The recordings were rounded to one decimal place. Oedema was assessed using the thumbs on the child's legs, feet, and face. The presence of oedema on the feet only was reported as grade 1 (+), both feet and legs were reported as grade 2 (++), and both feet, legs, hands, and face were reported as grade 3 (+++) (Gasparis et al., 2020). For non-

pregnant women, weight and height were taken using a weighing scale and stadiometer, respectively.

Neurodevelopment Outcomes Among Children Under Five Years in Nairobi Informal Settlements.

The data on neurodevelopmental outcomes were collected quantitatively using structured and semi-structured questions in the Malawi Developmental Assessment Tool (MDAT). The assessment involved observation with a checklist, getting a parental report, and directly assessing the child. This tool is relevant in assessing the neurodevelopment milestones of children between 0-6 years in Malawi and elsewhere in Africa and was refined and robustly tested using detailed psychometric techniques (Gladstone et al., 2010). The tool has been well-validated to assess children's neurodevelopmental milestones in African rural settings (Namazzi et al., 2019). The tool examines four areas of development: fine and gross motor skills, social skills, and language. The cognitive skills assessments are embedded in the areas of the child's motor skills and language. All items within each domain were reported as either "pass", or "fail". If the child fails to cooperate, it is reported as "unknown". The tool has a sensitivity and a validity of 97% in predicting neurodevelopmental milestones of children from 0-6 years. On the child's neurodevelopmental milestones, each domain had a cut-off score, and the child was considered to meet the cut-off points if their developmental score was above the cut-off (Komutambo 2022). Similar data was collected from the other two comparison groups to make it possible to infer the outcomes of relapse in acute malnutrition after treatment. Examples of elements that were assessed in each domain using the MDAT tool are listed in appendix IV.

3.8. Validity and Reliability Testing

3.8.1 Validity

To ensure that the tools used for neurodevelopmental assessment, nutritional assessment, and data collection are aligned with the study objectives, they were reviewed to confirm their relevance. The MDAT is considered locally appropriate and has been standardized on African populations, therefore, it is suitable for assessing the participants. It is been well-validated to assess children's neurodevelopmental milestones in African rural settings (Namazzi et al., 2019).

3.8.2 Reliability

The neurodevelopmental assessment tools were administered to a subgroup of participants on two separate occasions to check for consistency in results. A high correlation between the scores was an indicator of good reliability. Since multiple assessors were involved, the researcher ensured that there was agreement in scoring and interpretation. Reliability checks were conducted by having different assessors independently rate the same children and then calculate inter-rater agreement. Five research assistants were trained and observed to ensure that accurate and complete data were collected. The tools and methods were piloted in Kibera South Health Center to avoid contamination of the study sample. The piloting sample for the quantitative data collection was 10 respondents who were selected purposively. The researcher implemented data quality checks during data collection and entry to identify and correct errors promptly. There was pilot testing of all tools with a small sample to identify any inconsistencies or ambiguities. The tools were modified based on feedback to enhance reliability.

3.9 Data Collection Procedure

3.9.1 Acute Malnutrition and Relapse Data Extraction from the Health Facilities Records

Data on acute malnutrition and relapse cases was extracted from the hospital records (Nutrition registers). The extraction was carried out between January and December 2024 to report a time prevalence of one year.

3.9.2 Recruitment of the Study Participants for the Primary Data Collection

With the help of five research assistants, we approached caregivers of the under 5 children attending nutrition clinics at Mareba Health Center, (Viwandani), and Korogocho health center (Korogocho). Once the potential participants were identified, eligibility criteria were used to identify those who would participate in the study. Together with the research assistants, we sought consent from the study participants before administering the questionnaire.

3.9.3 Data Collection Process

This process began after receiving ethical approval and administrative clearance from the hospitals (health facilities). The process was then done as planned to ensure accuracy and reliability. Initially, a sampling framework was established to identify participants representative of the target population, and data collection instruments—such as questionnaires and interview guides—were developed and piloted to refine clarity and usability. Trained research assistants then administered the tools following standardized protocols, with quality checks and supervisory oversight in place to address any discrepancies promptly.

3.10 Data Analysis and Presentation

3.10.1 Quantitative Data

The data was cleaned and analyzed using STATA version 17.0. Analysis was done at both the bivariate and multivariate levels. Descriptive statistics were conducted on the continuous/numeric and categorical variables, and data were described using standard deviations and means. Crude (unadjusted) correlations were examined between relapse and potential risk factors. Multivariable adjusted logistic regression analysis since the outcome (relapse or not, either pass or fail of neurodevelopment assessment) is a binary outcome. The regression was done to identify factors associated with relapse as well as factors associated with a child's neurodevelopmental outcomes. Crude (unadjusted) correlations between neurodevelopmental scores (MDAT) and relapse and other potential predictors of neurodevelopmental outcome. Multivariate logistic regression was conducted to determine the association between relapse and neurodevelopmental outcomes by adjusting for other factors.

Household Factors

Household Socio-economic Determinants

Household Socio-economic Factors.

Data on the household socio-economic status were analyzed in STATA version 17.0. The indicator values were calculated and then divided by the sum of households that were in the national population's lowest wealth quintile by the sum of all households. The results were then multiplied by 100 to convert them to percentages. Data on specific questions on health, WASH, agriculture, etc., was disaggregated by wealth.

Household Food Insecurity.

Household food insecurity was assessed using the HFIAS questionnaire and prior to allocating the category. The categories were computed as recommended by FANTA, where the answer to the "no" question was coded as a "0" (Coates et al., 2007).

Decision on Income Usage.

For the women control over their own income, the indicator value was determined by counting the number of women who considered as "generating their own income" – i.e. the women who answered "it was more" The number of times the women would say that they decided on how their income would be used (alone or with someone else) will be counted then divided by the number by the total number of women who were considered as "generating own income" The results were then multiplied by 100 to convert it to a percentage.

Poverty Line.

The poverty line of the households was calculated using the poverty probability index (PPI) based on the answers to 10 Kenyan-specific questions about household characteristics and asset ownership. The indicator measured the likelihood that the household was living below the poverty line. The PPI look-up table was then used to convert the PPI scores to a likelihood of the respondents' household being below the poverty line based on Nairobi's poverty line.

Wealth Quintile.

The indicator for wealth was determined by asking participants a set of Kenyan-specific questions about the ownership of various assets. The questions were adopted from the equity tool, and each respondent was asked 12 easy-to-understand questions. The equity tool web-based application was used for data collection and automatic calculation of the results.

Environmental Health and Sanitation Factors

Basic Water Services.

In calculating the sum of households that were using "basic drinking water services", the sum of households that had access to water from the sources that were safe (always) and a collection time of 30 minutes or less was calculated.

Effective Water Treatment Methods.

The indicator was analyzed by categorizing the households effectively treating their drinking water (i.e. reported boiled, used ceramic/ sand/other water filters, adding bleach/ chlorine, used disinfectant powder, used solar disinfection, and had the required materials and were able to use them correctly).

Good Handwashing Practices.

This indicator was analyzed by categorizing respondents who reported washing their hands with soap or ash at least 3 out of 5 critical times.

Solid Waste Disposal.

This indicator was analyzed by categorizing the households that safely dispose of their solid waste i.e. buried it, burned it, or carried it to a designated waste disposal site).

Improved Sanitation Facilities.

This indicator was analyzed by categorizing the households using improved sanitation (i.e., using a pit latrine with slab, using a ventilated improved pit latrine, using a flush or pour toilet (connected to a sewer system or septic tank), or using a composting toilet).

Maternal Factors

Maternal Postpartum Depression.

The depression was assessed using the Edinburgh Postpartum Depression Scale (EPDS). The participants' responses to the 10 questions were scored based on the seriousness of the symptoms, while others were reverse. The overall score was found by adding together the scores for each of the 10 items. The respondents who scored 12 or 13 were classified to be having depression.

Maternal Nutrition Status.

Anthropometric data were analyzed using the WHO Anthro software. The mothers (not pregnant) with a body mass index (BMI) <18.5kg/m2 were classified as acute (Kpewou et al., 2020). That means that they had severe acute malnutrition.

Antenatal Care Coverage.

Data for the indicator was analyzed by counting the number of visits when they were pregnant with the child. The number was then compared to Kenya's Ministry of Health's WHO recommendation of eight antenatal checks since 2016.

Child Factors

Anthropometric Assessment.

Anthropometric data were analyzed using the WHO Anthro software. Children with a WHZ z score of < -2SD and a MUAC of <12.5cm were classified as having acute malnutrition (Hai et al., 2020).

Minimum Dietary Diversity.

The indicator value was calculated by dividing the number of children under five years old whose diet had five or more food groups by the sum of children who were in the study (The children whose caregivers didn't provide the required information were excluded). Data was disaggregated by gender, wealth, age groups, children's nutrition status, and children's neurodevelopmental outcomes.

Diarrhoea Among Children.

In calculating the indicator's value for diarrhoea, the number of children who had 3 or more loose stools per day was divided by the sum of surveyed children within the past two weeks. The result was multiplied by 100 to convert it to a percentage.

Dry Cough.

In calculating the indicator's value for dry cough, the number of children who had a dry cough at least for three days was divided by the sum of surveyed children within the past two weeks. The result was multiplied by 100 to convert it to a percentage.

Initiation of Breastfeeding.

This indicator was analyzed by looking at the time after birth the mother put the child on the breast. Early initiation of breastfeeding entailed putting the child to the breast within the first hour, which is related to positive outcomes, including reduced mortality and exclusive breastfeeding.

Neurodevelopmental Outcomes.

The specific domains of neurodevelopment outcomes were assessed separately, with cognitive capacity outcomes being embedded in the fine motor skills and language assessments as per the MDAT tool. Using the tool, children were then scored by generating a categorical score of either pass or fail. In case he/she failed two or more items in any domain at an age where at least 90% of the population of reference is expected to pass, then they were reported as failed. Both sets of scores were compared for the three study groups.

The strength of association between variables was calculated using the odds ratio (OR) with a 95% confidence interval (CI). Tables, graphs, and narratives were used to present the results and to facilitate interpretation and comparison.

3.10.2. Qualitative Data

Qualitative data were analyzed using reflexive thematic analysis (Byrne, 2022). The NVivo software using pre-determined themes was used in identifying and adding any emerging themes. The coding was done by two research assistants. To check for inter-reliability, the two research assistants coded a single transcript, and a coding comparison query was done using the Kappa coefficient. The coding comparison query showed that a Kappa coefficient was one and a coding agreement of 95% which indicated consistency in the coding. Emerging concepts from the qualitative data were also analyzed using Leximancer software (Software using large language model (LLM) to get concepts and interactions from the qualitative data).

3.11. Ethical Consideration

The study strictly followed the ethical guidelines for human subject protection. It involved obtaining informed consent from all participants after the purpose, confidentiality, benefits, risks, and the level of involvement explained to them in a language they clearly understood. The respondents thereafter signed the consent form to confirm their acceptance to participate in the study. For confidentiality, interviews were done in a private place, and only the project team was able to access the data. Data were anonymized before analysis. The respondents also agreed to an assessment to be done on the child. Approval from the AMREF University School of Graduate Studies, AMREF Ethics and Ethics and Science Research Committee (ESRC), the National Commission for Science, Technology, and Innovation (NACOSTI), and relevant authorities (Including health facility approvals) was sought before starting data collection.

3.12. Study Constraints and Limitations

1. The accuracy of information obtained from caregivers regarding historical events, such as treatment history and nutritional practices, could have been subject to recall bias, affecting the reliability of the data.
2. Medical records used for analyzing treatment history and relapse incidents could have been incomplete or unavailable for some participants, leading to missing data.
3. There could have been external factors influencing neurodevelopmental outcomes that are beyond the scope of this study, such as exposure to violence, environmental toxins, or family dynamics.

CHAPTER 4: RESULTS

4.1. Introduction

This section systematically presents the study results per the objectives, both quantitatively and qualitatively. The key sections presented include: The prevalence of acute malnutrition relapse after treatment in Viwandani and Korogocho, participants' characteristics, socio-demographic characteristics, and descriptive results of child, maternal, and household factors. This section also highlights the crude and adjusted associations between child, maternal, and household factors among children. The crude and adjusted associations between different factors and neurodevelopment outcomes among children are also presented.

4.2. Prevalence of Acute Malnutrition Relapse in Viwandani and Korogocho

To obtain the prevalence of acute malnutrition relapse in the hospitals where data collection was being done. A review of records was conducted in the malnutrition clinics, and a total of 634 records were abstracted between January and December 2024. The proportion of male children was 47.32% (n=300) while the proportion of female children was 52.68% (n=334) as shown in Table 3. The mean age (months) of the children was 24.23. The prevalence of acute malnutrition relapse after treatment in Korogocho and Viwandani in 2024 (January to December) was 41.01%, as shown in Table 1. The proportion of MAM children who relapsed was 31.55%(n=200), while the proportion of SAM children who relapsed was 9.46% (n=60).

Table 1: Child Characteristics and Prevalence of Relapse

Variable	Number	Percent
Location		
Viwandani	320	50.47%
Korogocho	314	49.53%
Total	**634**	**100%**
Sex		
Male	300	47.32%
Female	334	52.68%
Total	**634**	**100%**
Age categories		
0-6 months	127	20.03%
7 – 11 months	125	19.72%
12 – 23 months	144	22.72%
24 – 36 months	133	20.98%
37 – 59 months	105	16.56%
Total	**634**	**100%**
Malnutrition status		
Relapsed MAM cases	200	31.55%
Relapsed SAM cases	60	9.46%
Relapse cases	260	41.01%
Acute malnutrition cases	634	100%

Increased Instances of Acute Malnutrition Relapse After Treatment

Qualitative findings established that there were many instances of acute malnutrition relapse after treatment in the community, and in many cases, the mothers failed to bring their children for malnutrition treatment and follow-ups as described by a health provider:

"In the nutrition department, we have had many instances of relapse in acute malnutrition after treatment". ***HP6_Healthcare provider***

4.3. Child and Maternal Socio-demographic Characteristics for the Primary Data

In this comparative cross-sectional study, primary data were collected from a total of 267 children under five years of age and their mothers. The distribution of participants by settlement was nearly equal, with 50.18% (n = 134) from Viwandani and 49.82% (n = 133) from Korogocho, as detailed in Appendix V. The children were categorized into three groups, with 89 children in each group: those who had never experienced acute malnutrition, those who had a first episode of acute malnutrition, and those who had relapsed after treatment for acute malnutrition. The mean age of the children was 26.4 ± 10.2 months, ranging from 6 to 48 months.

Of the children included in the study, 47.19% (n = 126) were male and 52.81% (n = 141) were female. Among children with acute malnutrition, those experiencing a first episode, and those with relapse, the proportion of female children was 51.12% (n = 91), 52.81% (n = 47), and 49.44% (n = 44), respectively.

Children less than two years of age comprised 54.68% (n = 146) of the sample, while children aged two years and above accounted for 45.32% (n = 121). Among children with acute malnutrition, those with a first episode, and those with relapse, the proportions of children under two years were 53.37% (n = 95), 46.07% (n = 41), and 59.55% (n = 53), respectively.

The mean age of the mothers was 29.7 ± 5.6 years, with an age range of 18 to 45 years. Among the primary caregivers, 28.46% (n = 76) were under 25 years of age, while 71.54% (n = 191) were 25 years or older. Within the groups of children with acute malnutrition, first episode, and relapse, the proportions of mothers under 25 years of age were 32.02% (n = 57), 49.44% (n = 25), and 47.19% (n = 32), respectively.

Regarding household income, 22.85% (n = 61) of the primary caregivers reported a high average income (≥ Ksh. 10,000), while 77.15% (n = 206) reported a low average income (< Ksh. 10,000). Among children with acute malnutrition, those with a first episode, and those with relapse, the proportions of primary caregivers with low average income were 87.08% (n = 155), 84.27% (n = 75), and 89.89% (n = 80), respectively.

4.4. Child Factors

4.4.1. Child Health and Morbidity Factors

The proportion of children who had diarrhoea within the past two weeks was 26.22% (n=70) as shown in appendix VI. The proportion of children who were preterm at birth (Born before 37 weeks) among those who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 12.36% (n=22), 11.69% (n=11), and 14.29% (n=11), respectively.

The proportion of children who had low birth weight (< 2,500 grams) was 29.21% (n=78), while the proportion of those who had normal birth weight was 70.79% (n=189). The proportion of low-birth-weight children who had either overall acute malnutrition, the first episode of acute malnutrition, or relapsed was 38.20% (n=68), 40.45% (n=36), and 35.96% (n=32) respectively.

4.4.2. Child Feeding Factors

The proportion of children who didn't reach the minimum dietary diversity was 36.33% (n=97), while the proportion of those who reached the minimum dietary diversity was 63.69% (n=170), as shown in appendix VI. The proportion of children who didn't reach the minimum dietary diversity among those who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 41.57% (n=74), 33.71% (n=53), and 49.44% (n=44), respectively.

The proportion of children who had late initiation of breastfeeding (Put on the breast after one hour after birth) was 18.73% (n=50), while the proportion of those who had early initiation was 81.27% (n=217). The proportion of children who had late initiation among those who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 24.72% (n=35), 16.85% (n=15), and 32.58% (n=29), respectively.

The proportion of children who were not exclusively breastfed (Had complementary feeding within 6 months after birth) was 34.46% (n=92), while the proportion of those who were exclusively breastfed was 65.54% (n=175). Exclusive breastfeeding was retrospectively measured. The proportion of exclusively breastfed children among those who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 41.57% (n=74), 33.71% (n=30), and 49.44% (n=44) respectively.

4.5. Maternal Health Factors

The proportion of primary caregivers who had postnatal depression was 20.60% (n=55) while the proportion of those who didn't have postnatal depression was 79.40% (n=212) as shown in table 2. The proportion of the primary caregivers with postnatal depression among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 21.91% (n=39), 29.21% (n=26), and 14.61% (n=13), respectively.

The proportion of the primary caregivers who were acutely malnourished was 6.37% (n=17) while the proportion who had normal nutrition status was 93.63% (n=250). The proportion of acutely malnourished primary caregivers among those with children who had

either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 8.43% (n=15), 8.99% (n=9), and 7.87% (n=7), respectively.

The proportion of primary caregivers who attended antenatal care less than eight times while pregnant with the child was 39.70% (n=106). The proportion of those who attended antenatal care visits at least eight times while pregnant was 60.30% (n=161). The proportion of primary caregivers who attended antenatal care visits less than eight times while pregnant among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 55.06% (n=94), 51.69% (n=46), and 53.93% (n=48) respectively.

Table 2:Description of the Maternal Health Factors

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Postpartum depression				
No postpartum depression	212 (79.40)	139 (78.09)	63 (70.79)	76 (85.39)
Postpartum depression	55 (20.60)	39 (21.91)	26 (29.21)	13 (13.61)
Total	**267**	**178**	**89**	**89**
Maternal nutrition status				
Normal Nutrition Status	250 (93.63)	163 (91.57)	81 (91.01)	82 (92.13)
Malnourished	17 (6.37)	15 (8.43)	8 (8.99)	7 (7.87)
Total	**267**	**178**	**89**	**89**
Antenatal visit coverage				
Antenatal care at least eight times from any provider	161 (60.30)	84 (47.19)	43 (48.31)	41 (46.07)
Antenatal care less than eight times from any provider	106 (39.70)	94 (66.06)	46 (51.69)	48 (53.93)
Total	**267**	**178**	**89**	**89**

4.6. Household Factors

4.6.1. Household Socio-economic Determinants

The proportion of households that were food insecure was 58.05% (n=155), while the proportion of those that were food secure was 41.95% (n=112), as shown in appendix VII.

The proportion of food insecure households among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 69.10% (n=123), 66.29% (n=59), and 71.91% (n=64), respectively.

The proportion of households that were living below the poverty line was 33.33% (n=89) while the proportion of those that were living above the poverty line was 66.67% (n=178).

The proportion of households that were living below the poverty line among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 39.89% (n=71), 31.46% (n=28), and 48.31% (n=43), respectively.

The proportion of households within the bottom-line quintile was 43.07% (n=115) while the proportion of the households within the top wealth quintile was 56.93% (n=152). The proportion of households within the bottom wealth quintile among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 51.69% (n=92), 39.32% (n=32), and 62.92% (n=56), respectively.

The proportion of households that were not practicing urban farming was 84.64% (n=226) while the proportion of those who were practicing urban farming was 15.36% (n=41).

The proportion of households not practicing urban farming among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 56.52% (n=154), 88.76% (n=79), and 84.27% (n=75), respectively.

The proportion of households that had one biological parent was 20.97% (n=56) while the proportion of households that had two biological parents was 79.03% (n=211). The proportion of households that had one biological parent among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 23.03% (n=41), 16.85% (n=15), and 13.48% (n=12), respectively.

4.6.2. Environmental Health Factors

The proportion of households that had no access to basic drinking water services was 37.45% (n=100) while the proportion that had access to basic drinking water services was 62.65% (n=167) as shown in appendix VII. The proportion of households that had no basic drinking water services among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 43.82% (n=78), 52.81% (n=47), and 34.83% (n=31), respectively.

The proportion of households that were not effectively treating their drinking water was 59.18% (n=158), while the proportion of households that were effectively treating their drinking water was 40.82% (n=109). The proportion of households that were not effectively treating their drinking water among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 64.44% (n=44), 56.74% (n=57), and 64.04% (n=57), respectively.

4.6.3. Sanitation Factors

The proportion of households that didn't have good handwashing practices in designated handwashing places was 44.57% (n=119) as shown in appendix VII. The proportion of households that had good handwashing practices in designated handwashing places was 55.43% (n=148). The proportion of households with no good handwashing practices in designated handwashing places among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 53.93% (n=96), 51.69% (n=46), and 41.57% (n=50) respectively.

The proportion of households that were not using basic sanitation services was 97.00% (n=259), while the proportion of households that were using basic sanitation services was 3.00% (n=8). The proportion of households that were not using basic sanitation services among those with children who had either overall acute malnutrition, first episode of acute malnutrition, or relapsed in acute malnutrition after treatment was 98.88% (n=176), 98.88% (n=88), and 98.88% (n=88), respectively.

4.7. Crude Associations between Child Factors and Acute Malnutrition among Children

4.7.1. Child demographic, Health and Morbidity Factors

There was a significant association between the child's age (< 2 years) and the first episode of acute malnutrition [COR= 0.593; CI: 0.356, 0.992; p-value: 0.046] as shown in appendix VIII. However, there was no association between the child's age and acute malnutrition relapse [COR= 1.44; CI: 0.860, 2.419; p-value: 0.165]. There was no association between gender and either acute malnutrition, first episode of acute malnutrition, or relapse in acute malnutrition after treatment [COR= 0.815; CI: 0.489, 1.361; p-value: 0.436], [COR= 1.000; CI: 0.601, 1.665; p-value: 1.000], and [COR= 0.816; CI: 0.490, 1.359; p-value: 0.436], respectively.

There was a significant association between diarrhoea among children under five years who had their first episode of acute malnutrition [COR=3.120; CI:1.775, 5.508; p-value < 0.001]. However, there was no association between diarrhoea and those children who had acute malnutrition relapse after treatment [COR=0.970; CI: 0.544, 1.735; p-value: 0.922].

The proportion of children under five years who had been hospitalized within the past six months and had either never suffered from acute malnutrition, had their first episode of acute malnutrition or had acute malnutrition relapse after treatment was 14.61% (n=13), 38.20% (n=34), and 31.46% (n=28), respectively. There was a significant association between child hospitalization and children who had their first episode of acute malnutrition [COR= 2.065; CI: 1.190,3.587; p-value: 0.010]. However, there was no association between child hospitalization and acute malnutrition relapse [COR= 1.279; CI: 0.732, 2.235; p-value: 0.387].

The proportion of children who were preterm at birth and had either never suffered from acute malnutrition, had their first episode of acute malnutrition, or had acute malnutrition relapse after treatment was 6.49% (n=7), 11.69% (n=11), and 14.29% (n=11), respectively. However, the association between birth weight and acute malnutrition relapse after treatment was insignificant [COR= 1.611; CI: 0.932, 2.786; p-value:0.088].

4.7.2. Child Feeding Practices

The proportion of children under five years who didn't reach minimum dietary diversity and had either never suffered from acute malnutrition had their first episode of acute malnutrition or had acute malnutrition relapse after treatment was 25.84% (n=23), 33.71% (n=30), and 49.44% (n=44) respectively as shown in appendix VIII. There was a significant association between minimum dietary diversity and children under five years who had acute malnutrition relapse after treatment [COR=2.306; CI:1.364, 3.900; p-value < 0.002]. However, there was no association between minimum dietary diversity and the first episode of acute malnutrition [COR= 0.842; CI: 0.494, 1.437; p-value: 0.529].

The proportion of children under five years who had late initiation of breastfeeding and had either never suffered from acute malnutrition had their first episode of acute malnutrition or had acute malnutrition relapse after treatment was 6.74% (n=6), 16.85% (n=15), and 32.58% (n=29), respectively. There was a significant association between the initiation of breastfeeding and children under five years who had acute malnutrition relapse after treatment [COR=3.613; CI: 1.914, 6.822; p-value: < 0.001]. However, there was no association between the initiation of breastfeeding and the first episode of acute malnutrition [COR= 0.824; CI: 0.425, 1.613; p-value: 0.579].

The proportion of children under five years who were not exclusively breastfed and had either never suffered from acute malnutrition had their first episode of acute malnutrition, or were having acute malnutrition relapse after treatment was 20.22% (n=18), 33.71% (n=30), and 49.44% (n=44), respectively. There was a significant association between exclusive breastfeeding and acute malnutrition relapse [COR=2.648; CI: 1.557, 4.505; p-value: < 0.001]. However, there was no association between exclusive breastfeeding and the first episode of acute malnutrition [COR= 0.951; CI: 0.556, 1.627; p-value: 0.855].

4.8. Crude Association between Maternal Factors and Acute Malnutrition Status Among Children

There was a significant association between postpartum depression and the first episode of acute malnutrition [COR=2.120; CI:1.157, 3.886; p-value: 0.015] as shown in appendix IX. However, there was no association between postpartum depression and relapse [COR=0.550; CI: 0.280, 1.096; p-value: 0.090]. There was a significant association between education level and relapse [COR=2.384; CI:1.319, 4.310; p-value: 0.004]. However, there was no association between education level and the first episode of acute malnutrition [COR=0.765; CI:0.407, 1.438; p-value: 0.405].

There was a significant association between maternal age (< 25 years) and acute malnutrition relapse after treatment [COR=1.710; CI:0.986, 2.966; p-value: 0.050]. Additionally, there was a significant association between the average income and the first episode of acute malnutrition [COR= 1.922; CI: 0.993, 3.722; p-value: 0.050]. There was a significant association between antenatal visit coverage and the first episode of acute malnutrition [COR=2.104; CI: 1.252, 3.535; p-value: 0.005]. There was a significant association between antenatal visit coverage (Antenatal care less than eight times from any

provider) and acute malnutrition relapse after treatment [COR=2.422; CI:1.438, 4.080; p-value: 0.001].

4.9. Crude Association between Household Factors and Acute Malnutrition Among Children

4.9.1. Household Socio-economic Determinants

There was a significant association between household food insecurity and acute malnutrition, first episode of acute malnutrition, and acute malnutrition relapse after treatment [COR=3.984; CI: 2.328, 6.816; p-value: <0.001], [COR=1.680; CI: 0.990, 2.852; p-value: 0.050], and [COR=2.447; CI: 1.415, 4.233; p-value: 0.001], respectively as shown in Appendix X.

There was a significant association between household socioeconomic status (Living below the poverty line) and acute malnutrition relapse after treatment [COR=2.447; CI: 1.415, 4.233; p-value: 0.001]. There was also a significant association between household socioeconomic status and acute malnutrition [COR=2.617; CI: 1.439, 4.759; p-value: 0.002]. However, there was no association between household socioeconomic status and the first episode of acute malnutrition [COR=0.880; CI: 0.5111, 1.517; p-value: 0.646].

There was an association between the wealth quintile (Bottom wealth quintile) and acute malnutrition and relapse [COR=3.070; CI: 1.757, 5.365; p-value: <0.001], and [COR=3.420; CI: 2.012, 5.823; p-value: <0.001], respectively. However, there was no association between the wealth quintile and the first episode of acute malnutrition [COR=0.850; CI: 508, 1.427; p-value: 0.541].

There was a significant association between biological parents (One biological parent) and the first episode of acute malnutrition [COR=2.703; CI:1.478, 4.943; p-value: 0.001]. There was also a significant association between biological parents and acute malnutrition relapse after treatment [COR=0.474; CI: 0.236, 0.953; p-value: 0.036]. There was an association between decision on income usage (Women NOT Involvement in Decision Making) and relapse in acute malnutrition after treatment [COR=1.913; CI: 1.141, 3.210; p-value: 0.014].

4.9.2. Environmental Health and Sanitation Factors

There was a significant association between access to drinking water (NO basic drinking water services) and the first episode of acute malnutrition and acute malnutrition [COR= 2.64; CI: 1.560, 4.465; p-value: <0.001], and [COR= 2.375; CI: 1.350, 4.181; p-value: 0.003], respectively as shown in appendix X. However, there was no association between access to drinking water and acute malnutrition relapse after treatment [COR=0.844; CI:0.497, 1.435; p-value: 0.532].

There was an association between effective water treatment methods (Households NOT effectively treating their drinking water) and acute malnutrition [COR=1.822; CI:1.087, 3.052; p-value: 0.023]. However, there was no association between effective water treatment methods and the first episode of acute malnutrition and acute malnutrition relapse after treatment [COR=1.358; CI:0.804, 2.295; p-value: 0.253], and [COR=1.358; CI:0.804, 2.295; p-value: 0.253], respectively.

There was a significant association between hand-washing practice in designated hand-washing places (No good hand-washing practice in the designated hand-washing place) and relapse in acute malnutrition [COR=2.025; CI: 1.209, 3.393; p-value: 0.007].

However, there was no association between hand-washing practices in designated hand-washing places and the first episode of acute malnutrition [COR=1.538; CI: 0.922, 2.567; p-value: 0.099]. There was a significant association between improved sanitation facilities (Households NOT using basic sanitation services) and acute malnutrition [COR=2.094; CI: 1.119, 3.919; p-value: 0.021]. However, there was no association between improved sanitation facilities and the first episode of acute malnutrition and relapse [COR=3.602; CI: 0.436, 29.743; p-value: 0.234], and [COR=3.602; CI: 0.436, 29.743; p-value: 0.234], respectively.

4.10. Adjusted Logistic Regression Model on Associations between the Child, Maternal, and Household Factors and Acute Malnutrition

Statistically significant factors from the crude association were included in the multi-variate analysis (logistic regression). Multicollinearity was checked and some variable dropped as well. The significant predictors of acute malnutrition include food security, handwashing practices, average income, antenatal care coverage, child diarrhoea, early initiation of breastfeeding, birthweight, and exclusive breastfeeding. However, the insignificant predictors include wealth quintile, basic sanitation, solid wastes disposal, maternal education level, and maternal nutrition status as shown in Table 3.

Food insecurity was a significant predictor of acute malnutrition among children. Children from households that were food insecure were more likely to have a normal nutrition status [AOR=2.528; CI:1.138, 5.614; p-value: 0.023] as shown in Table 11. Handwashing practices (No good hand-washing practice in the designated hand-washing place) and average income (<Ksh.10,000(Low average income) were significant predictors of acute

malnutrition [AOR=0.334; CI:0.116, 0.966; p-value: 0.043], and [AOR=2.612; CI:1.005, 6.788; p-value: 0.049], respectively.

Women's antenatal care visit was a significant predictor of acute malnutrition among children. Children whose mothers attended at least four antenatal care visits during pregnancy were 4.422 times more likely to have a normal nutrition status [AOR=4.422; CI:1.949, 7.065; p-value: <0.001].

Diarrhoea among children was a significant predictor of acute malnutrition. Children without diarrhoea were 2.838 times more likely to have a normal nutrition status [AOR=2.838; CI:1.140, 7.065; p-value: 0.025]. The initiation of breastfeeding was a significant predictor of acute malnutrition. The children who had early initiation to breastfeeding were 4.044 times more likely to have a normal nutrition status compared to children who had late initiation [AOR=4.044; CI:1.309, 12.494; p-value: 0.015]. Children's birth weight was also a significant predictor of acute malnutrition. The children who had a normal birthweight were 2.876 times more likely to have a normal nutrition status compared to children who had a low birthweight [AOR=2.876; CI:1.205, 6.865; p-value: 0.017].

Table 3: Adjusted Associations between the Child, Maternal, and Household Factors and Acute Malnutrition

Acute Malnutrition	AOR	St.Err.	p-value	[95% Conf	Interval]	Sig
Food Security	2.528	1.029	.023	1.138	5.614	*
Socio-economic status	1.878	.781	.130	.831	4.243	
Wealth quintile	1.713	.672	.170	.794	3.696	
Access to Drinking water	.831	.342	.652	.370	1.863	
Water treatment	.993	.370	.986	.478	2.063	
Hand washing practice	.334	.181	.043	.116	.966	*
Basic sanitation	.535	.512	.513	.082	3.486	
Solid waste disposal	1.215	.523	.651	.523	2.823	
Education level	.723	.358	.513	.273	1.910	
Maternal nutrition	2.383	2.207	.348	.388	14.636	
Average income	2.612	1.273	.049	1.005	6.788	*
Antenatal care coverage	4.422	1.848	.000	1.949	10.033	***
Maternal age	1.127	.465	.772	.502	2.530	
Child diarrhoea	2.838	1.321	.025	1.14	7.065	*
Child hospitalization	2.234	.957	.061	.965	5.172	
Minimum dietary diversity	.919	.367	.832	.420	2.009	
Early initiation of breastfeeding	4.044	2.327	.015	1.309	12.494	*
Birthweight	2.876	1.277	.017	1.205	6.865	*
Exclusive breastfeeding	.758	.336	.532	.318	1.808	
Constant	.002	.003	.000	.000	.025	***

**** p<.001, ** p<.01, * p<.05*

4.11. Adjusted Associations between Child, Maternal, and Household Factors and the First Episode of Acute Malnutrition

Statistically significant factors from the crude association were included in the multi-variate analysis (logistic regression). Multicollinearity was checked and some variable dropped as well. The significant predictors to the first episode of acute malnutrition include access to drinking water, child diarrhoea, child hospitalization, child age, and biological parents. The insignificant predictors were food security, postpartum depression, average income, antenatal visit coverage, child hospitalization, and birthweight as shown in Table 4. Access to drinking water was a significant predictor of the first episode of acute malnutrition. Households that had access to safe drinking water were 2.142 times more likely not to have the first episode of acute malnutrition [AOR=2.142; CI:1.062, 4.318; p-value: 0.033].

Child diarrhoea was a significant predictor of the first episode of acute malnutrition. Children without diarrhoea were 2.214 times more likely not to have the first episode of acute malnutrition. The child's age was a significant predictor of the first episode of acute malnutrition. Children who were two years and above were 0.429 times more likely not to have the first episode of acute malnutrition [AOR=0.442; CI: 0.229, 0.804; p-value < 0.05]. The child's age and number of biological parents were significant predictors of the first episode of acute malnutrition [AOR=0.443; CI: 0.235, 0.835; p-value: 0.012], and [AOR=2.165; CI: 1.157, 3.502; p-value: 0.830], respectively.

Food security, average income, and childbirth weight were not predictors of the first episode of acute malnutrition [AOR=0.825; CI: 0.421, 1.618; p-value: 0.576], [AOR=1.100; CI: 0.493, 2.455; p-value: 0.815], and [AOR=1.838; CI: 0.965, 3.503; p-

value: 0.064], respectively. The Chank test comparing the model with interaction terms and the one without interaction terms showed that the interaction terms were insignificant (p-value: 0.343). ***(Appendix I and II).***

Table 4:Adjusted Associations between Child, Maternal, and Household Factors and the First Episode of Acute Malnutrition

First episode of acute malnutrition	AOR	St. Err.	p-value	[95% Conf	Interval]	Sig
Food security	.825	.283	.576	.421	1.618	
Access to drinking water	2.142	.766	.033	1.062	4.318	*
Postpartum depression	1.551	.753	.366	.599	4.016	
Average income	1.1	.45	.815	.493	2.455	
Antenatal visit coverage	1.581	.485	.135	.867	2.883	
Child diarrhoea	2.214	.723	.015	1.168	4.198	*
Child hospitalization	1.475	.485	.237	.774	2.81	
Child's age	.443	.143	.012	.235	.835	*
Birthweight	1.838	.605	.064	.965	3.503	
Biological parents	2.328	.83	.018	1.157	4.682	*
Constant	.165	.084	.000	.061	.445	***

Mean dependent var	0.667	SD dependent var	0.472
Pseudo r-squared	0.145	Number of obs	267
Chi-square	49.241	Prob > chi2	0.000
Akaike crit. (AIC)	312.658	Bayesian crit. (BIC)	352.117
Adjusted Odds Ratio (AOR)			

*** *p<.001, ** p<.01, * p<.05*

4.12. Adjusted Associations between Child, Maternal, and Household and Acute Malnutrition Relapse

Statistically significant factors from the crude association were included in the multi-variate analysis (logistic regression). Multicollinearity was checked and some variable dropped as well. Five factors were significant predictors of acute malnutrition relapse after treatment. They include food security, wealth quintile, handwashing practices, antenatal visit coverage, early initiation of breastfeeding, and biological parents. However, the insignificant predictors were socio-economic status, decision on income usage, education level, average income, maternal age, minimum dietary diversity, and exclusive breastfeeding as shown in Table 5.

Food security was a significant predictor of acute malnutrition relapse after treatment among children in Nairobi informal settlements [AOR=1.900; CI:0.909, 3.971; p-value: 0.008]. The wealth quintile was a significant predictor of acute malnutrition relapse after treatment. Households that were above the wealth quintile were 2.086 times more likely to have children who didn't relapse from acute malnutrition after treatment [AOR=2.086; CI:1.089, 3.996; p-value: 0.027]. Handwashing practices were a significant predictor of acute malnutrition relapse after treatment [AOR=0.352; CI: 0.139, 0.889; p-value: 0.027].

Antenatal visit coverage was a significant predictor of acute malnutrition relapse after treatment. Children whose mothers attended at least four antenatal care visits during pregnancy were 1.949 times more likely not to relapse from acute malnutrition after treatment [AOR=1.949; CI: 1.048, 3.652; p-value: 0.035].

Initiation of breastfeeding was a significant predictor of acute malnutrition relapse after treatment. Children who had early initiation of breastfeeding were 2.965 times more likely

not to relapse from acute malnutrition after treatment [AOR=2.965; CI: 1.386, 6.341; p-value: 0.005]. The number of biological parents was a significant predictor of acute malnutrition relapse after treatment [AOR=0.411; CI: 0.182, 0.930; p-value: 0.171].

Table 5: Adjusted Associations between Child, Maternal, and Household and Acute Malnutrition Relapse

Relapse	AOR	St.Err.	p-value	[95% Conf	Interval]	Sig
Food security	1.900	.715	.008	.909	3.971	**
Socio economic status	1.563	.524	.183	.810	3.017	
Wealth quintile	2.086	.692	.027	1.089	3.996	*
Hand washing practice	.352	.166	.027	.139	.889	*
Decision on income usage	1.190	.443	.639	.574	2.467	
Education level	1.732	.666	.153	.815	3.681	
Average income	1.423	.740	.498	.514	3.943	
Antenatal visit coverage	1.949	.617	.035	1.048	3.625	*
Maternal age	1.512	.517	.226	.774	2.954	
Minimum dietary diversity	1.556	.500	.169	.829	2.922	
Early initiation of breastfeeding	2.965	1.150	.005	1.386	6.341	***
Exclusive breastfeeding	1.404	.481	.322	.717	2.75	
Biological parents	.411	.171	.033	.182	.93	*
Constant	.316	.227	.109	.077	1.291	

Mean dependent var	0.667	SD dependent var	0.472
Pseudo r-squared	0.209	Number of obs	267
Chi-square	70.984	Prob > chi2	0.000
Akaike crit. (AIC)	296.915	Bayesian crit. (BIC)	347.136
Adjusted Odds Ratio (AOR)			

**** p<.001, ** p<.01, * p<.05*

Self and Inherent Social Stigma as a Contributor to Acute Malnutrition Relapse After Treatment

Qualitative findings established that social stigma was a major contributor to acute malnutrition relapse after treatment. Some parents get social stigma when their children become malnourished and therefore fear taking them to the hospital as reported by one primary caregiver.

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*"You know there are children who have this malnutrition and since children lose weight there are parents who feel ashamed when the child is suffering malnutrition and keep them at home instead of bringing them to the hospital".**CG6_Caregiver***

It was further noted that social stigma sometimes arises when the community perceives that the child is HIV positive. This perception makes the mother abscond from clinic visits, including for growth monitoring.

"In this community, once a child is seen eating Plumpy'nut most of them say the child is HIV positive and this contributes to this mother in absconding clinic visits, so it is upon me or any other CHV to go and tell this caregiver no, as far as this child is yours and you are after their development, don't listen to people

because you knew that your child is not HIV positive".

KII_CHV_8_Community health volunteer

Absentee Primary Caregivers

It came out from the interviews that; financial stability (low income) was not the only issue for relapse in acute malnutrition after treatment but the issue of absentee mothers who often have busy schedules was also a key contributor.

"Some mothers have money and food but lack the time to cook for the child, a child needs proper food according to the time schedule, and some parents are always busy going to work daily and therefor do not take care of their children as required". ***KII_CHV_Community Healthcare Volunteer***

Alcohol consumption within the informal settlements was also reported as one contributor to the mothers spending a lot of time in alcohol dens and not taking care of their children

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"Even if we give them the feeds we give here, they don't have time to feed the child when the mother comes home, she is drunk there is nothing we can do; it is like we are repeating the same cases, there is nothing we can do even though we feel sorry for the child, the parent is not responsible. You know for me I am here in the hospital once the day is over, I go home, tomorrow when we follow up during the clinic". ***KII_CHV_9_Community health volunteer***

The study also established that some mothers leave their children at daycare centres, however, some daycare centres may not take good care of the child as the mother would (Nampijja et al., 2023). The child ends up relapsing from acute malnutrition after treatment.

"The second factor is the lack of responsible care. You can find that if the mother leaves the baby at the baby's care together with food, the daycare person might not feed or encourage the baby to feed the way the mother does".

KII_CHV_2_Community health volunteer

Non-adherence to Treatment

It was reported that some caregivers fail to adhere to the treatment given by the healthcare provider which includes therapeutic and supplementary feeds, and nutritional education. This non-adherence later led to relapse after treatment.

"Some caregivers fail to adhere to the treatment and nutrition education given by the healthcare provider, they, therefore, relapse after being discharged".

KII_CHV_Community Health Volunteer

The study established that food insecurity within the households was a contributor to non-adherence to the treatment and instruction given by a healthcare provider.

"Also, you find that there is no food in the household, so the older children are the ones given plumpy nuts. We have had a case whereby we were giving a

mother plumply nuts and she ended up selling them to get money".

HP3_Healthcare provider

A healthcare provider reported that some mothers give incorrect contact addresses and locations which makes it difficult to do follow-ups when their children are having malnutrition. This therefore makes the children relapse.

"Some mothers provide incorrect contact numbers, which makes it difficult to follow up. Then, they don't come back to the facility on the given return date".

HP3_Healthcare provider

Socio-cultural Beliefs

The qualitative findings showed that some primary caregivers believe in traditional medicines other than the treatment given at the facility.

"A challenge that we may have is that there are some parents who maybe because of their cultural beliefs if they are given "dawa ya kienyeji" they can't give the supplement that we give into our facilities like they say they can't mix and that they prefer "kienyeji" ***KII_CHV_Community Health Volunteer***

Some participants highlighted that some mothers usually associate acute malnutrition with witchcraft and beliefs. Therefore, they become reluctant to address the underlying causes. This leads to relapse after initial treatment.

"By the way, such beliefs are there because, there is a mother I visited, and she complained her child is malnourished because of being thrown witchcraft on the eyes, stomach, and tongue. As a Kamba, I do not know such things but for them, they have such beliefs". ***KII_CHV_5_Community health volunteer***

"So, this mother, having been told it was the church, the naming, got confused and gave up bringing their children to the malnutrition clinic". ***KII_CHV_8_Community healthcare provider***

Diet Quality

It was reported that most caregivers give their children a diet that does not meet minimum dietary requirements and that causes the child to get malnutrition or relapse after treatment.

"The community focuses on the types of food cooked on the streets, such as 'Chapo Choma', which are not balanced in terms of diet. Most people prefer to eat on the street instead of cooking". ***KII_CHV_Community health volunteer***

Understaffed Healthcare Facilities

The qualitative findings established that understaffing at healthcare facilities was a key contributor to acute malnutrition relapse after treatment. This will result in mothers getting inadequate information.

"Another thing when they visit the hospital may be the mothers being attended by one nutritionist are many and there are queues, so you find that the nutritionist will give them minimal information which could be a contributing factor". ***KII_CHV_12_Community health volunteer***

Community Factors

It was established that the community and systemic factors were key contributors to acute malnutrition relapse after treatment in the Nairobi informal settlement. The community and systemic factor reported was the demolition of the houses. This causes financial instability and access to health facilities.

"A lot of house demolitions are happening, which compels the parents to vacate, affecting their financial status". ***HP3_Healthcare provider***

4.13. Neurodevelopment Outcomes Among Children

Neurodevelopment was assessed across four key domains: fine motor skills, gross motor skills, social skills, and language. Cognitive development was evaluated indirectly through tasks embedded within the motor and language domains. For each domain, assessment items were scored as either "pass" or "fail". When a child did not cooperate during assessment, the outcome was recorded as "unknown." Each domain had a predefined cut-off score based on age-specific expectations, and a child was considered to have achieved the developmental milestone if their score exceeded the cut-off. However, if a child failed

two or more items in any domain at an age when at least 90% of a reference population was expected to pass, they were considered to have failed in that domain.

As presented in Table 6, the overall proportion of children with poor neurodevelopmental outcomes was 44.57% (n=119), while 55.43% (n=148) had normal neurodevelopment. Among children under five who had never experienced acute malnutrition, 37.08% (n=33) showed poor neurodevelopment. For those with a first episode of acute malnutrition, the proportion was 42.70% (n=38). Notably, children who experienced relapse of acute malnutrition after treatment had the highest proportion of poor neurodevelopmental outcomes at 53.93% (n=48).

Table 6: Neurodevelopment Outcomes Among Children Under Five Years

	Poor Neurodevelopment n (%)	**Total n (%)**
Never suffered from acute malnutrition	33 (37.08)	89 (100)
First episode	38 (42.70)	89 (100)
Relapse	48 (53.93)	89 (100)
Total	**119 (44.57)**	**267 (100)**

4.14. Factors Associated with Neurodevelopmental Outcomes Among Children

Socio-demographic Factors

The proportion of primary caregivers with low education and children with poor neurodevelopmental outcomes was 23.53% (n=28) as shown in Table 7. The proportion of primary caregivers with low education levels and children with normal neurodevelopmental outcomes was 15.54% (n=23). The proportion of children less than two years old who had poor neurodevelopmental outcomes was 60.50% (n=72). The proportion of children less than two years old but had children with normal neurodevelopmental outcomes was 50.00% (n=74). The proportion of female children with poor neurodevelopmental outcomes was 49.57% (n=59), whereas the proportion who had normal neurodevelopmental outcomes was 55.41% (n=82). There was no association between maternal education level, maternal age, child's age, and gender and neurodevelopmental outcomes [COR=1.383; CI:0.775, 2.469; p-value: 0.273], [COR=1.009; CI:0.591, 1.723; p-value: 0.972], [COR=1.532; CI:0.940, 2.498; p-value: 0.087], and [COR=0.791; CI:0.488, 1.284; p-value: 0.344], respectively

Table 7: Associations between Socio-demographic Factors and Neurodevelopmental Outcomes Among Children

	Normal neurodevelopment n (%)	**Poor neurodevelopment n (%)**	**COR**	**95% CI**	**P-Value**
Education level					
High education level (Secondary and above)	125 (84.46))	91 (76.47)	1.383	0.775, 2.469	0.273
Low education level (Below secondary level)	23 (15.54)	28 (23.53)			
Total	**148 (100))**	**119 (100)**			
Maternal age					
25 years and above	93 (62.84)	69 (57.98)	1.009	0.591, 1.723	0.972
Less than 25 years	55 (37.16)	50 (42.02)			
Total	**148 (100)**	**119 (100)**			
Child's age					
2 years and above	74 (50.00)	47 (39.50)	1.532	0.940, 2.498	0.087
Less than 2 years	74 (50.00)	72 (60.50)			
Total	**148 (100)**	**119 (100)**			
Gender					
Male	66 (44.59)	60 (50.42)	0.791	0.488, 1.284	0.344
Female	82 (55.41)	59 (49.57)			
Total	**148 (100)**	**119 (100)**			

COR Crude Odds Ratio **CI** Confidence Interval

**** p<.001, ** p<.01, * p<.05*

4.15. Child, Maternal and Household Factors

4.15.1. Child Factors

Health and Morbidity Factors.

The proportion of children who experienced their first episode of acute malnutrition and subsequently exhibited poor neurodevelopmental outcomes was 31.93% (n=38). In contrast, 34.46% (n=51) of children with a first episode of acute malnutrition demonstrated normal neurodevelopmental outcomes, as presented in appendix XI. Among children who experienced a relapse of acute malnutrition after treatment, 40.33% (n=48) had poor neurodevelopmental outcomes, while 27.70% (n=41) maintained normal neurodevelopmental outcomes.

In terms of birthweight, 30.25% (n=36) of children with low birthweight had poor neurodevelopmental outcomes, whereas 28.38% (n=42) of low birthweight children exhibited normal neurodevelopmental outcomes.

A statistically significant association was observed between acute malnutrition relapse after treatment and neurodevelopmental outcomes (COR = 1.764; 95% CI: 1.056,2.949; p-value: 0.030). However, there was no significant association between a first episode of acute malnutrition and neurodevelopmental outcomes (COR = 0.892; 95% CI: 0.534, 1.491; p-value: 0.663). Additionally, child maturity was significantly associated with neurodevelopmental outcomes (COR = 3.750; 95% CI: 1.596, 8.811; p-value :0.002), while birthweight showed no significant association (COR = 1.094; 95% CI: 0.644, 1.859; p-value: 0.738).

Child Feeding Factors.

The proportion of children who did not meet the minimum dietary diversity and exhibited poor neurodevelopmental outcomes was 43.70% (n=52), as presented in appendix XI. Meanwhile, 30.41% (n=45) of children who failed to meet minimum dietary diversity standards demonstrated normal neurodevelopmental outcomes. Among children who were not exclusively breastfed, 45.38% (n=54) had poor neurodevelopmental outcomes, whereas 25.68% (n=38) showed normal neurodevelopmental outcomes.

Statistical analysis revealed a significant association between dietary diversity (Children who didn't reach the MDD) and neurodevelopmental outcomes (COR = 1.776; 95% CI: 1.073,2.940; p-value: 0.025), as well as between exclusive breastfeeding (No exclusive breastfeeding) and neurodevelopmental outcomes (COR = 2.404; 95% CI: 1.435,4.029; p-value: 0.001). Furthermore, there was a significant relationship between the timing of breastfeeding initiation (Late initiation) and neurodevelopmental outcomes (COR = 2.157; 95% CI: 1.152, 4.039; p-value: 0.016).

4.15.2. Maternal Factors

Maternal Health Factors.

The proportion of primary caregivers who were malnourished and had children with poor neurodevelopmental outcomes was 9.24% (=11), as shown in appendix XI. The proportion of the primary caregivers with normal nutrition status but with children with poor neurodevelopmental outcomes was 90.76% (n=108).

The proportion of primary caregivers who had postpartum depression and had children with poor neurodevelopmental outcomes was 31.93% (n=38). The proportion of the

primary caregivers who didn't have postpartum depression but had children with poor neurodevelopmental outcomes was 68.07% (n=81).

There was a significant association between both maternal nutrition status (Malnourished) and postpartum depression [COR=2.410; CI:0.864, 6.723; p-value: 0.093], and [COR=3.615; CI:1.915, 6.825; p-value: < 0.001], respectively.

4.15.3. Household Factors

Household Socio-economic Determinants.

The proportion of households that were food insecure and had children with poor neurodevelopmental outcomes was 64.71 (n=77) as shown in appendix XI. In contrast, the proportion of households that were food secure but had children with poor neurodevelopmental outcomes was 35.29% (n=42). There was a significant association between food insecurity and neurodevelopmental outcomes [COR=1.645; CI:1.002, 2.700; p-value: 0.040].

4.16. Logistic Regression of Factors Associated with Neurodevelopmental Outcomes Among Children in Nairobi Informal Settlements

Statistically significant factors from the crude association were included in the multi-variate analysis (logistic regression). Multicollinearity was checked and some variable dropped as well.

Acute malnutrition relapse after treatment was a significant predictor of neurodevelopment outcomes. Children who had either never relapsed from acute malnutrition after treatment or had normal nutrition status were 2.082 times more likely to have normal neurodevelopmental outcomes compared to children who had relapsed after treatment [AOR=2.082; CI:1.113, 3.895; p-value: 0.022] as shown in Table 8. The first episode of acute malnutrition was not a predictor of neurodevelopmental outcomes [AOR=1.058; CI:0.558, 2.006; p-value: 0.862]. Other significant predictors of neurodevelopment outcomes among children under 5 years in Nairobi informal settlements were maternal postpartum depression and child maturity at birth (either term or preterm).

Postpartum depression was a significant predictor of neurodevelopment outcomes. Children whose mothers did not having postpartum depression were 3.618 times more likely to have normal neurodevelopmental outcomes [AOR=3.618; CI:1.86, 7.038; p-value:<0.001]. Children's maturity at birth was a significant predictor of neurodevelopmental outcomes. Term babies were 2.930 times more likely to have normal neurodevelopmental outcomes compared to preterm babies [AOR=2.930; CI:1.205, 7.123; p-value: 0.018].

Table 8: Multivariate Logistic Regression of Factors Associated with Neurodevelopmental Outcomes Among Children

Neurodevelopment	AOR	St.Err.	p-value	[95% Conf	Interval]	Sig
First episode	1.058	.345	.862	.558	2.006	
Relapse	2.082	.665	.022	1.113	3.895	*
Postpartum depression	3.618	1.228	.000	1.860	7.038	***
Child maturity	2.93	1.328	.018	1.205	7.123	*
Constant	.101	.061	.000	.031	.331	***

Mean dependent var	0.554	SD dependent var	0.498
Pseudo r-squared	0.083	Number of obs	267
Chi-square	30.448	Prob > chi2	0.000
Akaike crit. (AIC)	346.537	Bayesian crit. (BIC)	364.473

Adjusted Odds Ratio (AOR)

*** *p<.001, ** p<.01, * p<.05*

The qualitative findings further established that relapse in acute malnutrition after treatment affects children's neurodevelopmental outcomes. Such children often have delayed developmental milestones which include poor school performance.

*"He's just okay but when you compare him with other children you find that other children of his age are far ahead, but we just have hopes that one day we'll also get there".**CG10_Healthcare provider***

*"For school-going children that are malnourished when the child reaches the stage of studying their concentration goes down".**CG6_Caregiver***

It was reported that sanitation and diarrhoea, which usually cause relapse to have an association with neurodevelopmental outcomes. The mother's level of education also determines whether the child will have a normal neurodevelopment or not.

"The child will be affected because if the environment in which the child is raised has poor sanitation standards, it means the child will not grow due to exposure to more contamination that will lead to vomiting and diarrheal. Such an environment will hinder the child's development." ***CG10_Caregiver***

The study participants reported that breastmilk was very important for children's neurodevelopment.

"Yes, you find that a mother breastfeeding the child has to follow the nutritional guidelines provided on how she is supposed to breastfeed the child. If the mother does not breastfeed the child as recommended, the child usually develops other health effects because breastmilk is renowned for being the best for child growth, child development, and child behavior". ***KII_CHV_2_Community health volunteer***

CHAPTER 5: DISCUSSIONS

This study established the presence of acute malnutrition relapse in Nairobi's informal settlements. This shows that more than a quarter of children under five years are treated for MAM relapse. The United Nations prevalence threshold for this malnutrition rate is classified as medium (Johnson, 2016). Other studies, for example, those conducted in Ethiopia, indicated almost similar relapse rates to SAM, with a relapse of 9.6% and 10.1% (Lambebo et al., 2021; Teshale et al., 2023). However, another study done in the same country indicated that the SAM cases that relapsed were 6.6% (Yitayew et al., 2023). A study conducted in Malawi found a prevalence of acute malnutrition relapse after treatment at 41%, and in Burkina Faso, 15.40%. In a systematic review of LMICs, a prevalence of 27% was found, and in the United States, a prevalence of 27% was also reported (O'Sullivan et al., 2018). All these studies found a lower prevalence rate of acute malnutrition relapse after treatment. However, a study done in the Democratic Republic of Congo found a higher prevalence of acute malnutrition relapse after treatment at 44.20% (Grellety et al., 2017). The discrepancies in all these studies can be attributed to exposure variations in the populations. Our findings, alongside findings from previous studies, show that malnutrition relapse rates vary significantly between countries, with Malawi showing a much higher prevalence (41%) compared to Burkina Faso (15.4%). This suggests that country-specific factors and post-treatment support systems may strongly influence relapse outcomes.

The significant predictors of acute malnutrition relapse were food security, wealth quintile, good handwashing practices, decisions on small purchases, antenatal care coverage, and initiation of breastfeeding.

Both food insecurity and lower wealth quintile show that the households are classified as poor, a situation that can make children relapse after treatment. A study done in Ethiopia found similar results, where poor households were significantly associated with acute malnutrition relapse after treatment (Yitayew et al., 2023). Children from households that did not have good handwashing practices were more likely to relapse from acute malnutrition after treatment compared to children from households that practiced good handwashing. Additionally, children who were not initiated into breastfeeding within one hour after birth were more likely to relapse from acute malnutrition after treatment compared to children who were initiated into breastfeeding within one hour after birth. These two findings (good handwashing practices and initiation of breastfeeding) are in line with a study conducted in Ethiopia, which showed that children from households practicing good handwashing and those who had early initiation of breastfeeding did not relapse from acute malnutrition after treatment (Abitew et al., 2020).

Children whose mothers attended less than eight antenatal care visits during pregnancy were more likely to have acute malnutrition relapse after treatment compared to children whose mothers attended antenatal clinics more than four times during pregnancy. The results from our study also showed that children from households where mothers were not decision-makers on small household purchases were more likely to relapse from acute malnutrition after treatment compared to households where women were making decisions on small purchases. Small purchases include food in small quantities and medication. This is an interesting result as a previous study showed that children influence family purchasing decisions (Sharma et al., 2014). Therefore, community empowerment on decision-making among women is key to reducing acute malnutrition relapse after treatment.

The qualitative findings established that social stigma, non-adherence to treatment, and socio-cultural beliefs were key contributors to relapse in acute malnutrition after treatment. Social stigma and socio-cultural beliefs cause mothers not to take their children to the hospital for management. Non-adherence to treatment causes children to experience acute malnutrition relapse after treatment. These findings are not unique, as a similar study done in Nigeria showed that there was a relationship between socio-cultural beliefs and the resurgence of acute malnutrition (Nwoke, 2022).

We further found that children having acute malnutrition relapse after treatment had delayed neurodevelopmental outcomes compared to children experiencing their first episode of acute malnutrition. These children also had delayed neurodevelopmental outcomes compared to children with normal nutritional status. Previous studies have shown the adverse long-term effects of acute malnutrition on children's neurodevelopmental outcomes. Research shows that children who experience acute malnutrition are at a higher risk of delayed neurodevelopmental outcomes compared to their peers who either had no history of malnutrition or were well-nourished (Lelijveld et al., 2021). This is because acute malnutrition compromises critical periods of brain growth and synapse formation (Schaefer et al., 2021). Furthermore, the risk of acute malnutrition may prolong exposure to systemic inflammations, nutritional deficiencies, and psychosocial stress, which may hinder optimal neurodevelopment (Prado et al., 2019). Studies from sub-Saharan Africa and other low-resource settings consistently report the association between acute malnutrition relapse and neurodevelopmental outcomes, with the assumption that children experiencing their first episode of acute malnutrition have a similar neurodevelopmental trajectory to those having relapse. The findings of this study highlight the persistent burden of acute malnutrition in

Nairobi's informal settlements and underscore the critical need for sustained nutritional support beyond initial treatment. The observed delayed neurodevelopmental outcomes among children who experienced a malnutrition relapse suggest that current interventions may not be sufficient to support full recovery and long-term developmental progress.

We found that postpartum depression is a significant predictor of delayed neurodevelopmental outcomes in children under five. These findings are clearer compared to a previous study, which established that this association was non-linear and not clear (Severo et al., 2023). Therefore, postpartum depression among women should be managed effectively to prevent their children from experiencing poor neurodevelopmental outcomes. This study established that term babies were more likely to have normal neurodevelopmental outcomes compared to preterm babies. Similar studies found that neurodevelopmental outcomes improved in term babies compared to preterm babies (Hua et al., 2022). The studies further established that neurodevelopmental outcomes improved with rising gestational weeks (Hua et al., 2022).

We found a significant association between food security and neurodevelopmental outcomes. Earlier studies also support this finding. Previous studies showed that food insecurity has long-lasting effects on cognitive development and behavior (Gallegos et al., 2021). We established a significant association between socioeconomic status and neurodevelopmental outcomes. Earlier studies showed that low socioeconomic status was significantly associated with poor neurodevelopmental outcomes, particularly affecting language and cognitive domains (Han et al., 2024). We also found that there was a significant association between exclusive breastfeeding and neurodevelopmental outcomes. This finding aligns with an earlier study that showed exclusive breastfeeding

has a significant positive association with children's neurodevelopmental outcomes (Onyango et al., 2022). Another study also established that longer durations of breastfeeding, including exclusive breastfeeding, were positively associated with higher IQ, educational attainment, and income in adulthood (Alghamdi et al., 2021).

Children treated for acute malnutrition in Viwandani and Korogocho informal settlements experienced acute malnutrition relapse. The relapsed cases showed delayed neurodevelopmental outcomes compared to children who had not relapsed and those with normal nutritional status. Interventions aimed at improving neurodevelopmental outcomes among children with acute malnutrition should focus on preventing relapse cases.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

This study underscores the urgent need to address both the immediate and underlying causes of acute malnutrition relapse among children in informal settlements. Recurrent episodes of malnutrition not only compromise physical health but also place children at heightened risk for delayed neurodevelopmental outcomes. Strengthening household nutrition security, promoting maternal empowerment, and enhancing early child health interventions are essential strategies for breaking the cycle of relapse and supporting long-term child development.

Based on these findings, we recommend that interventions by the county, sub-county governments, and relevant organizations working towards reducing malnutrition and poor neurodevelopment to focus on improving post-treatment follow-up and support mechanisms to prevent relapse, with a particular emphasis on enhancing food security and socioeconomic conditions in vulnerable households. Strengthening maternal and child health services through comprehensive antenatal care, promoting early initiation of breastfeeding, and enforcing proper hygiene practices are also critical. Mothers with children who have experienced an episode of acute malnutrition should be target with intervention to prevent relapse. Finally, addressing socio-cultural barriers such as social stigma and empowering women in household decision-making, e.g., through health education to communities and caregivers, should be prioritized to create an enabling environment that supports sustained recovery and improved neurodevelopmental outcomes. We also recommend that future studies be longitudinal in nature. This will help in comparing the time it takes after relapse to start developing poor neurodevelopmental outcomes.

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APPENDIX I: Adjusted Associations between Child, Maternal, and Household and Acute Malnutrition Relapse After Treatment with Interaction Terms Included

Interaction terms introduced

1. Socio-economic status and food security

Relapse	AOR	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Wealth quintile	2.617	.825	3.05	.002	1.411	4.853	**
Hand washing practice	.41	.182	-2.01	.045	.171	.979	*
Decision on income usage	.927	.323	-0.22	.829	.468	1.837	
Antenatal visit coverage	1.815	.56	1.93	.053	.991	3.322	
Maternal age	1.229	.404	0.63	.531	.645	2.342	
Minimum dietary diversity	1.76	.552	1.80	.071	.952	3.256	
Early initiation of breastfeeding	2.828	1.065	2.76	.006	1.352	5.916	**
Exclusive breastfeeding	1.348	.449	0.90	.37	.702	2.591	
Biological parents	.419	.173	-2.11	.035	.187	.94	*
Socio-economic status*Food security	1.726	.688	1.37	.171	.791	3.769	
Education level*Average income	3.298	1.831	2.15	.032	1.111	9.793	*
Constant	.654	.441	-0.63	.529	.175	2.45	

Mean dependent var	0.667	SD dependent var	0.472
Pseudo r-squared	0.203	Number of obs	267
Chi-square	68.844	Prob > chi2	0.000
Akaike crit. (AIC)	295.055	Bayesian crit. (BIC)	338.102
Adjusted Odds Ratio (AOR)			

*** *p<.001*, ** *p<.01*, * *p<.05*

2. Maternal education level and average income

APPENDIX II: Comparison between the Model without Interaction Terms (Reduced model) and the Model with Interaction Terms (Full model)

```
 LR chi2(2) =   2.14
Prob > chi2 = 0.3430
```

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
Full_model	267	-169.9493	-135.5273	12	295.0546	338.1016
Reduced_mo~l	267	-169.9493	-134.4573	14	296.9146	347.136

Note: BIC uses N = number of observations. See [R] BIC note.

Name	Command	Dependent variable	Number of param.	Title
Full_model	logistic	Relapse	12	*Logistic regression*
Reduced_mo~l	logistic	Relapse	14	*Logistic regression*

APPENDIX III: Operationalization of the Variables

Variable	Type of variable	Type of data	Scale of measurement
Child neurodevelopment	Dependent variable	Binary (Categorizing the scores, either pass or fail)	Nominal
Acute malnutrition relapse after treatment	Dependent variable (When assessing the predictors of acute malnutrition relapse after treatment	Binary	Nominal
Acute malnutrition relapse after treatment	Independent variable (When assessing predictors of poor neurodevelopmental outcomes	Binary	Nominal
Household Factors			
Economic and Financial Factors			
Household food security	Independent variable	Binary	Nominal
Socio-economic status	Independent variable	Nominal	Nominal
Wealth quintile	Independent variable	Nominal	Nominal
Number of biological parents	Independent variable	Binary	Nominal
Decision on income usage	Independent variable	Binary	Nominal
Urban farming	Independent variable	Binary	Nominal

Environmental health and sanitation factors			
Access to drinking water	Independent variable	Nominal	Nominal
Effective water treatment methods	Independent variable	Nominal	Nominal
Handwashing practices	Independent variable	Nominal	Nominal
Solid waste disposal	Independent variable	Nominal	Nominal
Sanitation facilities	Independent	Nominal	Nominal
Maternal Factors			
Education level	Independent variable	Ordinal	Ordinal
Age	Independent variable	Continuous	Ratio
Maternal nutrition status	Independent variable	Ordinal	Ordinal
Income	Independent variable	Continuous	Ratio
Antenatal Care Attendance	Independent	Binary	Nominal
Postpartum depression	Independent	Binary	Nominal
Child factors			
Demographic Factors			
Age	Independent variable	Continuous	Ratio
Gender	Independent variable	Binary	Nominal
Health and Morbidity Factors			
Birthweight	Independent variable	Continuous	Ratio
Length/height for age	Independent variable	Ordinal	Ordinal
Child hospitalization	Independent variable	Binary	Nominal

Child maturity at birth	Independent variable	Binary	Nominal
Nutritional factors and behavioural factors			
Dietary diversity	Independent variable	Binary	Nominal
Initiation of breastfeeding	Independent variable	Binary	Nominal
Exclusive Breastfeeding	Independent variable	Binary	Nominal

APPENDIX IV: Examples of Items Included in the MDAT

Developmental domain	Assessment method	What was assessed
Gross motor	Report from the parent	Pulls themself to stand, crawls
	Observing the child	The ability of the child to stand while holding onto something. Sits without being supported
	Direct assessment	Walks with the support of someone in both hands
Fine motor	Report from the parent	The child can transfer objects he/she is holding from one hand to another
	Observing/assessing the child	Imitates by putting stones in and out of a tin
Language skills	Report from the parent	Listens and understands when being cautioned e.g. when being cautioned to stop. Shakes either his/her head or hands to indicate he/she is saying "No".
	Observing the child	Makes words like sounds such as baba, tata, and mama (double syllable words) Says the other two worlds apart from the double-syllable words.
	Assessing the child directly	Follows commands correctly e.g. 'Give me the plate'

Developmental domain	Assessment method	What was assessed
Social skills	Report from the parent	The child indicates that they need to pee or poo
	Observing the child	Moves about in a cheerful way in response to playing with the mother
	Assessing the child	Independently drinks from a cup. Stretches hands to be picked

APPENDIX V: Child and maternal socio-demographic characteristics for the primary data

		Overall acute malnutrition	**First episode of acute malnutrition**	**Acute malnutrition relapse**
	Total n (%)	n (%)	n (%)	n (%)
Location				
Viwandani	134 (50.18%)	86 (48.31)	45 (50.56)	44 (49.44)
Korogocho	133 (49.82%)	92 (51.69)	44 (49.44)	45 (50.56)
Total	**267**	**178**	**89**	**89**
Gender				
Male	126 (47.19)	87 (48.88)	42 (47.19)	45 (50.56)
Female	141 (52.81)	91 (51.12)	47 (52.81)	44 (49.44)
Total	**267**	**178**	**89**	**89**
Child's Age				
≥ 2 years	121 (45.32)	83 (46.63)	48 (53.93)	35 (39.32)
< 2 years	146 (54.68)	95 (53.37)	41 (46.07)	53 (59.55)
Total	**267**	**178**	**89**	**89**
Gender				
Male	126 (47.19)	87 (48.88)	42 (47.19)	45 (50.56)
Female	141 (52.81)	91 (51.12)	47 (52.81)	44 (49.44)
Total	**267**	**178**	**89**	**89**
Maternal Age				
≥ 25 years	191 (71.54)	121 (67.98)	64 (50.56)	57 (52.81)
< 25 years	76 (28.46)	57 (32.02)	25 (49.44)	32 (47.19)
Total	**267**	**178**	**89**	**89**

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Average income				
≥ Ksh. 10,000 (High average income)	61(22.85)	23 (12.92)	14 (15.73)	9 (10.11)
< Ksh. 10,000 (Low average income)	206 (77.15)	155 (87.08)	75 (84.27)	80 (89.89)
Total	**267**	**178**	**89**	**89**
Education level				
High education level (Secondary and above)	208 (77.90)	132 (74.16)	72 (80.90)	60 (67.42)
Low education level (Below secondary level)	59 (22.10)	46 (25.84)	17 (19.10)	29 (32.58)
Total	**267**	**178**	**89**	**89**

APPENDIX VI: Description of the Child's Factors and Acute Malnutrition Status

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total (%)	**n (%)**	**n (%)**	**n (%)**
Diarrhoea Among Children				
No diarrhoea	197 (73.78)	118 (66.29)	52 (58.43)	66 (74.15)
Diarrhoea	70 (26.22)	60 (33.71)	37 (41.57)	23 (25.84)
Total	**267**	**178**	**89**	**89**
Child Hospitalization				
NOT Hospitalized	192 (71.91)	116 (65.17)	55 (61.80)	61 (68.54)
Hospitalized	75 (28.09)	62 (34.83)	34 (38.20)	28 (31.46)
Total	**267**	**178**	**89**	**89**
Child Maturity status at birth				
Term ((Born after 37 weeks)	238 (89.14)	156 (87.64)	78 (88.31)	78 (85.71)
Preterm (Born before 37 weeks)	29 (10.86)	22 (12.36)	11 (11.69)	11 (14.29)
Total	**267**	**178**	**89**	**89**
Birth weight				
Normal birth weight (≥2,500 grams)	189 (70.79)	110 (61.80)	53 (59.55)	57 (60.04)
Low birth weight (< 2,500 grams)	78 (29.21)	6 (38.20)	36 (40.45)	3(35.96)
Total	**267**	**178**	**89**	**89**

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Dietary Diversity				
Children who reached MDD	170 (63.67)	104 (58.43)	59 (66.29)	45 (50.56)
Children who didn't reach the MDD	97 (36.33)	74 (41.57)	30 (33.71)	44 (49.44)
Total	**267**	**178**	**89**	**89**
Initiation of Breastfeeding				
Early Initiation of Breastfeeding (Within an hour)	217 (81.27)	134 (75.28)	74 (83.15)	60 (67.42)
Late Initiation of Breastfeeding (More than one hour)	50 (18.73)	44 (24.72)	15 (16.85)	29 (32.58)
Total	**267**	**178**	**89**	**89**
Exclusive Breastfeeding				
Exclusive Breastfeed (6 months with only breastmilk)	175 (65.54)	104 (58.43)	59 (66.29)	45 (50.56)
Not exclusively breastfed	92 (34.46)	74 (41.57)	30 (33.71)	44 (49.44)
Total	**267**	**178**	**89**	**89**

APPENDIX VII: Description of Household Factors by Acute Malnutrition Status

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Food security				
Food secure households	112 (41.95)	55 (30.90)	30(33.71)	25 (28.09)
Food insecure households	155 (58.05)	123 (69.10)	59 (66.29)	64 (71.91)
Total	**267**	**178**	**89**	**89**
Socio-economic status				
Living above the poverty line	178 (66.67)	107 (60.11)	61 (68.54)	46 (51.69)
Living below the poverty line	89 (33.33)	71 (39.89)	28 (31.46)	43 (48.31)
Total	**267**	**178**	**89**	**89**
Wealth quintile				
Top wealth quintile	152 (56.93)	86 (48.31)	54 (60.67)	33 (37.08)
Bottom wealth quintile	115 (43.07)	92 (51.69)	35 (39.32)	56 (62.92)
Total	**267**	**178**	**89**	**89**
Decision on income usage				
Woman's Involvement in Decision Making	160 (59.93)	100 (56.18)	60 (49.43)	44 (49.43)
Women NOT Involvement in Decision Making	107 (40.07)	78 (43.82)	29 (50.56)	45 (50.56)
Total	**267**	**178**	**89**	**89**
Urban farming				
Urban farming	41 (15.36)	24 (13.48)	10 (11.24)	14 (15.73)
No urban farming	226 (84.64)	154 (86.52)	79 (88.76)	75 (84.27)
Total	**267**	**178**	**89**	**89**

		Overall acute malnutrition	First episode of acute malnutrition	Acute malnutrition relapse
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Number of biological parents				
Two biological parents	211 (79.03)	137 (76.97)	74 (83.15)	77 (86.12)
One biological parent	56 (20.97)	41 (23.03)	15 (16.85)	12 (13.48)
Total	**267**	**178**	**89**	**89**
Access to drinking water				
Basic drinking water services	167 (62.65)	100 (56.18)	42 (47.19)	58 (65.17)
NO basic drinking water services	100 (37.45)	78 (43.82)	47 (52.81)	31 (34.83)
Total	**267**	**178**	**89**	**89**
Effective water treatment methods				
Households effectively treating their drinking water	109 (40.82)	64 (35.96)	32 (35.96)	32 (35.96)
Households NOT effectively treating their drinking water	158 (59.18)	114 (64.04)	57 (64.04)	57 (64.04)
Total	**267**	**178**	**89**	**89**
Solid waste disposal				
Households that safely dispose of their solid waste	195 (73.03)	122 (68.54)	61 (68.54)	61 (68.54)
Households that didn't safely dispose of their solid waste	72 (26.97)	56 (31.46)	28 (31.46)	28 (31.46)
Total	**267**	**178**	**89**	**89**
Good hand-washing practice in the designated hand-washing place				
Good hand-washing practice in the designated hand-washing place	148 (55.43)	82 (46.07)	43 (48.31)	39 (58.43)

No good hand-washing practice in the designated hand-washing place	119 (44.57)	96 (53.93)	46 (51.69)	50 (41.57)
Total	**267**	**178**	**89**	**89**
		Overall acute malnutrition	**First episode of acute malnutrition**	**Acute malnutrition relapse**
	Total n (%)	**n (%)**	**n (%)**	**n (%)**
Improved sanitation facility				
Households using basic sanitation services	8 (3.00)	2 (1.12)	1 (1.12)	1 (1.12)
Households NOT using basic sanitation services	259 (97.00)	176 (98.88)	88 (98.88)	88 (98.88)
Total	**267**	**178**	**89**	**89**

APPENDIX VIII: Crude Associations Between Child Factors and Acute Malnutrition

	Acute malnutrition		**First episode of acute malnutrition**		**Acute malnutrition relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Gender *Male* *Female*	0.815 (0.489 1.361)	0.436	1.000 (0.601, 1.665)	1.000	0.816 (0.490, 1.359)	0.436
Age *≥ 2 years* *< 2 years*	0.853 (0.5106, 1.424)	0.543	0.593 (0.356, 0.992)	0.040*	1.442 (0.860, 2.419)	0.165
Diarrhoea Among Children *No diarrhoea* *Diarrhoea*	4.016 (1.941, 8.315)	<0.001***	3.120 (1.775, 5.508)	<0.001***	0.970 (0.544, 1.735)	0.922
Child Hospitalization *NOT Hospitalized* *Hospitalized*	3.124 (1.608, 6.071)	0.001**	2.065 (1.190,3.587)	0.010*	1.279 (0.732, 2.235)	0.387
Child Maturity Status at Birth *Term ((Born after 37 weeks)* *Preterm (Born before 37 weeks)*	1.652 (1.608, 6.071)	0.270	1.254 (1.190, 3.587)	0.579	1.254 (0.732, 2.235)	0.579
Birth Weight	4.883	<0.001***	2.199	<0.001***	1.611	0.088

Normal birth weight (≥2,500 grams) *Low birth weight (< 2,500 grams)*	(2.368, 10.073)		(1.273, 3.800)		(0.932, 2.786)	
	Acute malnutrition		**First episode of acute malnutrition**		**Acute malnutrition relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Dietary Diversity *Children who reached MDD* *Children who didn't reach the MDD*	2.042 (1.166, 3.576)	0.013*	0.842 (0.494, 1.437)	0.529	2.306 (1.364, 3.900)	0.002**
Initiation of Breastfeeding *Early Initiation of Breastfeeding (Within an hour)* *Late Initiation of Breastfeeding (More than one hour)*	4.542 (1.854, 11.126)	0.001**	0.828 (0.425, 1.613)	0.579	3.613 (1.914, 6.822)	<0.001***
Exclusive Breastfeeding *(6 months with only breastmilk)*	2.807 (1.545, 5.099)	0.001**	0.951 (0.556, 1.627)	0.855	2.649 (1.557, 4.505)	<0.001***
COR Crude Odds Ratio **CI** Confidence Interval **** p<.001, ** p<.01, * p<.05*						

APPENDIX IX: Crude Association between Maternal Factors and Acute Malnutrition Among Children

	Acute malnutrition		**First episode of acute malnutrition**		**Acute malnutrition relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Postpartum depression *No postpartum depression* *Postpartum depression*	1.280 0.670, 2.445)	0.455	2.120 (1.157, 3.886)	0.015*	0.550 (0.280, 1.096)	0.090
Education level *High education level (Secondary and above)* *Low education level (Below secondary level*	2.037 (1.035, 4.010)	0.039*	0.765 (0.407, 1.438)	0.405	2.384 (1.319, 4.310)	0.004**
Maternal nutrition status *Normal Nutrition Status* *Malnourished*	4.003 (0.895, 17.908)	0.040*	1.855 (0.690, 4.984)	0.221	1.430 (0.527 3.904)	0.480
Average income *≥Ksh.10,000(High average income)* *<Ksh.10,000(Low average income)*	5.021 (2.737, 9.212)	<0.001***	1.922 (0.993, 3.722)	0.050*	3.668 (1.714, 7.852)	0.001**
Antenatal visit coverage *Antenatal care at least eight times from any provider*	7.180 (3.653, 14.113)	<0.001***	2.104 (1.252, 3.535)	0.005 **	2.422 (1.438, 4.080)	0.001**

Antenatal care less than eight times from any provider						
	Acute malnutrition		**First episode of acute malnutrition**		**Acute malnutrition relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Maternal age *≥ 25 years* *< 25 years*	1.736 (0.956, 3.152)	0.070*	0.973 (0.553, 1.7115)	0.924	1.710 (0.986, 2.966)	0.050*
COR Crude Odds Ratio **CI** Confidence Interval **** p<.001, ** p<.01, * p<.05*						

APPENDIX X: Crude Association between Household Factors and Acute Malnutrition Status Among Children

	Acute malnutrition		**First episode of acute malnutrition**		**Acute malnutrition relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Food security *Food secure households* *Food insecure households*	3.984 (2.328, 6.816)	<0.001***	1.680 (0.990 2.852)	0.050*	2.447 (1.415, 4.233)	0.001 **
Socio-economic status *Living above the poverty line* *Living below the poverty line*	2.617 (1.439, 4.759)	0.002**	0.880 (0.511, 1.517)	0.646	2.680 (1.572, 4.577)	<0.001***
Wealth quintile *Top wealth quintile* *Bottom wealth quintile*	3.070 (1.757, 5.365)	<0.001***	0.850 (0.508, 1.427)	0.541	3.420 (2.012, 5.823)	<0.001***
Urban farming *Urban farming* *No urban farming*	1.515 (0.766, 2.995)	0.232	1.666 (0.776, 3.575)	0.190	0.958 (0.475, 1.934)	0.904
Biological parents *Two biological parents* *One biological parent*	1.476 (0.766, 2.844)	0.244	2.703 (1.478, 4.943)	0.001 **	0.475 (0.236, 0.953)	0.036*

Decision on income usage *Woman's Involvement in Decision Making* *Women NOT Involvement in Decision Making*	1.614 (0.947, 2.750)	0.078	0.828 (0.491, 1.398)	0.480	1.913 (1.141, 3.210)	0.014*
	Acute malnutrition		**First episode**		**Relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Access to drinking water *Basic drinking water services* *NO basic drinking water services*	2.375 (1.350, 4.181)	0.003 **	2.645 (1.560, 4.465)	<0.001***	0.844 (0.497, 1.435)	0.532
Effective water treatment methods *Households effectively treating their drinking water* *Households NOT effectively treating their drinking water*	1.822 (1.087, 3.052)	0.023 *	1.358 (0.804, 2.295)	0.253	1.358 (0.804, 2.295)	0.253
Good hand washing practice in designated hand	3.359 (1.922, 5.873)	<0.001***	1.539 (0.922, 2.567)	0.099	2.025 (1.209, 3.393)	0.007**

washing place *Good hand-washing practice in the designated hand-washing place* *No good hand-washing practice in the designated hand-washing place*						
	Acute malnutrition		**First episode**		**Relapse**	
	COR (95% CI)	**Sig[1]**	**COR (95% CI)**	**Sig[1]**	**COR (95% CI)**	**Sig[1]**
Improved sanitation facility *Households using basic sanitation services* *Households NOT using basic sanitation services*	6.361 (1.257, 32.191)	0.025 *	3.602 (0.436, 29.743)	0.234	3.602 (0.436, 29.743)	0.234
Solid waste disposal *Households that safely dispose of their solid waste* *Households that didn't safely dispose of their solid waste*	2.094 (1.119, 3.919)	0.021*	1.398 (0.797, 2.453)	0.243	1.398 (0.797, 2.453)	0.243
COR Crude Odds Ratio **CI** Confidence Interval *** *p<.001, ** p<.01, * p<.05*						

APPENDIX XI: Association between Child, Maternal, and Household Factors and Neurodevelopmental Outcomes

	Normal neurodevelopment n (%)	**Poor neurodevelopment n (%)**	**COR**	**95% CI**	**P-Value**
First episode					
Non-first episode	97 (65.54)	81 (68.07)	0 .892	0.534, 1.491	0.663
First episode	51 (34.46)	38 (31.93)			
Total	**148 (100)**	**119 (100)**			
Acute malnutrition relapse					
No relapse	107 (72.30)	71 (59.66)	1.764	1.056, 2.949	0.030*
Relapse	41 (27.70)	48 (40.33))			
Total	**148 (100)**	**119 (100)**			
Birthweight					
Normal birth weight (≥2,500 grams)	106 (71.62)	83 (69.75)	1.095	0.644, 1.859	0.738
Low birth weight (< 2,500 grams)	42 (28.38)	36 (30.25)			
Total	**148 (100)**	**119 (100)**			
Child maturity at birth					
Term ((Born after 37 weeks)	140 (94.59)	98 (82.35)	3.750	1.596, 8.811	0.002 **
Preterm (Born before 37 weeks)	8 (5.41)	21 (17.65)			
Total	**148 (100)**	**119 (100)**			
Diet diversity					
Children who reached MDD	103 (69.59)	67 (56.30)	1.776	1.073, 2.940	0.025 *

Children who didn't reach the MDD	45 (30.41)	52 (43.70)			
	Normal neurodevelopment n (%)	**Poor neurodevelopment n (%)**	**COR**	**95% CI**	**P-Value**
Total	**148 (100)**	**119 (100)**			
Exclusive breastfeeding					
Exclusive Breastfeed *(6months with only breastmilk)*	110 (74.32)	65 (54.62)	2.405	1.435, 4.029	0.001**
No exclusive breastfeeding	38 (25.68)	54 (45.38)			
Total	**148 (100)**	**119 (100)**			
Initiation of breastfeeding					
Early initiation *(Put on the breast within one hour after birth)*	128 (86.49)	89 (74.79)	2.157	1.152, 4.039	0.016*
Late initiation	20 (13.51)	30 (25.29)			
Total	**148 (100)**	**119 (100)**			
	Normal neurodevelopment n (%)	**Slow neurodevelopment n (%)**	COR	95% CI	P-Value
Maternal nutrition status					
Normal nutrition status	142 (95.95)	108 (90.76)	2.410	0.864, 6.723	0.093*
Malnourished	6 (4.05)	11 (9.24)			
Total	**148 (100)**	**119 (100)**			

	Normal neurodevelopment n (%)	Poor neurodevelopment n (%)	COR	95% CI	P-Value
Postpartum depression					
No postpartum depression	131 (88.51)	81 (68.07)	3.615	1.915, 6.825	<0.001 ***
Postpartum depression	17 (11.49)	38 (31.93)			
Total	**148 (100)**	**119 (100)**			
Food security					
Food secure	70 (47.30)	42 (35.29)	1.645	1.002, 2.700	0.040*
Food insecure	78 (52.70)	77 (64.71)			
Total	**148 (100)**	**119 (100)**			

COR Crude Odds Ratio **CI** Confidence Interval

**** p<.001, ** p<.01, * p<.05*

APPENDIX XII: Quantitative Questionnaire

Screening Questions

1. Are you the mother of this child?
2. Is your child currently being treated for malnutrition?

1. Yes
2. No

3. Is this the first time he/she is being treated for s?

1. Yes
2. No

4. Has your child ever been treated for malnutrition before?

1. Yes
2. No

5. How many malnutrition episodes has your child suffered and being treated?

6. Does your child suffer from any long-term disease that you know of?

1. Yes
2. No

7. If yes, Which ones
8. Have you been staying with your child in Korogocho and Viwandani for the past year? /since the child was born (For children less than one year)

1. Yes

2. No

Individual Factors- Maternal

1. What is your age ?

Age in years

2. Have you ever attended school?

1. Yes
2. No

3. If yes, what is the highest level of education completed?

1. Primary
2. Secondary
3. Technical/Vocational
4. University

4. What is your main occupation?

1. Agriculture - Own farm
2. Agriculture-Someone else farm
3. Salaried employee (Has pay slip)
4. Self-employed (Including business)
5. Student
6. Unemployed
7. Casual employment

5. What is your religion?

1. Orthodox
2. Catholic
3. Protestant
4. Muslim
5. Traditional
6. Other (Specify)

6. Please specify your religion

1. Yes
2. No

7. When you were pregnant with this child, did you ever attend antenatal care clinic?

1. Yes
2. No

8. How many times did you attend ANC clinic?

Number

In the past seven days:

1. You have been able to see the funny side of things:

As much as I always could [0]

Not quite so much now [1]

Definitely not so much now [2]

Not at all [3]

2. You have looked forward with enjoyment to things:

As much as I ever did [0]

A little less than I used to [1]

Much less than I used to [2]

Hardly at all [3]

3. You have blamed myself when things went wrong, and it wasn't my fault:

Yes, most of the time [3]

Yes, some of the time [2]

Not very much [1]

No, never [0]

4. You have been worried and I don't know why:

No, not at all [0]

Hardly ever [1]

Yes, sometimes [2]

Yes, very much [3]

5. You have felt scared or panicky and I don't know why:

Yes, quite a lot [3]

Yes, sometimes [2]

No, not much [1]

No, not at all [0]

6. You have had difficulty in coping with things:

Yes, most of the time I haven't been managing at all [3]

Yes, sometimes I haven't been managing as well as usual [2]

No, most of the time I have managed quite well [1]

No, I have been managing as well as ever [0]

7. You have been so unhappy I have had difficulty sleeping:

Yes, most of the time [3]

Yes, sometimes [2]

Not very much [1]

No, not at all [0]

8. You have felt sad and miserable:

Yes, most of the time [3]

Yes, quite a lot [2]

Not very much [1]

No, not at all [0]

9. You have been so unhappy that I have been crying:

Yes, most of the time [3]

Yes, quite a lot [2]

Only sometimes [1]

No, never [0]

10. You have thought of harming myself or ending my life:

Yes, quite a lot [3]

Sometimes [2]

Hardly ever [1]

Never [0]

Individual Factors- Child Factors

1. What is the age of your child?

   Age in months
2. What was the birthweight of this child?

   Birthweight in grams
3. How many months of pregnancy had you completed when this baby was born? (Months)
4. After delivery, was the child admitted to a nursery?

1. Yes
2. No

5. If yes, how many days was the child admitted to the nursery?

6. Has your child been hospitalized in the past 6 months? (Exclude hospitalization during delivery which is aimed at stabilizing the mother and the child or child waiting to receive the BCG vaccine).

1. Yes
2. No

7. Did your child have any health challenges within 3 months after delivery?

1. Yes
2. No

8. If yes, which complications?

1. Inability to feed well
2. Unconsciousness
3. Convulsions
4. Fever
5. Other Specify

9. 24-hour dietary intake based on re-call

Now I would like to ask you to describe everything that your child ate or drunk yesterday during the day or night, whether it was eaten at home or anywhere else. Please include all foods and drinks, any snacks or small meals as well as any main meals. Remember to include all foods the child may have eaten while preparing meals or preparing food for others. Please also include the food they may have eaten anywhere away from home.

Did the child eat any solid, semi-solid, or soft foods yesterday during the day or at night?

1. Yes

2. No

How many times did the child eat solid, semisolid, or soft foods yesterday during the day or at night?

What kind of solid, semi-solid, or soft foods did the child eat?

Child breastfeeding

1. Was your child ever breastfed?

1.Yes

2. No

2. How long after birth did you put your child to the breast?

1. within one hour after birth

2. More than one hour after birth

3. I can't remember

3. If yes, Was the child exclusively breastfed?

1. Yes

2. No

4. Is the child currently breastfeeding?

1. Yes

2. No

5. If No, At what age did the child stop breastfeeding?

Age in months

6. If yes, yesterday, during the day or at night, was the child given any breast milk?

1. Yes

2. No

3. The child has stopped breastfeeding

Diarrhoea

1. In the past two weeks, did your child have diarrhoea?

Yes/No/I don't know

2. During this time, did s/he pass 3 or more loose stools in the course of one day?

Yes/No/I don't know

3. In the past two weeks, did your child have dry cough?

Yes/No/I don't know

4. If yes, did the cough persist for more than 3 days?

Yes/No/I don't know

Household Questions

1. Please give me the number of the people who usually live in your household.

2. Just to make sure that I have a complete number: are there any other people such as small children or infants that we have not included in the number stated?

1. Yes

2. No

3. What is your relationship to the household head?

1. Self

2. Husband

3. Son/Daughter

4. Brother/Sister

5. Son in-law

6. Daughter in-law

7. Step child/Adopted/Foster

8. Grand child

9. Parent

10. Parent in-law

Does your household have the following *(The item should be functional)*

1. Electricity
2. Radio
3. Television
4. Non-mobile telephone
5. Computer
6. Refregirator
7. Table
8. Chair
9. Mattress and bed
10. Kerosene/Pressure lamp
11. None of the above

What is the ownership type of your household dwelling?

1. Owned
2. Free of charge/Subsidized

3. Rented from employer/agency/individual
4. Other (Specify)

What is the main material on the floor where your household dwel?

1. DungEarth
2. Earth
3. Wood planks
4. Carpet
5. Cement
6. Ceramic tiles
7. Bamboo
8. Finished wood
9. Vinyl strip
10. Other (Specify)

What type of material is the roof where your household dwel made of ?

1. There is no roof
2. Palm leaf
3. Sod
4. Bomboo/Palm
5. Cardboards
6. Finished roofing
7. Corrugated iron
8. Wood

9. Tiles (Ceramic)
10. Cement
11. Other (Specify)

What material (main) is your household's exteror wall where you dwel?

1. No wall
2. Cane/palm/Trunks/Bamboo/Reed
3. Stone with mud
4. Uncovered adobe
5. Plywood
6. Cardboard
7. Reused wood
8. Cement
9. Stone with lime/Cement
10. Bricks
11. Cement blocks
12. Covered adobe
13. Wood planks/Shingles
14. Other (Specify)

4. I will now ask you about the births you have ever had. Have you ever given birth?

1. Yes
2. No

5. How many children live with you in your household?

HOUSEHOLD WATER, AND SANITATION HYGIENE QUESTIONS

1. In your household, what is the main source of the water you usually drink?

1. Piped water into the dwelling

2. Pipped water to yard/plot

3. Pipped water to the neighbour

4. Standpipe/Tap used by public

5. Borehole

6. Rainwater

7. Well (Protected)

8. Well (Unprotected)

9. Spring (Protected)

10. Spring (Unprotected)

11. Tanker truck

12. Cart with small tank

13. Surface water

14. Bottled water

15. Other source

2. Where is that water source located?

3. Do you usually do anything to make the drinking water safer?

1. Yes

2. No

4. What is ussually done to the wate to make it safer?

1. Boiling

2. Adding chemical agents (Chlorine solution, Aqua tabs, purr, Water guard)

3. Water filtration (Ceramic, sand, composite)

4. Disinfection using solar

5. Straining through a clothe

6. letting it stand and settle

7. Other (Specify)

5. Did you wash your hands yesterday (Within the last 24 hours)?

1. Yes

2. No

6. What was used in handwashing?

1. Only water

2. Water and soap

3. Water and ash

4. Water and herbs

5. Other (Specify)

7. Do you have a designated place for handwashing?

1. Yes

2. No

8. What kind of toilet facility do members of your household usually use?

1. Flush to piped sewer system

2. Flush to septic tank

3. Flush to pit latrine

4. Flush to somewhere else

5. Flush and don't know where

6. Ventilated improved pit latrine

7. Pit latrine with slab

8. Pit latrine without slab/open pit

9. Composing toilet

10. Bucket toilet

11. Hanging toilet/hanging latrine

12. No facility/Bush/Field

13. Other

9. Do you share this toilet facility with other households?

1. Yes
2. No

10. Including your own household, how many households use this toilet facility?

11. Where is this toilet facility located?

1. In own dwelling
2. In own yard/plot
3. Elsewhere

12. Where do you dispose of your household's solid waste?

1. Burry it
2. Burn it
3. Carry to a designated waste disposal site

4. Carry it to an unofficial waste dump

5. Other (Specify)

Household Food Security

1. In the past four weeks, did you worry that your household would not have enough food?

Yes/No

2. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

3. In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?

Yes/No

4. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

5. In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?

Yes/No

6. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

7. In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?

Yes/No

8. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

9. In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?

Yes/No

10. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

11. In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?

Yes/No

12. How often did this happen?

1. Rarely (once or twice in the past four weeks)

2. Sometimes (three to ten times in the past four weeks)

3. Often (more than ten times in the past four weeks)

13. In the past four weeks, was there ever no food to eat of any kind in your household because of a lack of resources to get food?

1. Yes
2. No

14. How often did this happen?

1. Rarely (once or twice in the past four weeks)
2. Sometimes (three to ten times in the past four weeks)
3. Often (more than ten times in the past four weeks)

15. In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?

Yes/No

16. How often did this happen?

1. Rarely (once or twice in the past four weeks)
2. Sometimes (three to ten times in the past four weeks)
3. Often (more than ten times in the past four weeks)

17. In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Yes/No

18. How often did this happen?

1. Rarely (once or twice in the past four weeks)
2. Sometimes (three to ten times in the past four weeks)
3. Often (more than ten times in the past four weeks)

19. Do you or any member of your household practice kitchen gardening/have a piece of land within Nairobi where you usually plant crops?

1. Yes
2. No

20. Do you or any member of your household have livestock or poultry?

1. Yes
2. No

Did your household use any of the following coping strategies in the past 30 days?

1. At least one additional member seek employment or any income source, including daily labor, street vending, engaging in dangerous work practices (e.g., dangerous constructions, etc.) or any instance of moving away from home to seek work

2. Re-sharing the housing unit with other nuclear families (including with parents' house)

3. Relocating to a cheaper/smaller housing unit

4. Sold any not productive assets (e.g., jewelry, furniture, etc.)

5. Borrow/rely on help from friends, relatives, or neighbors for staple food or borrow money to spend on food or essential household needs

6. Raising livestock/poultry in the housing unit as a source of food for your family (e.g., in the living room)

7. Sold any productive assets (e.g., livestock, electronics, land, etc.)

8. Sold the entire house (e.g., moving to rental)

9. Engaging in socially unacceptable or degrading activities, such as begging

10. Delay seeking medical attention for critical health problems

11. Stop sending children to school to engage them in working for economic gain and/or productive household activities (to collect firewood/fetch water/work etc.)

12. Engaging in illegal activities (e.g., driving a taxi without a license, illegally selling in the streets without getting approval from municipalities, robberies, pickpocketing, etc.)

13. Marrying daughters earlier than otherwise planned

14. Marrying sons earlier than otherwise planned

Household Factors

1. Have you earned income in the past one month?

   Yes/No

2. If yes, What is the average income you have earned in the last one month?

   KSH…..

3. Who decided how this money would be used?

1. Respondent herself

2. Respondent's husband

3. Respondent and husband jointly

4. Another household member

5. Respondent and another household member jointly

6. Someone outside the household

5. Who usually decides about making smaller purchases, such as food and other less expensive needs?

1. Respondent herself

2. Respondent husband

3. Respondent and husband jointly

4. Another household member

5. Respondent and another household member jointly

6. Someone outside the household

Anthropometric Assessment

Weight of the child (In grams)

Length/Height of the child (cm)

How was the measurement for length/Height taken?

1. Lying
2. Standing

Mid Upper Arm Circumference (MUAC) of the child in cm (Only for children between 6 months to 5 years)

Nutritional oedema

1. Yes

2. No

Height of the mother in cm

Weight of the mother in kg

MUAC of the mother in cm (Only for pregnant women)

MDAT (Malawi Developmental Assessment Tool)

Complete for all children:

1. Child's Name: _____ CHNAMSC

2. Parent/guardian's Name: _____ GUNAMSC

Parental consent: Verbal[1] / Written[2] |___| SCRCONSENT

3. Phone number 1: |___|___|___|___|___|___|___|___|___|___| PHNOSC1

4. Phone number 1: |___|___|___|___|___|___|___|___|___|___| PHNOSC2

5. Child's DOB (dd/mm/yy): |___|___| / |___|___| / |___|___|___|___| CHDOBSC

6. Age of child today:|___|___| (months)

7. Child's Hospital ID: |___|___|___|___|___|___|___| CHHOSPIDSC

Please ask the following question for all children:

12. On more than one occasion, has your child had fits, become rigid or lost consciousness?

Compared to other children of a similar age…. *(Please code Q1-10 No[0] / Yes[1])*

1. Does the child learn to do things like other children his/her age?

   |___| **TQQ1**

2. Does your child have difficulty seeing?

   |___| **TQQ2**

3. Does your child appear to have difficulty hearing?

   |___| **TQQ3**

4. Does/did your child have difficulty breast feeding, sucking or swallowing?

   |___| **TQQ4**

5. Does your child choke or cough during feeding?

   |___| **TQQ5**

6. Does your child's neck feel floppy?

   |___| **TQQ6**

7. Does the child have weakness and/or stiffness in the arms or legs?

   |___| **TQQ7**

8. When being held does your child arch his/her back like they are pulling away from you? |___| **TQQ8**

9. Does your child keep his/her hands closed all the time or use his hands differently from other children? |___| **TQQ9**

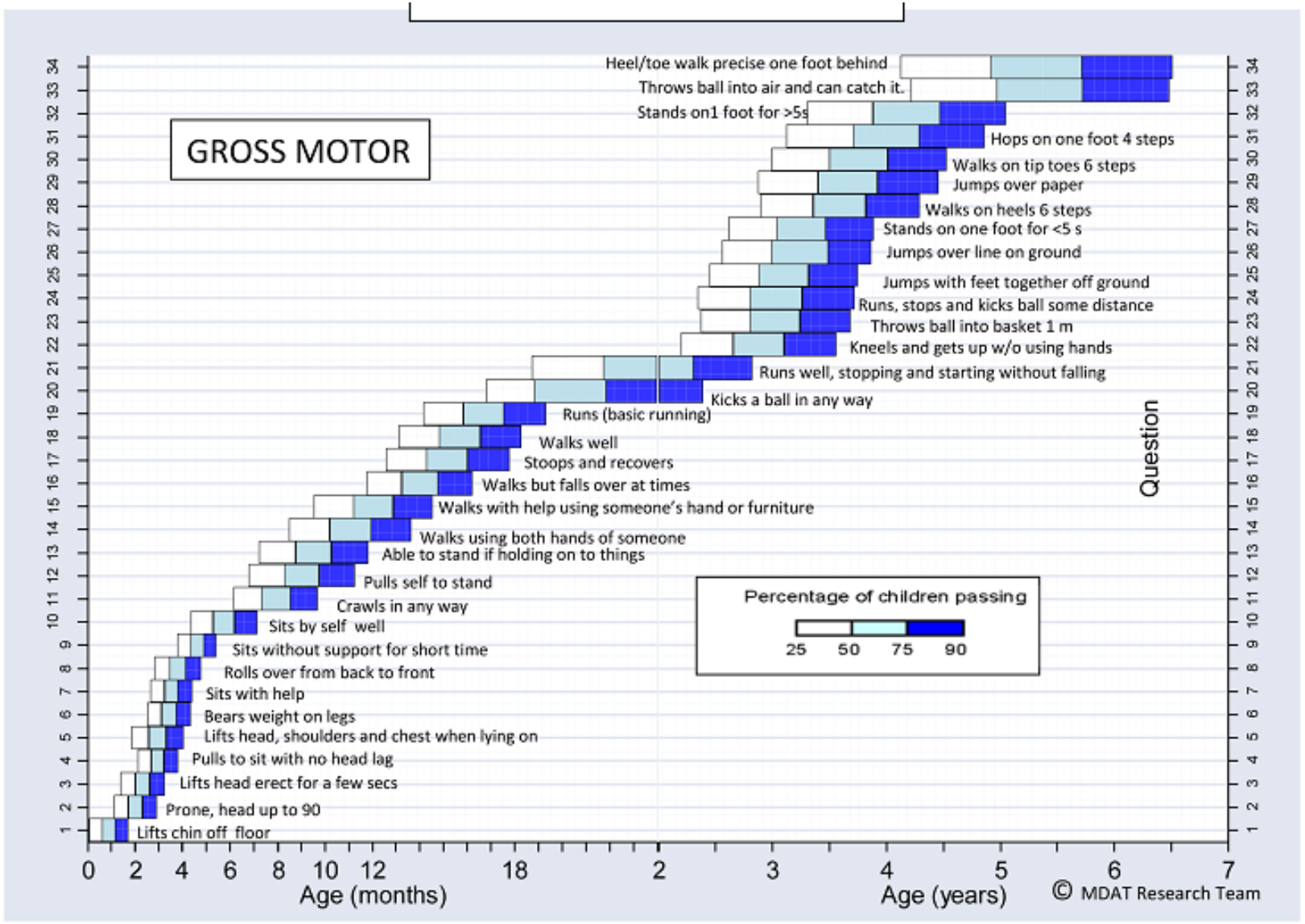
10. Does the child sometimes have fits, become rigid, or lose consciousness?

    |___| **TQQ10**

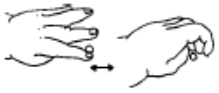
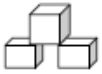
This form must be completed together with MDAT for every child at initial screening

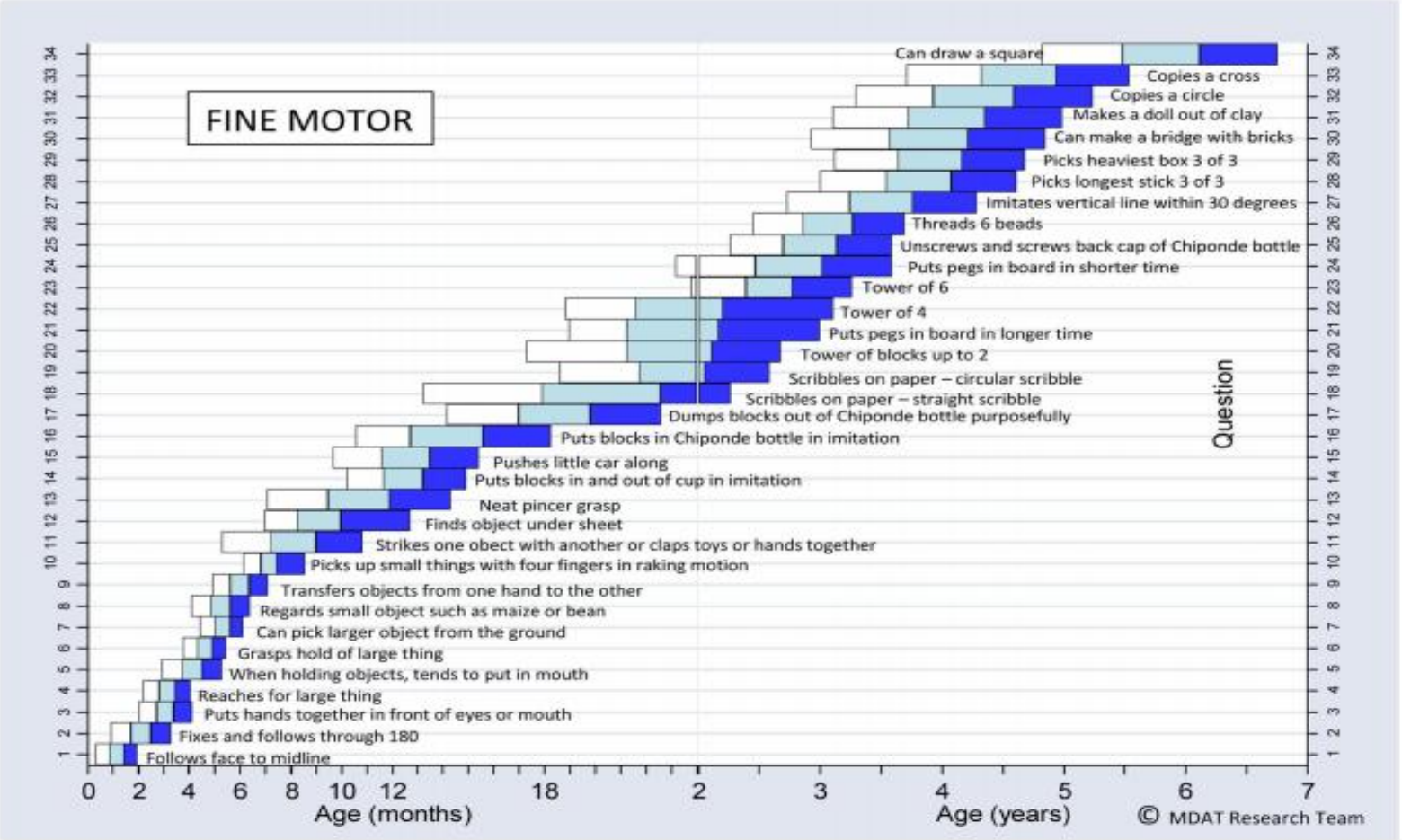
A GROSS MOTOR

1. Lifts chin up off the floor for a few seconds 	2. Prone (on his or her tummy), can lift head up to 90 degrees 	3. Holds head upright for a few seconds 	4. Pulls to sit with no head lag 	5. Lifts head, shoulders and chest when lying on stomach 	6. Bears weight on legs (holds legs strongly when put in standing position) 
7. Sits with help (with a nice straight back) 	8. Rolls over from back to front 	9. Sits without support for a short time. 	10. Sits by self well. 	11. Crawls (in any way) 	12. Pulls self to stand 
13. Able to stand if holding on to things 	14. Walks using both hands of someone . 	15. Walks with help using someone's hand or furniture 	16. Walks but falls over at times 	17. Stoops over and gets back up 	18. Walks well 
19. Runs (basic running) 	20. Kicks a ball (in any way- even only a little bit) 	21. Runs well, stopping and starting without falling over 	22. Does your child climb on to furniture to reach things that they want?	23. Throws a ball overhand (raising his arm and shoulder)	24. Kneels and can get up without using hands. 
25. Climbs and jumps off platform with support	26. Jumps off platform on their own	27. Throwsa ball in to a basket at 1 metre 	28. Runs, stops and kicks a ball at some distance 	29. Jumps with feet together off the ground 	30. Jumps over line on the ground 
31. Stands on one foot for less than 5 seconds 	32.Walks on heels six steps 	33. Jumps over a piece of paper or larger object. 	34. Walks on tip toes six steps. 	35. Hops on one foot four steps 	36. Stands on one foot for more than 5 s (eg. >10s – 1 min 


GROSS MOTOR
Heel/toe walk precise one foot behind
Throws ball into air and can catch it.
Stands on1 foot for >5s
Hops on one foot 4 steps
Walks on tip toes 6 steps
Jumps over paper
Walks on heels 6 steps
Stands on one foot for <5 s
Jumps over line on ground
Jumps with feet together off ground
Runs, stops and kicks ball some distance
Throws ball into basket 1 m
Kneels and gets up w/o using hands
Runs well, stopping and starting without falling
Kicks a ball in any way
Runs (basic running)
Walks well
Stoops and recovers
Walks but falls over at times
Walks with help using someone's hand or furniture
Walks using both hands of someone
Able to stand if holding on to things
Pulls self to stand
Crawls in any way
Sits by self well
Sits without support for short time
Rolls over from back to front
Sits with help
Bears weight on legs
Lifts head, shoulders and chest when lying on
Pulls to sit with no head lag
Lifts head erect for a few secs
Prone, head up to 90
Lifts chin off floor
Question
Percentage of children passing
25 50 75 90
0 2 4 6 8 10 12 18 2 3 4 5 6 7
Age (months)
Age (years)
© MDAT Research Team

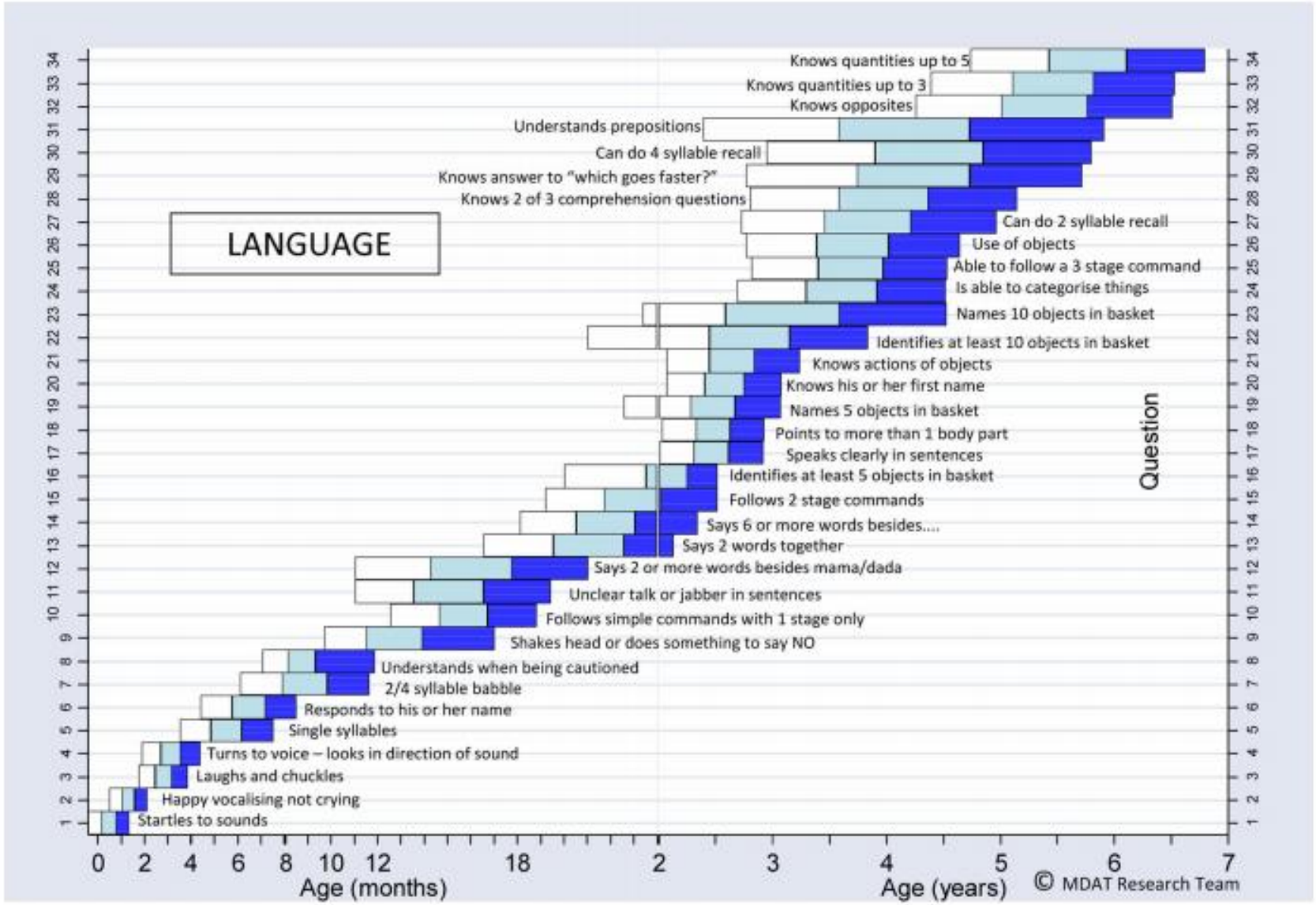
B FINE MOTOR/COGNITION

1. Follows mum/carer's face to mid line. 	2. Fixes and follows completely from right to left 	3.Puts hands together in front of eyes or mouth. 	4.Reaches for a large thing. 	5. When holding objects tends to put them in the mouth 	6. Grasps hold of large things. 
7. Can pick a larger object from the ground such as a wooden spoon. 	8. Looks at a small object held in the hand such as a bean or maize piece. 	9. Transfers objects from one hand to another 	10. Picks up small things with four fingers in a raking motion 	11. Strikes one object with another or claps toys or hands together 	12. Finds object hidden under a sheet 
13. Can use a neat pincer grasp to pick up object between thumb and forefinger 	14. Puts blocks or stones in and out of a plastic tea cup in imitation. 	15. Copies pushing a little wooden or wire car along 	16. Puts blocks or 2 cm size stones in and out of a plastic jar in imitation. 	17. Is able to understand to dump the blocks or stones out of the jar in imitation. 	18. Scribbles on paper with chalk or on the ground with a stick in straight lines. 
19.Scribbles on paper with chalk or on the ground with a stick in a circular motion 	20.. Can build a tower of two bricks 	21. Puts pegs in a board in a longer time. (< 2 min) 	22. Ask child to hold four bricks in their hands and to give you one of them (make sure they have four in their hand at the time)	23. Makes a tower of four bricks 	24. Makes a tower of at least six bricks 
25 Fill up two cups. One with very little water and one with a lot of water and ask the child to give you the cup with more water (do it three times)	26 Can do the peg board quicker – within 30 s (<30s) 	27. Unscrews and screws the cap on and off a peanut butter plastic jar 	28.. Threads six beads 	29. With two cups of different sizes (same colour) child is able to give you bigger cup.Say to the child, "Give me the bigger one?"	30. Imitates a vertical line drawn by the assessor
31. Picks the "longer" stick 3 out of 3 times 	32. Picks the heaviest of two objects 	33.Can make a bridge 	34. Makes a doll or a car out of clay 	35. Copies a circle drawn on paper or on the sand 	36. Copies a cross drawn on paper or on the sand 


FINE MOTOR
Can draw a square
Copies a cross
Copies a circle
Makes a doll out of clay
Can make a bridge with bricks
Picks heaviest box 3 of 3
Picks longest stick 3 of 3
Imitates vertical line within 30 degrees
Threads 6 beads
Unscrews and screws back cap of Chiponde bottle
Puts pegs in board in shorter time
Tower of 6
Tower of 4
Puts pegs in board in longer time
Tower of blocks up to 2
Scribbles on paper – circular scribble
Scribbles on paper – straight scribble
Dumps blocks out of Chiponde bottle purposefully
Puts blocks in Chiponde bottle in imitation
Pushes little car along
Puts blocks in and out of cup in imitation
Neat pincer grasp
Finds object under sheet
Strikes one obect with another or claps toys or hands together
Picks up small things with four fingers in raking motion
Transfers objects from one hand to the other
Regards small object such as maize or bean
Can pick larger object from the ground
Grasps hold of large thing
When holding objects, tends to put in mouth
Reaches for large thing
Puts hands together in front of eyes or mouth
Fixes and follows through 180
Follows face to midline
Question
0 2 4 6 8 10 12 18 2 3 4 5 6 7
Age (months)
Age (years)
© MDAT Research Team

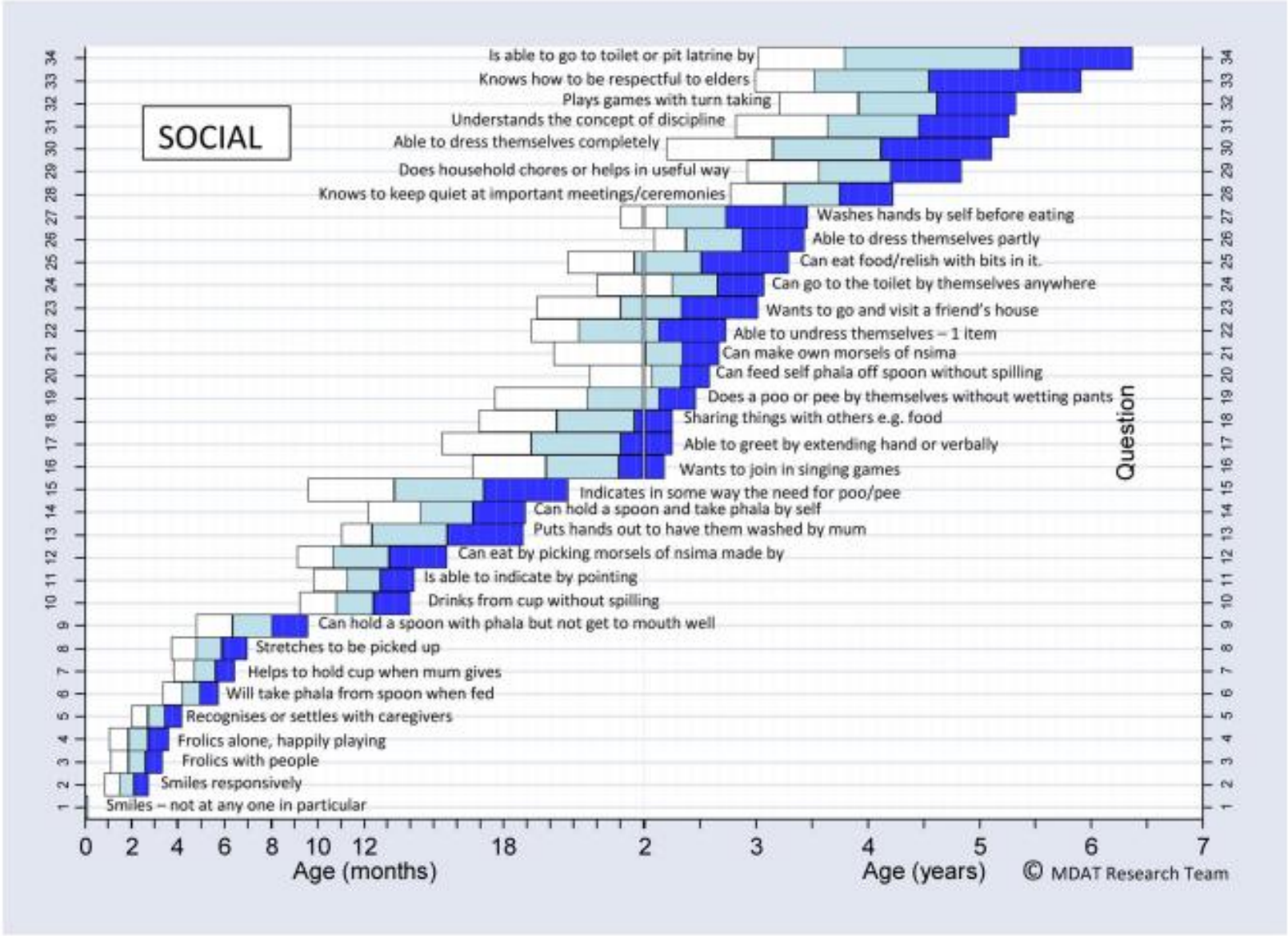
C LANGUAGE

1. Startles to sounds	2. Happy making sounds such as "uh", "eh", "a" which are separate from crying sounds.	3.Laughs and chuckles 	4. Turns to voice – looks in the direction of a voice or a sound. 	5. Makes single syllable sounds such as .. ma/da/pa/ba	6. Responds and turns to his or her name being called. 
7. Says two syllable babble such as ....dada, lala, mimi, tata,	8. Understands when being told "no" or being cautioned 	9. Shakes head or does something to indicate "No" 	10. Follows one stage commands such as "give me the cup" 	11. Unclear talk or jabber in sentences..(sounds like sentences but not always clear to the listener)	12. Says two words other than mama or dada e.g. cup/cow/spoon/
13. Says two words together such as "mama-cup" or "dada-water" or "dada goes"	14. Says at least six or more words	15. Follows two stage commands "go and get the cup over there and put it in the basket"	16. Can pull out/identify from the box up to 5 things e.g. cup/ball/spoon/bottle/cloth Say to the child "give me the cup...ball...spoon...bottle..cloth." More than 5 recognised	17. Speaks clearly in sentences that are understood well (three words together at a time).	18. Points to more than one body part Ask..."Where is your....nose/eyes/mouth"... > 1 body part 
19. Names at least five (5) things in the box. Ask the child...."What is this?" and pull out of basket a cup/spoon, ball, bottle, cloth... Named at least 5.	20. Knows his or her first name – When asked, "What is your name?" – can tell you their name"	21. Knows actions of objects.."Which one is used for sweeping?" "Which one is used for drinking?"....Ask them to pick them up..	22. Can pull out/identify from the box up to 10 things e.g. cup/ball/spoon/bottle/cloth/soap, battery/ brush/bicycle/plate Say to the child "give me the cup...ball...spoon etc..etc.." More than 10 RECOGNISED	23. Names at least ten (10) things in the box. Ask the child...."What is this?" and pull out of basket a cup/ball/spoon/bottle/cloth/soap, battery/ brush/bicycle/plate NAMED at least 10	24. Can the child talk or explain things that happened in the past e.g talk to you in the past tense about what happened yesterday
25. Can the child sing songs or repeat rhymes from memory	26. Is able to categorise things... Ask the child.... "Tell me some things that you eat"... "Tell me some animals you know" See if they can answer at least one of these questions..	27 Able to follow a three stage command e.g. "stand up, clap your hands and go over to the....".?	28. Knows the use of objects e.g. "What do you do with a cup?" "What do you do with soap?"	29. Can copy 2 syllables that are repeated..Say to the child...When I say this..copy me.. : "Pa, Chi, Tu, Go" 2 out of 4 eg. Pa, Chi	20. Knows the answer of 2 out of 3 questions with an adjective e.g What do you do when you are hungry? What do you do when you are tired? What do you do when you are thirsty?
31. Understands the term "faster". E.g. "which goes faster – a car or a bicycle?"	32. Can copy 4 syllables that are repeated..Say to the child...When I say this....copy me.. : "Pa, Chi, Tu, Go" 4 out of 4 _____	33. Understands prepositions e.g. "Put the stone/block under the cup, put the stone/block on the cup/put it next to the cup/put it behind the cup". Needs to do 3 of 4 of  these.	34. Knows opposites e.g. "A man is big, a baby is ....", "If the sun comes up in the day, the moon comes up in....." (must do 2 of 3 of these)	35 Knows quantities.. can count some bricks or stones... Put bricks on the table and ask the child..."Can you count these?" Can count up to THREE bricks	36 Knows quantities...can count some bricks or stones... Put bricks on the table and ask the child..."Can you count these?" Can count up to FIVE bricks


LANGUAGE
Knows quantities up to 5
Knows quantities up to 3
Knows opposites
Understands prepositions
Can do 4 syllable recall
Knows answer to "which goes faster?"
Knows 2 of 3 comprehension questions
Can do 2 syllable recall
Use of objects
Able to follow a 3 stage command
Is able to categorise things
Names 10 objects in basket
Identifies at least 10 objects in basket
Knows actions of objects
Knows his or her first name
Names 5 objects in basket
Points to more than 1 body part
Speaks clearly in sentences
Identifies at least 5 objects in basket
Follows 2 stage commands
Says 6 or more words besides....
Says 2 words together
Says 2 or more words besides mama/dada
Unclear talk or jabber in sentences
Follows simple commands with 1 stage only
Shakes head or does something to say NO
Understands when being cautioned
2/4 syllable babble
Responds to his or her name
Single syllables
Turns to voice – looks in direction of sound
Laughs and chuckles
Happy vocalising not crying
Startles to sounds
Question
0 2 4 6 8 10 12 18 2 3 4 5 6 7
Age (months)
Age (years)
© MDAT Research Team

D SOCIAL

1. Smiles but not at a particular person. . 	2. Smiles in response to a person.. 	3. Frolics with mother or caregiver in response to being played with. 	4. Frolics alone, happily playing, moving around moving body and kicking legs in a happy way. 	5.Recognises or settles (quiets) with caregivers/known family members. Stops crying or quiets when mum or another known carer takes the baby.	6. Will take phala (porridge) from a spoon when fed by a caregiver 
7.Helps hold a cup while mum gives a drink. 	8. Stretches to be picked up. 	9. Can HOLD a spoon with phala (porridge) but NOT get to mouth well yet.	10. Drinks from a cup by self without spilling. 	11. Is able to indicate by pointing that they want something. 	12. Can eat by picking up morsels (of nsima/maize) made by mum.
13. Puts hands out to be washed by mum or carer – helps by putting hands out. 	14. Can hold a spoon and take phala (porridge) by self but spills some/a little bit 	15.Indicates in some way the need for a poo or a pee. For example by crying, pulling at pants or saying something...	16. Wants to join in singing games. Ask "Does the child like to be included in singing games even if he/she can not yet do them?"	17. Able to greet either by extending hand or verbally. 	18. Understands to share things with others and will do so if with friends or family and asked to share.
19. Does a poo or a pee by themselves without wetting their pants.	20. Eats phala (porridge) off a spoon without spilling. 	21. Does the child play by pretending objects are something else?	22. Will the child pretend to cook or make something (like sudsa) with imaginary play things e.g tin and sand?	23. Can make own morsels of nsima/maize and put in mouth (often with relish)	24. Is able to undress by themselves – can take off even one item of clothing e.g. shorts or skirt..need to be able to remove it completely. 
25. Wants to go and visit a friend's house.. shows independence	26.Can go to the toilet by themselves anywhere (not necessarily at the pit latrine) 	27. Can eat food or relish with bits or bones in it such as fish with bones or tangerines with seeds	28. Is able to dress but not completely. Can put on at least one item e.g. T shirt/skirt 	29. Washes hands well by self before/after eating 	30. Knows how to keep quiet at important meetings or ceremonies. 
31.Does household chores in a useful way e.g. drawing water or hoeing. could be even a small amount of help but not just pretend.	32. Able to dress by self completely. May need help with buttons, shoe, laces or zips. 	33. Understands the concept of discipline e.g. causes and consequences such as that saying bad words might lead to punishment...	34. Plays games with turn taking such as fulaye, mira, jingo. 	35. Knows how to be respectful to elders. Is polite and shows respect such as putting hands together or kneeling before elders	36. Can go to the toilet or pit latrine by self. 


SOCIAL
Is able to go to toilet or pit latrine by
Knows how to be respectful to elders
Plays games with turn taking
Understands the concept of discipline
Able to dress themselves completely
Does household chores or helps in useful way
Knows to keep quiet at important meetings/ceremonies
Washes hands by self before eating
Able to dress themselves partly
Can eat food/relish with bits in it.
Can go to the toilet by themselves anywhere
Wants to go and visit a friend's house
Able to undress themselves – 1 item
Can make own morsels of nsima
Can feed self phala off spoon without spilling
Does a poo or pee by themselves without wetting pants
Sharing things with others e.g. food
Able to greet by extending hand or verbally
Wants to join in singing games
Indicates in some way the need for poo/pee
Can hold a spoon and take phala by self
Puts hands out to have them washed by mum
Can eat by picking morsels of nsima made by
Is able to indicate by pointing
Drinks from cup without spilling
Can hold a spoon with phala but not get to mouth well
Stretches to be picked up
Helps to hold cup when mum gives
Will take phala from spoon when fed
Recognises or settles with caregivers
Frolics alone, happily playing
Frolics with people
Smiles responsively
Smiles – not at any one in particular
Question
0 2 4 6 8 10 12 18 2 3 4 5 6 7
Age (months)
Age (years)
© MDAT Research Team

To be completed by researcher immediately after assessment (Please Circle)

1.	Affect of child through most of the testing **(AFFECTSC)**	a. Happy, smiles and laughs	1	d. Mostly sad, crying, whining or complaining	4
		b. Mostly happy	2	e. Very sad, crying, whining or complaining	5
		c. Neutral	3		
2.	Engagement and enthusiasm for activities **(ENGAGSC)**	a. Interested, engaged and enthusiastic	1	c. Some interest but easily distracted or stops engaging	3
		b. Mostly interested and engaged	2	d. Uninterested and uninvolved	4
3.	Cooperativeness **(COOPSC)**	a. Readily does what tester asks	1	c. Slightly uncooperative	3
		b. A bit shy or slow to cooperate but mostly does so	2	d. Very difficult and uncooperative	4

4.	Fear/anxiety **(FEARSC)**	a. Not shy or afraid	1	c. Quite anxious or frightened	3
		b. A bit shy or anxious	2	d. Too anxious or frightened to get involved	4
5.	Caregiver's involvement **(CARESC)**	a. Encourages child greatly, shows activities	1	d. Actively discouraging	4
		b. Encourages child passively, without showing most activities	2	e. none present	5
		c. Passively watches	3		

EVALUATION OF SCORES & DECISION

Record the number of fails in each domain based on the child's age (adjusted in case of prematures).

If the child **has 2 fails in any domain**, refer to Griffiths and HINES

If the child **has failed 1 in each domain** and is less than 9 months old, arrange a repeat MDAT to be done a month from today

DOMAIN	**FAILS**	**PASSES**
GROSS MOTOR	**(GMF)**	**(GMP)**
FINE MOTOR	**(FMF)**	**(FMP)**
LANGUAGE	**(LNGF)**	**(LNP)**
SOCIAL	**(SOCF)**	**(SOCP)**

Decision: Normal development[0] / Referred for Griffiths & HINE[1] / Return for repeat MDAT [2] |___| **MDATOUTC**

Date of return visit if required (dd/mm/yyyy): |___|___|/|___|___| / |___|___|___|___| **DATRET**

Note down any other useful comments about the assessment session, the child or parents…….

State any risk factors to the baby assessed……..

Completed by: |___|___|___| MDATCOM **Date:** |___|___| / |___|___| / |___|___|___|___| **MDATDA**

APPENDIX XIII: Key Informant Interview Guide: For Healthcare Providers /Community Health Assistants and Community Health Volunteers

1. **Relapse Patterns:**

- Can you describe any observed patterns or trends in the relapse of acute malnutrition among children under five years in Nairobi informal settlements?
- Are there specific factors contributing to the recurrence of acute malnutrition in this population?

2. **Impact on Neurodevelopment:**

- In your experience, have you noticed any distinct neurodevelopmental outcomes in children who have experienced a relapse in acute malnutrition compared to those who haven't?
- Are there certain types of neurodevelopmental issues that seem more prevalent in cases of relapse?

3. **Risk Factors for Relapse:**

- What are the identified risk factors for relapses in acute malnutrition, and how do these factors intersect with potential neurodevelopmental consequences?
- Are there modifiable factors that, if addressed, could reduce the risk of relapses and improve neurodevelopmental outcomes? Culture, adherence to prescription

4. **Interventions post-relapses:**

- How are cases of relapses currently managed in terms of nutritional and developmental interventions for under 5 children in informal settlements?

- Are there specific strategies that have shown promise in minimizing the impact of relapses on neurodevelopment?

5. **Monitoring and Follow-up:**

- What challenges exist in monitoring and providing follow-up care for children who have experienced a relapse in acute malnutrition?
- Are there gaps in the continuity of care, especially concerning neurodevelopmental assessments?

6. **Parental and Community Involvement:**

- How do parental and community factors contribute to or mitigate the risk of relapses in acute malnutrition, and subsequently, impact neurodevelopmental outcomes?
- Are there community-based initiatives that focus on preventing relapses and supporting children's overall development?

7. **Access to Rehabilitation Services:**

- Are there adequate rehabilitation services in place for children who have relapsed into acute malnutrition and may be at risk for neurodevelopmental issues?
- What barriers exist in accessing these services, and how might they be addressed?

8. **Long-term Implications:**

- From your perspective, what are the potential long-term implications for children who experience relapses in acute malnutrition, particularly in terms of their neurodevelopmental trajectories?

- Are there success stories or positive examples where interventions have effectively mitigated long-term consequences?

APPENDIX XIV: In-depth Interview Guide: Mothers

1. **Experience with Acute Malnutrition:**

- Can you share your personal experiences or observations regarding your child's episodes of acute malnutrition?
- How did you first become aware that your child was experiencing malnutrition, and what were the initial signs?

2. **Understanding Relapse:**

- Have you noticed any relapses or recurrent episodes of malnutrition in your child? If yes, could you describe those experiences?
- What do you believe are the factors contributing to the relapse of acute malnutrition in your child?

3. **Impact on Child's Development:**

- In your opinion, have you observed any specific changes or challenges in your child's development following episodes of relapse in acute malnutrition?
- How do you feel your child's cognitive and motor skills have been affected, if at all?

4. **Barriers to Sustaining Nutritional Improvements:**

- What challenges or barriers do you face in sustaining improvements in your child's nutrition after a period of acute malnutrition?
- Are there external factors, such as economic constraints or limited access to nutritious food, that contribute to relapses?

5. **Access to Healthcare Services:**

- Can you describe your experiences in accessing healthcare services for your child, particularly in terms of follow-up care after a relapse?
- Are there any difficulties you encounter in seeking medical attention for your child's nutritional and developmental needs?

6. **Community Support and Stigma:**

- How does the community around you respond to children who have experienced malnutrition or relapse, and how does that impact your experiences as a mother?
- Are there support networks within the community that have been helpful or, conversely, any stigmas associated with malnutrition?

7. **Parental Involvement in Rehabilitation:**

- What role do you play as a parent in the rehabilitation and recovery of your child after a relapse in acute malnutrition?
- Are there specific challenges or successes you've encountered in this role?

8. **Hopes and Concerns for the Future:**

- Looking ahead, what are your hopes and concerns for your child's overall development and well-being, considering the experiences of malnutrition and relapse?
- Are there specific interventions or support systems you believe would make a significant difference?

9. **Suggestions for Improvement:**

- From your perspective, what changes or improvements could be made in existing programs or services to better support mothers and children in preventing relapse and addressing neurodevelopmental concerns?

APPENDIX XV: Focus Group Discussion Guide: With mothers

1. **Introduction and Icebreaker:**

- Can each of you share a bit about your experiences as mothers in the community, especially regarding your children's nutrition and development?

2. **Understanding Relapse:**

- How familiar are you with the concept of relapse in acute malnutrition among young children? Have any of your children experienced a relapse?
- What signs or factors do you associate with the relapse of acute malnutrition in your children?

3. **Impact on Children's Development:**

- In your view, what impact does a relapse in acute malnutrition have on your child's overall development, especially in terms of cognitive and motor skills?
- Can you share specific instances or observations related to your child's development after a relapse?

4. **Challenges in Nutritional Practices:**

- What challenges do you face in maintaining proper nutritional practices for your children to prevent relapses?
- Are there specific cultural or economic factors that contribute to difficulties in sustaining good nutrition?

5. **Access to Healthcare and Follow-up:**

- How accessible are healthcare services for follow-up care after a child has experienced a relapse in acute malnutrition?
- Have you encountered any obstacles or difficulties in seeking medical attention for your child's nutritional and developmental needs?

6. **Community Support and Stigma:**

- How does the community respond to mothers whose children have experienced malnutrition or relapse, and how does this impact your experiences?
- Are there support networks within the community that have been helpful, or conversely, any stigmas associated with malnutrition?

7. **Parental Involvement in Rehabilitation:**

- What role do you believe parents should play in the rehabilitation and recovery of children after a relapse in acute malnutrition?
- Are there specific challenges or successes you've encountered in this role?

8. **Communication and Awareness:**

- How well-informed do you feel mothers in the community are about the link between acute malnutrition relapses and neurodevelopmental outcomes in young children?
- Are there communication channels that could be utilized to improve awareness among mothers?

9. **Suggestions for Support Systems:**

- From your perspective, what support systems or interventions would be most helpful for mothers in preventing relapses and addressing neurodevelopmental concerns in children under 5?
- Are there successful practices from within the community or elsewhere that could be adopted here?

10. **Hopes and Concerns for the Future:**

- Looking ahead, what are your hopes and concerns for your children's overall development and well-being, considering the experiences of malnutrition and relapse?
- Are there specific interventions or support systems you believe would make a significant difference in securing a better future for your children

APPENDIX XVI: Consent Form

[This ICF should only be used for those who have attained the age of majority, 18 years]

Study Title	**Association between Acute Malnutrition Relapse after Treatment and Neurodevelopmental Outcome among Under 5 Children in Nairobi Informal Settlement**
Investigator(s)	**Investigators** Patrick Amboka - Tel: +254 702602571 or +254715688703 **Co-investigators:** Dr Peninah Masibo ---Tel. +254 721 952 175 Dr Margret Nampijja --- Tel.+256 759 464 725
Study Sponsor(s)	N/A
Collaborators	

This Informed Consent Form has two parts:

- Information Sheet (to share information about the study with you)
- Certificate of Consent (for signatures if you choose to participate)
- You will be given a copy of the full Informed Consent Form

Part I: Information Sheet

This study is being undertaken to determine the association between acute malnutrition relapse after treatment and neurodevelopmental outcome among under 5 children in Nairobi informal settlements. We are giving you this information because we would like you to participate in our research project. If you prefer not to participate, you are free to choose to do so. You will continue to receive services the way that you normally would, with no negative impact. We want to make sure that you have all the information that you need before you decide. Members of our team are here to help you understand more about the project. If you do not understand any of the words or ideas that you see on this form, please ask us to explain the information to you. You can talk to anyone from our team whom you feel comfortable with about the research.

Why is this Project Important?

This interview is part of a study aimed at understanding the association between acute malnutrition relapse after treatment and neurodevelopmental outcome among under 5 children in Nairobi informal settlements.

Who Can Participate?

You are being invited to take part in this research project because you have an under 5 child who has relapsed from acute malnutrition after treatment/you have a normally nourished child/your child has only had one episode of acute malnutrition (Is having the first episode of acute malnutrition).

Participation is Your Choice

Your participation in this research is completely voluntary. You will make the choice about whether you will participate or not. If you choose not to take part, you will continue to receive all of the services that you usually get and nothing will change.

What Is Involved in this Project?

You will be asked for your personal opinions and thoughts on this topic. You will also be asked questions about your child. Assessment of both nutrition status and neurodevelopmental outcomes will be done to your child. Your nutrition status will also be assessed. Participation in this activity is voluntary, and you can request to end it at any time or choose not to answer any specific question. We are seeking your permission to record the audio for further transcription. The research team guarantees confidentiality of all the information you share with us during this interview. Results from these interviews may be included in a published peer-reviewed journal without attributing responses to any specific person or institution.

How long will the Project Last?

This study takes three months in Nairobi informal settlements. You are only going to participate in one interview that lasts about 45-60 minutes. You may however be called upon later to validate some of the findings of the study in form of a stakeholder workshop.

What are the Risks?

There is a risk that you may share some personal or confidential information by chance, or that you may feel uncomfortable talking about some of the topics in this study. However, we do not wish for this to happen. You do not have to answer any question or take part in

the survey if you feel the question(s) are too personal or if talking about them makes you uncomfortable.

What are the Benefits?

There will be no direct benefit to you, either material or monetary. However, we feel that your participation is likely to help us find out more about how to improve children's health. It will further contribute to understanding the current predictors of relapse in child malnutrition after treatment.

How will we protect your Information and Confidentiality?

The information that we collect from this research project will be kept private. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is, and we will lock that information up with a lock and key. It will not be shared with or given to anyone outside of our project.

What will happen with the Results?

The knowledge that we get from this research will be shared with you in a stakeholder forum for validation before it is made widely available to the public. Following the meetings, we will publish the results so that other interested people may learn from the research.

Can I Refuse to Participate or Withdraw from the Study?

You do not have to take part in this research if you do not wish to do so. If you choose not to participate, you will continue to receive all of the normal services from your employer/ faculty/ university department that you usually get, and nothing will change. If you wish to stop participating in the study after you begin, you can stop at any time by telling

someone on our project team. If you choose to stop taking part, you will not be penalized.

Who Can I Contact?

If you have any questions about this interview or the study, you can ask anyone from our team now or later. If you have questions later, about your **rights as a research participant**, you may contact:

Patrick Amboka, (Principal Investigator) on Tel: +254702602571 or +254715688703 ambokapatrick2951@gmail.com.

If you have any questions about this interview or the study, please contact the local AMREF Ethics and Scientific Research Committee on email addresses:

esrc.kenya@amref.org cc samuel.muhula@amref.org or Call or write to:

The Research Officer, AMREF Kenya, Wilson Airport, Lang'ata Road.

Office Tel: +254 20 6994000, Fax: +254 20 606340,

P.O Box 30125-00100, Nairobi, Kenya

Do you have any questions currently?

Part II: Certificate of Consent

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked to have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant	[at least forename and surname]
Signature of Participant	
DD/MM/YYYY	

If visually impaired, physically impaired, mentally impaired or illiterate

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print Name of Participant	[at least forename and surname]
Thumb/Footprint of Participant	

Signature of Witness	[A literate witness must sign and should be selected by the participant and MUST have no connection to the research team.
DD/MM/YYYY	

Statement by the researcher/person taking consent.

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done**:**

1. At the visit, the participant will answer an interview of about 45-60 minutes
2. The participant's information will be kept confidential.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Print Name of Researcher/person taking the consent	[at least forename and surname]
Signature of Researcher/person taking the consent	
DD/MM/YYYY	

INFORMED CONSENT CHECKLIST

Participant ID: ***Please initial box***

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions, and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected. ☐

3. I give my permission for the interview/focus group to be audio recorded. I understand that the content of this activity will first be typed up word-for-word so the discussion can be analyzed by members of the research team. ☐

4. I understand that the audio recordings will be destroyed after they have been analyzed and published. ☐

5. I understand that although a number will replace my name on any subsequent reports, my anonymity cannot be guaranteed. ☐

6. I agree to take part in the interview/focus group discussion, and to be contacted again in case the research team deems it necessary to clarify any information during this activity. ☐

7. I agree for my data that is collected for the above study to be used in future research studies, which have been approved by a Research Ethics Committee. ☐

Name of Participant: _____ Date_____

Signature_____

Name of Person taking consent: _____ Date _____ Signature: _____

When completed, keep 1 copy for interviewee; and 1copy for researchers file?

APPENDIX XVII: Plagiarism Checker Certificate

Patrick Amboka

Patrick Amboka_Thesis

Proposals

MPH Proposals

Amref International University (AMIU)

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APPENDIX XVIII: Approval and Authorization Licences

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **857277**

Date of Issue: **03/May/2024**

RESEARCH LICENSE

This is to Certify that Mr.. Patrick Amboka of Amref International University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: Association between Acute Malnutrition Relapse after Treatment and Neurodevelopmental Outcomes among Under Five Children in Viwandani and Korogocho, Nairobi for the period ending : 03/May/2025.

License No: **NACOSTI/P/24/34714**

857277

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions

amref health africa

Amref Health Africa in Kenya

REF: AMREF – ESRC P1609/2024 **March 25, 2024**

Patrick Amboka
Amref International University
P.O. Box 10787-00100,
Nairobi, Kenya
Tel: +254702602571
Email: ambokapatrick2951@gmail.com

Dear Patrick Amboka,

RESEARCH PROTOCOL: ASSOCIATION BETWEEN ACUTE MALNUTRITION RELAPSE AFTER TREATMENT AND NEURODEVELOPMENTAL OUTCOMES AMONG UNDER-FIVE CHILDREN IN NAIROBI INFORMAL SETTLEMENTS.

Thank you for submitting your protocol to the Amref Ethics and Scientific Review Committee (ESRC).

The committee noted that this is a well written protocol. The following comments can help improve your protocol:

1. **Title:** Consider revising the title to address the fact that only 2 out of the 40 informal settlements in Nairobi will be included in the study.
2. **Literature Review:** Although substance use is mentioned, consider revising the Literature Review to specifically include the effects of maternal smoking and alcohol intake on childhood neurodevelopment,. Please refer to the following: *Polańska K, Jurewicz J, Hanke W. Smoking and alcohol drinking during pregnancy as the risk factors for poor child neurodevelopment – A review of epidemiological studies. Int J Occup Med Environ Health. 2015;28(3):419-443. doi:10.13075/ijomeh.1896.00424.*
3. **Study tools:**
   a. On page 20. MDAT tool. Clarify what this statement means: *"Says the other two worlds apart from the double-syllable words"*
   b. Quantitative questionnaire. Question 6 (maternal questions) is repetitious. What is the purpose of the following questions: *"In the past seven days..."* and *"Did your household use any of the following coping strategies in the past 30 days?"*.
4. **Study population:** Kindly note that the inclusion criteria (P13-14) do not quite match the 3 groups described in the narrative. Point 2 is unclear and could be removed.
5. **Sample size:** Kindly note that the study sites, sample size, and sampling methodology will not answer the first specific objective which is to determine the prevalence of acute malnutrition relapse after treatment among under-5 children in Nairobi informal settlements. Only 2 informal settlements are being studied, and the sampling is purposive and not randomized.
6. **Sampling procedures:** Consider indicating what is meant by *quota sampling*. For the qualitative data (IDIs; FGDs; KIIs), the protocol states that quota sampling will be used. The numbers of participants in each group (caregivers; healthcare providers, community health volunteers, and community health assistants) and for each type of activity need to be given. How will the Focus Group Discussions be organized?
7. **Participant recruitment:** Consider indicating which participants will be used for the pilot study to test the tools, and the number of participants.

NAIROBI CITY COUNTY
www.nairobi.go.ke

12 JUN 2024

HEALTH, WELLNESS AND NUTRITION

Office of the County Chief Officer – Medical Services

REF: NCCG/HWN/REC/554 **DATE: 14th MAY 2024**

PATRICK AMBOKA
AMREF INTERNATIONAL UNIVERSITY
NAIROBI

12 JUN 2024

Dear Mr. Patrick,

RE: RESEARCH AUTHORIZATION

This is to inform you that the Nairobi City County – County Health Research Ethics Committee (REC) reviewed the documents on the study titled "Association between Acute Malnutrition Relapse after Treatment and Neurodevelopmental Outcomes among Under Five Children in Viwandani and Korogocho, Nairobi."

I am pleased to inform you that you have been authorized to carry out the study in Nairobi County. The researcher will be required to adhere to the ethical code of conduct for health research in accordance with the Science Technology and Innovation Act, 2013 and the approval procedure and protocol for research for Nairobi.

On completion of the study, you will submit one hard copy and one copy in PDF of the research findings to the REC. In addition, you required to disseminate the research findings to health sector in liaison with the county REC. By copy of this letter, the Sub County Medical Officers of Health – Makadara, Embakasi North and Kasarani are to accord you the necessary assistance to carry out this research study.

Yours sincerely,

DR. IRENE MUCHOKI
CHIEF OFFICER MEDICAL SERVICES &
Ag. CHIEF OFFICER NUTRITION, WELLNESS & SCHOOL FEEDING PROGRAM

Cc: Chief Officers – Public Health and Health Facilities
Sub County Medical Officers of Health - Makadara, Embakasi North and Kasarani