FEEDING PRACTICES, NUTRIENT ADEQUACY AND NUTRITIONAL STATUS OF CHILDREN 12-23 MONTHS IN KWANIA AND APAC DISTRICTS, NORTHERN UGANDA

BY

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DECLARATION

This dissertation is my original work and has not been presented and published for a degree in any other University.

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Main Supervisor:

I approve that this dissertation is written under my supervision and is suitable for submission to the board of Examiners and Directorate of Research and Graduate Training of Kyambogo University.

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DEDICATION

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LIST OF ACRONYMS

AFRII	Africa Innovation Institute
LFA	Length for Age (HAZ)
IYCF	Infant and Young Child Feeding
HAZ	Height for age Z-scores
MAD	Minimum Acceptable Diet
MDD	Minimum Meal Frequency
MMF	Minimum Meal Frequency
MoH	Ministry of Health
MUAC	Mid Upper Arm Circumference
RTI	Respiratory Tract Infections
SD	Standard Deviation
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Scientists
UDHS	Uganda Demographic and Health Survey
UBOS	Uganda Bureau of Statistics
UNICEF	United Nations Children's Fund
WFA	Weight for Age Z-Scores (WAZ)
WFL	Weight for length
WHO	World Health Organisation

OPERATIONAL DEFINITIONS

Anthropometry	Measurement of body dimensions.
Complementary Feeding	Introduction of solid, semi-solid or soft foods at 6 months in addition to breastfeeding.
Continued Breastfeeding	The continuation of breastfeeding from 6 months to 24 months of the child's life.
Nutrition Status	A child's health condition as it is influenced by the intake and utilisation of nutrients.
Minimum Dietary Diversity	Consumption of foods and beverages from at least five out of eight defined food groups during the previous day.
Minimum Meal Frequency	Consumption of solid, semi-solid or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more during the previous day.
Minimum Acceptable Diet	Consumption of foods meeting a minimum meal frequency and minimum dietary diversity during the previous day.
Inadequate Nutrients	Nutrients whose intake is lower than the estimated average requirement.
Stunting	Length for age below −2 standard deviations (−2 z scores).
Underweight	Weight for age below −2 standard deviations (−2 z scores).

Wasting	Weight for length below −2 standard deviations (−2 z scores)
Dietary Practices	The dietary intake of an individual determined by their preference in food consumption, meal frequency, dietary diversity and nutrient adequacy of the diet.
Nutrient Adequacy	The level of intake of an essential nutrient in relation to the nutrient requirement for adequate health, which is expressed as the percentage of recommended dietary allowance.

ABSTRACT

Sub-optimal feeding practices is responsible for one third of all cases of child malnutrition. The effects are more severe in children between the ages of 12-23 months since this is a crucial period for development with irreversible effects of poor nutrition. The high prevalence of malnutrition among children in rural areas in Uganda, along with a dearth of insight on feeding practices and the nutrient adequacy of local foods, is proving to be a major concern.

To determine the association between feeding practices, nutrient adequacy and nutritional status of children 12-23 months in Apac and Kwania district.

This was part of an ongoing study which adopted quantitative cross-sectional and descriptive study design. Based on the 11.5% of children in Lango meeting a minimum dietary diversity, a sample size of 156 children was used. Multi stage simple random sampling was used to select households with the index child 12-23 months. Structured interviews, weighed food record and anthropometric assessment were used for data collection. Nutri-Survey (Version 2007), IMAPP (Version 1.0) and WHO Anthro softwares (Version 3.1) were used to analyze nutrient adequacy and categorize nutritional status respectively. Chi-square test and multinomial regression test were used to establish associates and predictors of nutritional status outcomes respectively. This was performed at a 95% confidence interval ($p < 0.05$).

About 18.6% of the children met the minimum dietary diversity (MDD), 28.2% met the minimum meal frequency (MMF) and 9.6% of the children met the minimum acceptable diet (MAD). The children's diet was inadequate in dietary fibre, vitamin B_1, B_2, vitamin E, calcium, iron, and zinc. 19.3% of the children were stunted, 12.2% of the children were underweight and 2.5% of the children were wasted. Wasting was significantly associated with bottle feeding ($p=0.019$, $\chi^2=5.47$) practice and late initiation of breastfeeding ($p=0.05$, $\chi^2=3.606$). Stunting was significantly associated with dietary diversity and meeting a minimum acceptable diet ($p=0.037$, $\chi^2=5.552$) and ($p=0.042$, $\chi^2=3.591$), respectively. Children with adequate calcium intake were 0.301 times less likely to be stunted (AOR=0.301, 95% CI: 0.113-0.803, p=0.016). Children who had inadequate intake of vitamin A were 7.9 times more likely to be underweight compared to those who took adequate amounts (AOR=7.967, 95% CI: 1.169-54.309, p=0.034).

In conclusion, this study highlights significant concerns regarding the sub-optimal feeding practices and inadequate nutritional content in the foods examined. The findings indicate a pressing need for improved dietary practices and increased attention to essential nutrients, including energy, niacin, iron, zinc, calcium, dietary fiber, and vitamins.

Keywords: Child nutrition, Feeding practices, Nutrient adequacy, Complementary foods.

CHAPTER ONE: INTRODUCTION

1.1 Background

Adequate nutrition during infancy and early childhood is essential to ensure the proper growth, health, and development of children (Corkins et al., 2016; Christian et al., 2015). The first 2 years of a child's life are particularly important, as optimal nutrition during this period lowers morbidity and mortality, reduces the risk of chronic disease, and fosters better development overall (UNICEF, 2017).

Globally, undernutrition accounts for more than a third (45%) of child deaths (UNICEF, 2016). The double burden of malnutrition including stunting and wasting, deficiencies in essential micronutrients, and overweight and obesity in children, continue to be of great concern (World Health Organization, 2021). Poor nutrition in the first 1,000 days of a child's life can lead to malnutrition, which is associated with impaired cognitive ability and reduced school and work performance (De Onis & Branca, 2016). The first two years of life provide a critical window of opportunity for ensuring children's appropriate growth and development through optimal feeding hence addressing malnutrition in children 6-23 months (Abiodun & Tamramat, 2013). Poor nutrition throughout the developmental years is associated with considerable morbidity, delayed mental and motor development, and death (UNICEF, 2017). Early dietary deficiencies are associated with worse intellectual ability, employment capacity, reproductive outcome, and general health during adolescence and adulthood (Patton et al., 2016). Infants aged 12-23 months are at a vital period for promoting adequate complementary diets, both in terms of quality and quantity, for optimal growth, health, and development. Inappropriate feeding methods during this period can have serious effects on the child's growth, development, and survival.

The 2019 global level and trend of child malnutrition report indicated that two out of five (40%) of the stunted children under five years and more than one quarter (27%) of the wasted children

live in Africa (UNICEF & WHO, 2019). The prevalence of vitamin A deficiency (VAD) in children under the age of five declined from 39 percent to 29 percent in low- and middle-income countries between 1991 and 2013 while in Sub-Saharan Africa, vitamin A deficiency prevalence increased from 45 percent in 1991 to 48 percent in 2014 (Stevens et al., 2015). In Eastern Africa, an estimated 69 percent of children under the age of five are deficient in either vitamin A or iron (UNICEF, 2019).

In Uganda, 29% of children under the age of five are stunted, it rises with age reaching 37% among children aged 18-35 months (UBOS & ICF, 2018b). Stunting is more common among children in rural settings (30%) than in urban areas (24%), with some regional differences. Anaemia affects more than half of children under the age of five reflecting a variety of nutritional deficiencies and infections (UBOS & ICF, 2018). Despite progress in economic growth and poverty reduction over the past decade, critical food security and nutrition problems persist in Uganda with the northern region having the greatest burden (UBOS, 2018).

The relevance of effective practices in early life is shown by the association between optimal complementary feeding practices and a 5 percent decrease in childhood stunting and up to a 6 percent reduction in childhood fatalities (Black et al., 2008). Nevertheless, in low- and middle-income nations complementary meals with low nutrient densities that do not satisfy young children's nutritional needs are frequently served. Meals with insufficient energy and the nutritional needs of infants and young children's rapid growth are the main cause of child malnutrition (Keeley et al., 2019). One of the most successful public health interventions to reduce child mortality in developing nations is to ensure that infants and young children have healthy eating habits, including the best complementary feeding practices (Lassi et al., 2020).

UNICEF and WHO recommend that children from age 6 months should be given solid or semi-solid complementary food in addition to continued breastfeeding until they are fully weaned

(UNICEF, 2019). The Infant and young child feeding (IYCF) guidelines recommend that breastfed children be fed from 4 or more foods groups at least twice a day for children 6–8 months, and at least three times a day for children 9–23 months (WHO, UNICEF, 2021). Before six months of age, complementary meals should not be offered to infants (UNICEF, 2017). It is advised that non-breastfed children have milk or milk products, as well as meals from four or more food categories, at least four times each day (Tiwari et al., 2016).

The 2016 UDHS (UBOS & ICF, 2018) indicates that the majority of infants and young children aged 6 – 23 months in Uganda were not being fed appropriately. Overall, a low proportion of children aged 6-23 months were fed a minimum acceptable diet among non-breastfed (13%) and breastfed (15%). There is regional variation in the proportion of children aged 6-23 months receiving the minimum acceptable diet, from 3% in the Acholi region to 27% in the Ankole region. In the Lango sub-region, only 11.3%, 28.7%, and 7.8% of the children 6-23 months of age had met the minimum dietary diversity, minimum meal frequency, and minimum acceptable diet respectively (UBOS & ICF, 2018).

The use of appropriate, locally available foods while introducing complementary meals is emphasized in the Global Strategy for Infant and Young Child Feeding (World Health Organization., 2003). The majority of developing nations, international organizations, and non-governmental organisations (NGOs) are advocating food-based strategies that use readily accessible local foods as a sustainable strategy to alleviate nutritional insecurity (Thompson & Amoroso, 2014). The use of locally available food during the complementary feeding period is aligned with traditional eating habits and cultural food preferences and it is assumed that local meals may be readily accepted by the community (Thompson & Amoroso, 2014). Another presumption of the food-based strategy is that it can easily be accessed, resulting in obtaining nutrient-dense foods locally for the children. Poor choice and combination of local foods may result in the inability of the children to meet the recommended nutrient requirements

(Osendarp et al., 2016). Additionally, there might be wide variations in cultures and eating habits, which makes it important to consider the nutritional profiles of regional foods when making dietary recommendations (Fahmida et al., 2015).

Using a set of tools and metrics to measure child dietary intakes in a more accurate manner like dietary analysis using Nutri-Survey software for linear programming and IMAPP software (Version 1.0), is one of the first steps to improving the nutritional quality of the diet of infants and young children based on local available and affordable foods. Understanding the nutrient adequacy of local complementary foods can reveal the presence or absence of essential nutrients in these foods. This knowledge is crucial for guiding caregivers and policymakers in formulating balanced diets for infants and young children to support their healthy growth and development. The aim of this study is therefore to determine the association between feeding practices, nutrient adequacy, and nutritional status of children 12-23 months in Kwania and Apac District, Northern Uganda.

1.2 Problem statement

Sub-optimal feeding is one of the leading causes of undernutrition which contributes to over 45% of all deaths among children under 5 years of age (World Health Organisation, 2021). Globally in 2020, 149 million children under 5 were estimated to be stunted, 45 million were estimated to be wasted, and 38.9 million were overweight or obese (World Health Organisation, 2021). Poor choice, inadequate quality of the complementary foods, and poor feeding practices are some of the contributing factors to malnutrition among infants and young children in a majority of African countries (UNICEF., 2016). Due to the use of mostly starchy staples, complementary feeds in sub-Saharan Africa is frequently inadequate of essential nutrients (Oladiran & Emmambux, 2022). While the 2016 Uganda Demographic and Health Survey (UDHS) report showed an increase in the percentage of infants exclusively breastfed infants for the first six months from 63 percent in 2011 to 66 percent in 2016, it also showed

that only 15 percent of infants aged 6 to 23 months had received the minimum acceptable diet during complementary feeding, meaning that 86% of infants had suboptimal feeding (UBOS & ICF, 2018). In the Lango sub-region, a serious problem in young child feeding is recorded as only 11.5% and 7.8% of the children 6-23 months of age are fed on foods with minimum dietary diversity and minimum acceptable diet respectively (UBOS & ICF, 2018b). A study in Lango by Omute & Kirungi, (2022), showed that early initiation of breastfeeding and exclusively breastfeeding was prevalent among 67% and 43.9% of the mothers respectively.

Despite the evidence from studies done in Uganda (Ickes et al., 2015, 2017; Mokori et al., 2017; Tumwesigye et al., 2016; Young et al., 2014; Birungi & Ejalu, 2022), regarding infant feeding and young child practices, little is known in Lango regarding the association between feeding practices, nutrient adequacy and nutritional status of children 12-23 month. However, evidence suggests the complementary feeding period of 12-23 months is when there is a spike in all three indicators of childhood malnutrition; stunting, underweight, and wasting (D'Auria et al., 2020; World Health Organization, 2009a; UBOS & ICF, 2018b). The levels peak at 16 months indicating the complementary feeding period is a high-risk period for malnutrition (UBOS & ICF, 2018b).

The challenges of poor complementary feeding practices in Uganda and the spike in malnutrition levels in that period possess several questions on whether the problem is linked to practices or the source of essential nutrients needed to nourish children appropriately. This study, therefore, assessed the linkage between feeding practices, nutritional adequacy of feeds and nutritional status of children 12-23 months. Establishing the existing feeding practices and the nutrient adequacy of complementary foods is a contribution to the knowledge and evidence for achieving Sustainable Development Goals (SDGs) for 2016-2030 especially SDG 2 on Zero

Hunger[1] and SDG 3 on Good Health and Wellbeing[2] (UN, 2015). In essence, the outcomes of this study may strengthen health and nutrition interventions targeting complementary feeding and overall growth and development of children in Uganda and other parts of the world.

1.3 Objectives of the study

1.3.1 General objective

The main of objective of the study was to establish the association between feeding practices, nutrient adequacy, and nutritional status of children 12-23 months in Kwania district and Apac district, Northern Uganda.

1.3.2 Specific objectives

The specific objectives of this study were to;

1. Assess the feeding practices of children 12-23 months of age in Kwania district and Apac district, Northern Uganda.
2. Determine the nutrient adequacy of complementary feed provided to children 12-23 months in Kwania district and Apac district, Northern Uganda.
3. Assess the nutritional status of children 12-23 months in Kwania district and Apac district, Northern Uganda.
4. Identify the association between feeding practices, nutrient adequacy and nutritional status outcomes in children 12-23 months in Kwania District and Apac district, Northern Uganda.

1.4 Study hypothesis

1. H0 (Null Hypothesis): There is no significant association between feeding practices, nutrient adequacy, and the nutritional status of children aged 12 to 23 months.

[1]End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
[2]Ensure healthy lives and ensure well-being for all at all ages.

2. H1 (Alternative Hypothesis): There is a significant association between feeding practices, nutrient adequacy, and the nutritional status of children aged 12 to 23 months.

Explanation:

The null hypothesis (H0) suggests that, feeding practices and nutrient adequacy might not have an influence on the nutritional status of children aged 12 to 23 months.

On the other hand, the alternative hypothesis (H1) proposes that specific feeding practices and adequate nutrient intake might have an influence on the nutritional status of children in this age group.

The study will aim to gather data through appropriate research methods, such as surveys, interviews, or dietary assessments, to explore the association between feeding practices, nutrient adequacy, and the nutritional status of children aged 12 to 23 months. The analysis of the collected data will then be used to either reject or fail to reject the null hypothesis, ultimately contributing to the understanding of the association between these variables in this particular age group.

1.5 Research questions

1. What is the nutritional status of children 12-23 months in Kwania District and Apac district, Northern Uganda?
2. Are the children 12-23 months in Kwania District and Apac district meeting the complementary feeding recommendations?
3. What nutrient gaps are in the complementary foods of children 12-23 months in Kwania District and Apac district?
4. Could there be an association between the feeding practices of children 12-23 months in Kwania District and their nutritional status?

1.6 Significance of the study

Establishing the dietary practices of the children and nutrient adequacy of local complementary foods aims at achieving the WHO emphasis in the Global Strategy for Infant and Young Child Feeding (World Health Organization., 2003) on the use of appropriate locally available foods while introducing complementary meals.

Establishing the dietary practices of the children and nutrient adequacy of local foods will also inform the development of a set of evidence-based, population-specific, food-based recommendations (FBRs) that can be promoted to improve the adequacy of local complementary foods and nutritional status of infants and young children in Lango Sub-region, Northern Uganda. This will also support policies that promote the use of locally available food during the complementary feeding period which is aligned with traditional eating habits and cultural food preferences as a sustainable strategy to alleviate nutritional insecurity (Thompson & Amoroso, 2014).

The findings from this study will also inform programming focused on improving caregivers' knowledge of the choice and combination of local complementary foods that will most likely enable the children to meet the recommended nutrient requirements during this period.

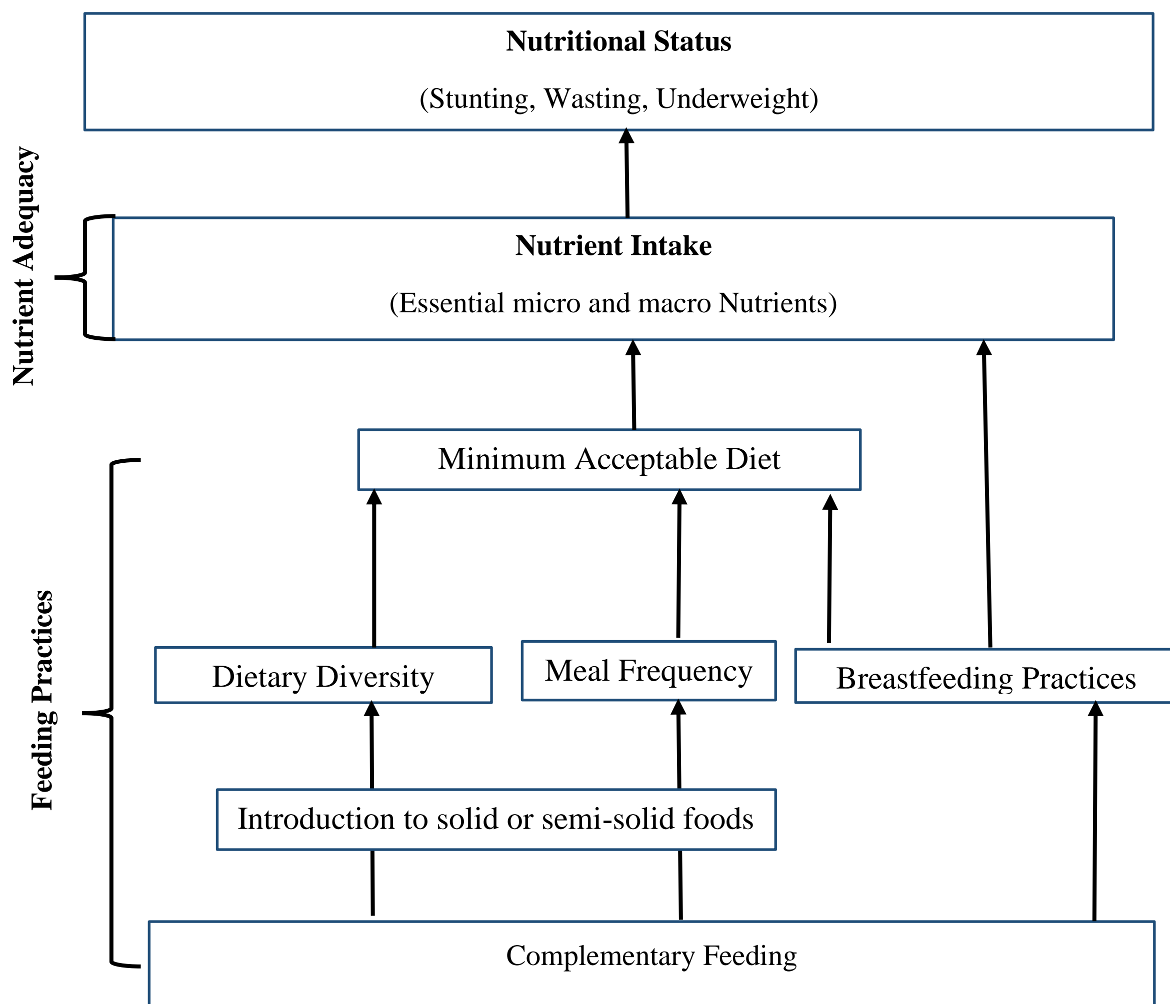
This study will also contribute to the body of knowledge. Academicians and scholars may use it as a useful addition to the body of available information on the nutritional adequacy of complementary foods for infants between 6-23 months in Kwania District and Apac district, Northern Uganda.

1.7 Conceptual framework

Complementary foods can be used to adequately feed and improve the nutritional status of children 12-23 months (Dewey, 2013; Dewey & Vitta, 2013; Fahmida & Santika, 2016). This

is only possible if appropriate dietary practices are followed in terms of foods meeting the minimum dietary diversity standards, and minimum meal frequency standards resulting in a minimum acceptable diet. Consuming a minimum acceptable diet increases the chances of adequate nutrient intake. In addition, following the recommended breastfeeding practices also contribute to an adequate nutrient intake during this period (World Health Organization, 2021). The intake of adequate amounts of nutrients from the diet is an important determinant of a child's nutritional status in terms of indicators like stunting, wasting, underweight, and other micronutrient deficiencies.

Figure 1: Association between dietary practices, nutrient adequacy, and nutritional status of Children 6-23 months



1.8 Scope of the study

This study aimed to investigate the association between feeding practices, nutrient adequacy, and nutritional status among children aged 12-23 months in Kwania and Apac districts, Northern Uganda. It involved a structured interview and measurement of weight and length. Dietary intake was assessed by using weighed food record. The primary variables of interest included feeding practices indicators, nutrient adequacy indicators and nutritional status indicators such as weight-for-height, height-for-age, and weight-for-age. By examining these factors in both districts, the research was seeking to identify potential associations, contributing valuable insights towards improving child nutrition and providing recommendations for targeted interventions to address any identified gaps in the feeding practices.

CHAPTER TWO: LITERATURE REVIEW

2.1 Nutritional status

2.1.1 Nutritional status of children

Nutritional status can be defined as one's health as influenced by the intake of and utilisation of nutrients (Todhunter, 1970). The National Research Council (US) Committee on Diet and Health (1989) and Himmelgreen and Miller (2018) define this as the state of a person's health as it is influenced by their nutrient intake and utilization. Undernutrition (undernourished) and over nutrition are two types of nutritional status. Stunting, wasting, and underweight issues are commonly caused by undernutrition or undernourishment, which frequently stems from a habit of poor nutrient intake or usage. Having an ideal nutritional status is seen to be a sign of health and is essential for both preventing and treating disease (WHO, 2003). To determine those who have a poor nutritional status (are malnourished) or are at danger of developing certain diseases, it is crucial to analyze the nutritional state of individuals.

Nutritional status can be assessed by several methods including taking anthropometric (body composition) measurements and collecting information about a client's medical history, clinical and biochemical characteristics, dietary practices, current treatment, and food security situation (FAO, 2007; Holmes, Racettel, & McCarthy, 2021). Anthropometry is the most useful tool for assessing the nutritional status of children. There are many anthropometric indicators in use, such as height for age, weight for age and weight for height (Hasan, Zulkifle, & Ansari, 2011). The nutritional status of children from 6 to 59 months was classified as follows, greater or equal to -1 z-score is normal, greater or equal to -3 z-score and less than -2 z-score (≥ -3 SD & < -2 SD) is known to be moderate acute malnutrition. Less than -3 z-score(<3SD) is known to be severe acute malnutrition (World Health Organizaton, 2023). Nutritional status can also be assessed using dietary assessment methods like 24hr recall, food frequency questionnaires and others.

In Uganda, the national prevalence of wasting among children 6-59 months of age is 4%, the prevalence of underweight among children under 5 years is (11%) and the prevalence of stunting among children under 5 years is 29% (UBOS & ICF, 2016). Stunting is 33 percent higher among first-born children of girls under 18 years (Sudfeld, Ezzati, & Fawzi, 2014). According to the Uganda Demographic and Health Survey report of 2016, the prevalence of iron anaemia among children age 6-59 months still stands at 53%. In Lango sub region, 27.1% of the children are stunted, 7.2% are wasted and 8.6% of the children below five years are underweight(UBOS & ICF, 2018a).

2.1.2 Infant feeding practices and nutritional status

The most crucial investment in optimal nutrition in the First 1000 Days is optimal baby, infant and young child feeding (Cunha et al., 2015; Pietrobelli et al., 2017). One of the six WHO global nutrition objectives is to increase the rate of exclusive breastfeeding to at least 50% by the year 2025, according to the Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition, which was approved by the World Health Assembly in 2012(World Health Organization, 2014).

Globally, malnutrition is the underlying cause of death of about 3 million (or 45%) under-five children every year. Of these, 11.6% (804,000) children die due to suboptimal breastfeeding (USAID, 2018). A study in Ethiopia also showed that higher dietary diversity score was associated with higher HAZ (Disha, et al., 2012). A study in Ethiopia showed a low attainment of minimum dietary diversity among children 6-23 months (Dinku et al., 2020). In another study in Nigeria the duration of breastfeeding was found to be statistically significant with the occurrence of wasting in under-fives (Olodu, Adeyemi, Olowookere, & Olapeju, 2019).

A study in Uganda showed that stunting in different parts of the country was associated with diets containing larger proportions of staple foods with lower diversity (Amaral, Herrin, &

Gulere, 2018). In Uganda it is also noted that only 15% of breastfed children aged 6–23 months receive a minimum acceptable diet, which might be one of the causes of malnutrition among children of that age group (UBOS & ICF, 2018a).

2.2 Infant and young child feeding practices

2.2.1 Complementary foods

Complementary meals are often made at the household level by caregivers using other conventional ways in the majority of low- and middle-income countries. These are sometimes referred to as handmade supplementary foods. In many developing countries, commercial fortified foods are typically out of reach for the poor. As a result, homemade complementary foods are increasingly being used during child feeding (USAID, 2010). The fundamental recipe food components used for the manufacture of supplemental meals are frequently based on locally accessible staples, however the choice of individual food item varies greatly amongst groups due to tradition, availability, and convenience of access (Kuyper et al., 2013). Cereals, roots, and starchy fruits are mainstays in many low and middle income countries because they are high in carbohydrates and give energy (USAID, 2010).

In South Africa, mothers frequently utilize mushy, bulky, and poor nutritional density maize meal porridge when introducing their new-borns to complementary foods. The maize meal is often diluted to a thin consistency with water, lowering the nutritional density while increasing the weight of the dish. Because of its high phytate content, iron and zinc absorption and bioavailability are severely impeded (Du Plessis et al., 2013).

A study in Ethiopia showed that, homemade complementary foods are predominantly based on cereals and legumes and mostly an extension of family foods. The complementary foods are made from staple cereals or starchy tubers such as maize, sorghum, millet, oat, teff, rice and

yam, potato, and barley and yam. The usual complementary foods are served as gruel, porridge, fetfet, kitta, and dabo. Consumption of animal-source foods as well as fruits and vegetables is very low (Du Plessis et al., 2013; Perlas, 2013; Temesgen, 2013).

A traditional fermented maize porridge was the predominant supplemental diet for new born babies up to 6 months of age, according to a research in Ghana (koko). The infants were fed the family food with additional nursing beginning at 6 months of age. When introducing complementary foods, family staples such as cereal, starchy tubers, legumes, and vegetables were employed (Oguntoyinbo, 2014; Onofiok & Nnanyelugo, 1998). In Guatemala, family meals utilized as supplemental foods are significantly short in micronutrients, such as iron, zinc, and calcium, even if appropriate levels of protein, B vitamins [vitamins B-1, B-2, B-6, and B-12], and vitamin C would be given (Allen, 2012).

2.2.2 Timely introduction to complementary foods

The World Health Organization recommends exclusive breastfeeding for 6 months and introduction of complementary foods at 6 months of age with continued breastfeeding (Dewey, 2003). The time of introduction and type of complementary food given to an infant are very important for the child's nutritional status. According to the WHO recommendations (World Health Organization, 2021), complementary feeding should be introduced into the child's diet at the age of 6 months. Early introduction of complementary foods increases infant morbidity and mortality while late introduction of complementary foods is harmful to the health of the baby, because infant growth stops or slows down and the risk of malnutrition and micronutrient deficiency increases (K. Dewey, 2003). A study in Ethiopia and Zambia showed that timely introduction of complementary food between 6-8 months of age was positively associated with WFA (ES 0.17, $p<0.001$ in Ethiopia; ES 0.04, $p<0.10$ in Zambia). These studies allude to the

need of reinforcing age-appropriate IYCF practices to address child undernutrition. (Disha, et al., 2012).

A study in Vhembe District of Limpopo Province in South Africa on infant feeding practices of mothers and nutritional status of infants revealed that about 43.2% of the infants had been introduced to foods at the age of three months, 18.9% at four months and above and 15.2% at two months and below (Mushaphi et al., 2008). Another study by (Kumudha et al., 2010) in the rural Utter Pradesh on increasing appropriate complementary feeding showed that only 13% of children were started on complementary food at the correct age of 6 months.

In Uganda, only 15% of the children consume a minimum acceptable diet. In Lango sub region, only 11. 3% of the children consume foods meeting a minimum dietary diversity, 28.7% of the children are fed on a minimum meal frequency and only 7.8% of the children met the minimum acceptable diet (UBOS & ICF, 2018a).

2.2.3 Continued breast feeding 12-23 months

According to the WHO Global Strategy for Infant and Young Child Feeding, children should breastfeed for at least two years (World Health Organization., 2003). After one year, children who are still breastfeeding can meet a significant percentage of their energy demands with breast milk in their diet. Breastfeeding should be continued during sickness because, while unwell children frequently have little interest for solid food, it can assist avoid dehydration while also delivering the nutrients needed for recovery (Abeshu et al., 2016). Breastfeeding might save half of all infectious illness fatalities between the ages of six and 23 months (Sankar et al., 2015).

Breastfeeding is consistently connected with greater IQ test performance in children and adolescents, with children breastfed for more than 12 months benefiting the most (Victora et al., 2015). Breastfeeding for longer lengths of time may lessen a child's chance of becoming

overweight or obese (Victora et al., 2016). Breastfeeding is particularly essential for moms since it lowers their risk of breast cancer and may lower their risk of ovarian cancer and type 2 diabetes (Chowdhury et al., 2015).

In the period 2010–2018, the weighed prevalence of continuous breastfeeding at 1 year is 83.1%, and at 2 years, it is 56.2%. Upper middle-income countries (38.4%) outscored lower middle-income countries (47.4%), while the Eastern Mediterranean (34.5%) and European regions (43.7%) outpaced South-East Asia/Western Pacific (55.2%) (Wu et al., 2021). South-East Asia/Western Pacific (51.0%), low-income (66.4%) or lower middle-income (58.2%) countries (vs. higher middle-income countries (81.7%), and other regions (68.3%–84.1%). In 44 selected LMICs, the overall prevalence of continued breastfeeding at 1 year declined by 1.7% (Wu et al., 2021). In Uganda, 86.9% of the children are continuously breastfed at 1 year while only 43.2% of the children continue breastfeeding at 20-23 months of age (UBOS & ICF, 2018a).

2.2.4 Meal Frequency

According to the WHO's guiding principles for feeding the breastfed child, complementary foods should be given to breastfed babies between the ages of 9 to 23 months are fed three to four times daily, with extra nutrient-rich snacks delivered once or twice daily (World Health Organization, 2021). The recommendation for non-breastfed children is increased by the Guiding Principles on Feeding the Non-Breastfed Child to 4-5 meals each day (World Health Organization, 2021). Suboptimal feeding of infant and young children might affect the overall amount of calories and micronutrients consumed, which can lead to growth retardation, stunting, and micronutrient shortages. In other countries, child feeding frequencies are higher compared to Uganda. A study done in rural Utter Pradesh (Kumudha et al., 2010) on the frequency of feeding showed a higher number of children (63%) aged 6-23 months who were

given the minimum recommended number of feeds. In Uganda, the minimum meal frequency is low as per WHO recommendations, the Uganda Demographic and Health Survey of 2016 revealed that of all the children 6-23 months, only two thirds were fed the minimum number of times (ICF & UBOS, 2016). In Lango sub-region the proportion is even lower (only 7.8%).

2.2.5 Minimum Dietary Diversity for Children (MDD)

Minimum Dietary Diversity for Children (MDD-C) is a measurement used to assess the nutritional quality of a child's diet (WHO, 2021). It emphasizes the consumption of a minimum number of food groups over a specific period, aiming to ensure children receive a diverse range of nutrients essential for their growth, health, and development.

According to WHO guiding principles for feeding the breastfed child and non-breastfed child, children aged 6-23 months should be provided a range of meals to ensure that nutrient demands are satisfied. Diverse food groups are connected with improved linear growth in early children (Onyango et al., 2014). A diet deficient in variety can raise the risk of micronutrient deficiencies, which can harm children's physical and cognitive development (Prado & Dewey, 2014).

The WHO (2021) recommendation minimum dietary diversity for children 6-23 months old is consumption of foods from ≥ 5 groups out of 8. The consumption is based on a 24-hour recall to avoid recall bias if the recall period was longer (World Health Organization, 2021). The consumption of foods from at least 5 food groups means that the child has a high likelihood of consuming at least one animal-source food and at least one fruit or vegetable that day, in addition to a staple food (grain, root or tuber). Providing a variety of foods from different food groups is seen as a challenge to many mothers. A study done in rural Utter Pradesh (Kumudha *et al.*, 2010) of children aged 6-23 months revealed that only 30% were fed at least three types

of food. A study in Ethiopia showed that higher dietary diversity score was associated with higher HAZ (Menon, 2012).

Another study by (Tessema et al., 2013) on the feeding patterns and stunting during early childhood in rural communities of Ethiopia showed that the median diet diversity score for the study participants was two, where 86% of the children had dietary diversity below the minimum dietary diversity recommended by the WHO (> 5 food groups) (World Health Organization, 2008). A study by Wu et al. (2013) in Wuyi county, China among children aged 6-23 showed similar results, their dietary diversity was poor as only 10.0% of the children were fed with foods from at least four food groups. Similarly, a study by Malhotra (2013) in India revealed that only 17% of children between the ages 12 and 18 months, were fed adequately from four or more food groups. In Uganda, 15% of the children are fed on a minimum dietary diversity while only 11.3% of the children in Lango sub-region are fed on a minimum dietary diversity (UBOS & ICF, 2018a).

2.3 Nutrient adequacy of local complementary foods

Nutrient adequacy refers to the sufficient intake of essential nutrients, such as vitamins, minerals, and macronutrients (carbohydrates, proteins, and fats), necessary for maintaining good health and preventing nutrient deficiencies (Hatløy et al., 1998). It ensures the body's physiological needs are met, supporting growth, development, and overall well-being.

Studies done in Eastern Uganda, Central Tanzania and South Africa, showed that the local complementary foods were rich in calories, protein, vitamin A, Vitamin C (Kimere et al., 2022; Raymond et al., 2017; Sayed & Schönfeldt, 2021). Other studies in Myanmar and South Africa showed that the local complementary foods provided adequate amounts of Vitamin B_{12} in the infants' diet (Sayed & Schönfeldt, 2021; Hlaing et al., 2016).

According to a study conducted in Ethiopia, just 4.2% of breastfed infants aged 6-23 months received a minimum recommended diet. According to this study, gaps are generally caused by low nutritional quality or poor feeding methods, if not both. Commercial fortified meals are frequently out of reach for the poor. As a result, handmade supplemental meals are still widely utilized (Abeshu et al., 2016). Complementary foods are required to offer enough energy density to meet a growing child's daily energy requirements. The quantity of kilocalories of energy in a food per millilitre per gram of that food is referred to as its energy density. The minimum energy density advised for supplemental meals is 0.8 kcal/g greater than that of breast milk. In actuality, the energy density of complementary meals ranges between 0.6 and 1.0 kcal/g, with watery and dilute foods having an even lower energy density of 0.3 kcal/g. Breast milk has an energy density of around 0.7 kcal/ml (World Health Organization, 2021). At 12-23 months, the total energy requirement for healthy breastfed babies is estimated to be 894 kcal/day (Prado & Dewey, 2014). In low and middle income countries, new-borns with "average" breast milk intake, the energy need from complementary food increases from 200 kcal/day to 500 kcal/day for children 12–23 months (World Health Organization, 2009b).

Infants and young children require more protein as they get older. The quantity of protein necessary to meet their daily dietary requirements (in grams per day) is 10.9 g for 12-23 months. Breast milk meets a major amount of infants' and young children's daily protein requirements. When typical breast-milk consumption is considered, the amount of protein required from complementary meals at 12-23 months is 6.2 g/day (57%) (Abeshu et al., 2016; Disha et al., 2012; Ferguson et al., 2015; Onyango et al., 2014; World Health Organization, 2008, 2021). The amount of micronutrients required from complementary meals ranges from 30 to 97%. For example, supplementary meals are required to include 97% iron, 86% zinc, 81% phosphorus, 76% magnesium, 73% sodium, and 72% calcium (Prado & Dewey, 2014; World Health Organization, 2009b, 2021).

2.4 Inadequate nutrients in local complementary foods

Inadequate nutrients are the specific nutrients found to be below the recommended requirement in the diet. The determination of inadequate nutrients in local complementary foods is a step towards developing food based recommendations that fills the nutrient gaps. According to studies in Myanmar, Eastern Uganda and Rural Kenya, iron was inadequate in local complementary foods, meaning that there was a discrepancy between the amount of iron required by the infant and the actual amount observed in the diet (Hlaing et al., 2016; Kimere et al., 2022; & Ferguson et al., 2015). Studies in Kwazulu Natal, South Africa, Eastern Uganda, Rural Kenya and Indonesia shows that Zinc and Calcium were also inadequate in the local complementary foods (Sayed & Schönfeldt, 2021; Kimere et al., 2022; Hlaing et al., 2016 & Santika et al., 2009). Niacin was also inadequate in infants' complementary foods according to studies done in South Africa, Indonesia and Uganda (Hlaing et al., 2016; Fahmida et al., 2015; Kimere et al., 2022).

CHAPTER THREE: METHODOLOGY

3.1 Study design

The study adopted a cross-sectional descriptive design and employed quantitative and qualitative data collection and analysis methods. This design was appropriate in collecting data regarding the food intake of children 12-23 months to support understanding their dietary practices, nutrient adequacy of their foods, and its association with the nutritional status of the children. The design was selected because it is relatively quick and easy to collect data on all variables at once, multiple outcomes and exposures can be studied and most importantly the design is good for descriptive analysis (Aggarwal & Ranganathan, 2019; Omair, 2015; Ranganathan & Aggarwal, 2018).

This study was part of an ongoing Innovative Methods and Metrics for Agriculture and Nutrition Actions (IMMANA) research project grant. The project aimed to refine and validate, two novel ICT tools to measure maternal time use, and / or practices related to diet, hygiene, and childcare from households with children aged 12-23 months in northern Uganda.

3.2 Study area

The study was conducted in the Apac district and Kwania district in Northern Uganda. Apac district is located approximately 30km by road, southwest of Lira, the largest city in the Lango sub-region, coordinates 1.8730° N, 32.6277° E (GlobeFeed, 2022). This location is about 230 kilometers (140 mi), by road, north of Kampala, the capital and largest city of Uganda. Apac district is composed of sub-counties like Abongomola, Aduku, Akokoro, Apac Town Council, Cegere, Chawente, Ibuje, Inomo, and Nambieso (Apac, 2020). Kwania district is a district in Northern Uganda. It was formed from the Apac district sub-counties Chawente, Abongomola, Nambyeiso, Inomo, Aduku; and Aduku town councils. The other sub-counties are Ayabi,

Ayabi town council, Akali, Atongtidi, and Inomo town council, totaling 11 sub-counties, coordinates 1.9033° N, 32.7633° E (Kwania, 2021). In Apac, the study was conducted in the seven sampled villages of Ajo-odur, Miciri B, Ayomjeri, Aluga Central, Adyegi Ibana, Ajwinya, and Abongo-dero, meanwhile, in Kwania, the study was conducted in the six sampled villages of Abapiri, Odalowang, Amia A, Etekiber, Omwono B and Agwa A.

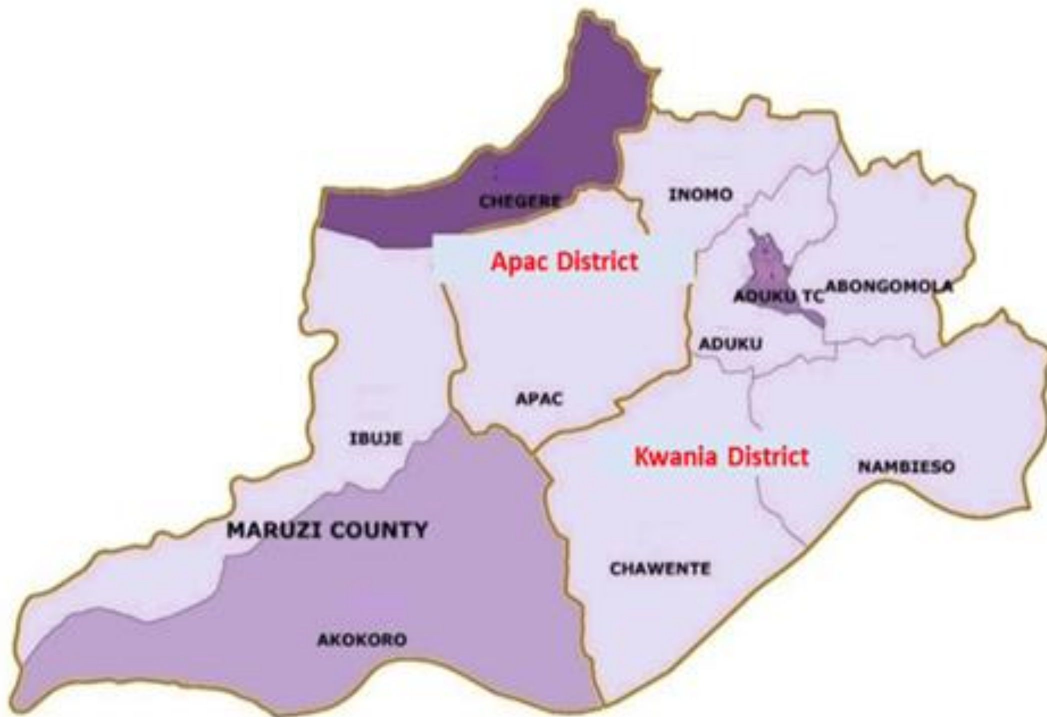


Figure 2: Map of Apac district and Kwania district

3.3 Study population

The primary respondents in this study were mothers with children 12-23 months randomly selected to participate in Apac and Kwania districts. Our primary target was children 12-23 months however the information was got from their biological mothers who were selected to participate in the study. This age group was considered for the study because it is more likely to find children 12-23 who are feeding on more diversified family foods compared to children below 12 months (Bedada et al., 2020). This allows for a more comprehensive understanding

of their feeding practices and nutritional outcome. The likelihood of finding mothers with two children within the same age range is also low so the study considered the upper range (12-23 months) of the complementary feeding period.

3.5 Selection of participants

Inclusion criteria

(i) The study included only children 12-23 months in the selected villages from Apac and Kwania districts.

(ii) The study included only mothers in the selected villages from Apac and Kwania districts who consented to participate.

Exclusion criteria

(i) The children who were sick at the time of data collection were excluded from this study because the illness may influence the findings.

(ii) Mothers whose spouse refuses to give consent to participate in the study were also excluded from the study.

(iii) Mothers with more than one child between the age of 12-23 months were excluded from the study

(iv) Children who were not cared for by their biological mothers were excluded from the study.

(v) Multiple birth children such as twins and triplets were excluded from the study

3.6 Sampling procedure

The sample size of 156 was distributed by Probability Proportional to Size (PPS) at the district level, with the populations in the different districts being the measure of size. In Apac district, 84 participants were randomly selected and 72 were randomly selected from Kwania district.

Multistage sampling method applying a simple random sampling technique was used to select the participants by chance using the procedure below.

Apac district has 10 sub-counties and 52 parishes while Kwania district has 11 sub-counties and 49 parishes. Four sub-counties were randomly selected from Apac district and 4 sub-counties were randomly selected from Kwania district. In Apac district 7 Parishes were randomly selected (using Microsoft Excel application) from the 4 sub-counties and in Kwania district 6 parishes were randomly selected from the 4 sub-counties. Among the 7 parishes selected from Apac district, 1 village was randomly selected per parish. In Kwania district 1 village was also randomly selected per parish. The list of all eligible participants in the selected villages was provided by Chairperson LC 1 and assigned random numbers. From each village, 12 participants were randomly selected village to participate in the study.   The study therefore lasted for two and half months with 12 female enumerators.

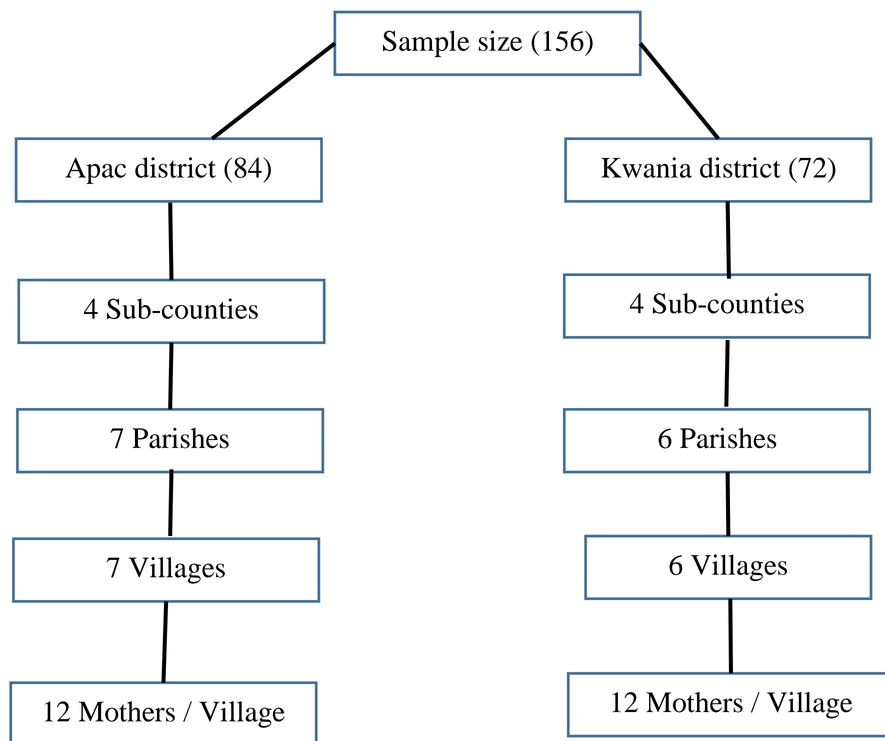


Figure 3: Sampling Procedure

Using a multistage sampling method made it possible to draw a sample from a population using smaller and smaller groups (units) at each stage while using a simple random sampling is a enabled the researcher to randomly select a subset of participants from a population.

3.4 Sample size determination

The sample size was calculated using Fisher's formula. This formula was used because it allows for calculating an ideal sample size given a desired level of precision, desired confidence level, and the estimated proportion of the attribute present in the population (Fisher, 1925).

$$n = \frac{Z^2 Pq}{d^2}$$

Where n= the desired sample size

z= the standard normal deviation which is 1.96 at a 95% confidence interval

p= proportion of children meeting the minimum dietary diversity in the Lango sub-region 11.5% percent in rural areas (UBOS & ICF, 2018)

q=1-p the proportion of mothers with adequate nutrition knowledge.

d= Precision (set at 0.05)

Therefore;

$$n = \frac{Z^2 Pq}{d^2}$$

n= $(1.96)^2$X0.115X (1-0.115)/0.0025 =156

3.7 Definition of study variables

The research study was conducted based on two variables described as the independent and the dependent variables as demonstrated in the conceptual framework components in Table 1.

Table 1: Definition of study variables

Dependent variables	Independent variables
Weight for age Z-score (Underweight)	Ever breastfed
Height for age Z-score (Stunting)	Initiation of breastfeeding after birth
Weight for height Z-score (Wasting)	Exclusively breastfed for 6 months after birth
	Continued breastfeeding for 12-23 months
	Minimum Dietary Diversity (MDD)
	Minimum Meal Frequency (MMF)
	Minimum Acceptable Diet (MAD)
	Bottle feeding
	Nutrient adequacy of the foods

3.8 Data collection methods

3.8.1 Measuring length

A calibrated length board was used in the measurement of length. Children were measured while lying down, barefoot, and with no headgear. Children's shoulder blades, buttocks, and heels touched the surface of the length board; knees were fully straight and arms stretched on the sides; and the neck was straight with eyes looking straight ahead with the headpiece/foot piece placed firmly in position during measurement. The measurement was read to the nearest 0.1 cm.

3.8.2 Measuring weight

A *multicenter Growth Reference Study (MGRS) portable electronic scale* (specifically the UNICEF electronic scale 890 or UNISCALE) with taring ability was used to measure the weight of the children (Bhan & Norum, 2004). The weighing scale was calibrated to zero before

each measurement is taken. Mother was made to first stand on the scale and her weight tared. The assistant handed the child to the mother and the weight readings were taken as soon as the indicator on the scale has stabilized. The weight was recorded to the nearest 0.1kg (100g). Duplicate, serial (i.e., all child measurements were done twice).

3.8.3 Assessing feeding practices

To determine whether the child was consuming a minimum meal frequency, minimum dietary diversity, and minimum acceptable diet, the day's food and beverage intake for each child was measured and recorded in a weighed food record (WFR) form. The enumerator weighed every meal and drink the child was being served. In case the food was being prepared at home, the enumerators weighed raw components for the recipe and the final cooked food, and they recorded the cooking techniques. In addition, a structured questionnaire was also used to establish the mothers' other breastfeeding practices like whether the child has ever been breastfed, was introduced to breastfeeding within 1 hour after birth, was still on continued breastfeeding and whether the child was exclusively breastfed for the first two days after birth. The bias in the weighed food record dietary assessment method was reduced through the sensitization of the participants about the relevance of the study and the need to maintain a normal lifestyle and usual eating pattern during the period of data collection. Probing was also done in order to have an in-depth understanding of the family infant or young child meal pattern.

3.9 Data collection tools

3.9.1 Nutritional status assessment tools

Weight and length of children were assessed by use of a length Board and a *multicenter Growth Reference Study (MGRS) portable electronic scale* with the taring ability.

3.9.2 Complementary feeding practices

In this study, the Weighed Food Record (WFR) method was employed to collect detailed data on feeding practices for children using direct observation, measurement, and recording techniques. Data collection was carried out over a 13-hour period, starting from when the households woke up until they went to sleep, ensuring a comprehensive assessment of the child's daily food intake.

The data collectors used a Weighed Food Record form (Annex 2) and a precise dietary scale (1 g; Salter Disc Electronic Digital Scale) to capture accurate information on the foods consumed by the child throughout the day. The process began with the preparation of food, where researchers weighed each ingredient before cooking. This initial measurement provided a baseline for understanding the quantity and type of food prepared. As the food was served to the child, the exact amount was measured and recorded. This step ensured that the data reflected the specific portions offered to the child. After the child finished eating, any leftovers were weighed and documented. By subtracting the weight of the leftovers from the initial serving, researchers accurately determined the actual food intake.

To mitigate the ethical challenges of the Weighed Food Record (WFR) method in dietary assessment, researchers sought informed consent, explained to participants to help them understand the study's purpose and procedures. Further, I requested them to treat the period of study as their normal routine as much as possible. Participants were explicitly informed of their right to refuse participation or withdraw at any time, especially in situations where they felt uncomfortable. This approach prioritized respect for participant autonomy and minimized potential behavioural changes due to the study's intrusiveness.

To limit the change of behaviour, comprehension sensitization was also done to emphasizing that the household continue with their normal way of life.

3.9.3 Validity, reliability of research tools

Reliability and validity test for the Seca weighing scale and length board was performed through conducting a rigorous assessment. Reliability was examined through test-retest methods, ensuring consistent results over multiple trials. Additionally, inter-rater reliability was evaluated by comparing measurements from different operators. For validity, criterion validity was assessed by comparing measurements with a gold standard (reference scale). Construct validity was tested by correlating measurements with related variables. Calibration checks and maintenance was performed to ensure accuracy over time. A comprehensive evaluation of both reliability and validity ensured the equipment's precision and accuracy in measurements.

3.9.4 Pretesting of research tools

The research tools were like Seca scale, weighed food record, and length board were pretested through performing pilot testing with a small sample in Naguru go down in Kampala and Akot in Kwania district. Pretesting assessed the effectiveness and identified potential flaws in the research tools which enabled necessary improvements. This ensured the reliability and validity of the tools before implementing them in the main research study.

3.10 Data analysis

3.10.1 Nutritional status classification

Raw data was cleaned, coded, and entered into the computer using Statistical Package for Social Sciences (SPSS) and WHO Anthro software. Descriptive statistics was established using Statistical Package for Social Sciences (SPSS version 23). The children's nutritional status was analysed using WHO Anthro (Version 3.1) interpreted using the Z- Score (WHO, 2006a). Children with a Z-score of below -2SD for WFA, WFH, and HFA were considered underweight, wasted, and stunted respectively. Children below -3SD for WFA, WFH, and HFA

were considered severely malnourished. Children between -2SD and -3SD for the above indices were considered moderately malnourished. Those above -2SD were considered normal or well-nourished (WHO, 2006a).

3.10.2 Analysing feeding practices

The data collected and the responses were entered into SPSS (version 23) for analysis. The main feeding practice indicators were breastfeeding indicators and complementary feeding indicators. The proportion of the above practices by the mothers was determined by running SPSS frequencies to determine the infant feeding indicators as shown in Table 2 below.

Table 2: Analysis of the infant feeding practices using SPSS

Feeding Practice	**Analysis**
Ever breastfed	Percentage of children born in the last 24 months who were ever breastfed.
Early initiation of breastfeeding	Percentage of children born in the last 24 months who were put to the breast within one hour of birth.
Continued breastfeeding for 12-23 months	Percentage of children 12–23 months of age who were fed breast milk in a day.
Exclusive breastfeeding	Percentage of children 12–23 months of age who were exclusively breastfed for the first 6 months after birth.
Bottle Feeding	Percentage of children 12–23 months of age who were fed from a bottle with a nipple in a day.
Minimum Dietary Diversity	Percentage of children 12–23 months of age who consumed foods and beverages from at least five out of eight defined food groups in a day (WHO, 2021).

Minimum Meal Frequency	Percentage of children 12–23 months of age who consumed solid, semi-solid, or soft foods at least 3 times a day for breastfed children and at least 4 times a day for non-breastfed children in a day.
Minimum Acceptable Diet	Percentage of children 12–23 months of age who consumed a minimum acceptable diet in a day.

3.10.3 Establishing nutrient adequacy

The Weighed Food Record data was cleaned and entered into Nutri-Survey software for analysis and IMAPP. Data from Nutri-Survey was entered into IMAPP for nutrient adequacy analysis. The IMAPP software use the principles explained below.

Nutrient adequacy ratio (NAR) which is the level of intake of an essential nutrient in relation to the nutrient requirement for adequate health, expressed as the percentage of recommended dietary allowance was determined using the Nutri-Survey software. Dietary analysis using Nutri-Survey software for linear programming is one of the first steps to improve the nutritional quality of the diet of infants and young children based on locally available and affordable foods (Briend et al., 2001). It was assessed whether dietary requirements for nutrients including protein, energy, fiber, and each of the 11 vitamins A, B6, B12, C, thiamine, riboflavin, niacin, folate, calcium, iron, and zinc met the recommended daily requirement for the individual child. Each nutrient's percentage was computed by dividing the individual's intake of that nutrient by the Recommended Daily Allowance (RDA) for that micronutrient and then multiplying the result by 100. The maximum NAR value for each individual was 100% (Hatløy et al., 1998).

The NAR of the average daily intake of selected vitamins and minerals was calculated on the basis of the American Recommended Dietary Allowances (National Research Council, 1989).

As an overall measure of the nutrient adequacy, the Mean Adequacy Ratio (MAR) was calculated as described by (Madden et al., 1976):

MAR (Mean Adequacy Ratio) = Sum of NAR (each truncated at 1) / Number of nutrients

NAR was truncated at 1 so that a nutrient with a high NAR could not compensate for a nutrient with a low NAR.

The level of intake of an essential nutrient in relation to the nutrient requirement for adequate health (nutrient adequacy) was evaluated by computing the Mean Adequacy Ratio of the diet using Nutri-Survey. The mean adequacy ratio (MAR) is a measure that is used to evaluate the quality of dietary intake (Patrick & Yoder, 1971). It was measured by comparing the daily nutrient intake of children to a standard or recommended level of nutrient intake. The MAR was calculated by dividing the mean intake of a nutrient by the recommended dietary allowance (RDA) for that nutrient. A value of 1.0 or higher indicated that the average intake of a nutrient is sufficient to meet the RDA (Hatløy et al., 1998). A value less than 1.0 suggested that the average intake of the nutrient is below the RDA and may indicate a risk for nutrient deficiency (Inadequate Nutrient).

Non-breastfeeding children were excluded from the nutrient adequacy analysis since including them while using breast milk as a reference would lead to inaccurate and misleading results (World Health Organization, 2010). In addition, the nutritional requirements of non-breastfeeding children can differ from those of breastfed infants since non-breastfed children have a wide range of dietary options, including various formulas and solid foods which have distinct compositions.

3.10.4 Association between feeding practices, nutrient adequacy and nutritional status

This was established using a chi-square statistical test where a P-value less than 0.05 meant a statistically significant association between the variables. This analysis was performed using SPSS software and association was established between the feeding practices indicators, nutrient intake and nutritional status indicators. Variables that were significantly associated were considered for multinomial logistic regression (at $p < 0.05$) to determine the potential predictors of nutritional status.

3.11 Ethical considerations

Permission to conduct this study was initially granted by the Directorate of Research and Graduate Training of Kyambogo University. The ethical approval was obtained from the Uganda Council for Science and Technology (UNCST) (A24ES), the London School of Hygiene and Tropical Medicine's Observational / Interventions Research Ethics Committee (Project ID: 1420), and University of Greenwich's Faculty of Engineering and Science Ethics Committee (Project ID: BO501). Following community sensitization, verbal explanation of the study, and demonstration of study the methodology, a signed informed consent/thumbprint was obtained from all mothers who participated in the study. Permission was obtained from the head of the different households before the commencement of data collection.

The study exclusively employed female data collectors to interact with female caregivers, thereby minimizing ethical concerns and preventing potential male intrusion into female-dominated spaces. To mitigate the ethical challenges of the Weighed Food Record (WFR) method in dietary assessment, researchers sought informed consent, ensuring participants understood the study's purpose and procedures. Participants were explicitly informed of their right to refuse participation or withdraw at any time, especially in situations where they felt uncomfortable.

CHAPTER FOUR: RESULTS

4.1 Child characteristics and household socio-demography

One hundred and fifty-six young children aged 12-23 months from 156 predominantly rural households were surveyed in Apac district (53.8%) and Kwania district (46.2%) in Northern Uganda. Over 60 percent of the children were aged 18–23 months, while the remaining 13.9% were aged 12-17 months. The mean (SD) age of the children was 18.2 (3.66) months with no difference observed across the two districts. Over 53.2% of the children were males and 46.8% were females. The majority (58%) of the children were from households with 1-5 members while 42% of the children were from households with more than five members. Overall, the mean (SD) household size was 5.6 (2.76), with no significant difference across districts. Most of the children (46.8%) in the study were from mothers aged 18-25 years old, 35.3% from mothers 26-35 years old, and only 17.9% of the children were from mothers 36-51 years old. The mean (SD) age of the mothers was 27.7 (7.20). On average, the mothers from Apac district were slightly older than the mothers from Kwania district with mean (SD)age of 28.2 (7.15) and 27.1 (7.20) respectively. The mothers were mostly in monogamous marriages (48.1%), 13.5% in polygamous marriages and 21.1% of the mothers were cohabiting. Regarding the mothers' religion, 98.7% of the mothers were Christians while only 1.3% of them were Muslims. Regarding education level, majority (62.5%) of the mothers had incomplete primary education and only 6.5% had attended tertiary education. Over 73.1% of the mothers knew how to read and write while 23.1% of the mothers could neither read nor write (Table 3).

Table 3: Sociodemographic characteristics of the children and mothers

Characteristic		All samples (%)	Apac (%)	Kwania (%)
Children's age	12-17 Months	62(39.8)	35(56.5)	27(43.5)
	18-23 Months	94(60.2)	49(52.1)	45(47.9)
	Total	156(100)	84(53.8)	72(46.2)

Mean children's age	Mean (SD)	18.2(3.66)	18.1(3.93)	18.3(3.35)
Sex of child	Male	83(53.2)	46(55.4)	37(44.6)
	Female	73(46.8)	38(52.1)	35(47.9)
	Total	156(100)	84(53.8)	72(46.2)
Household size	1-5 Members	90(57.7)	45(50)	45(50)
	>=6 members	66(42.3)	39(59.1)	27(40.9)
	Total	156(100)	84(53.8)	72(46.2)
Mean household size	Mean (SD)	5.6(2.76)	5.6(2.22)	5.6(2.35)
Mothers' age	18-25 Years	73(46.8)	37(50.7)	36(49.3)
	26-35 Years	55(35.3)	31(56.4)	24(43.6)
	36-51 Years	28(17.9)	16(57.1)	12(42.9)
	Total	156(100)	84(53.8)	72(46.2)
Mean mothers age	Mean (SD)	27.7(7.20)	28.2(7.15)	27.1(7.20)
Religion	Christianity	154(98.7)	83(53.9)	71(46.1)
	Islam	2(1.3)	1(50)	1(50)
	Total	156(100)	84(53.8)	72(46.6)
Marital status	Single	15(9.6)	8(53.3)	7(46.7)
	Monogamous married	75(48.1)	37(49.3)	38(50.7)
	Polygamous married	21(13.5)	14(66.7)	7(33.3)
	Separated/Divorced	10(6.4)	7(70)	3(30)
	Widow	1(0.6)	1(100)	0(0)
	Cohabiting	34(21.8)	17(50)	17(50)
	Total	156(100)	84(53.8)	72(46.6)
Mothers education	No formal education	7(4.5)	4(57.1))	3(42.9)
	Primary incomplete	98(62.8)	58(59.2)	40(40.8)
	Primary complete	25(16)	11(44)	14(56)
	Senior incomplete	14(9)	5(35.7)	9(64.9)
	Senior complete	2(1.3)	1(50)	1(50)
	Tertiary	10(6.4)	5(50)	5(50)
	Total	156(100)	84(53.8)	72(46.6)
Mothers literacy	None	36(23.1)	20(55.6)	16(44.4)
	Only read	6(3.8)	3(50)	3(50)

	Read and write	114(73.1)	61(53.5)	53(46.5)
	Total	156(100)	84(53.8)	72(46.6)

4.2 Feeding practices of children 12-23 months

Results in Table 4 show that over 98.7% of the children were ever breastfed. A majority (53.3%) of the sampled children were introduced to breast breastfeeding beyond one hour after birth and only 46.7% of the children were introduced to breast milk within one of birth. Only 10.9% of the children were not exclusively breastfed for the first six months after birth. Over 77% of the children were on continued breastfeeding and 25% of the children were on bottle feeding and breast milk. Most of the children (89%) were introduced to complementary foods at 6 months of age, and over 11% of the children were introduced to complementary feeding before 6 months of age.

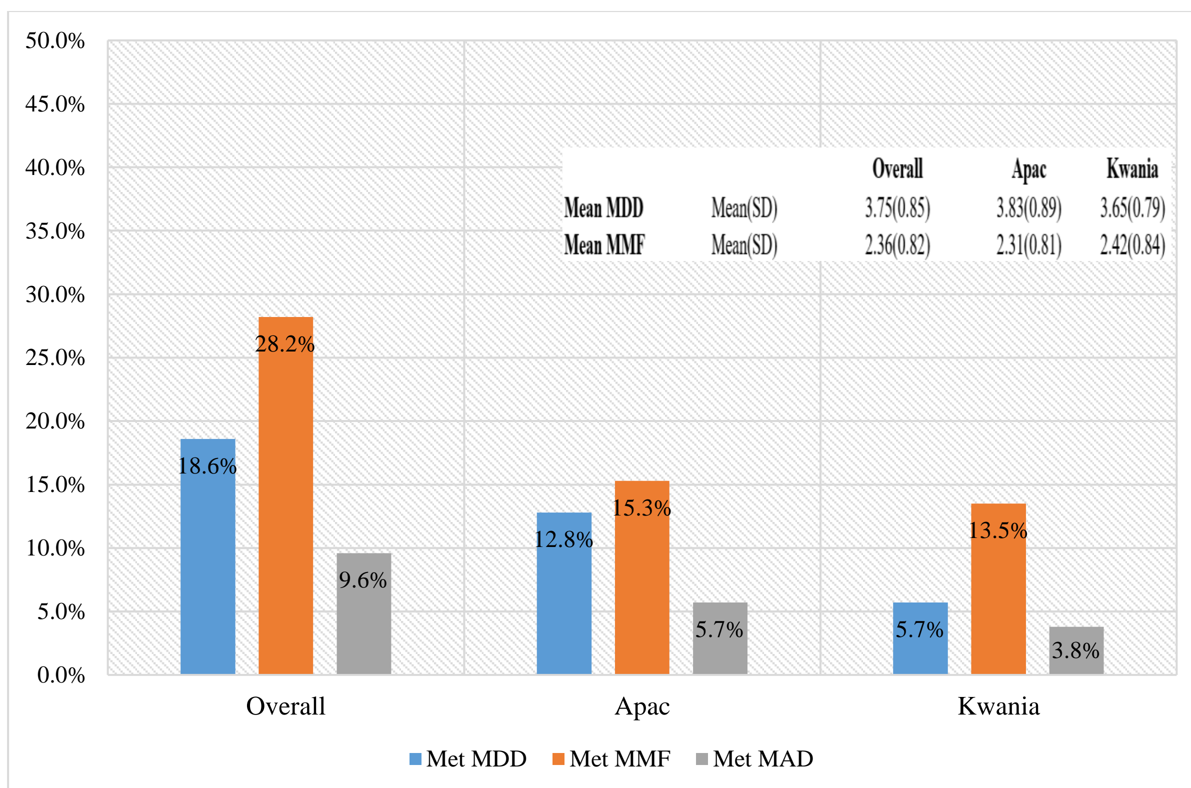
Table 4: Breastfeeding practices and bottle feeding practice among of children 12-23 months

Feeding Practices		**All Sample(N=156)**	**Apac (n=84)**	**Kwania(n=72)**
Child breastfed	No	2(1.3)	1(50)	1(50)
	Yes	154(98.7)	83(53.9)	71(46.1)
	Total	156(100)	84(53.8)	72(46.2)
Initiation of breastfeeding	<=1 Hour	72(46.7)	34(47.2)	38(53.5)
	> 1 hour	82(53.3)	49(59.8)	33(46.5)
	Total	154(100)	83(53.9)	71(46.1)
Exclusive breastfeeding	No	17(10.9)	9(52.9)	8(47.1)
	Yes	139(89.1)	75(54)	64(46)
	Total	156(100)	84(53.8)	72(46.2)
Continued breastfeeding	No	36(23.1)	19(52.8)	17(47.2)
	Yes	120(76.9)	65(53.3)	57(46.7)
	Total	156(100)	84(53.8)	72(46.2)
BF stop age	9 to 15 Months	10(27.8)	6(60)	4(40)
	16 to 23 months	26(72.2)	12(46.2)	14(53.8)
	Total	36(100)	18(50)	18(50)
Bottle feeding	No	117(75)	62(53)	55(47)
	Yes	39(25)	22(56.4)	17(43.6)

	Total	156(100)	84(53.8)	72(46.2)
Timely introduction of complementary feeding	No	17(10.9)	9(52.9)	8(47.1)
	Yes	139(89.1)	75(54)	64(46)
	Total	156(100)	84(53.8)	72(46.2)
Breastfed last night	No	36(23.1)	19(52.8)	17(47.2)
	Yes	120(76.9)	65(53.3)	57(46.7)
	Total	156(100)	84(52.5)	72(46.2)

The complementary feeding practices among children 12-23 months in Apac and Kwania districts

The complementary feeding practices findings in Figure 4 shows that 18.6% of the sampled children had consumed meals meeting the minimum dietary diversity (MDD) standard of at least five different food groups per day out of the eight food groups. 12.8% and 5,7% of the children met the MDD standard in Apac and Kwania districts respectively. The mean (SD) MDD for the two districts was 3.75 (0.85), with the mean (SD) MDD more in Apac district compared to Kwania district, 3.83(0.89) and 3.65(0.79) respectively. 28.2% of the sampled children 12-23 months in Apac and Kwania were consuming a Minimum Meal Frequency (MMF) of at least 2 to 3 meals for breastfed and at least 3 to 4 meals for non-breastfed children per day. In Apac and Kwania districts, 15.3% and 13.5% had meet the minimum meal frequency standard respectively. The mean (SD) MMF for the two districts was 2.36 (0.82), with the mean MDD more in Kwania district compared to Apac district, 2.31 (0.81) and 2.41 (0.84) respectively. The overall acceptability of a child's diet (Minimum Acceptable Diet(MAD) based on meeting a minimum dietary diversity and a minimum meal frequency was also assessed and our findings show that only 9.6% of the children 12-23 months of age in Apac and Kwania had met the minimum acceptable diet. In Apac district, 5.7% children had met the MAD standard while in Kwania district 3.8% had met the MAD standard.



Key: MDD- Minimum dietary diversity, MMF- Minimum Meal Frequency, MAD- Minimum acceptable diet.

Figure 4: The complementary feeding practices among children 12-23 months in Apac and Kwania districts

Consumption of foods from different groups by children 12-23 months

The weighed food record results in Figure 4 shows that all the children consumed at least one food from the cereals, roots, tuber, and plantains group. The majority of the children ate cassava, sweet potatoes, and maize porridge or posho. 85% of the children ate food from the legumes, nuts, and seeds groups. Beans and ground nuts were the most common foods consumed from the legumes, nuts and pulses food group. In addition, 16.7% of the children consumed milk and milk products, the majority of which were cow's milk. Eggs consumption was found to be the lowest among children, at only 2.6%. Furthermore, 25.6% of the children ate fleshy foods high in animal protein, such as fish, poultry, and beef. In regards to the consumption of fruits and vegetables, only 26.3% of the children consumed vitamin A-rich fruits and vegetables and 41.7% of the children consumed other fruits and vegetables. The majority of the fruits and vegetables consumed by the children were amaranths, pumpkin

leaves, boo, mangoes, and citrus fruits. Breastfeeding was prevalent among 76.9% of the children, indicating that about 23% of the sampled children had stopped breastfeeding at this age.

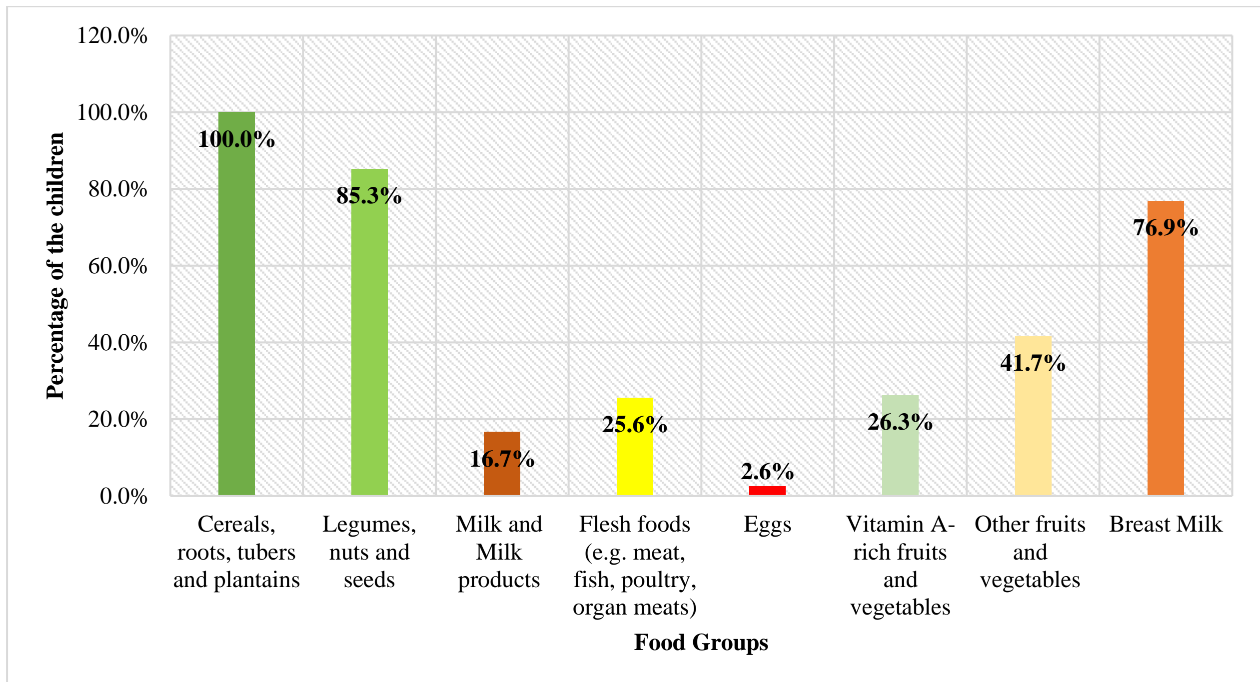


Figure 5: Consumption of foods from different groups by children 12-23 months in 24hrs

4.3 Nutrient adequacy of the complementary feeds

The nutrient adequacy of the complementary feeds was computed for only 120 children who were on continuous breastfeeding given the contribution of breastmilk in their diet. NutriSurvey examined 32 foods, including 27 commonly consumed foods and 5 nutrient-dense foods that are infrequently consumed, such as two vegetables, two fruits, eggs, chicken, and beef. The amount of essential nutrients consumed was also assessed in proportion to the nutritional need for adequate health (nutrient adequacy). The results in Table 5 show that only protein, vitamin A, vitamin B_{12}, folic acid and vitamin C of the 13 nutrients and energy analyzed met the 100% nutritional adequacy ratio. Energy and seven other nutrients, including dietary fibre, vitamin B_2, vitamin B_1, vitamin E, niacin, calcium, iron, and zinc, were discovered to be insufficient when compared to the cut-off for nutrient adequacy ratio of 1. A

value less than 1 showed that a nutrient consumption is less than the nutrient adequacy ratio cut-off and may signify a risk of nutrient deficiency, these nutrients were therefore termed inadequate nutrients in the complementary feeds the children 12-23 months in Apac district and Kwania district are consuming.

The proportion of children with nutrient intake below the recommendations varied between the nutrients. Over 95.8% the children had an insufficient intake of energy and 25.8% had insufficient intake of protein. Vitamin A and folic acid had the least proportion of children below recommended daily intake 7.5% and 3.3% respectively. Results in Table 5 show that in most nutrients, the higher the nutrient adequacy ratio, the lower the proportion of the children who were below the recommended daily intake of the given nutrient and the lower the nutrient adequacy ratio, the higher the proportion of children who were below the recommended daily intake of the nutrient. Even though energy, vitamin E and Zinc had the same nutrient adequacy ratio (0.66), 95.5%, 85.5% and 90% of the children did not meet the daily nutrient recommendation.

Table 5: Nutrient composition and inadequate nutrients in complementary foods of children 12-23 months

Nutrient	**Mean (SD) Nutrient intake**	**RDA[3]**	**Mean (SD) NAR[4]**	**(%RDA fulfilment)**	**Inadequate Nutrients**	**% of children intake below RDA**
Energy (kcal)	852.51	1300	0.66	66	Energy	95.8
Protein (g)	27.79	16	1.74	100		25.8
Dietary fiber (g)	10.3	14	0.74	74	Dietary Fiber	77.5
Vitamin A (μg)	603.65	400	1.51	100		7.5
Vitamin B_{12} (μg)	0.98	0.5	1.96	100		34.2

[3] National Research Council. (1989). *Recommended dietary allowances*.

[4] Hatløy, A., Torheim, L. E., & Oshaug, A. (1998). Food variety—a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*, *52*(12), 891–898.

Vitamin B_2 (mg)	0.63	0.8	0.79	80	Vitamin B_2	79.2
Niacin (mg)	6.65	9	0.74	74	Niacin	84.2
Vitamin B_1 (mg)	0.61	0.7	0.87	87	Vitamin B_1	72.5
Vitamin C (mg)	74.01	40	3.77	100		20.8
Vitamin E (mg)	3.95	6	0.66	66	Vitamin E	85.8
Folic acid (µg)	188.42	50	3.80	100		3.3
Calcium (mg)	352.68	400	0.67	67	Calcium	77.5
Iron (mg)	4.72	7	0.69	69	Iron	62.5
Zinc (mg)	3.82	5.5	0.66	66	Zinc	90.0

RDA= Recommended daily allowance, NAR= Mean Adequacy Ratio, MAR= Mean Adequacy Ratio (DGE, FAO-WHO recommendations) Assumed each child consumed 549 g/day of breast milk. The energy and nutrient content per 100 g of breast milk was: energy = 68 kcal, protein = 1.13 g, Fe = 0.03 mg, Zn = 0.1 mg, Ca = 27 mg, thiamine = 0.015 mg, riboflavin = 0.038 mg, niacin = 0.17 mg, folate = 8 µg DFE, vitamin B12 = 0.10 µg, vitamin, E= 0.011 mg, vitamin A = 69 µg, and vitamin C = 3.9 mg, Calcium = 29 and Iron = 0.058.

The results in Figure 6 shows that the mean adequacy ratio (0.76) which measures the overall adequacy of children's nutrient intake was below the recommended cut-off of 1. Over 65% of the children's nutrient intake were below 0.8 mean adequacy ratio while 32% of the children's nutrient intake was above 0.8. About 3% of the children's nutrient intake met the cut-off of level of 1. Overall, the majority of the children's intake of essential nutrients was below the RDA. 95.8% and 90% of the children had energy and zinc intake below the RDA respectively.

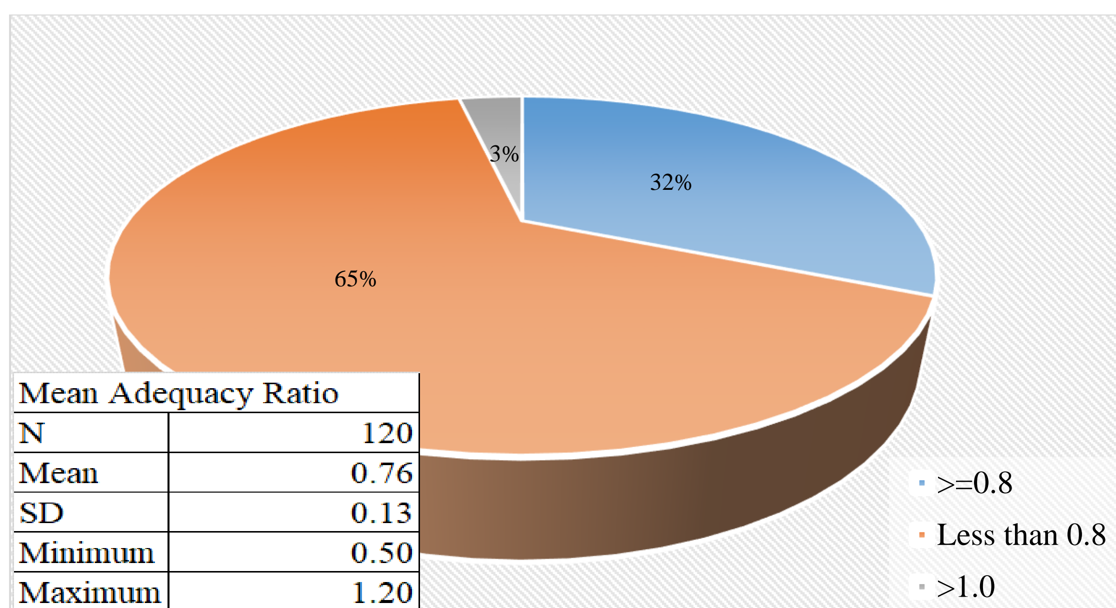


Figure 6: Mean adequacy ratio

4.4 Nutrition status of the children

4.4.1 Nutritional status of the children

The results in Figure 7 show that stunting was prevalent among 19.3% of the children sampled children, with 13.5% moderately stunted and 5.8% severely stunted. Underweight was prevalent among 12.2% of the children with 10.9% moderately underweight and 1.3% severely underweight. Wasting was prevalent among 2.5% of the children and only 0.6% were severely wasted while 1.9% in moderately wasted. None of the sampled children had bilateral pitting oedema.

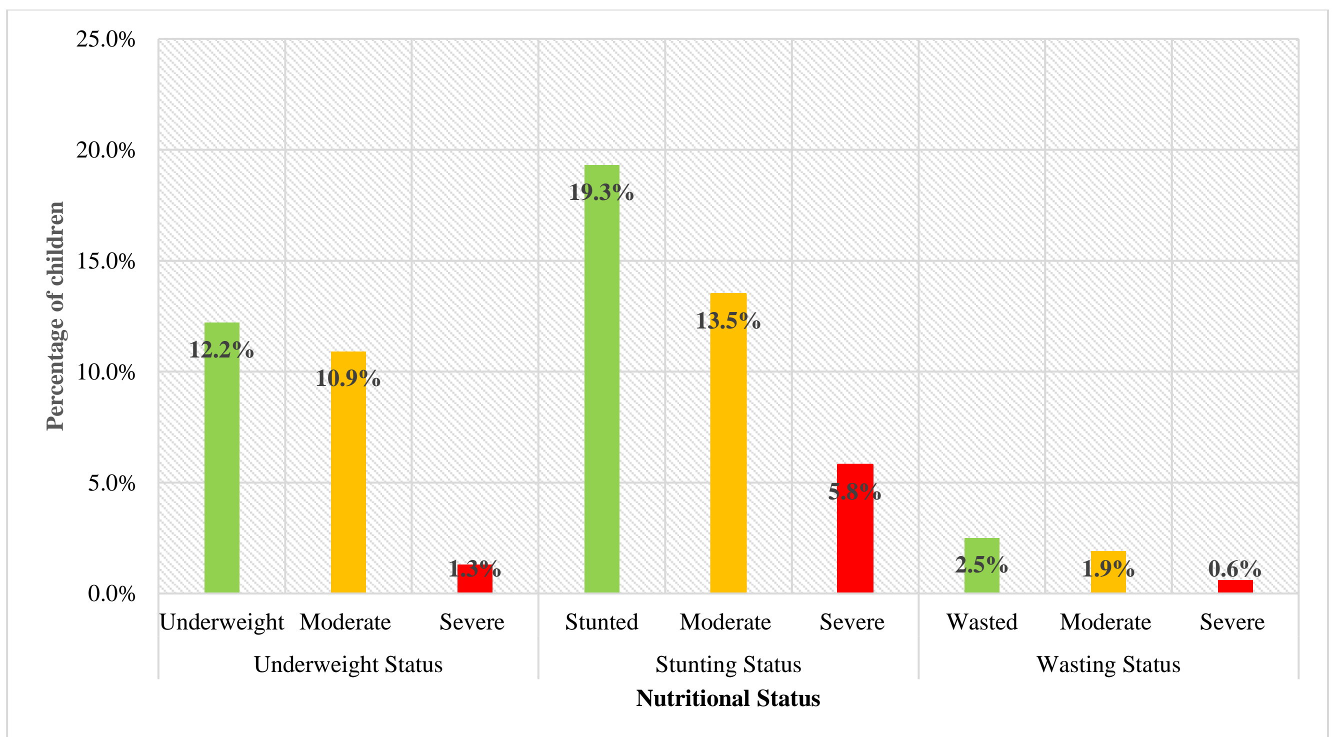


Figure 7: Nutritional Status of the Children

Nutritional Status of the Children by district

Results in Figure 8 shows that underweight was more prevalent in Apac (7.5%) district compared to Kwania district (5.1%). 10.9% of the sampled children in Apac district while

8.3% of children were stunted in Kwania district. Wasting prevalence was equally distributed among the sampled children in Apac and Kwania districts (1.2%).

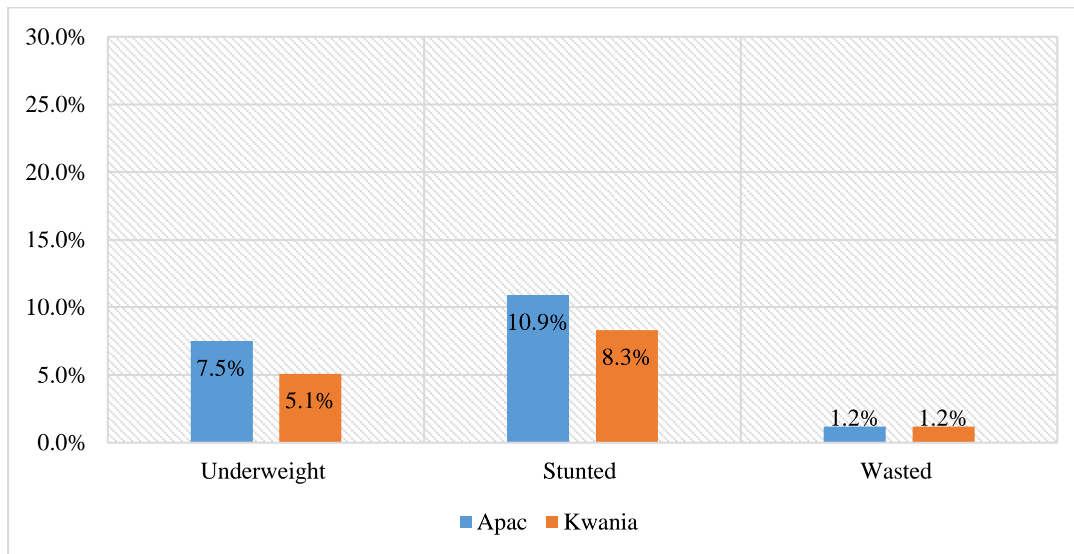


Figure 8: Nutritional Status of the Children by district

Nutritional Status of the Children by gender

The prevalence of underweight, stunting and wasting was more among males compared to females. As shown in Figure 9, 7.1% of sampled male children were underweight while 5.1% of the sampled female children were underweight. 10.2% of the males were stunted while 8.9% of the females were stunted and all the wasted sampled children were males (2.5%).

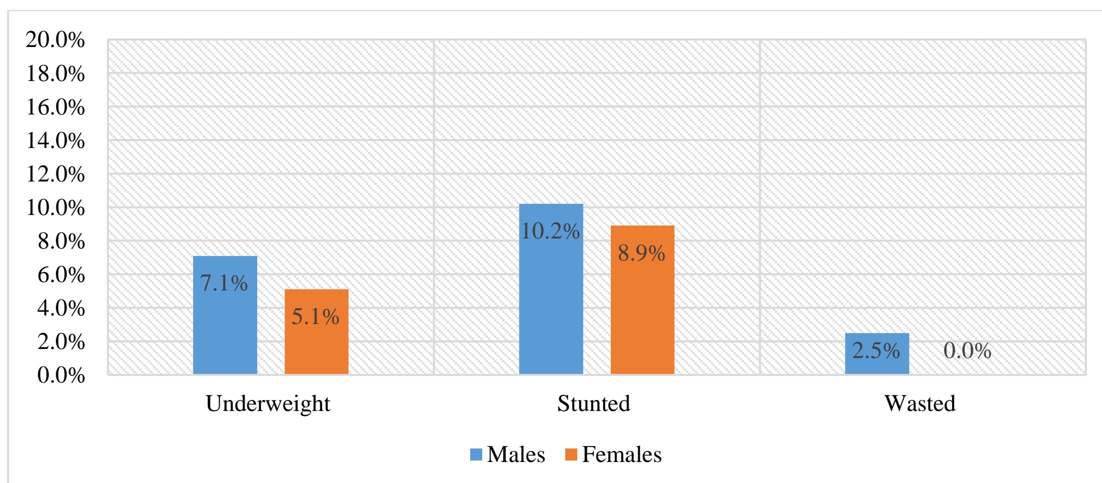


Figure 9: Nutritional Status of the Children by gender

Nutritional Status of the Children by age

Undernutrition in all its forms was more prevalent among children 18-23 months of age compared to children 12-17 months of age. 9.6%, 12.8% and 2.5% of the sampled children 18-23 months were underweight, stunted and wasted respectively while 2.5% and 6.4% of the sampled children were underweight and stunted respectively (Figure 10).

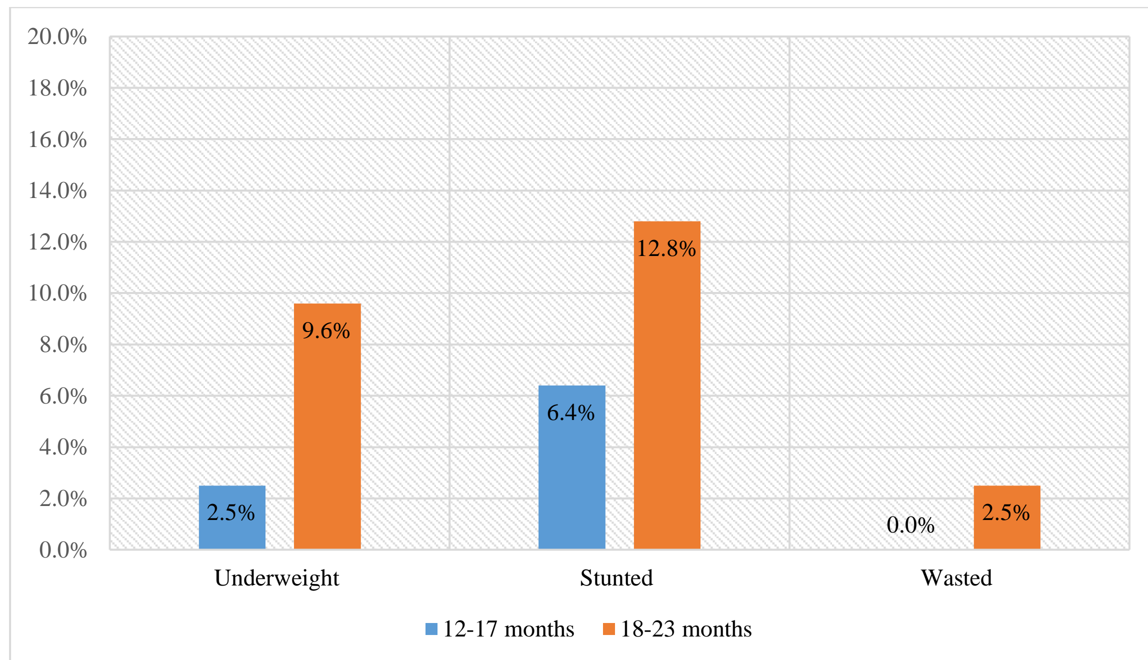


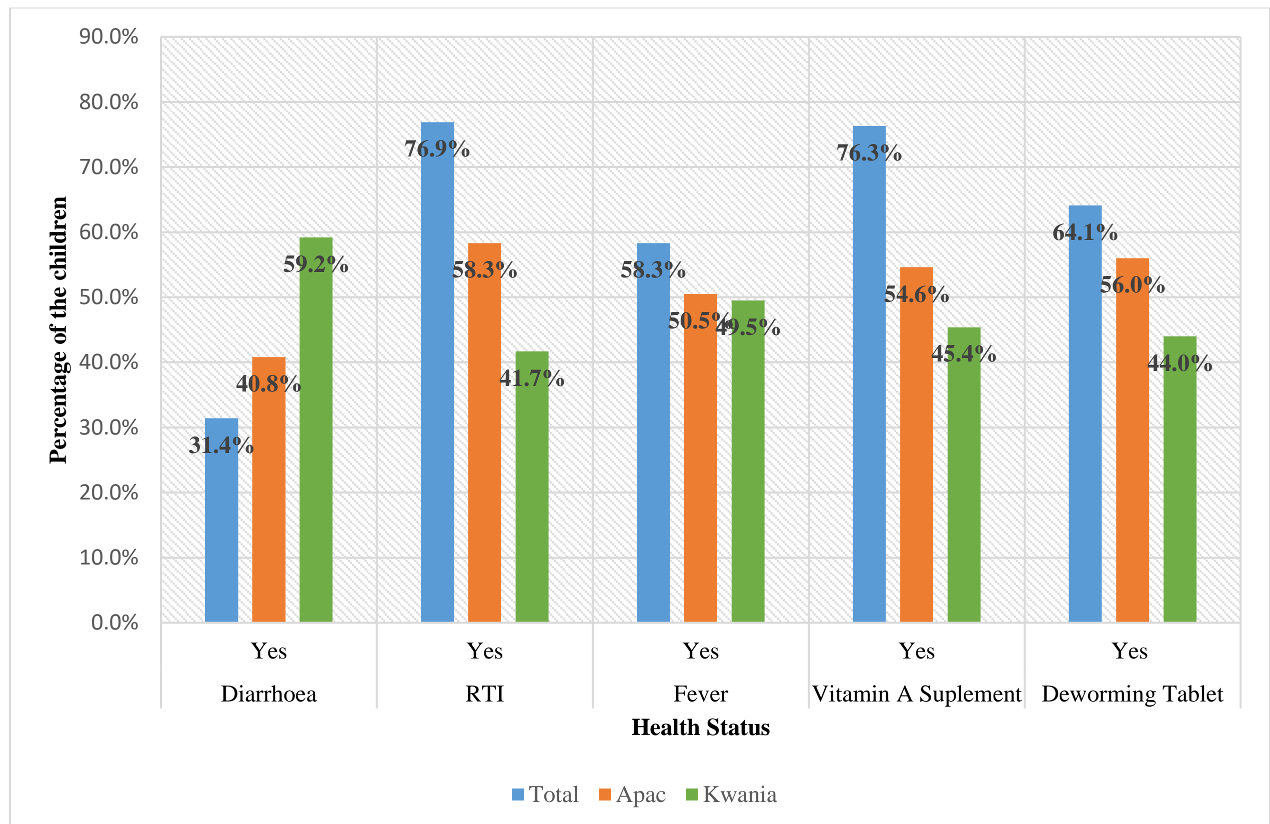
Figure 10: Nutritional Status of the Children by age

4.4.2 Health status of the Children

Among the sampled children, 31.4% of them had diarrhoea in the last two weeks before the survey while 8% had ongoing diarrhoea episodes. The majority of these children who suffered diarrhoea were from Kwania district (59.2%). Over 77% of the children were reported to have suffered from respiratory tract infections in the last two weeks. In addition, 58.3% of these children who suffered from respiratory tract infections were from Apac district, and only 41.7% were from Kwania district. About 58% of them suffered from fever, among which 50.3% were from Apac district. To prevent vitamin A deficiency and other infections, 76.3% of the children were given prophylactic Vitamin A. The proportion of children who received vitamin A supplementation was higher in Apac district compared to Kwania district, 54.6%, and 45.4%

respectively. Over 64.1% of the children were given deworming tablets in the last 6 months before the survey. Among the children who were given deworming tablets in the last 6 months before the survey, 56% were from Apac district while only 44% were from Kwania district.

Figure 11: Health Status of the Children



4.5 The association between nutritional status and feeding practices of children 12-23 months

A bivariate analysis was performed using chi-square with the confidence interval set at 95%. The findings in Table 6 show that wasting has a statistically significant association with the initiation of breastfeeding after birth (p=0.04, χ^2=3.606). 100% of the children who were wasted, were initiated to breastfeeding beyond one hour after birth. According to this study, being underweight also had a statistically significant association with the initiation of breastfeeding (p=0.049, χ^2=3.637). Over 53.2% of the underweight children 12-23 months were initiated to breastfeeding beyond one hour of birth. A statistically significant association

was also found between wasting among children and being breastfed the previous night ($p=0.03$, $\chi^2=6.235$). It was noted that 75% of the wasted children were not breastfed the previous night before the study. Similarly, a statistically significant association was found between underweight and children being breastfed the previous night ($p=0.007$, $\chi^2=7.192$) however, it was found that the majority of the children breastfed the previous night (77%) were underweight. Bottle feeding practice among the caregiver was found to have a statistically significant association with wasting in children ($p=0.019$, $\chi^2=5.473$). Among the wasted children, 75% were on bottle feeding.

Stunting, being underweight, and wasting also showed a statistically significant association with consumption of vitamin A-rich fruits and vegetables ($p=0.025$, $\chi^2=5.029$), ($p=0.001$, $\chi^2=11.160$) and ($p=0.018$, $\chi^2=3.637$) respectively. Among the wasted and underweight children, a majority were consuming fruits and vegetables, 75% and 57.9% respectively. However, among the stunted children, 56.7% were not consuming vitamin A-rich fruits and vegetables. Our study also found a statistically significant association between stunting and dietary diversity (($p=0.037$, $\chi^2=5.552$). Over 76.7% of the stunted children did not meet the minimum dietary diversity standard. Another statistically significant association was found between stunting and meeting a minimum acceptable diet standard by the children ($p=0.042$, $\chi^2=3.591$). It was found that a majority of the stunted children in our study (86.7%) did not meet the minimum acceptable diet standards.

Table 6: The association between nutritional status and feeding practices of children 12-23 months

Feeding Practices	**Wasting Status**			**Underweight Status**			**Stunting status**		
	Not Wasted (n=152)	**Wasted(n=4)**	**Total (N=156)**	**Not underweight (n=137)**	**Underweight(n=19)**	**Total (N=156)**	**Not stunted(n=126)**	**Stunted(n=30)**	**Total (N=156)**
Initiation of Breastfeeding									
One and Below	72(48)	0(0)	72(46.8)	67(49.6)	5(26.3)	72(46.8)	58(46.4)	14(48.3)	72(46.8)
Beyond one hour	78(52)	4(100)	82(53.2)	68(50.4)	14(73.7)	82(53.2)	67(53.6)	15(51.7)	82(53.2)
Chi-square statistics		***p =0.040***	χ^2***=3.606***		***p =0.049***	χ^2***=3.637***		***p =0.855***	χ^2***=0.033***
Ever Breastfed									
No	2(1.3)	0(0)	2(1.3)	2(1.5)	0(0)	2(1.3)	1(0.8)	1(0.8)	2(1.3)
Yes	150(98.7)	4(100)	154(98.7)	135(98.5)	19(100)	154(98.7)	125(99.2)	29(96.7)	154(98.7)
Chi-square statistics		***p =0.817***	χ^2***=0.053***		***p =0.596***	χ^2***=0.281***		***p =0.266***	χ^2***=1.235***
Breastfed Last Night									
No	31(20.4)	3(75)	34(21.8)	25(18.2)	9(47.4)	34(21.8)	24(19)	10(33.3)	34(21.8)
Yes	121(79.6)	1(25)	122(78.2)	112(81.8)	10(52.6)	122(78.2)	102(81.0)	20(66.7)	122(78.2)
Chi-square statistics		***p=0.009*****	χ^2***=6.818***		***p =0.004*****	χ^2***=8.301***		***p =0.089***	χ^2***=2.901***
Continued Breastfeeding									
No	33(21.7)	3(75.0)	36(23.1)	27(19.7)	9(47.4)	36(23.1)	26(20.6)	10(33.3)	36(23.1)
Yes	119(78.3)	1(25.0)	120(76.9)	110(80.3)	10(52.6)	120(76.9)	100(79.4)	20(66.7)	120(76.9)
Chi-square statistics		***p =0.013****	χ^2***=6.235***		***p =0.007*****	χ^2***=7.192***		***p =0.138***	χ^2***=2.201***
Bottle Feeding status									
No	116(76.3)	1(25)	117(75)	105(76.6)	12(63.2)	117(75.0)	93(73.8)	24(80.0)	117(75.0)
Yes	36(23.7)	3(75)	39(25)	32(23.4)	7(36.8)	39(25.0)	33(26.2)	6(20.0)	39(25.0)
Chi-square statistics		***p =0.019****	χ^2***=5.475***		***p =0.203***	χ^2***=1.618***		***p =0.482***	χ^2***=0.495***
Introduction of Complementary feeding									
Before 6 months	17(11.2)	0(0)	17(10.9)	15(10.9)	2(10.5)	17(10.9)	14(11.1)	3(10.0)	17(10.9)
From 6 months	135(88.8)	4(100)	139(89.1)	122(89.1)	17(89.5)	139(89.1)	112(88.9)	27(90)	139(89.1)

Feeding Practices	Wasting Status			Underweight Status			Stunting status		
	Not Wasted (n=152)	Wasted(n=4)	Total (N=156)	Not underweight (n=137)	Underweight(n=19)	Total (N=156)	Not stunted(n=126)	Stunted(n=30)	Total (N=156)
Chi-square statistics		***p =0.479***	***χ^2=0.502***		***p =0.956***	***χ^2=0.003***		***p =0.861***	***χ^2=0.036***
Age stopped Breastfeeding									
9 to 15 Months	9(29.0)	1(33.3)	10(29.4)	8(32.0)	2(22.2)	10(29.4)	9(36.0)	1(11.1)	10(29.4)
16 to 23 months	22(71.0)	2(66.7)	24(70.6)	17(68.0)	7(77.8)	24(70.6)	16(64.0)	8(88.9)	24(70.6)
Chi-square statistics		***p =0.876***	***χ^2=0.024***		***p =0.581***	***χ^2=0.305***		***p =0.160***	***χ^2=1.975***
Cereals, roots, tubers, and plantains									
Yes	152(100)	4(100)	156(100)	137(100)	19(100)	156(100)	126(100)	30(100)	156(100)
No	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Chi-square statistics		***p =a***	***χ^2 =a***		***p =a***	***χ^2=a***		***p =aa***	***χ^2=a***
Legumes, nuts, and seeds									
No	22(14.5)	1(25)	23(14.7)	20(14.6)	3(15.8)	23(14.7)	18(14.3)	5(16.7)	23(14.7)
Yes	130(85.5)	3(75)	133(85.3)	117(85.4)	16(84.2)	133(85.3)	108(85.7)	25(83.3)	133(85.3)
Chi-square statistics		***p =0.558***	***χ^2=0.344***		***p =0.891***	***χ^2=0.019***		***p =0.741***	***χ^2=0.109***
Milk and Milk products									
No	127(83.6)	3(75.0)	130(83.3)	116(84.7)	14(73.7)	130(83.3)	107(84.9)	23(76.7)	130(83.3)
Yes	25(16.4)	1(25)	26(16.7)	21(15.3)	5(26.3)	26(16.7)	19(15.1)	7(23.3)	26(16.7)
Chi-square statistics		***p =0.651***	***χ^2=0.205***		***p =0.228***	***χ^2=1.189***		***p =0.276***	***χ^2=0.109***
Flesh foods (e.g. meat, fish, poultry, organ meats)									
No	113(74.3)	3(75)	116(74.4)	101(73.7)	15(78.9)	116(74.4)	94(74.6)	22(73.3)	116(74.4)
Yes	39(25.7)	1(25)	40(25.6)	36(26.3)	4(21.1)	40(25.6)	32(25.4)	8(26.7)	40(25.6)
Chi-square statistics		***p =0.976***	***χ^2=0.001***		***p =0.625***	***χ^2=0.239***		***p =0.886***	***χ^2=0.020***
Eggs									
No	148(97.4)	4(100)	152(97.4)	133(97.1)	19(100)	152(97.4)	122(96.8)	30(100)	152(97.4)
Yes	4(2.6)	0(0.0)	4(2.6)	4(2.9)	0(0)	4(2.6)	4(3.2)	0(0)	4(2.6)
Chi-square statistics		***p =0.742***	***χ^2=0.108***		***p =0.451***	***χ^2=0.569***		***p =0.323***	***χ^2=0.977***

Feeding Practices	Wasting Status			Underweight Status			Stunting status		
	Not Wasted (n=152)	Wasted(n=4)	Total (N=156)	Not underweight (n=137)	Underweight(n=19)	Total (N=156)	Not stunted(n=126)	Stunted(n=30)	Total (N=156)
Vitamin A-rich fruits and vegetables									
No	114(75)	1(25)	115(73.7)	107(78.1)	8(42.1)	115(73.7)	98(77.8)	17(56.7)	115(73.7)
Yes	38(25)	3(75)	41(26.3)	30(21.9)	11(57.9)	41(26.3)	28(22.2)	13(43.3)	41(26.3)
Chi-square statistics		***p =0.025****	***χ^2=5.029***		***p =0.001*****	***χ^2=11.160***		***p =0.018****	***χ^2=5.574***
Other fruits and vegetables									
No	89(58.6)	2(50)	91(58.3)	78(56.9)	13(68.4)	91(58.3)	74(58.7)	17(56.7)	91(58.3)
Yes	63(41.4)	2(50)	65(41.7)	59(43.1)	6(31.6)	65(41.7)	52(41.3)	13(43.3)	65(41.7)
Chi-square statistics		***p =0.117***	***χ^2=0.117***		***p =0.341***	***χ^2=0.906***		***p =0.837***	***χ^2=0.042***
Meeting MDD									
Below MDD	124 (81.6)	3 (75.0)	127(81.4)	112(81.8)	15(78.8%	127(81.4)	104(82.5)	23(76.7)	127(81.4)
Met MDD	28(18.4)	1(25)	29(18.6)	25(18.2)	4(21.1)	29(18.6)	22(17.5)	7(23.3)	29(18.6)
Chi-square statistics		***p =0.738***	***χ^2=0.111***		***p =0.768***	***χ^2=0.087***		***p =0.037****	***χ^2=5.552***
Minimum meal frequency									
Below MMF	110(72.4)	2(50)	112(71.5)	99(72.3)	13(68.4)	112(71.8)	91(72.2)	21(70.0)	112(71.8)
Met MMF	42(27.6)	2(50)	44(28.2)	38(27.7)	6(31.6)	44(28.2)	35(27.8)	9(30.0)	44(28.2)
Chi-square statistics		***p =0.326***	***χ^2=0.963***		***p =0.727***	***χ^2=0.122***		***p =0.808***	***χ^2=0.059***
Minimum Acceptable Diet									
Below MAD	138(90.8)	3(75)	141(90.4)	125(91.2)	16(84.2)	141(90.4)	115(91.3)	26(86.7)	141(90.4)
Met MAD	14(9.20)	1(25)	15(9.6)	12(8.8)	3(15.8)	15(9.6)	11(8.7)	4(13.3)	15(9.6)
Chi-square statistics		***p =1.118***	***χ^2=0.290***		***p =0.330***	***χ^2=0.949***		***p =0.042****	***χ^2=3.591***

**p<0.05, **p>0.01, a=No statistics are computed because Cereals, roots, tubers, and plantains are a constant.*

Key: MDD- Minimum dietary diversity, MMF- Minimum Meal Frequency, MAD- Minimum acceptable diet.

4.6 The association between nutritional status and nutrient adequacy

A bivariate analysis was performed using chi-square with the confidence interval set at 95% to establish the association between nutrient adequacy of the complementary feeds and nutritional status of the children. The findings in Table 7 show that wasting has a statistically significant association with the inadequate energy intake (p=0.01, χ^2=6.555). Over 66.7% of the wasted children had inadequate daily energy intake of below the recommended 1300kcals per day. There was also a significant association observed between underweight and vitamin A intake (p=0.046, χ^2=3.861). Majority of the underweight children (60%) had inadequate vitamin A intake from the foods they consumed in the 24 hours. Intake of vitamin B2 also showed a statistically significant association with underweight. Over 60% of the underweight children had inadequate intake of vitamin B_2. Our study also found that stunting was significantly associated with calcium intake. Majority of the stunted children were found to have inadequate calcium intake from the foods they consumed in the 24 hours.

Table 7: Association between nutrient adequacy of complementary feeds and nutritional status of children 12-23 months

Nutrients Intake status		**Underweight status**			**Wasting Status**		**Stunting status**		
	Not underweight (n=105)	**Underweight (n=15)**	**Total (N=120)**	**Not wasted (n=115)**	**Wasted (n=3)**	**Total (N=120)**	**Not stunted (n=97)**	**Stunted (n=23)**	**Total (N=120)**
Energy									
Inadequate	101(96.2)	14(93.3)	115(95.8)	113(96.6)	2(66.7)	115(95.8)	94(96.9)	21(91.3)	115(95.8)
Adequate	4(3.8)	1(6.7)	5(4.2)	4(3.4)	1(33.3)	5(4.2)	3(3.1)	2(8.7)	5(4.2)
Chi-square statistics	p=0.604	χ^2=0.268		p=0.010*	χ^2=6.555		p=0.227	χ^2=1.462	
Protein									
Inadequate	29(27.6)	2(13.3)	31(25.8)	31(26.5)	0(0)	31(25.8)	24(24.7)	79(30.4)	31(25.8)
Adequate	76(72.4)	13(86.7)	89(74.2)	86(73.5)	3(100)	89(74.2)	73(75.3)	16(69.6)	89(74.2)
Chi-square statistics	p=0.237	χ^2=1.398		p=0.301	χ^2=1.072		p=0.575	χ^2=0.314	
Dietary fibre									
Inadequate	81(77.1)	12(80)	93(77.5)	91(77.8)	2(66.7)	93(77.5)	77(79.4)	16(69.6)	93(77.5)
Adequate	24(22.9)	3(20)	27(22.5)	26(22.2)	1(33.3)	27(22.5)	20(20.6)	7(30.4)	27(22.5)
Chi-square statistics	p=0.804	χ^2=0.061		p=0.207	χ^2=649		p=0.311	χ^2=1.027	
Vitamin A									
Inadequate	0(0)	9(60)	9(7.5)	8(6.8)	1(33.3)	9(7.5)	8(8.2)	1(4.3)	9(7.5)
Adequate	105(100)	6(40)	111(92.5)	109(93.2)	2(66.7)	111(92.5)	89(91.8)	22(95.7)	111(92.5)
Chi-square statistics	p=0.046*	χ^2=3.861		p=0.085	χ^2=2.960		p=0.523	χ^2=0.408	
Vitamin B_{12}									
Inadequate	36(34.3)	5(33.3)	41(34.2)	40(34.2)	1(33.3)	41(34.2)	33(34)	8(34.8)	41(34.2)
Adequate	69(65.7)	10(66.7)	79(65.8)	77(65.8)	2(66.7)	79(65.8)	64(66)	15(62.2)	79(65.8)

Nutrients Intake status	Underweight status			Wasting Status			Stunting status		
	Not underweight (n=105)	**Underweight (n=15)**	**Total (N=120)**	**Not wasted (n=115)**	**Wasted (n=3)**	**Total (N=120)**	**Not stunted (n=97)**	**Stunted (n=23)**	**Total (N=120)**
Chi-square statistics	p=0.942	χ^2=0.005		p=0.975	χ^2=0.001		p=0.945	χ^2=0.005	
Vitamin B_2									
Inadequate	86(81.9)	9(60)	95(79.2)	94(80.3)	1(33.3)	95(79.2)	79(81.4)	16(69.6)	95(79.2)
Adequate	19(18.1)	6(40)	25(20.8)	23(19.7)	2(66.7)	25(20.8)	18(18.6)	7(30.4)	25(20.8)
Chi-square statistics	p=0.049*	χ^2=3.318		p=0.148*	χ^2=0.919		p=0.207	χ^2=1.590	
Vitamin B_1									
Inadequate	78(74.3)	9(60)	87(72.5)	86(73.5)	1(33.3)	87(72.5)	73(75.3)	14(60.9)	87(72.5)
Adequate	27(25.7)	6(40)	33(27.5)	31(26.5)	2(66.7)	33(27.5)	24(24.7)	9(39.1)	33(27.5)
Chi-square statistics	p=0.246	χ^2=1.343		p=0.124	χ^2=2.367		p=0.165	χ^2=1.930	
Niacin									
Inadequate	89(84.8)	12(80)	101(84.2)	100(85.5)	1(33.3)	101(84.2)	82(84.5)	19(82.6)	101(84.2)
Adequate	16(15.2)	3(20)	19(15.8)	17(14.5)	2(66.7)	19(15.8)	15(15.5)	4(17.4)	19(15.8)
Chi-square statistics	p=0.637	χ^2=0.223		p=0.115*	χ^2=0.966		p=0.820	χ^2=052	
Folic Acid									
Inadequate	3(2.9)	1(6.7)	4(3.3)	4(3.4)	0(0)	4(3.3)	2(2.1)	2(8.7)	4(3.3)
Adequate	102(97.1)	14(93.3)	116(96.7)	113(96.6)	3(100)	116(96.7)	95(97.9)	21(91.3)	116(96.7)
Chi-square statistics	p=0.442	χ^2=0.591		p=0.745	χ^2=106		p=0.111	χ^2=2.539	
Vitamin C									
Inadequate	23(21.9)	2(13.3)	25(20.8)	25(21.4)	0(0)	25(20.8)	20(20.6)	5(21.7)	25(20.8)
	82(78.1)	13(86.7)	95(79.2)	92(78.6)	3(100)	95(79.2)	77(79.4)	18(78.3)	95(79.2)

Nutrients Intake status		Underweight status			Wasting Status			Stunting status	
	Not underweight (n=105)	**Underweight (n=15)**	**Total (N=120)**	**Not wasted (n=115)**	**Wasted (n=3)**	**Total (N=120)**	**Not stunted (n=97)**	**Stunted (n=23)**	**Total (N=120)**
Adequate									
Chi-square statistics	p=0.444	χ^2=0.585		p=0.368	χ^2=810		p=0.905	χ^2=0.014	
Vitamin E									
Inadequate	91(86.7)	12(80)	103(85.8)	102(87.2)	1(33.3)	103(85.8)	86(88.7)	17(73.9)	103(85.8)
Adequate	14(13.3)	3(20)	17(14.2)	15(12.8)	2(66.7)	17(14.2)	11(11.3)	6(26.1)	17(14.2)
Chi-square statistics	p=0.480	χ^2=0.489		p=0.108	χ^2=0.741		p=0.068	χ^2=0.325	
Calcium									
Inadequate	67(63.8)	8(53.3)	75(62.5)	73(62.4)	2(66.7)	75(62.5)	59(60.8)	14(66.7)	73(62.5)
Adequate	38(36.2)	7(46.7)	45(37.5)	44(37.6)	1(33.3)	45(37.5)	38(39.2)	7(33.3)	45(37.5)
Chi-square statistics	p=0.433	χ^2=0.615		p=0.880	χ^2=023		p=0.010*	χ^2=6.630	
Iron									
Inadequate	81(77.1)	12(80)	93(77.5)	91(77.8)	2(66.7)	93(77.5)	77(79.4)	16(69.6)	93(77.5)
Adequate	24(22.9)	3(20)	27(22.5)	26(22.2)	1(33.3)	27(22.5)	20(20.6)	7(30.4)	27(22.5)
Chi-square statistics	p=0.804	χ^2=0.061		p=0.649	χ^2=207		p=0.311	χ^2=1.027	
Zinc									
Inadequate	94(89.5)	14(93.3)	108(90)	106(90.6)	2(66.7)	108(90)	88(90.7)	20(87)	108(90)
Adequate	11(10.5)	1(6.7)	12(10)	11(9.4)	1(33.3)	12(10)	9(9.3)	3(13)	12(10)
Chi-square statistics	p=0.645	χ^2=0.212		p=0.172	χ^2=1.861		p=0.293	χ^2=0.588	

**p<0.05, **p>0.01*

4.7 The predictors of malnutrition among children 12-23 months

A logistic regression was performed to ascertain the effects of feeding practices and nutrient adequacy on the nutritional status of children. Results in Table 8 Show that there was a significant association between inadequate intake of vitamin A and underweight. Children who had inadequate intake of vitamin A were 7.9 times more likely to be underweight compared to those who took adequate amounts (AOR=7.967, 95% CI: 1.169-54.309, p=0.034). Consumption of vitamin A-rich fruit and vegetables was significantly associated with underweight. Children who consume more vitamin A rich fruits and vegetables were 0.176 times less likely to be underweight (AOR=0.176, 95% CI: 0.045-0.692, p=0.013). Stunting was significantly associated to inadequate calcium intake. Children with adequate calcium intake were 0.301 times less likely to be stunted (AOR=0.301, 95% CI: 0.113-0.803, p=0.016). In addition, having a family size of 6 and above members and being a single mother had a significant association with underweight, (AOR=3.247, 95% CI: 0.978-10.791, p=0.045) and (AOR=4.97, 95% CI: 1.473-16.774, p=0.01) respectively. The children from large families of 6 and above family members were 3.2 times more likely to be underweight compared to others from 1-5 family members. The likelihood of underweight was 4.97 times among children from single mothers compared to children from married mothers.

Table 8: Predictors of malnutrition among children 12-23 months

Nutritional Status	**Exposures**	**B**	**df**	**p-value**	**AOR**	**95% CI for Exp(B)**	
						Lower Bound	Upper Bound
Underweight	Intercept	-1.699	1	0.005			
	Vitamin A Inadequate	2.075	1	0.034	7.967	1.169	54.309
	More Vitamin A-rich Fruit/Vegetable	-1.737	1	0.013	0.176	0.045	0.692
	6 and above family size	1.178	1	0.045	3.249	0.978	10.791

	Single	1.603	1	0.01	4.97	1.473	16.774
Stunted	Intercept	0.272	1	0.74			
	Calcium adequate	-1.199	1	0.016	0.301	0.113	0.803

CHAPTER FIVE: DISCUSSION

5.1 Feeding practices of the children

Among 156 children 12-23 months in Apac and Kwania districts of Lango Sub-region, Northern Uganda who participated in this study, early initiation breastfeeding within the first hour of birth, this study showed a higher prevalence (46.7%) compared to findings from the UDHS in Lango sub-region (44.8%) (UBOS & ICF, 2018b). A similar study by Abdel-Rahman et al., 2020 in South Sudan showed a higher prevalence of early initiation of breastfeeding (69%) compared to our study. A study by Rukindo et al., 2020 in Western Uganda also reported a higher prevalence of early initiation of breastfeeding (72%) compared to our study. This result may indicate that mothers in Apac and Kwania districts have limited knowledge regarding the early initiation of breastfeeding within the first hour after birth. Our study findings may also indicate poor monitoring of breastfeeding initiation after birth by skilled personnel in the district of Apac and Kwania. Other biomedical, sociodemographic, psychosocial, healthcare and community factors could also be influencing the mothers in Apac and Kwania districts from initiating breastfeeding within the first hour after birth.

In regards to the timely introduction of complementary feeding, our study findings in *Table 4* show that a higher proportion of the children were introduced to complementary feeding at 6 months of age. A similar study in Lamwo district, Northern Uganda by Aber et al. (2018) showed that a lower prevalence (47%) of the children were introduced to complementary feeding at 6 months compared to our study. Our study finding in regards to the timely introduction of complementary feeding was however, lower than the findings of a similar study in Kisoro district, western Uganda where over 95% of the caregivers had timely introduced solid, semi-solid, or soft foods at 6 months of age (Birungi & Ejalu, 2022). Another study by Kumudha et al. (2010) in rural Utter Pradesh on increasing appropriate complementary feeding showed a lower prevalence of only 13% of children being started on complementary food at

the correct age of 6 months compared to our study findings. Our study findings, therefore, indicate that the timely introduction of complementary feeding was highly practiced among the caretakers of the sampled children in Apac district and Kwania district following the World Health Organization recommendations (World Health Organization., 2021).

Regarding consumption of foods from the different food groups, a similar study in Turkey by Köksal et al. (2015) showed that more children were consuming eggs (87%), fleshy foods (83%), legumes (82%), and cow's milk (78%) compared to the findings of our study. Our study agrees with a study by Birungi & Ejalu (2022) in Western Uganda in regards to the majority of the children (93.4%) consuming grains, roots, and tubers and the least consumption of eggs among the children (6%). Our findings however show that a higher proportion of children consumed Vitamin A-rich fruits and vegetables compared to the findings of the study by Birungi & Ejalu (2022) (2%). Similar findings were made by a study conducted in Northern Uganda, where individuals claimed that the affordability and accessibility of grains led to greater consumption of cereals than items of animal origin (Mokori, 2012). This finding underscores the importance of promoting a diverse and balanced diet during this crucial developmental stage, aiming to ensure adequate nutritional intake and overall well-being for these young children. This study may also indicate a low level of awareness about dietary diversity in children's diet or due to their high cost of foods in the area. The low level of consumption of eggs and vitamin A-rich fruits and vegetables and other fruits and vegetables in our study may indicate an inadequate intake of some vitamins and minerals. Policy implications include increasing public education on diverse diets, subsidizing nutritious foods, and improving access to vitamin A-rich fruits and vegetables. Addressing these issues can enhance overall nutrient intake and public health outcomes.

The results of this study regarding the young child feeding practices are similar to the Uganda National Demographic Survey (UDHS) results in the Lango sub-region which indicated that the infant feeding practices were sub-optimal (UBOS & ICF, 2018b). Our study findings regarding minimum dietary diversity in Table 4 were however higher than the UDHS findings of 11.3% in the Lango region. In addition, our study findings regarding the minimum meal frequency (28.2%) of the children were almost the same as the UHDS findings for the Lango subregion (28.7%). Even though our findings in regards to children meeting the minimum acceptable diet were low, it was slightly higher (9.6%) than the UDHS findings (7.8%) (UBOS & ICF, 2018b). our study findings above can be explained by the fact that Weighed Food Record which is the gold standard in dietary assessment was used. The study, therefore, did not depend on the caretaker's memory. A low dietary diversity could therefore be a result of over-dependence on home-grown foods and failure to include animal-source foods in the children's diet as shown in Figure 4.

Another study by Birungi & Ejalu, 2022 in Kisoro district showed that a higher proportion of children (76.5%) 6 to 23 months had met the minimum meal frequency standards (MMF), this was higher than the findings of our study in Table 4. The same study by Birungi & Ejalu (2022) had similar findings to our study in regards to the low proportion of children that had met a minimum acceptable diet 4.4% and 9.6% respectively. The proportion of children that had met a minimum acceptable diet standard in our study was lower compared to findings from a similar study in Kivu DRC Congo (33%) (Kambale et al., 2021). Our findings in regards to children meeting a minimum acceptable diet were also lower compared to other studies in Tanzania (Vitta et al., 2016), Bangladesh (Zongrone et al., 2012), and Indonesia (Dewanti et al., 2015) reporting 38, 42, and 48% in, respectively.

The variances and low proportion of children meeting a minimum acceptable diet in our study compared to other studies could be attributed to regionally specific cultural feeding traditions

as well as variations in prenatal and postnatal care, including health education and counselling for breastfeeding and supplemental feeding (Cleminson et al., 2015; Ramulondi et al., 2021; Street & Lewallen, 2013). The young age of the mothers could have also led to the low proportion of the children meeting a minimum acceptable diet. Our findings also show that the majority of the mothers (46.8%) in our study were below 26 years of age. A study by Assefa et al., 2021 showed that young mothers have limited knowledge regarding infant and young child feeding practices. The failure to achieve the minimum acceptable diet standard by the majority of the children in our study area could lead to poor health outcomes and delayed growth and development (UBOS & ICF, 2018b; World Health Organization, 2021). The children run the risk of undernutrition, notably stunting and micronutrient deficiencies, as well as higher rates of morbidity and death. A low minimum acceptable diet standard among children might have also been due to other multiple factors, including poverty, food insecurity, poor feeding practices, poor hygiene and sanitation, limited access to healthcare, and cultural beliefs and practices as found in other studies by (Abebe et al., 2021; Gaga Rukorera, 2019; Gizaw & Tesfaye, 2019; Molla et al., 2021; Tassew et al., 2019). Addressing these factors requires a multi-sectoral approach that involves improving access to nutritious foods, promoting proper feeding practices, increasing knowledge about child nutrition, improving hygiene and sanitation, and addressing cultural barriers to healthy diets.

5.2 The nutrient adequacy of the diet of children 12-23 months

Our study showed that on average only 7 out of 14 nutrients were being consumed to adequate levels in the diet. Only protein, vitamin A, vitamin B_{12}, folic acid and vitamin C of the 13 nutrients and energy analysed met the 100% nutritional adequacy ratio. Energy and seven other nutrients, including dietary fibre, vitamin B_2, vitamin B_1, vitamin E, niacin, calcium, iron, and zinc (Table 5). Our study agreed with studies in Myanmar, Eastern Uganda, and Rural Kenya,

which showed that iron was inadequate in local complementary foods. Studies in Kwazulu Natal, South Africa, Eastern Uganda, Rural Kenya, and Indonesia show that Zinc and Calcium were also inadequate in the local complementary foods (Sayed & Schönfeldt, 2021; Kimere et al., 2022; Hlaing et al., 2016 & Santika et al., 2009) also agreed with our study findings. Our study findings regarding the consumption of recommended calories per day also agreed with other studies in sub-Saharan Africa showing the increasing burden of malnutrition in the region as a result of low calories intake (Kalu & Etim, 2018; Komakech et al., 2018; Siddiqui et al., 2020). The findings regarding the inadequate nutrients in the children's diet can be explained by the fact that the children's diet had low diversity and there was low consumption of animal-source foods that are rich in some of the inadequate nutrients like calcium, iron, and zinc. In addition, the finding above may also be explained by the low consumption of vitamin A-rich fruits and vegetables and other fruits and vegetables which are good sources of dietary fibre, Vitamin B_2, Vitamin E, and Zinc.

The findings of our study highlight a concerning trend of inadequate energy, iron, zinc, calcium, dietary fibre, vitamin A, B_1 and B_2 intake among children aged 12-23 months. These essential nutrients play pivotal roles in supporting proper growth and development during this critical stage of life. Addressing this deficiency through targeted interventions, such as promoting nutrient-rich foods and appropriate supplementation, is imperative to safeguard the health and well-being of these young children and prevent potential long-term health implications.

5.3 Nutritional status of children

Overall, malnutrition in all forms existed among some children who participated in our study. The majority of the malnourished children were stunted, followed by underweight and wasting. The prevalence of stunting and wasting among the children 12-23 months in our study was lower than the national and Lango region prevalence of 27.1% reported by the UHDS (UBOS

& ICF, 2018b). However, the underweight prevalence among the children in our study was higher than the Lango region prevalence reported in the UDHS (UBOS & ICF, 2018b). A similar study in Mpigi district reported a higher prevalence of stunting and wasting with a lower prevalence of underweight of 32%, 3%, and 10% respectively as compared to our study findings (Tumwesigye et al., 2016). Another similar study in Eastern Uganda by Kimere et al., 2022, shows a higher prevalence of stunting (22%) and wasting (3.8%) compared to our study findings in Northern Uganda. Our findings regarding stunting and wasting were still lower compared to a similar study in Tanzania. However, the prevalence of underweight in our study was higher compared to the study in Tanzania (Raymond et al., 2017). Our study, therefore, indicates that malnutrition in all forms is less prevalent in Apac district and Kwania district compared to other areas as shown by studies in Eastern Uganda, Tanzania, and Lango subregion above. The result regarding malnutrition is however not desirable therefore there is a need for improvement in infant and young child feeding practices to prevent malnutrition in all forms.

The findings of our study provide compelling evidence of a significantly lower prevalence of malnutrition among children in our study area when compared to other regions. This encouraging observation suggests the potential effectiveness of existing interventions, nutritional initiatives, and healthcare services implemented within the study area. However, it is vital to exercise caution in directly attributing this success solely to local efforts, as other factors, such as socioeconomic conditions, access to healthcare, and cultural practices, may also be influencing these outcomes. Further research is warranted to delve deeper into these factors, aiming to identify successful strategies that can be adapted and implemented in areas facing higher rates of malnutrition, thus contributing to more effective and holistic public health approaches.

5.4 Factors associated to nutritional status of the children 12-23 months

According to our study, wasting was significantly associated with hours of breastfeeding initiation, bottle feeding, current breastfeeding status, consumption of vitamin A-rich fruits and vegetables, and being breastfed the previous night. Underweight also shows a significant association with the initiation of breastfeeding, continued breastfeeding, and bottle feeding. Stunting is on the other side significantly associated with the consumption of vitamin A-rich fruits and vegetables, minimum dietary diversity, and minimum acceptable diet.

The findings of our study agree with finding from studies by Tucunan, 2022 in Indonesia and Anato, 2022 in Ethiopia showing a significant association between wasting among children and initiation of breastfeeding. A study in Tanzania however found no association between initiation of breastfeeding and wasting (Smith et al., 2017). The World Health Organization recommends that children should be introduced to exclusive breastfeeding within one hour of birth (WHO & UNICEF, 2018). It is noted that early initiation of breastfeeding boosts children's ability to defend against infections, minimize the danger of diarrhea, and increase their survival rate (World Health Organization, 2021). Regarding the practice of bottle feeding, similar studies by Darsene et al., 2017 in Ethiopia and another by Abdilahi et al., 2020 in the Somali region of Ethiopia had similar findings with ours showing a significant association between wasting and bottle feeding practice. A similar study in India agrees with our study findings, showing a significant association between bottle feeding and Underweight among children (Jeyakumar et al., 2022). According to the World Health Organization, bottle feeding should be avoided for infant and young child feeding because it interferes with good breastfeeding and proper supplemental feeding, and bottles with a nipple are prone to contamination (World Health Organization, 2005). A contaminated feeding bottle may expose the baby to diarrhoea and other infections that may be a risk of malnutrition (Arvelo et al., 2010; Ferdous et al., 2013; Gupta et al., 2015). Overall, these studies suggest that bottle feeding

may be associated with an increased risk of wasting in infants and young children, compared to exclusive or partial breastfeeding. Infrequent feeding, not feeding enough, or giving inappropriate foods, was associated with wasting. For example, a study conducted in Ghana found that caregivers of wasted children reported feeding them less frequently or less food than recommended, and giving them inadequate or inappropriate foods (Aryeetey et al., 2014). It is important to promote and support breastfeeding as the optimal feeding choice for infants, and to ensure that bottle feeding is done safely and appropriately for those who cannot or choose not to breastfeed.

A similar study in Uganda agrees with our study reporting that stunting in different parts of the country was associated with diets containing larger proportions of staple foods with lower diversity (Amaral et al., 2018). Another study by Aboagye et al., 2021 in Sub-Saharan Africa shows that stunting was significantly associated with the consumption and foods meeting a minimum dietary diversity. A report from an analysis of basic health research in Indonesia also had similar findings to our study, showing that stunting is significantly associated with young child dietary diversity (Samosir et al., 2023). Our study clearly shows that a low percentage of the children had met the minimum dietary diversity standard. There was low consumption of animal-source foods and most children consumed foods from cereals, roots, tubers, and plantains groups. This could be one of the factors that led to the stunting prevalence observed among children in our study. Results from other studies show that consumption of animal-source foods is associated with reduced stunting among children (Darapheak et al., 2013; Headey et al., 2018; Krasevec et al., 2017; Sari et al., 2010). Other studies also suggest that breastfeeding, dietary diversity, and meal frequency are all important factors in reducing the risk of stunting in children. Promoting exclusive breastfeeding for the first six months of life, promoting a diverse diet that includes a variety of food groups, and ensuring frequent feeding

throughout the day may help reduce the burden of stunting in children (Gebreayohanes & Dessie, 2022; Tadele et al., 2022; Tello et al., 2022).

Our study also explored the association between nutrient adequacy and nutritional status. Wasting was associated to inadequate energy intake according to our study. Another study in Kenya had similar findings with ours, showing that inadequate energy intake was a predictor of malnutrition (Mwaniki & Makokha, 2013). A similar study by Werdani & Utari, 2020 in Tangerang district, Indonesia showed that energy intake is a dominant factor associated with wasting among children 6-23 months. Other studies by Bhutta et al., 2017; Carrero et al., 2013; Wolde et al., 2015 also had consistent findings like ours in regards to wasting being associated with inadequate energy intake among children.

The findings of this study contribute to the existing body of literature by confirming a significant association between inadequate energy intake and wasting. Our results align with prior research, providing further evidence that insufficient calorie intake plays a crucial role in the development and progression of wasting. These consistent findings emphasize the importance of addressing energy deficits in the prevention and management of wasting, particularly in populations at risk. Interventions focused on improving energy intake, such as promoting adequate dietary diversity and increasing caloric consumption, should be prioritized to mitigate the burden of wasting and enhance nutritional outcomes. Future research should delve deeper into understanding the underlying mechanisms and explore targeted interventions to ensure sufficient energy intake and combat wasting effectively.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study highlights significant concerns in the dietary practices and nutritional adequacy among children aged 12-23 months in Apac and Kwania districts. While breastfeeding rates are high, delayed initiation and low exclusive breastfeeding rates indicate the need for enhanced education and support programs. Although continued breastfeeding rates are encouraging, the prevalence of bottle feeding suggests a need for better guidance on feeding practices. The introduction of complementary foods is timely, yet low adherence to recommended dietary diversity and meal frequency standards reveals substantial gaps in the quality of feeding, leaving many children without nutritionally adequate diets, which can impact their long-term growth and development.

The study revealed significant nutritional inadequacy among these children, with only half of the essential nutrients being consumed at adequate levels. Notably, protein, vitamins A, B12, folic acid, and C met the 100% nutritional adequacy ratio, while energy and seven other nutrients, including dietary fibre, calcium, and iron, were deficient. The low dietary diversity and insufficient consumption of animal-source foods and vitamin A-rich fruits and vegetables largely explain these deficiencies. This underscores the urgent need for targeted interventions to promote diverse, nutrient-rich diets and appropriate supplementation to address these gaps, supporting proper growth and development during this critical stage of life and preventing potential long-term health implications.

The study also found malnutrition in various forms among participating children, with stunting being the most prevalent, followed by underweight and wasting. Although the prevalence of stunting and wasting was lower than national and regional averages, the higher prevalence of

underweight is concerning. The study showed significant associations between feeding practices and malnutrition, with delayed breastfeeding initiation, bottle feeding, and inadequate consumption of vitamin A-rich foods linked to wasting and underweight, while low dietary diversity was associated with stunting. These findings emphasize the need for early breastfeeding initiation, promoting dietary diversity, and reducing bottle feeding to mitigate malnutrition risks. Addressing these nutritional challenges is crucial for preventing malnutrition and ensuring the health and development of children in these districts.

6.2 Recommendations

Our study found sub-optimal complementary feeding practices that could be posing a to malnutrition among children. The following is recommended to improve the infant feeding practices and nutritional status of the children.

1. Implement programs to increase awareness about the importance of early initiation and exclusive breastfeeding for the first six months, making these programs accessible through healthcare centers and community outreach.
2. Develop and distribute educational materials and campaigns to encourage caregivers to introduce a variety of nutrient-rich foods at appropriate times, ensuring balanced diets and adherence to dietary guidelines.
3. Ensure children in high-risk areas receive appropriate supplementation to address deficiencies in essential vitamins and minerals, particularly those not sufficiently met through diet alone.
4. Develop policies to integrate comprehensive nutritional education into healthcare services and community programs, focusing on dietary practices and supplementation to improve overall child nutrition.

5. Increase efforts in regular growth monitoring and provide support programs for malnourished children to ensure timely interventions and recovery, while raising awareness about the impacts of malnutrition.
6. Fund and support community-based programs aimed at improving feeding practices, increasing dietary diversity, and reducing malnutrition through education, resources, and ongoing monitoring.
7. Implement regulations to ensure the availability of safe, diverse, and nutritious foods, and monitor the quality of complementary foods.

6.3 Methodological strengths and limitations of the Study

Strengths

The study utilized the Weighed Food Record (WFR) method, considered the gold standard in dietary assessment, to evaluate the nutritional adequacy of the population. This comprehensive approach allowed for detailed measurement of food intake and calculation of the Mean Adequacy Ratio (MAR), which provided insights into the overall nutritional adequacy of the population. By focusing on MAR, the study assessed the broader picture of dietary quality rather than concentrating solely on individual nutrients. This method helps in understanding how well the population's diet meets overall nutritional needs

Weaknesses

1. The nutrient adequacy indicator was based on RDAs, which may vary for some nutrients (like zinc and iron) depending on the assumed absorption, which can differ depending on the type of food consumed thus, even a MAR of 1 (meaning requirements of all nutrients are met) does not guarantee that a population’s needs are met nor that individuals within the population can properly absorb and use the nutrients.

2. The study was part of an ongoing trial that did not use design effect in sample size calculation leading to a small sample size.

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ANNEXES

Annex 1: Information letter, Consent form and Recruitment form

Information and Informed Consent Form

Observational data collection for *Validation of ICTs for understanding women's time use, dietary diversity, and hygiene practices.*

Individual Participant Information and Informed Consent Form – for Mothers of 6-23 month old infants

IRB research approval number: *This approval will elapse on:*

Funding Source for Research: IMMANA
Principal Investigator: Dr Kate Wellard Dyer
Local lead investigator: Dr Nambooze Joweria

Invitation and Summary

We'd like to invite you to take part in our research study, using mobile phones and cameras to understand women's time use, maternal and child nutrition outcomes and hygiene practices. Joining the study is entirely up to you. Before you decide we would like you to understand why the research is being done and what it would involve for you. A member of our team will go through this participant information sheet with you, to help you decide whether you would like to take part and answer any questions you may have. We suggest this will take about 15 minutes.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to understand whether and how new digital technologies can be used to better collect important information about women's time use, maternal and infant nutrition, and childcare and hygiene practices in the Northern Region of Uganda. As a mother or primary caregiver of a child between 12 and 23 months of age living in this village, you and your household have been chosen by a random selection process to participate in the study.

WHAT WILL HAPPEN DURING THIS STUDY?

In this study, maternal time use patterns and maternal and child dietary practices was assessed over 5 consecutive days. Each day may be different, but there was a combination of 5 methods

of data collection: (1) direct 15-hour observation (where a research assistant will stay with you all day to observe and weigh all of the food that you and your young child eat), (2) a camera, (3) a mobile phone, an accelerometer, and (4) a 24-hour image-assisted dietary, maternal use recalls (where a research assistant will sit down with you to view photos taken with the camera to help document all of the foods you and your child ate and the activities you did the day before). For the camera, you will be required to wear a camera on the front of your shirt that takes photos every 30-seconds to capture your daily activities. For the mobile phone, you will be issued with a mobile phone that will ring once in one day with an automated message to help you record via the keypad what food groups you and your child ate throughout the day. For the accelerometer, you will be required to wear an accelerometer on your waist to record your daily calorie expenditure. At the end of the study, a focus group discussion will be held where you will share your experiences with each of the tools.

In addition, your participation will involve answering questions related to your household's health and wellbeing, dietary intake using a 24-hour list-based recall, and your experience using the camera and the mobile phone. We will also measure your height and weight and that of your child aged 6-23 months old selected randomly as the index child.

Data collection will happen alongside your typical daily routine and the interviews will take place at your home.

HOW MANY PEOPLE WILL PARTICIPATE?

Approximately 156 households will take part in this study conducted by investigators at the Natural Resources Institute University of Greenwich, London School of Hygiene & Tropical Medicine, Africa Innovations Institute, and Inchuli Institute.

HOW LONG WILL I BE IN THIS STUDY?

If you agree to take part in this study, your involvement will last for 5 consecutive days.

WHAT ARE THE RISKS OF THIS STUDY?

There are no known risks associated with this research other than the potential for mild boredom or fatigue. There may also be some disruption to typical daily activities as a result of either the observer or the innovative equipment (camera and mobile phone). While wearing the camera it is possible that it will capture sensitive or personal moments of yourself, household- or community- members. You can prevent such cases by removing or covering the camera. In

cases where sensitive pictures have been taken, you may always and unconditionally ask for these images to be deleted (you do not need to provide a reason). Any identifiable images will not be viewed by anyone outside the research team. They will be stored in a manner that prevents others from viewing them.

WHAT ARE THE BENEFITS OF THIS STUDY?

There are no specific benefits to you for participating in this study aside from knowing that your participation may lead to future benefits for families in Uganda and elsewhere.

WHAT IF I DO NOT WANT TO PARTICIPATE?

Your participation in the study is completely voluntary. You are free to withdraw your consent and discontinue participation at any time and/or to refuse to answer any questions or decline to participate in any activities. To protect your privacy, all of the data will be anonymised (your personal details will be deleted) at the end of the project so that your response cannot be identified as yours. Because the data will be anonymised at the end of the project, it means that you can withdraw your consent up until the end of data collection. You may also ask any questions concerning the study at any time.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

There is no cost to you to participate in this study.

WILL I BE PAID FOR PARTICIPATING?

You will not be paid for being in this research study. You will however be given a T-shirt, a bar of soap, and cooking oil as a token of appreciation for participating in the study.

WHO IS FUNDING THIS STUDY?

The UKAid in the United Kingdom and the Bill and Melinda Gates Foundation have provided funds for this study through an IMMANA grant.

HOW WILL YOU KEEP MY INFORMATION CONFIDENTIAL?

We will keep your participation in this research study confidential to the extent permitted by law.

All data will be handled in accordance with General Data Protection Regulations and University data handling policies. Data will only be shared with members of the research project team who will all abide by national data protection laws. All data will be anonymised

prior to publication (your personal details will be deleted).

To help protect your confidentiality, we will keep the data file with your name in a locked, secure location. Images that are collected by the wearable camera, and location data collected by the GPS loggers will be kept exclusively on encrypted/secured storage media and in locked safe boxes. If we write a report or article about this study or share the study data set with others, we will do so in such a way that you cannot be directly identified.

WHAT IF I DECIDE TO WITHDRAW FROM THE STUDY?

You may withdraw by telling the study team you are no longer interested in participating in the study. After wearing the camera, you will also be given the option of deleting any photos you do not wish to be included in the study (no explanation required). If you decide to leave the study early, we will ask you to directly inform the study coordinator, Dr. Nambooze Joweria by phone or in person who may ask you for the reasons for your decision to withdraw. You will be provided with a copy of this study information letter that will include these contacts details.

WILL I RECEIVE NEW INFORMATION ABOUT THE STUDY WHILE PARTICIPATING?

If we obtain any new information during this study that might affect your willingness to continue participating in the study, we'll promptly provide you with that information.

CAN SOMEONE ELSE END MY PARTICIPATION IN THIS STUDY?

Under certain circumstances, the researchers might decide to end your participation in this research study earlier than planned. This might happen because your child becomes very ill or if you move away from the selected study areas.

WHAT IF I HAVE QUESTIONS?

We encourage you to ask questions. If you have any questions about the research study itself or any questions, concerns, or complaints about your rights as a research participant, please contact: Dr. Nambooze Joweria, [0701193017], or Dr. Kate Wellard, [+447827456177]. For more information about your rights and welfare, you may also contact the IRB chairperson, Dr. Kabwigu Samuel, [0779610100] or the executive secretary of the Uganda National Council for Science and Technology, [0414705500].

DECLARATION OF CONSENT

This consent form is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You are not waiving any legal rights by agreeing to participate in this study. Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a signed copy of this form.

This agreement certifies that (tick boxes that apply):

- ☐ I was invited to participate in the research, following the information described above in this form
- ☐ I read this form and I understood it
- ☐ This form has been read to me in __________ (INSERT LANGUAGE) and I understood it
- ☐ This form has been interpreted to me and I understood it
- ☐ I have spoken with a project staff member who has explained to me the benefits and risks of this research

I specifically understand:

- ☐ That I am free to accept or refuse the invitation to participate
- ☐ That if I join the research, I am free to change my mind later and to stop participating. If I do so, I will still receive the same level of health and agriculture services and other services

I give my consent that information about me and my family from this research may be reviewed and analyzed by members of the evaluation team who are required to maintain confidentiality

I agree to participate in this research

Name:

Date

Witnessed by

Name:

Date

Annex 2: Data collection tools

Household ID:	Mother ID:	Child ID:
Enumerator ID:		Supervisor ID:
District:		Village:

Household Demographics			
Nº	QUESTIONS	CATEGORIES	Codes
QN1	How many people in total generally live in your household?	Total number of people living in the household	☐☐
QN2	How many children under the age of 24 months live in the household? Including the target child.	Total number of children under 24 months	☐☐
QN3	How old are you?	Number of years	☐☐
QN4	What is the highest level of school you have completed?	Completed primary school Completed secondary school Technical college Higher / university Don't know No formal education	1 2 3 4 5 6

Index Child

READ ALOUD: Now I'm going to ask you some questions about your child [INDEX CHILD]. Please get the Child Health Card for [INDEX CHILD].

QN5	Date of birth	Day: Month: Year:
QN5a	Source of information **Select only one**	1=Immunisation Card 2=Other document 3=Recall

QN6	Sex	0=Male 1=Female
QN7	Birth weight *(kg)*	__.____ IDK
QN7a	Source of information **Select only one**	1=Immunisation Card 2=Other document 3=Recall

Child Health

READ ALOUD: Now I am going to ask some questions about the health of [INDEX CHILD].

QN8	Has [INDEX CHILD] had diarrhoea in the last 2 weeks? **(i.e. weekday to weekday)** **3+ loose or watery stools per day, or blood in stool**	0 = No (Skip to **QN9**) 1 = Yes 88= IDK
QN9	Has [INDEX CHILD] had a Respiratory Tract Infection in the last 2 weeks? **(i.e. weekday to weekday)** **running nose or persistent productive cough or both**	0 = No (Skip to **QN10**) 1 = Yes 88= IDK
QN10	Has [INDEX CHILD] had high temperature in the last 2 weeks? **(i.e. weekday to weekday)** **temperature above 37°C - NOT just malaria**	0 = No 0 = No (Skip to **QN11**) 1 = Yes 88= IDK
QN11	Has [INDEX CHILD] received a Vitamin A Supplement In the last six months?	0 = No 1 = Yes (Child Health Card) 2= Yes (recall) 88= IDK
QN12	Has [INDEX CHILD] received a deworming tablet in the last six months?	0 = No 1 = Yes (Child Health Card) 2= Yes (recall) 88= IDK

Breastfeeding Practices

READ ALOUD: Now I am going to ask you some questions about breastfeeding [INDEX CHILD].

QN13	Has [INDEX CHILD] ever been breastfed?	0=No (Skip to **Q20)** 1=Yes
QN14	How long after birth was [INDEX CHILD] first put to the breast? *If immediately, write "000"* *If less than one hour, write "00" hours* *If less than 24 hours, record hours* *Otherwise, record days*	
QN15	In the first two days after delivery, was [NAME] given anything other than breast milk to eat or drink – anything at all like water, infant formula, or ***[insert common drinks and foods,*** ***including ritual feeds, that may be*** ***given to newborn infants]?***	0=No 1=Yes 88=IDK
QN16	Are you currently breastfeeding [INDEX CHILD]?	0=No 1=Yes (Skip to **Q20**)
QN17	Was [NAME] breastfed yesterday during the day or at night?	0=No 1=Yes
QN18	Did [NAME] drink anything from a bottle with a nipple yesterday during the day or at night?	0=No 1=Yes
QN19	At what age did you stop breastfeeding [INDEX CHILD]?	_ _ (months)
QN20	Are you currently breastfeeding another child?	0=No 1=Yes
QN19	At what age did you stop breastfeeding [INDEX CHILD]?	_ _ (months)
QN20	At what age did you did you introduce the index child to solid and semi solid foods [INDEX CHILD]?	_ _ (months)

Anthropometric Assessment Scores *(Index child 6-23 months olds)*

QN21	Weight of the Child	
QN22	Height of the Child	

Weighed Food Records (WFR)- Young Child Feeding Practices

<table>
<tr><td>Household ID:</td><td>Mother ID:</td><td>Child ID:</td></tr>
<tr><td>Enumerator ID:</td><td colspan="2">Supervisor ID:</td></tr>
<tr><td>District:</td><td colspan="2">Village:</td></tr>
<tr><td>Salter calibration ID:</td><td colspan="2">Salter calibration weight:</td></tr>
<tr><td>Date of record: (dd/mm/yy)
Day of the week <u>today</u>:</td><td colspan="2">Time ARRIVED: (24-hr):
Time DEPARTED: (24-hr):</td></tr>
<tr><td>Is today a market day?
☐ Yes ☐ No</td><td colspan="2">Is <u>today</u> a holiday or a non-working day?
☐ Yes ☐ No</td></tr>
<tr><td colspan="3">Complete at the end of the day – asking the mother these questions</td></tr>
<tr><td colspan="3">How would you describe {INDEX CHILD} food consumption today regarding the <u>AMOUNT</u> of food consumed?
☐ Usual ☐ <u>Less</u> than Usual ☐ <u>More</u> than usual

If the amount was LESS THAN USUAL, what were the reasons it was less than usual? (Tick all that apply)
☐ Sick ☐ Not hungry ☐ Away from home;
☐ Food was not enough; ☐ Did not like food served;
☐ Other, specify:

If the amount was MORE THAN USUAL, what were the reasons it was more than usual?
☐ Feast day; ☐ Hungrier than usual; ☐ Liked food;
☐ More food in house than usual;
☐ Other, specify:______________________________

Were the types of foods or beverages {INDEX CHILD} consumed today different from those that s/he would normally eat?
☐ Yes, some were different ☐ No, usual

Was {INDEX CHILD} breastfed today? ☐ Yes ☐ No</td></tr>
<tr><td>Are you planning to feed {INDEX CHILD} anything after I leave today and before s/he goes to bed?
☐ Yes (24-hour recall must be done) ☐ No</td><td colspan="2"></td></tr>
<tr><td colspan="3">Checked and signed off by supervisor: ☐ Yes Checked and signed off by co-ordinator: ☐ Yes</td></tr>
</table>

Time *24 hr*	**Food**	**Description**	**Recipe #**	**Source**	**W /R**	**Empty plate / cup** (g)	**Amount served** (g) *w plate/cup*	**Amount left-over** (g) *w plate/cup*	**Mix #**	**Who Served**

Source: **1**- home produced; **2**- wild / gathered; **3**- bought direct from farmer; **4**- borrow/bought from friend/neighbour; **5-** bought from daily city market; **6**- bought from monthly market; **7**- bought from weekly market; **8**- bought from daily village market; **9**- bought from village shop; **10**- bought from mobile vendor; **11**- bought from street vendor; **12**- bought from market via taxi/boda boda driver; **13**- Gift; **14**- Payment in kind (work for food); **15**- food aid; **16-** other (specify)______________
Who Served: **1** – mother; **2** – other female adult (≥ 13 years); **3** – male adult (≥ 13 years); **4** – child (<13 years); **5** – child served him/herself

Weighed Food Records (WFR)-Recipes

Recipe #	**Name of Recipe**	**Ingredients**	**Description**	**Source**	**Empty Cooking Pot weight** (g)	**Empty Plate weight** (g)	**Ingredient weight** (g)	**Cooked food weight** (g)	**Cooking method**

Annex 3: Activity plan

The table below shows a scheduled plan for various activities that took place during the project.

Project activities	July 2022	Aug-Sept 2022	Jan 2023	February 2023	June 2023
Topic selection					
Literature review					
Proposal writing					
Data collection					
Approval of the proposal					
Data cleaning					
Data analysis					
Report writing					
Analysis of results					
Compilation					
Approval of the report					
Submission of report					