**University of Zambia**

**School of Agricultural Sciences**

**Department of Food Science and Nutrition**

**Factors Associated with Minimum Dietary Diversity Among Children aged 6-23 months in Selected Wards in Rufunsa District, Zambia**

**A Thesis Submitted in Fulfillment of the Master of Science Degree in Human Nutrition**

**By**

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**DECLARATION**

This dissertation is the original work of Priscilla Funduluka, produced in accordance with the guidelines for an MSc in Human Nutrition dissertation at the University of Zambia. The dissertation has not undergone submission for a degree at this or any other university.

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**CERTIFICATE OF APPROVAL**

This dissertation of Priscilla Funduluka fulfills the requirement for the award of a Doctor of Philosophy Degree (Ph.D.) in Human Nutrition of the University of Zambia.

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**ABSTRACT**

Malnutrition among children aged 6–23 months remains a critical public health concern in Zambia, driven by suboptimal complementary feeding practices and socioeconomic factors. This study assessed; dietary patterns in Chinyunyu, Rufunsa District, soybean processing and utilization in Eastern Province and the nutrient profile of cowpea and soybean genotypes to determine their role in improving child nutrition. A mixed-methods approach was employed, integrating a descriptive cross-sectional survey with laboratory analyses. Dietary patterns were examined using grounded theory through photo voice, focus group discussions, and in-depth interviews. A cross-sectional survey and phenomenological study explored soybean processing and utilization, while laboratory analysis determined the nutrient composition of cowpea and soybean genotypes. Data were analyzed using NVIVO QSR10 and Stata MP 15 software. Findings revealed that complementary feeding in Chinyunyu relied on staple foods such as porridge and nshima, with limited animal-source foods, fruits, and vegetables. Economic constraints and low nutrition awareness contributed to the frequent consumption of unhealthy foods. Feeding frequency varied, with some children receiving inadequate meals due to maternal workload and food scarcity. Gender dynamics influenced food access, with men controlling resources while women managed household nutrition. Soybean processing and utilization in Eastern Province remained low despite the region’s agricultural potential. Limited access to inputs, weak extension services, and inadequate value chain governance hindered adoption. Male-headed households and those with off-farm income were more likely to process and consume soybean, while older household heads showed lower participation. Laboratory analysis revealed significant nutrient variations. Cowpea genotypes (LT 11-3-3-12, Lukusuzi, LT 4-2-4-1, Lutembwe, and LT 3-8-4-6) had high mineral content, while soybean genotypes (Lukanga, Safari, Dina, SC Saga, GX 2033-16 GZ, TG 2033-93GZ, and SG Sentinel) were rich in magnesium and phosphorus. Both crops exceeded protein requirements for children, with soybean genotypes providing superior iron and B vitamins. Mineral correlations indicated strong synergistic relationships among calcium, potassium, magnesium, sodium, and phosphorus, supporting bone mineralization, electrolyte balance, and cellular metabolism. Principal Component Analysis (PCA) highlighted key nutrient drivers, while cluster analysis identified nutrient-rich genotypes. However, zinc-iron (-0.38) and potassium-iron (-0.29) antagonistic interactions suggest competition for absorption, which should be considered in dietary planning for children aged 6 to 23 months. These findings underscore the complex interplay between dietary patterns, soybean utilization, and nutrient availability in shaping child nutrition outcomes. Poor dietary diversity and low soybean adoption highlight the need for targeted interventions. Strengthening nutrition education, promoting household soybean processing, and integrating nutrient-rich legumes into complementary feeding programs can improve child nutrition.

**Keywords:** Child nutrition, complementary feeding, dietary diversity, soybean utilization, cowpea genotypes, nutrition education, Rufunsa District, Eastern Province, Zambia.

**DEDICATION**

I dedicate this dissertation to the legends my late parents Dickson Mudenda Funduluka and Rosa Moono Funduluka, for their support in my early childhood, sacrifice in my schooling and encouragement to work hard throughout my life. Likewise, I dedicate this dissertation to my girl; Muleya Michelo Lubaya Lungu and my three boys; Schultz Shimukuni Shangala, Funduluka Shangala and Musaka Shangala for their love and support that gave me strength to carry on.

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**ABBREVIATIONS AND ACRONYMS**

**MDD** Minimum Dietary Diversity

**MMF** Minimum Meal Frequency

**MAD** Minimum Acceptable Diet

**IYCF** Infant and Young Child Feeding

**WHO** World Health Organization

**UNICEF** United Nations Children’s Fund

**BFHI** Baby-Friendly Hospital Initiative

**CMAM** Community Management of Acute Malnutrition

**PLW** Pregnant and Lactating Women

**ANC** Antenatal Care

**ASF** Animal Source Foods

**FFV** Fruits and Fresh Vegetables

**FBDG** Food-Based Dietary Guidelines

**RDA** Recommended Dietary Allowance

**DRI** Dietary Reference Intake

**MICs** Multiple Indicator Cluster Surveys

**SBCC** Social and Behavior Change Communication

**MIYCN** Maternal, Infant and Young Child Nutrition

**SUN** Scaling Up Nutrition

**NFNC** National Food and Nutrition Commission (Zambia)

**WFP** World Food Programme

**FAO** Food and Agriculture Organization

**24HR** 24-Hour Recall

**HDDS** Household Dietary Diversity Score

**WDDS** Women’s Dietary Diversity Score

**DDS** Dietary Diversity Score

**FFQ** Food Frequency Questionnaire

**SMART** Standardized Monitoring and Assessment of Relief and Transitions

**DEFINITIONS**

**Minimum Dietary Diversity (MDD)-**The proportion of children aged 6–23 months who receive foods from at least 5 out of 8 food groups in the previous 24 hours.

**Minimum Meal Frequency (MMF)-**The proportion of breastfed and non-breastfed children aged 6–23 months who receive solid, semi-solid, or soft foods (and milk feeds for non-breastfed children) the minimum number of times or more in the previous 24 hours.

**Minimum Acceptable Diet (MAD)-**A composite indicator combining MDD and MMF, reflecting both the quality and quantity of a child’s diet.

**Infant and Young Child Feeding (IYCF)-**A set of guidelines and practices recommended by WHO/UNICEF for optimal feeding of children aged 0–23 months to ensure proper growth and development.

**Food-Based Dietary Guidelines (FBDGs)-**National guidelines promoting the consumption of a variety of foods to meet nutrient needs and support healthy dietary patterns.

**Animal Source Foods (ASF)-**Foods derived from animals such as meat, eggs, dairy, and fish that are rich in high-quality proteins and micronutrients like iron and zinc.

**Recommended Dietary Allowance (RDA)-**The average daily dietary intake level sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular age and gender group.

**Dietary Diversity Score (DDS)-**A simple count of food groups consumed over a reference period, typically 24 hours, used as a proxy for micronutrient adequacy.

**Household Dietary Diversity Score (HDDS)-**A measure of the number of different food groups consumed by a household, used as a proxy for household food access.

**Women's Dietary Diversity Score (WDDS)-**A measure of dietary diversity specifically for women of reproductive age, often used as a proxy for nutrient adequacy.

**24-Hour Recall (24HR)-**A dietary assessment method where individuals recall all foods and beverages consumed in the previous 24 hours.

**Food Frequency Questionnaire (FFQ)-**A tool that assesses dietary patterns by recording how often foods or food groups are consumed over a specific period.

**Social and Behavior Change Communication (SBCC)-**A strategic approach to change behaviors through communication, education, and advocacy to improve health outcomes.

**Scaling Up Nutrition (SUN)-**A global movement to end malnutrition through coordinated multi-sectoral action at the national and community levels.

**Community Management of Acute Malnutrition (CMAM)-**A decentralized approach to treat children with acute malnutrition at the community level using ready-to-use therapeutic foods (RUTFs).

**Essential Nutrition Actions (ENA)-**A set of proven interventions to improve nutrition during the first 1,000 days of life, including breastfeeding, complementary feeding, and micronutrient supplementation.

**Multiple Indicator Cluster Surveys (MICS)-**Household surveys developed by UNICEF to assess health, education, and nutrition indicators, including IYCF practices.

**National Food and Nutrition Commission (NFNC)-**Zambia’s government institution responsible for coordinating national food and nutrition programs and policies.

**Standardized Monitoring and Assessment of Relief and Transitions (SMART)-**A methodology used to assess nutritional status and mortality in emergency and development settings.

**Codex Alimentarius-**A collection of internationally recognized standards and guidelines related to food safety and quality developed by FAO and WHO.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Undernutrition remains a leading cause of morbidity and mortality among children under five (Uribe-Quintero *et al.*, 2022), with poor infant and young child feeding (IYCF) practices contributing significantly to this burden (Jeyakumar *et al.*, 2022). Undernutrition is a condition where the body does not get enough essential nutrients, affecting a person's health (Franco *et al.*, 2024). One of the most critical indicators for assessing complementary feeding adequacy is **Minimum Dietary Diversity (MDD),** defined by the World Health Organization (WHO) as the proportion of children aged 6–23 months who consume foods from at least five out of eight designated food groups in a 24-hour period (WHO, 2025). MDD serves as a proxy for micronutrient adequacy of the child’s diet and could contribute to attaining SDG 2.2 (ending all forms of malnutrition by 2030). Despite WHO recommendations, only 27.5% of children in low- and middle-income countries (LMICs) meet the minimum dietary diversity, with sub-Saharan Africa reporting some of the lowest rates (Martín-Rodríguez *et al.*, 2022).

In sub-Saharan Africa, low MDD may be explaining why malnutrition persists with studies identifying **maternal, household (Jalata and Asefa, 2022)** and **food systems factors** as significant determinants of MDD (O’Meara *et al.*, 2021).

In Zambia, undernutrition remains a pressing public health concern. According to the Zambia Demographic and Health Survey (ZSA, 2024), 32% of children under age 5 are stunted (short for their age), and 10% are severely stunted. Three percent of children under age 5 are wasted (thin for their height), 1% are severely wasted, and 4% are overweight. Twelve percent of children under age 5 are underweight, and 2% are severely underweight. Recent reports of prevalence of anaemia among the under-five children are at 53.8% (Nawa *et al.*, 2023). Up to 9.2% of the children are overweight. Only twenty-two percent of children age 6–23 months are fed with a minimum dietary diversity (ZSA, 2024). These reports show significant nutritional gaps during the critical complementary feeding period.

Rufunsa District, located in Lusaka Province, is predominantly rural and experiences unique challenges related to food security, caregiver practices, and access to health and nutrition services. A recent formative qualitative study conducted in Chinyunyu community within Rufunsa explored feeding indicators for children aged 6–23 months using focus group discussions, photovoice, and in-depth interviews (Funduluka *et al.*, 2022). This study revealed that diets were largely based on starchy staples like maize porridge and nshima, with limited inclusion of animal-source foods, fruits, and vegetables. Key barriers included low maternal nutrition awareness, economic constraints, seasonal food scarcity, and gendered household dynamics affecting food access.

While the formative study conducted in Rufunsa provided rich, contextual insights into caregiver perceptions, behaviors, and structural barriers to dietary diversity, it was qualitative in nature and did not quantify the prevalence or strength of associations between these factors and MDD. Therefore, a quantitative study is now warranted to measure the extent to which specific factors—at individual, household, community, and enabling policy environment in a interplay with the food systems—are statistically associated with MDD among children aged 6–23 months. This quantitative evidence will be critical to inform targeted interventions and policy actions at both district and national levels.

## 1.2 Problem Statement

Efforts to improve complementary feeding practices continue to face critical challenges, particularly in low-resource settings where child undernutrition persists (Elhady *et al.*, 2023; Bridge and Lin, 2024) despite the adoption of global and national nutrition policies. While international guidelines emphasize dietary diversity as an essential aspect of infant and young child feeding (WHO and UNICEF, 2021), there remains a gap in translating these recommendations into measurable, community-level outcomes. This gap is particularly evident in rural and underserved districts like Rufunsa District where localized evidence is insufficient to guide programmatic decisions.

Rufunsa District in Zambia reflects this challenge because although national data suggest that child feeding practices are suboptimal, the specific magnitude and drivers of inadequate dietary diversity within the district are not well understood. A recent formative qualitative study conducted in Chinyunyu community provided valuable insight into the feeding indicators among children aged 6-23 months (Funduluka *et al.*, 2022). However, being qualitative in nature, the study did not estimate the prevalence of Minimum Dietary Diversity (MDD) nor statistically assess how key factors are associated with dietary diversity among children.

This lack of quantitative data limits the ability of policymakers, district health officials, and development partners to identify high-risk populations, allocate resources efficiently, and evaluate the impact of nutrition interventions. In contrast, regional evidence from sub-Saharan Africa highlights that MDD is strongly associated with child and maternal factors (Ba *et al.*, 2022), as well as community level factors (Belay *et al.*, 2022). Yet, the applicability of these associations to Rufunsa remains unknown in the absence of empirical data.

There is, therefore, a critical need to conduct a quantitative study in Rufunsa District to assess the prevalence of MDD and examine the factors influencing dietary diversity among children aged 6–23 months. This will not only complement existing qualitative findings but also provide actionable evidence to inform targeted, locally relevant interventions and enhance progress toward Zambia’s national nutrition targets and ultimately sustainable development goals.

## 1.3 Significance of the Study

This study is of high relevance to public health and child nutrition in Zambia, particularly in rural areas such as Rufunsa District where undernutrition and suboptimal feeding practices persist. Dietary diversity is globally recognized as a critical determinant of nutrient adequacy and child health, particularly during the complementary feeding period. Inadequate dietary diversity has been linked to micronutrient deficiencies (Saha *et al.*, 2023), stunting (Aboagye *et al.*, 2021), impaired cognitive development (Anane, Nie and Huang, 2021), and increased morbidity and mortality (Aboagye *et al.*, 2021) among children aged 6–23 months. By assessing the prevalence of Minimum Dietary Diversity (MDD) and examining its associated factors in Rufunsa District, this study will provide essential data to inform locally relevant interventions that aim to improve child nutrition and reduce malnutrition.

While a previous qualitative study in Rufunsa was a formative research in Chinyunyu community. The study showed various socio-cultural and behavioral perceptions as barriers to optimal feeding (Funduluka *et al.*, 2022). There remains a lack of quantitative evidence to estimate how widespread these challenges are or how strongly specific factors influence child dietary outcomes. This study will therefore address a critical data gap by quantifying the prevalence of MDD and identifying the key predictors of dietary diversity. Such information will enable program planners, community health officers, and non-governmental organizations to design more precise and evidence-informed nutrition programs. Moreover, understanding the statistical strength of associations between variables will allow interventions to be prioritized based on measurable risk.

Beyond local programmatic impact, the study will contribute to Zambia’s progress toward achieving national and global nutrition goals. Specifically, it will support implementation of the Zambia National Food and Nutrition Strategic Plan (2023–2027) and the Zambia Multisectoral Nutrition Action Plan (ZMSNAP II), both of which emphasize improving complementary feeding practices and increasing dietary diversity among young children. At the global level, the findings will contribute to achieving Sustainable Development Goal 2 particularly Target 2.2, which aims to end all forms of malnutrition by 2030 and will feed into international monitoring frameworks such as the Global Nutrition Targets 2025 and WHO/UNICEF Infant and Young Child Feeding indicators.

This study will also have scientific significance as it is to the best of our knowledge the first quantitative study on the determinants of dietary diversity among children in Rufunsa District. By generating empirical data, this research will not only complement existing qualitative findings but also expand the evidence base for child nutrition in Rufunsa and similar settings in rural sub-Saharan Africa. The results may inform graduate-level nutrition training, academic research, and cross-district learning for areas with similar socio-economic and environmental contexts.

Lastly, the study will serve as an important tool for policy advocacy and resource mobilization. The findings can support evidence-based lobbying for increased investment in maternal and child nutrition, especially in rural and underserved districts. The data can also be used to inform the integration of nutrition education into health service delivery, guide the targeting of nutrition-sensitive agricultural programs, and influence the design of social protection interventions. In summary, the study’s outcomes will be instrumental in strengthening both the evidence base and the practical response to child malnutrition in Rufunsa District and similar settings.

## 1.4 Main Objective

To determine the prevalence of Minimum Dietary Diversity and identify the factors associated with achieving dietary diversity among children aged 6–23 months in selected wards of Rufunsa District, Zambia.

## 1.5 Specific Objectives

1. To estimate the proportion of children aged 6–23 months who meet the Minimum Dietary Diversity (MDD) criterion in selected wards of Rufunsa District.
2. To examine the factors associated with the achievement of Minimum Dietary Diversity among children aged 6–23 months.

## 1.6 Research Questions

1. What proportion of children aged 6–23 months in selected wards of Rufunsa District meet the Minimum Dietary Diversity (MDD) requirement?
2. What factors are associated with achieving Minimum Dietary Diversity among children aged 6–23 months in Rufunsa District?

## 1.7 Hypotheses

**Specific Objective 1:**

To estimate the proportion of children aged 6–23 months who meet the Minimum Dietary Diversity (MDD) criterion in selected wards of Rufunsa District.

* **Null Hypothesis (H₀):**  
  There is no significant difference in the proportion of children meeting Minimum Dietary Diversity across different wards in Rufunsa District.
* **Alternative Hypothesis (H₁):**  
  There is a significant difference in the proportion of children meeting Minimum Dietary Diversity across different wards in Rufunsa District.

**Specific Objective 2:**

To examine the association between factors and the achievement of Minimum Dietary Diversity among children aged 6–23 months.

* **Null Hypothesis (H₀):**  
  There is no statistically significant association between individual factors and the achievement of Minimum Dietary Diversity among children aged 6–23 months in Rufunsa District.
* **Alternative Hypothesis (H₁):**  
  There is a statistically significant association between individual factors and the achievement of Minimum Dietary Diversity among children aged 6–23 months in Rufunsa District.

## 1.8 Assumptions

1. **Respondents provide accurate and honest responses:** It is assumed that caregivers or mothers of children aged 6–23 months will truthfully report the types and quantities of food consumed by their children during the 24-hour dietary recall period.
2. **The 24-hour recall period reflects usual dietary intake:** The study assumes that the dietary data collected using the 24-hour recall method is a valid proxy for the child’s usual dietary intake and is not significantly influenced by unusual events or seasonal variations.
3. **Minimum Dietary Diversity is a valid proxy for micronutrient adequacy:** The study is based on the WHO assumption that meeting the Minimum Dietary Diversity (≥5 of 8 food groups) correlates with adequate micronutrient intake among children aged 6–23 months.
4. **Selected wards are representative of the broader Rufunsa District:** It is assumed that the wards selected for the study adequately represent the sociodemographic, economic, and food system characteristics of the entire Rufunsa District, thereby allowing generalization of the findings.
5. **Associations reflect underlying causal mechanisms:** The study assumes that identified associations between caregiver, household, and community-level factors and MDD reflect real influences, though causality will not be inferred due to the cross-sectional nature of the design.
6. **Measurement tools are valid and reliable:** It is assumed that the data collection tools (e.g., structured questionnaires and dietary diversity indicators) are culturally appropriate, valid, and reliable for assessing dietary diversity and related factors in the local context.
7. **Caregivers are the primary decision-makers for child feeding:** The study assumes that mothers or primary caregivers are responsible for feeding practices and are therefore best placed to provide accurate data on child dietary patterns.
8. **External factors such as food aid or programs are evenly distributed:** It is assumed that nutrition-specific or nutrition-sensitive interventions (e.g., food aid, growth monitoring, SBCC programs) that might influence dietary diversity are either uniformly distributed or accounted for during analysis.

## 1.9 Conceptual Framework

This study adopts a caregiver-centered theoretical framework (Lobo *et al.*, 2023) while integrating the Socioecological Model (SEM) of the Ottawa Charter of Health Promotion of 1986 in an interplay with the Food Systems Framework (Noort *et al.*, 2022) to understand the factors influencing Minimum Dietary Diversity (MDD) among children aged 6–23 months in Rufunsa District. The decision to combine these frameworks is based on the understanding that child care practices such as feeding are not shaped by caregiver behavior alone but are influenced by a complex interplay of environmental, social, and systemic determinants (Smith, 2024). Placing the caregiver at the center of analysis enables the study to explore how individuals operate within broader food systems, and how their choices and constraints at each level of the SEM affect child nutrition outcomes.

The food system is conceptualized here as a sequence of stages production, processing, distribution, preparation, and consumption (Crippa *et al.*, 2021) each of which intersects with the caregiver’s ability to access and provide a diverse diet to their child. At the food production stage, caregivers are often dependent on subsistence farming or community agriculture, where land access, climate variability, and seasonal crop availability shape the variety of foods produced. These factors are influenced by agricultural extension services, local policy implementation, and household-level resource constraints (Amadu, 2022; Kauky, 2024). At the food processing and distribution stages, the availability of local markets, preservation and milling facilities, and transport infrastructure affect both the diversity and affordability of foods accessible to the caregiver. Gender norms and household income dynamics further influence caregivers’ control over food purchasing and decision-making (Pemjean *et al.*, 2024).

At the household level, food preparation is strongly linked to caregiver time availability, access to cooking fuel, and cultural feeding norms. For example, even when diverse foods are available, preparation practices and beliefs about child-appropriate foods may limit what is actually fed to the child (Sleet, 2019). At the final stage consumption the caregiver’s knowledge, beliefs, and practices directly determine whether the child receives a diverse, age-appropriate diet. This is where the individual-level of the SEM most clearly aligns with the food consumption stage (Cheung, 2024). The framework also considers the cross-cutting enabling environment, which includes national and local policies on food and nutrition, infant and young child feeding (IYCF) strategies, social protection measures, WASH infrastructure, and the availability of health and nutrition services. These structural factors either constrain or facilitate caregivers' capacity to practice adequate complementary feeding (Fikadu *et al.*, 2025).

The use of this integrated framework is justified for several reasons. First, it acknowledges the multi-level influences on caregiver behavior (Pellecchia *et al.*, 2024), in line with the socioecological model, and highlights the importance of both proximal and distal factors (Pellecchia *et al.*, 2024) affecting child nutrition. Second, it aligns with the food systems approach, which emphasizes the systemic nature of food access (Leeuwis *et al.*, 2021), transformation, and governance (Sonnino, 2023). Third, this framework is particularly relevant for rural Zambia, where household food production (Kenney *et al.*, 2024), informal markets (Dinku *et al.*, 2023), gendered roles (Bukachi *et al.*, 2022), and limited institutional support (Dinku *et al.*, 2023) shape both food availability and feeding practices. Lastly, it supports multisectoral action by identifying potential intervention points across agriculture, health, education, and social protection systems. By linking caregiver behavior to broader food system stages, this framework provides a comprehensive lens through which to analyze and address the determinants of dietary diversity among young children in Rufunsa District.

**Caregiver-Centered Food Systems–SEM Interplay**

| Food System Stage | Socioecological Level | Caregiver Experience and Influence on MDD |
| --- | --- | --- |
| Food Production | Community / Policy Level | Caregivers rely on household or community farming to access diverse foods. Their access is influenced by land ownership, seasonal availability, climate shocks, and agricultural extension services. |
| Food Processing | Community / Institutional | Availability and use of local processing (e.g. milling, drying, fortification) affects the caregiver’s ability to prepare safe, age-appropriate complementary foods. |
| Food Distribution | Community / Organizational | Caregivers’ access to local markets and affordable diverse foods is influenced by transport, prices, and women’s mobility. Gender norms and access to income shape purchasing power. |
| Food Preparation | Household / Interpersonal | Feeding decisions are made within the household context. Caregivers are influenced by time constraints, cooking fuel, family support, and cultural feeding practices. |
| Food Consumption | Individual Level | At the point of feeding, caregiver knowledge, health beliefs, and understanding of infant feeding guidelines directly impact what, when, and how foods are given. |
| Enabling Environment | Cross-cutting Across Levels | Caregivers are shaped by policies (e.g. food and nutrition), access to health/nutrition education, WASH infrastructure, and social safety nets (e.g. food subsidies or maternal support programs). |

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter critically examines existing literature on Minimum Dietary Diversity (MDD) among children aged 6–23 months, focusing on its prevalence, determinants, and the interplay between socioecological factors and food systems. The review encompasses global, regional, and national perspectives, highlighting gaps that this study aims to address.

## 2.2 State of Minimum Dietary Diversity

Minimum Dietary Diversity (MDD) is a critical indicator for evaluating the quality and adequacy of complementary feeding among children aged 6–23 months. Defined as the proportion of children in this age group who consume foods from at least five out of eight specified food groups within a 24-hour period, it serves as a proxy for micronutrient sufficiency in the diet (WHO and UNICEF, 2021).

Globally, the prevalence of adequate MDD remains suboptimal, particularly in low- and middle-income countries (LMICs). An analysis of national surveys from 80 LMICs found that only 21.3% of countries reported MDD prevalence rates above 50%, with the lowest levels observed in Western and Central Africa (Gatica-Domínguez *et al.*, 2021). Similarly, only four out of 49 LMICs using Demographic and Health Survey (DHS) data exceeded the 50% threshold for MDD, with Sub-Saharan Africa reporting the lowest regional prevalence at 18%, and Latin America and the Caribbean recording the highest at 54% (Baye and Kennedy, 2020). Further evidence from 197,514 children across 59 LMICs showed that 73.8% of children aged 6–23 months did not meet the MDD requirement (Heemann *et al.*, 2022). In South Asia, the overall weighted MDD prevalence was 23.4%, based on DHS data from Bangladesh, India, Maldives, Nepal, and Pakistan. The highest MDD prevalence was recorded in the Maldives (70.7%), while the lowest was observed in Pakistan (14.2%) (Rahman *et al.*, 2023).

In Sub-Saharan Africa (SSA), the prevalence of inadequate minimum dietary diversity (MDD) among children aged 6–23 months remains alarmingly high. A recent analysis covering four major regions of SSA which are Eastern, Central, Western, and Southern Africa based on standardized cross-sectional Demographic and Health Survey (DHS) data, revealed a pooled prevalence of inadequate MDD intake of 76.5%, with rates ranging from 50.5% in South Africa to 94.4% in Burkina Faso (Belay *et al.*, 2022). A separate study conducted in the same year across three SSA countries, Gambia, Liberia, and Rwanda using DHS data reported that only 23.2% of children met the MDD threshold. The prevalence varied significantly, from as low as 8.6% in Liberia to 34.4% in Rwanda (Ba *et al.*, 2022). Similarly, an earlier study analyzing DHS data from 32 SSA countries found an overall MDD prevalence of 25.1%, with South Africa recording the highest prevalence at 43.9% and Burkina Faso the lowest at 5.6% (Aboagye *et al.*, 2021). More recent evidence from an analytical cross-sectional study using DHS data from 31 SSA countries reported a pooled MDD prevalence of just 11%, ranging from 1.3% in Burkina Faso to 32.9% in South Africa (Paulo et al., 2024). In Ethiopia, a community-based cross-sectional study found that only 24.4% of children achieved minimum dietary diversity (Sema *et al.*, 2021).

In Zambia national averages show that only 22% of children aged 6–23 months meet the MDD criterion (ZSA, 2024). A study conducted in Luapula Province highlighted that even in communities with access to nutrient-rich foods like fish, dietary diversity remains low at 23% (Marinda *et al.*, 2023). In another study across 28 rural districts in 8 out of the 10 Zambian provinces, only 25.6% of the sampled children met the MDD criteria. More children in the 18–23 months age group met the MDD criteria followed by those in the 12–17 months’ age group, with the lowest proportion meeting the MDD criteria being in the 6–11 months age group (Bwalya *et al.*, 2023).

## 2.3 Factors Associated with Minimum Dietary Diversity

**Individual level**

Individual level factors associated with meeting MDD are Age of the child for 12-17 months vs 6-11 months (Gatica-Domínguez *et al.*, 2021; Sema *et al.*, 2021; Ba *et al.*, 2022; Bwalya *et al.*, 2023), child sex (Sema *et al.*, 2021), children of mothers aged 45-49 compared to those of mothers aged 15-19 (Paulo *et al.*, 2024), mothers with secondary/higher education compared to those with no education (Sema *et al.*, 2021; Ba *et al.*, 2022; Belay *et al.*, 2022; Bwalya *et al.*, 2023; Paulo *et al.*, 2024), maternal decision making (Sema *et al.*, 2021; Bwalya *et al.*, 2023), having a mother who is employed versus a mother who is unemployed (Ba *et al.*, 2022; Belay *et al.*, 2022; Rahman *et al.*, 2023), media (Ba *et al.*, 2022; Belay *et al.*, 2022; Rahman *et al.*, 2023) those who visited health care facility in the last 12 months (Ba *et al.*, 2022), having a health institution delivery (Sema *et al.*, 2021; Belay *et al.*, 2022), increased antenatal as well as growth monitoring and promotion (GMP) visits (Sema *et al.*, 2021; Bwalya *et al.*, 2023; Rahman *et al.*, 2023; Paulo *et al.*, 2024), postnatal care (Sema *et al.*, 2021). Having children older than four years in a household reduced the chances of the child aged 6-23 months meeting MDD. MDD increases with women literacy (Baye and Kennedy, 2020).

**Household level**

At household level, factors are living in affluent vs poor household (Baye and Kennedy, 2020; Ba *et al.*, 2022; Belay *et al.*, 2022; Rahman *et al.*, 2023; Paulo *et al.*, 2024), absolute annual household incomes exceeding∼US$20,000 (Gatica-Domínguez *et al.*, 2021; Belay *et al.*, 2022). MDD increases with food supply diversity (Baye and Kennedy, 2020). Living in a household without access to adequately diversified diet reduces the likelihood of the child meeting MDD (Bwalya *et al.*, 2023).

**Community Level**

Community level positive factors reported are living in upper middle-income country (Belay *et al.*, 2022). Urban compared to rural residence (Baye and Kennedy, 2020; Belay *et al.*, 2022; Paulo *et al.*, 2024).

**Structural Level**

At structural level Log GDP per capita was positively associated with MDD (Gatica-Domínguez *et al.*, 2021). Breast milk was the only type of food with a pro-poor distribution, whereas animal source foods (dairy products, flesh foods, and eggs) showed the most pronounced pro-rich inequality (Gatica-Domínguez *et al.*, 2021). MDD proportion increases with higher Gross National Income at Purchasing Power Parity (GNI PPP) (Baye and Kennedy, 2020).

## 2.4 Commonly offered foods

Children aged 6–23 months are offered food from eight recommended food groups with varying frequency. Breastmilk and grains are the most commonly consumed, followed by vitamin A-rich fruits and vegetables, dairy products, and flesh foods. Other fruits and vegetables were offered less frequently, with eggs and legumes or nuts being the least consumed (Heemann *et al.*, 2022).

## 2.5 Implications of meeting MDD

Baye and Kennedy, (2020) postulated that a significant proportion (> 11 million) of stunting cases could have been averted if≥ 90% of IYC had met the MDD. Aboagye et al., (2021) also showed that children who had adequate dietary diversity were 12% less likelihood of being stunted, had lowered risk of being stunted by 17% and 13% reduced odds of wasting.

## 2.6 Gaps in the Literature

While existing studies provide valuable insights into the determinants of dietary diversity, there is a paucity of research that quantitatively examines the interplay between SEM constructs and food systems in rural Zambian contexts. Most studies have focused on either socioecological factors or food systems in isolation, without exploring their combined effects on child feeding practices. This gap underscores the need for a comprehensive study such as the current study that integrates these frameworks to inform targeted interventions.

# CHAPTER THREE

# MATERIALS AND METHODS

**3.1 Research design**

This was a cross sectional survey. The cross-sectional study was suitable to answer the research question because it allows the measurement of multiple variables at a one-time point.

**3.2 Study site**

The research was conducted in three wards in Rufunsa district, Lusaka Province **(Fig.1)**. The wards were Nyangwena, Bundabunda and Rufunsa. Rufunsa district is situated 15°04′ south of the Equator and 29°40′ east of the Greenwich meridian. The indigenous people in Rufunsa are the remnants of the Soli people with the main economic stay being subsistence farming (Kanema and Gumindoga, 2022). Rufunsa district to which the three wards belong is estimated to have a population of about 81,733 people (Brinkhoff, 2022). The 2024 Zambia Demographic and Health Survey (ZDHS) indicates a decline in stunting rates in Lusaka Province (ZSA, 2024), yet malnutrition remains a serious challenge, particularly in rural districts like Rufunsa, where specific data on on feeding patterns is limited. Between 2018 and 2024, stunting among children under five in Lusaka Province decreased from 36% to 20.1% (ZSA, 2020, 2024). However, Rufunsa’s vulnerability to climate shocks (Kanema and Gumindoga, 2022), erratic rainfall, and food insecurity suggests a high risk of malnutrition due to inadequate feeding practices among children aged 6-23 months. The lack of district-specific emperical nutrition data and dietary data underscores the need for focused research to assess dietary diversity among children aged 6-23 months, a key driver of malnutrition.



**Fig. 1:** Lusaka Province map showing Rufunsa District

**Source:** [map of Lusaka province showing Rufunsa District - Search Images](https://www.bing.com/images/search?view=detailV2&ccid=VVbK34dt&id=D40033FDDD3AA3CEFA2E5D03FFC36DFE68A321F8&thid=OIP.VVbK34dt_XpqUbOpUvbiogHaHa&mediaurl=https%3a%2f%2fprintablemapjadi.com%2fwp-content%2fuploads%2f2019%2f07%2flusaka-zambia-map-map-of-lusaka-zambia-eastern-africa-africa-printable-map-of-lusaka.jpg&cdnurl=https%3a%2f%2fth.bing.com%2fth%2fid%2fR.5556cadf876dfd7a6a51b3a952f6e2a2%3frik%3d%252bCGjaP5tw%252f8DXQ%26pid%3dImgRaw%26r%3d0&exph=1024&expw=1024&q=map+of+Lusaka+province+showing+Rufunsa+District&simid=608055516427402032&FORM=IRPRST&ck=5DF4B33DA5483C44C597CB058F513F11&selectedIndex=0&itb=0&cw=1257&ch=602&idpp=overlayview&ajaxhist=0&ajaxserp=0)

**3.2 Target population**

The target population for this study comprised primary caregivers responsible for the daily care and feeding of children aged 6 to 23 months. Caregivers play a critical role in shaping infant and young child feeding practices, which are essential determinants of growth, development, and overall health during this vulnerable period of rapid physical and cognitive development (Kalra and Shah, 2023). Their knowledge, attitudes, socio-demographic characteristics, and access to food resources directly influence dietary diversity, meal frequency, and nutritional adequacy of complementary feeding (Kemboi, 2021). Therefore, focusing on caregivers as the study population provides valuable insights into household-level factors that affect child nutrition outcomes and informs the design of targeted interventions to improve infant and young child feeding practices (Zerfu *et al.*, 2025).

**3.3 Eligibility criteria**

**3.3.1 Inclusion criteria**

Caregivers eligible for inclusion were individuals aged 18 years and above who were primarily responsible for feeding and caring for children aged 6–23 months. Participants had to reside in the study area for at least six months prior to data collection and provide informed consent to participate. Only caregivers of biologically related or legally adopted children within the specified age group were included to ensure accurate reporting of feeding practices and household factors.

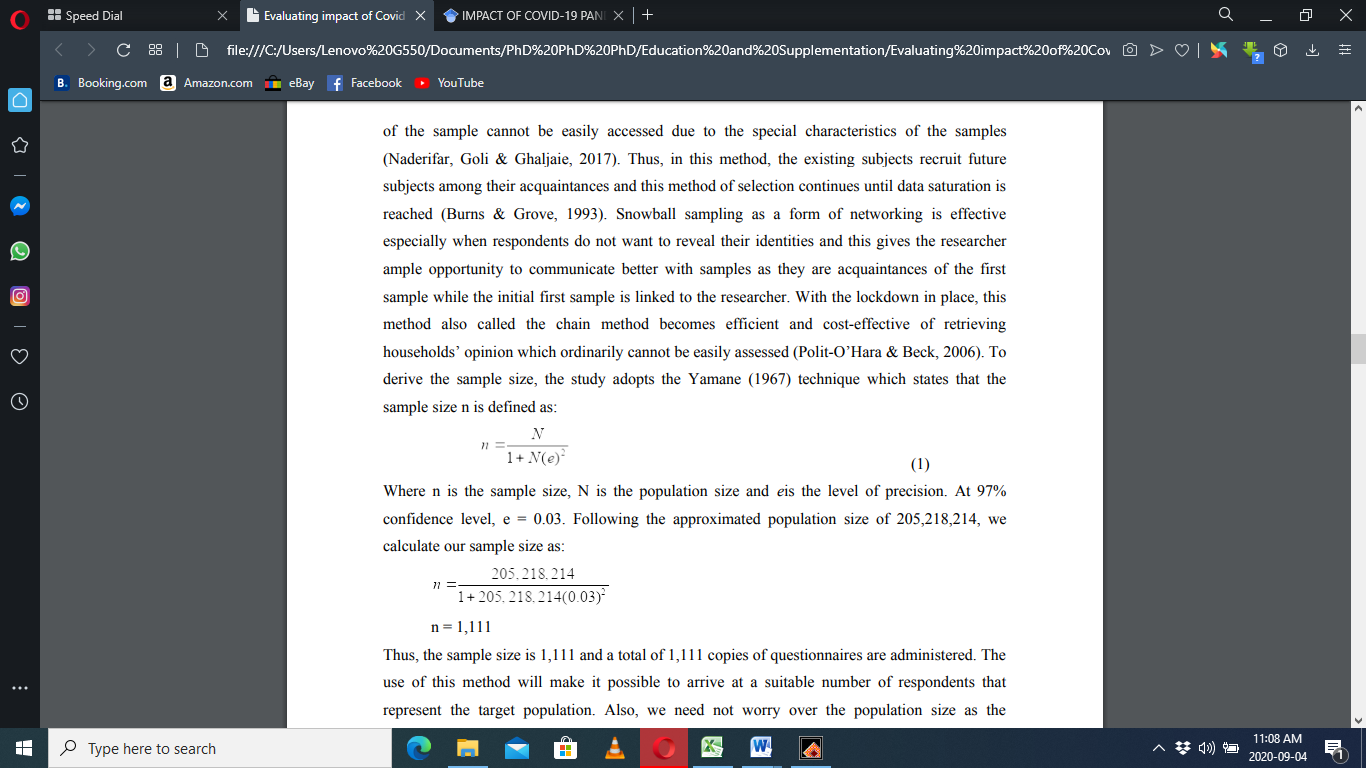
**3.3.2 Exclusion criteria**

Caregivers were excluded if they were currently participating in another nutrition-related intervention or research study that could influence feeding practices. Those with known psychiatric disorders, substance abuse problems, or conditions that could impair reliable data provision were also excluded. Furthermore, caregivers of children with congenital anomalies, metabolic disorders, or chronic conditions that require specialized feeding practices such as non-breastfeeding children were excluded to minimize confounding factors related to dietary diversity outcomes.

**34 Sampling**

**3.4.1 Sample size determination**

The Yamane (1967) formula was adopted for determining the sample size in this study due to its simplicity, efficiency, and suitability for cross-sectional survey designs involving finite populations. It allows for the calculation of an appropriate sample size based on the total population, a desired level of precision, and confidence level, ensuring representativeness while minimizing sampling error (Yamane, 1967). This method is particularly appropriate in resource-limited settings where overly large samples may not be feasible, yet statistical reliability remains essential.



Where n is the sample size, N is the population size and e is the level of precision. At 95% confidence level, e = 0.05. Following the approximated population sizes of the sampled wards in Rufunsa district (ZSA, 2022), the sample size was calculated as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ward | Population | 6% of population | 1+N(e)2 | n | n Plus 3% non-response rate |
| Nyangwena | 4461 | 267 | 1.6675 | 160 | 165 |
| Bundabunda | 4686 | 281 | 1.7025 | 165 | 170 |
| Rufunsa | 4673 | 280 | 1.7 | 165 | 170 |
| Total (n) |  |  |  |  | 505 |
| Source of non-response rate for WRA (ZSA, 2024) | | | | | |

**3.4.2 Sampling Technique and Procedure**

This study employed a two stage sampling approach to select caregivers of children aged 6–23 months residing in the wards of Nyangwena, Bundabunda, and Rufunsa. In the first stage, the three wards were selected based on probability proportional to size (PPS) to represent both rural settings within Rufunsa District, reflecting variations in socio-economic status, food systems, and access to health and nutrition services. In the second stage, a complete list of households with children aged 6–23 months was developed with the help of the senior headman. Using this sampling frame, households were randomly selected using simple random sampling to ensure that each eligible child had an equal chance of being included in the study. The random number generator downloaded on the smart mobile phone was used.

The primary unit of analysis was the caregiver-child pair, with caregivers defined as the primary individual responsible for feeding and caring for the child. Community health workers assisted in locating the selected households to ensure accurate identification of eligible participants. The process in described in **fig.2.**

|  |
| --- |
| Rufunsa: calculated sample size (n=165)  Bundabunda: calculated sample size (n=165)  Nyangwena: calculated sample size (n=160)  Plus non response rate (n=170)  Plus non response rate (n=170)  Plus non response rate (n=165)  Caregiver/child pairs listed (n=…)  Caregiver/child pairs randomized to the study (n=16)  Caregiver/child pairs listed (n=…)  Caregiver/child pairs listed (n=…)  Caregiver/child pairs randomized to study (n=27)  Caregiver/child pairs randomized to the study (n=46)  Final sample (n=89) |

**Fig. 2:** Flow diagram of caregiver/child pairs enrolment and inclusion in the MDD-C study

**Top of Form**

**Bottom of Form**

**Data Collection Tools and Procedures**

**Questionnaire**

A semi-structured, researcher administered questionnaire uploaded on a smart phone (KGTEL 4G) was used to collect the data. The questionnaire comprised closed ended questions. It was administered to the participating caregivers of children aged 6-23 months. The questionnaire was developed in English and uploaded to the smart phone in English. Translations into Nyanja, the local language that is commonly spoken in Rufunsa, the study site were done during interviews. The questionnaire was created in the kobocollect tool box. The sub-sections of the questionnaire namely demographic characteristics and 24 hour recall were adapted from the global questionnaire that had been earlier developed by the global research team in consultation with country partners. This questionnaire was then adapted to fit the local context. Some of the adaptations included inclusion of locally consumed food in Zambia, inclusion of variable for wards and villages, among others. The questionnaire was designed based on constructs from the **Socioecological Model-food systems interplay** (WHO, 1986; Noort *et al.*, 2022), incorporating key indicators from both frameworks. The first page of the questionnaire also included a participant information sheet outlining the purpose of the study, the voluntary nature of participation, and the intended benefits.

**Pre-testing**

To ensure that the instrument used was valid, an initial design of the questionnaire was administered to the research team, comments received, were used to make adjustments in the questionnaire, the corrected version was administered to the research team the second time in which additional corrections were made before dissemination. The team used this exercise as an opportunity to refine the questionnaire. Some issues raised included clarity of questions, probing techniques when conducting the open recall, reliance on the care givers to remember the foods consumed by the child 24 hours prior to the interview. After the pre-testing exercise, the research team discussed methodological and logistical issues that arose during the pretesting exercise that needed to be addressed.

**Research Assistants**

Research assistants (enumerators) were recruited and oriented before pre-testing the data collection tool. All enumerators practiced conducting interviews during the pilot testing with the aim of them familiarizing themselves with the questions and also getting a chance to practice the interviewing technique.

**Data collection procedure**

The data for this study was collected from 17th to 21st August 2021. Data was collected through face-to-face interviews using a structured questionnaire. Informed consent was obtained from all respondents prior to data collection. The primary respondent was a care giver who was knowledgeable about food consumption patterns of a child aged 6-23 months. This respondent provided information on child feeding practices.

Data collection was conducted in adherence to the **World Health Organization (WHO) COVID-19 prevention guidelines**. These include maintaining physical distance of at least one meter, mandatory use of face masks, frequent hand washing, and the use of alcohol-based hand sanitizer in locations where hand washing facilities are unavailable (WHO, 2023).

The well-being of children during the pandemic will be modeled out based on their dietary diversity. According to WHO Children need to eat food from at least 4 out of the 8 food groups daily; 1) Grains, roots and tubers 2) Legumes and nuts 3) Dairy products (milk, yoghurt and cheese) 4) Flesh foods (meat, fish, poultry and liver/organ meats) 5) Eggs 6) Vitamin A rich fruits & vegetables 7) Other fruits and vegetable 8) Breast milk. Dietary diversity for Infants and young children was chosen because it is a sensitive indicator of house hold dietary diversity, nutritional status and health. Furthermore, the extent of dietary diversity is dependent on the income levels and the households’ extent of COVID19 impact on their financial wellbeing. We will model the responses on dietary diversity measured by minimum dietary diversity (MDD) on the dichotomous scale as follows; Meeting minimum dietary diversity = 1; Not meeting minimum dietary diversity = 0. The responses for predictor variables will also have a dichotomous scale where a decrease/adverse effect = 1; no decrease/no effect = 0. Logistic regression will be applied to check for associations. Confounders will be controlled for by including them in the model. These are age, gender and social economic status.

**Data Analysis**

**Study Variables**

The dependent variable for this study was Minimum Dietary Diversity (MDD) among children aged 6–23 months. MDD was operationalized as a binary variable, where a score of "1" indicated that the child met the minimum dietary diversity (i.e., consumed five or more out of eight recommended food groups), and a score of "0" indicated that the child did not meet this threshold. The MDD variable was summarized using frequencies and percentages to describe the proportion of children achieving or failing to achieve dietary diversity.

Independent variables were drawn from both the Socioecological Model (including micro-, meso-, and exo-system levels) and Food Systems constructs (encompassing the food environment, enabling policy environment, and support systems). Categorical independent variables were summarized using frequencies and percentages. Continuous variables were analyzed based on their distribution: those following a normal distribution were reported as means with standard deviations, while non-normally distributed variables were presented as medians with interquartile ranges.

**Regression Model Framework**

**Model 1: Crude (Unadjusted) Associations**

In this initial model, each variable under the SEM and food systems domains is entered independently to examine its unadjusted association with MDD.

Logit (MDD) = β₀ + β₁X₁ + β₂X₂ + ... + βₙXₙ + ε

Where:

* X₁ to Xₙ represent individual predictors (e.g., individual and household characteristics such as maternal education, access to health services and household food security ).
* β₁ to βₙ are the regression coefficients for each predictor.
* ε is the error term.

**Model 2: Adjusted Model**

In this model, SEM and food systems constructs were again entered in **blocks**, and potential confounders were adjusted for. This hierarchical approach respects the theoretical influence of upstream vs downstream variables.

Logit (MDD) = β₀ + β₁(Individual) + β₂(Household) + β₃(Community) + β₄(Societal) + β₅(Food Environment) + β₆(Enabling Policy Environment) B7(Support System)+ ε

**Model 3: Best Fit Model**

This final model retains only variables that were statistically significant (e.g., p<0.05) or conceptually important from Model 2, using backward stepwise selection or likelihood ratio testing for parsimony.

Logit (MDD) = β₀ + β₁X₁ + β₂X₂ + ... + βₖXₖ + ε

Where:

* X₁ to Xₖ = retained significant predictors across SEM and Food System domains.
* Model fit was evaluated using Hosmer-Lemeshow goodness-of-fit.

The odds ratios (OR) and 95% confidence intervals were reported for each predictor to show the likelihood of a child achieving MDD in relation to each SEM-Food systems level factor. Interaction terms were also explored where theory suggests effect modification (e.g., between maternal education and household food security). The data was analyzed with the aid of Stata MP 14 (StataCorp, College Station, TX, USA).

**Results**

**Micro-system versus Food Environment**

**Sociodemographic characteristics**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | | | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value |
| Mother-Child pairs for children aged 6-23 months | | 89(100.00) | 27(100.00) | 16(100.00) | 46(100.00) |  |
| Children’s age in months | | 6-8 | 17(19.10) | 3(11.11) | 4(25.00) | 10(21.74) | 0.1021 |
| 9-11 | 21(23.60) | 4(14.81) | 3(18.75) | 14(30.43) |
| 12-23 | 51(57.30) | 20(74.07) | 9(56.25) | 22(47.83) |
| Children’s gender | | Male | 49(55.06) | 15(55.56) | 11(68.75) | 23(50.00) | 0.4335 |
| Female | 40(44.94) | 12((44.44) | 5(31.25) | 23((50.00) |
| Child’s birthweight | | Median (IQR) | 3.2(1.00) | 3(0.80) | 2.95(0.75) | 3.5(1.10) | 0.0152 |
| Received under-five clinic during Covid19 lockdown | | Yes | 13(14.61) | 4(14.81) | 3(18.75) | 6(13.04) | 0.9440 |
| No | 76(85.39) | 23(85.19) | 13(81.25) | 40(86.96) |
| Child Vaccination status | | Fully vaccinated | 53(59.55) | 18(66.67) | 12(75.00) | 23(50.00) | 0.1484 |
| Partially vaccinated | 32(35.96) | 8(29.63) | 2(12.50) | 22(47.83) |
| Not vaccinated | 4(4.49) | 1(3.70) | 2(12.50) | 1(2.17) |
| Child place of birth | | Health facility | 87(97.75) | 25(92.59) | 16(100.00) | 46(100.00) | 0.8581 |
| Home | 2(2.25 ) | 2(7.41) | 0(0.00) | 0(0.00) |
| Child days past since diarrhea | | >15 days ago | 61(68.54) | 17(62.96) | 10(62.50) | 34(74) | 0.0143 |
| within\_15\_day\_ago | 8(8.99) | 3(11.11) | 2(12.50) | 3(6.52) |
| within\_10\_day\_ago | 7(7.87) | 0(0.00) | 4((25.00) | 3(6.52) |
| within\_5\_days\_ago | 13(14.61) | 7(25.93) | 0(0.00) | 6(13.04) |
| Child and older sibling difference | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child sick previous day | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Care givers’ age | | 18-19 | 9(10.11) | 2(7.41) | 1(6.25) | 6(13.04) | 0.0090 |
| 20-24 | 27(30.34) | 14(51.85) | 0(0.00) | 13(28.26) |
| 25-29 | 27(30.34) | 6(22.22) | 5(31.25) | 16(34.78) |
| 30-34 | 16(17.98) | 3(11.11) | 8(50.00) | 5(10.87) |
| >35 | 10(11.24) | 2(7.41) | 2(12.50) | 6(13.04) |
| Caregiver Height | |  |  |  |  |  |  |
| Care giver physiological state | |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Taken iron tablets 7 days prior to the survey | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Mother Vitamin A last three months | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Caregiver received antenatal care | | Yes | 82(92.13) | 23(85.19) | 15(93.75) | 44(95.65) | 0.7527 |
| No | 7(7.87) | 4(14.81) | 1(6.25) | 2(4.35) |
| Caregiver farmer | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Other care giver activities | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Care giver education | |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Care giver mother crops | |  |  |  |  |  |  |
|  |  |  |  |  |  |

**Feeding Indicators for children aged 6-23 months**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value | Variable |
| Met Minimum Dietary Diversity | Yes | 8(8.99) | 2(7.41) | 2(12.50) | 4(8.70) | 0.8501 |
| No | 81(91.01) | 25(92.59) | 14(87.50) | 42(91.30) |
| Met Minimum Meal Frequency | Yes | 28(31.46) | 9(33.33) | 3(18.75) | 16(34.78) | 0.4815 |
| No | 61(60.54) | 18(66.67) | 13(81.25) | 30(65.22) |
| Met Minimum Acceptable Diet | Yes | 8(8.99) | 1(3.70) | 3(18.75) | 4(8.70) | 0.2517 |
| No | 81(91.01) | 26(96.30) | 13(81.25) | 42(91.30) |
| Infants 6-8 months received complementary foods | **Total** | **18(100.00)** | **3(100.00)** | **4(100.00)** | **11(100.00)** | 0.4880 |
| Yes | 14(77.78) | 2(66.67) | 4(100.00) | 8(72.73) |
| No | 4(22.22) | 1(33.33) | 0(0.00) | 3(27.27) |
| Consumed micronutrients (iron) | Yes | 9(10.11) | 5(18.52) | 0(0.00) | 4(8.70) | 0.1384 |
| No | 80(89.89) | 22(81.48) | 16(100.00) | 42(91.30) |
| Consumed cowpea meal | Yes | 1(1.12) | 1(3.70) | 0(0.00) | 0(0.00) | 0.3172 |
| No | 88(98.88) | 26(96.30) | 16(100.00) | 46(100.00) |
| No | 58(65.17) | 24(88.87) | 8(50.00) | 26(56.52) |
| Consumed Soybean meal | Yes | 1(1.12) | 0(0.00) | 0(0.00) | 1(2.17) | 0.6267 |
| No | 88(98.89) | 27(100.00) | 16(100.00) | 45(97.83) |
| No | 58(65.17) | 19(70.37) | 4(25.00) | 35(76.09) |
| Consumed ASF | Yes |  |  |  |  |  |
| No |  |  |  |  |  |
| Child Food Consumption |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child had breakfast |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child had mid-morning snack |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child had lunch |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child had afternoon snack |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child Dinner |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Child had evening snack |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Reference care giver foods |  |  |  |  |  |  |
|  |  |  |  |  |  |

Nutrition Status of Mother-child pairs

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value | Variable |
| **Child** |  |  |  |  |  |  |
| WAZ Mean (SD) |  |  |  |  |  |  |
| HAZ Mean (SD) |  |  |  |  |  |  |
| WHZ Mean (SD) |  |  |  |  |  |  |
| Care giver height |  |  |  |  |  |  |
| Child Underweight | Moderate | 8(8.99) | 3(11.11) | 1(6.25) | 4(8.70) | 0.302 |
| Normal | 80(89.89) | 24(88.89) | 14(87.50) | 42(91.30) |
| Obese | 1(1.12) | 0(0.00) | 1(6.25) | 0(0.00) |
| Child stunting | Severely stunted | 6(6.74) | 3(11.11) | 1(6.25) | 2(4.35) | 0.708 |
| Moderately stunted | 12(13.48) | 4(14.81) | 1(6.25) | 7(15.22) |
| Normal | 71(79.78) | 20(74.07) | 14(87.50) | 37(80.43) |
| Child Wasting | SAM | 2(2.25) | 0(0.00) | 2(12.50) | 0(0.00) | 0.173 |
| MAM | 4(4.49) | 1(3.70) | 0(0.00) | 3(6.52) |
| Normal | 78(87.64) | 25(92.59) | 13(81.25) | 40(86.96) |
| Overweight | 1(1.12) | 0(0.00) | 0(0.00) | 1(2.17) |
| Obese | 4(4.49) | 1(3.70) | 1(6.25) | 2(4.35) |
| Child Oedema | Yes | 3(3.37) | 1(3.70) | 0(0.00) | 2(4.35) | 0.704 |
| No | 86(96.63) | 26(96.30) | 16(100.00) | 44(95.65) |
| **Height of caregiver** |  |  |  |  |  |  |

Mesosystem characteristics of study participants

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value | Variable |
| Mother-Child pairs for children aged 6-23 months | | 89(100.00) | 27(100.00) | 16(100.00) | 46(100.00) |  |
| HH head age category |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Household head gender | Male | 68(76.40) | 23(85.19) | 14(87.50) | 31(67.39) | 0.1181 |
| Female | 21(23.60) | 4(14.81) | 2(12.50) | 15(32.61) |
| HH size category |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Children Under 2 |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Household member with regular income | Yes | 39(43.82) | 19(70.37) | 7(43.75) | 13(28.26) | 0.0023 |
| No | 50(50.18) | 8(29.63) | 9(56.25) | 33(71.74) |
| Household toilet type | Flushing | 4(4.49) | 2(7.41) | 1(6.25) | 1(2.17) | 0.5455 |
| Pit | 85(95.51) | 25(92.59) | 15(93.75) | 45(97.83) |
| Source of drinking water |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Energy for cooking |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Floor type |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Roof Type |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Grow cowpea n(%) | Yes | 15(16.85) | 2(7.41) | 5(31.25) | 8(17.39) | 0.1321 |
| No | 74(83.15) | 25(92.59) | 11(68.75) | 38(82.61) |
| Prepare Cowpea in household meals | Yes | 46(51.69) | 7(25.93) | 10(62.50) | 29(63.04) |  |
| No | 43(48.31) | 20(74.07) | 6(37.50) | 17(36.96) |  |
| Whole, boiled with maize gritsa |  | 18(20.22) | 5(71.43) | 6(60.00) | 7(24.14) | 0.0061 |
| Mashed & prepared as soup |  | 15(16.85) | 1(3.70) | 1(10.00) | 13(44.83) |
| Whole, boiled as relish |  | 7(7.87) | 0(0.00) | 1(10.00) | 6(20.69) |
| Otherb |  | 6(6.74) | 1(3.70) | 2(20.00) | 3(10.34) |
| Prepare Cowpea for children n(%) | Yes | 31 (34.83) | 3 (11.11) | 8 (50) | 20 (43.48) | 0.0078 |
| No | 58 (65.17) | 24 (88.89) | 8 (50) | 26 (56.52) |
| Grow soybean n(%) | Yes | 8(8.99) | 2(7.41) | 2(12.50) | 4(8.70) | 0.8501 |
| No | 81(91.01) | 25(92.59) | 14(87.50) | 42(91.30) |
| Prepare Soybean in Household meals n(%) | Yes | 23(25.84) | 4(14.81) | 10(62.50) | 9(19.57) | 0.001 |
| No | 66(74.16) | 23(85.19) | 6(37.50) | 37(80.43) |
| Flour |  | 8(34.78) | 2(50.00) | 4(40.00) | 2(22.22) | 0.5186 |
| Soup |  | 7(30.43) | 1(25.00) | 2(20.00) | 4(44.44) |
| Porridge |  | 5(21.74) | 1(25.00) | 2(20.00) | 2(22.22) |
| otherc |  | 3(13.05) | 0(0.00) | 2(20.00) | 1(11.11) |
| Prepare soybean for children | Yes | 31(34.83) | 8(29.63) | 12(75.00) | 11(23.91) | 0.001 |
| No | 58(65.17) | 19(70.37) | 4(25.00) | 35(76.09) |
| Agricultural production increase | Yes | 20(22.47) | 9(33.33) | 1(6.25) | 10(21.74) | 0.1218 |
| No | 69(77.53) | 18(66.67) | 15(93.75) | 36(78.26) |
| Had extension services during Covid19 lock down |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Hired labour access | Yes | 11(12.36) | 5(18.52) | 1(6.25) | 5(10.87) | 0.4554 |
| No | 78(87.64) | 22(81.48) | 15(93.75) | 41(89.13) |
| Cash for inputs available | Yes | 25(28.09) | 9(33.33) | 2(12.50) | 14(30.43) | 0.3026 |
| No | 64(71.91) | 18(66.67) | 14(87.50) | 32(69.57) |
| Low input Agriculture option during Covid19 lock down | Yes | 48(53.93) | 13(48.15) | 12(75.00) | 23(50.00) | 0.1765 |
| No | 41(46.07) | 14(51.85) | 4(25.00) | 23(50.00) |
| Access to irrigation water during Covid19 lock down |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Income increase during Covid19 lock down | Yes | 13(14.61) | 8(29.63) | 0(0.00) | 5(10.87) | 0.0179 |
| No | 76(85.39) | 19(70.37) | 16(100.00) | 41(89.13) |
| Price increase during Covid19 lock down |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Opted for alternative foods during covid19 lock down | Yes | 17(19.10) | 7(25.93) | 3(18.75) | 7(15.22) | 0.5353 |
| No | 72(80.90) | 20(74.07) | 13(81.25) | 39(84.78) |
| Any family member Covid19 positive | Yes |  |  |  |  |  |
| No |  |  |  |  |  |
| Household assistance category |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Basic needs not met |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Substituted imported food during the Covid19 lock down |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |

**Exosystem characteristics of study participants**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value | Variable |
| **Mother-Child pairs for children aged 6-23 months** | | **89(100.00)** | **27(100.00)** | **16(100.00)** | **46(100.00)** |  |
| Access to extension services | Yes | 9(10.11) | 3(11.11) | 1(6.25) | 5(10.87) | 0.8531 |
| No | 80(89.89) | 24(88.89) | 15(93.75) | 41(89.13) |
| Access to Irrigation water access | Yes | 55(61.80) | 22(81.48) | 10(62.50) | 23(50.00) | 0.0292 |
| No | 34(38.20) | 5(18.52) | 6(37.50) | 23(50.00) |
| Food Price increase experience on local market during covid19 lock down | Yes | 72(80.90) | 22(81.48) | 12(75.00) | 38(82.61) | 0.7993 |
| No | 17(19.10) | 5(18.52) | 4(25.00) | 8(17.39) |
| Imported food substitution | Yes | 12(13.48) | 3(11.11) | 2(12.50) | 7(15.22) | 0.8785 |
| No | 77(86.52) | 24(88.89) | 14(87.50) | 39(84.78) |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Agricultural inputs available during Covid19 lock down |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Agricultural inputs prices high during the Covid19 lockdown |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Input reserves available during the Cvid19 lockdown |  |  |  |  |  |  |
|  |  |  |  |  |  |

**Macrosystem characteristics of study participants**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable | Total  N(%) | Nyangwena  n(%) | Bundabunda  n(%) | Rufunsa  n(%) | p-Value | Variable |
| **Mother-Child pairs for children aged 6-23 months** | | **89(100.00)** | **27(100.00)** | **16(100.00)** | **46(100.00)** |  |
| Social Protection offered to households | FISP | 11(12.36) | 5(18.52) | 2(12.50) | 4(8.70) | 0.218 |
| CST | 5(5.62) | 0(0.00) | 1(6.25) | 4(8.70) |
| None | 72(80.90) | 22(81.48) | 12(75.00) | 38(82.61) |
| SFP | 1(1.12) | 0(0.00) | 1(6.25) | 0(0.00) |
| Households who sold the vouchers |  |  |  |  |  |  |
|  |  |  |  |  |  |
| Social Protection for COVID 19 | Yes | 8(8.99) | 0(0.00) | 2(12.50) | 6(13.04) | 0.1504 |
| No | 81(91.01) | 27(100.00) | 14(87.50) | 40(86.96) |

Association between meeting MDD and background characteristics

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variable |  | Meeting MDD | | | |  |
|  | Did not meet MDD | | Met MDD | |  |
|  | No | % | No | % | p-value |
| Total children aged 6-23 months | Total | 81 | 100 | 8 | 100 |  |
| Age of children in months | *12-23* | 45 | 55.56 | 6 | 75 | 0.2372 |
|  | *6-8* | 15 | 18.52 | 1 | 12.5 |  |
|  | *6-9* | 1 | 1.23 | 0 | 0 |  |
|  | *9-11* | 20 | 24.69 | 1 | 12.5 |  |
| Met MMF | *No* | 57 | 70.37 | 4 | 50 | 0.2392 |
|  | *Yes* | 24 | 29.63 | 4 | 50 |  |
| Met MAD | *No* | 77 | 95.06 | 4 | 50 | 0.0001 |
|  | *Yes* | 4 | 4.94 | 4 | 50 |  |
| Consumed micronutrients | *No* | 75 | 92.59 | 5 | 62.5 | 0.0074 |
|  | *Yes* | 6 | 7.41 | 3 | 37.5 |  |
| Consumed cowpeas |  |  |  |  |  |  |
| Consumed soyabeans |  |  |  |  |  |  |
| Aged 6-8 months received complementary food |  |  |  |  |  |  |
| Gender of children | *Female* | 38 | 46.91 | 2 | 25 | 0.2372 |
|  | *Male* | 43 | 53.09 | 6 | 75 |  |
| Age of caregiver |  |  |  |  |  |  |
| Household factors |  |  |  |  |  |  |
| Age of household head | *15-19* | 1 | 1.23 | 0 | 0 | 0.9478 |
|  | *20-24* | 10 | 12.35 | 1 | 12.5 |  |
|  | *25-29* | 18 | 22.22 | 2 | 25 |  |
|  | *30-34* | 19 | 23.46 | 1 | 12.5 |  |
|  | *35-39* | 6 | 7.41 | 1 | 12.5 |  |
|  | *40-44* | 10 | 12.35 | 1 | 12.5 |  |
|  | *45-49* | 6 | 7.41 | 2 | 25 |  |
|  | *50-54* | 2 | 2.47 | 0 | 0 |  |
|  | *55-59* | 4 | 4.94 | 0 | 0 |  |
|  | *60-64* | 1 | 1.23 | 0 | 0 |  |
|  | 65-69 | 1 | 1.23 | 0 | 0 |  |
|  | 70-74 | 1 | 1.23 | 0 | 0 |  |
|  | 75-79 | 2 | 2.47 | 0 | 0 |  |
| Age of respondent | *18-19* | 7 | 8.64 | 2 | 25 | 0.9055 |
|  | *20-24* | 26 | 32.1 | 1 | 12.5 |  |
|  | *25-29* | 24 | 29.63 | 3 | 37.5 |  |
|  | *30-34* | 16 | 19.75 | 0 | 0 |  |
|  | *>35* | 8 | 9.88 | 2 | 25 |  |
| Gender of HH head | *Male* | 62 | 76.54 | 6 | 75 | 0.9223 |
|  | *Female* | 19 | 23.46 | 2 | 25 |  |
| HH with regular income | *No* | 44 | 54.32 | 6 | 75 | 0.2635 |
|  | *Yes* | 37 | 45.68 | 2 | 25 |  |
| Level of education of household head |  |  |  |  |  |  |
| Toilet type | *Pit* | 77 | 95.06 | 8 | 100 | 0.5225 |
|  | *Flush* | 4 | 4.94 | 0 | 0 |  |
| Grow cowpea | *No* | 68 | 83.95 | 6 | 75 | 0.5212 |
|  | *Yes* | 13 | 16.05 | 2 | 25 |  |
| Prepare Cowpea in HH meals |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Prepare Cowpea for children | *No* | 53 | 65.43 | 5 | 62.5 | 0.8689 |
|  | *Yes* | 28 | 34.57 | 3 | 37.5 |  |
| Grow soybean | *No* | 74 | 91.36 | 7 | 87.5 | 0.7175 |
|  | *Yes* | 7 | 8.64 | 1 | 12.5 |  |
| Prepare soybean in HH meals |  |  |  |  |  |  |
| Prepare Soybean for children | *No* | 53 | 65.43 | 5 | 62.5 | 0.8689 |
|  | *Yes* | 28 | 34.57 | 3 | 37.5 |  |
| Community & Society factors |  |  |  |  |  |  |
| Production increased | *No* | 62 | 76.54 | 7 | 87.5 | 0.4812 |
|  | *Yes* | 19 | 23.46 | 1 | 12.5 |  |
| Extension services accessed | *No* | 72 | 88.89 | 8 | 100 | 0.3227 |
|  | *Yes* | 9 | 11.11 | 0 | 0 |  |
| Income increased | *No* | 70 | 86.42 | 6 | 75 | 0.3856 |
|  | *Yes* | 11 | 13.58 | 2 | 25 |  |
| Hired labor | *No* | 70 | 86.42 | 8 | 100 | 0.2682 |
|  | *Yes* | 11 | 13.58 | 0 | 0 |  |
| Food price increase experience | *No* | 16 | 19.75 | 1 | 12.5 | 0.6206 |
|  | *Yes* | 65 | 80.25 | 7 | 87.5 |  |
| Cash for inputs availability | *No* | 56 | 69.14 | 8 | 100 | 0.0654 |
|  | *Yes* | 25 | 30.86 | 0 | 0 |  |
| Imported Food  Substitution | *No* | 71 | 87.65 | 6 | 75 | 0.3202 |
|  | *Yes* | 10 | 12.35 | 2 | 25 |  |
| Alternative food option | *No* | 65 | 80.25 | 7 | 87.5 | 0.6206 |
|  | *Yes* | 16 | 19.75 | 1 | 12.5 |  |
| Low input agriculture option | *No* | 37 | 45.68 | 4 | 50 | 0.8161 |
|  | *Yes* | 44 | 54.32 | 4 | 50 |  |
| Irrigation water access | *No* | 29 | 35.8 | 5 | 62.5 | 0.1404 |
|  | *Yes* | 52 | 64.2 | 3 | 37.5 |  |
| Social Protection | *farmer\_input\_support\_* | 9 | 11.11 | 2 | 25 | 0.1868 |
|  | *None* | 66 | 81.48 | 6 | 75 |  |
|  | *school\_feeding\_progra* | 1 | 1.23 | 0 | 0 |  |
|  | *social\_cash\_transfer* | 5 | 6.17 | 0 | 0 |  |
| Social Protection was for Covid 19 |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable | | Adjusted model | | Best Fit Model | |
|  | | OR(95%CI) | p-value | OR(95%CI) | p-value |
| Total Children aged 6-23 months | |  |  |  |  |
| Met MMF | |  |  |  |  |
| Met MAD | |  |  |  |  |
| Consumed Micronutrients | |  |  |  |  |
| Consumed Cowpea | |  |  |  |  |
| Consumed Soybean | |  |  |  |  |
| Aged 6-8 months received complementary foods | |  |  |  |  |
| Age of children in months | 6-8 |  |  |  |  |
| 9-11 |  |  |  |  |
| 12-23 |  |  |  |  |
| Gender of children | Male |  |  |  |  |
| Female |  |  |  |  |
| Age of caregiver | 18-19 |  |  |  |  |
| 20-24 |  |  |  |  |
| 25-29 |  |  |  |  |
| 30-34 |  |  |  |  |
| >35 |  |  |  |  |
| Household factors | |  |  |  |  |
| Age of household head | 15-19 |  |  |  |  |
| 20-24 |  |  |  |  |
| 25-29 |  |  |  |  |
| 30-34 |  |  |  |  |
| 35-39 |  |  |  |  |
| 40-44 |  |  |  |  |
| 45-49 |  |  |  |  |
| 50-54 |  |  |  |  |
| 55-60 |  |  |  |  |
| 60+ |  |  |  |  |
| Age of respondent | 20-24 |  |  |  |  |
| 25-29 |  |  |  |  |
| 30-34 |  |  |  |  |
| 35-39 |  |  |  |  |
| 40-44 |  |  |  |  |
| 45-49 |  |  |  |  |
| 50-54 |  |  |  |  |
| 55-60 |  |  |  |  |
| 60+ |  |  |  |  |
| Gender of HH head | Male |  |  |  |  |
| Female |  |  |  |  |
| HH with regular income | Yes |  |  |  |  |
| No |  |  |  |  |
| Level of education of household head |  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Toilet type | flushing |  |  |  |  |
| Pit |  |  |  |  |
| Grow cowpea |  |  |  |  |  |
| Prepare Cowpea in HH meals | |  |  |  |  |
|  | Whole, boiled with maize gritsa |  |  |  |  |
| Mashed & prepared as soup |  |  |  |  |
| Whole, boiled as relish |  |  |  |  |
| Otherb |  |  |  |  |
| Prepare Cowpea for children | Yes |  |  |  |  |
| No |  |  |  |  |
| Grow soybean | Yes |  |  |  |  |
| No |  |  |  |  |
| Prepare soybean in HH meals | Yes |  |  |  |  |
| No |  |  |  |  |
|  | Flour |  |  |  |  |
| Soup |  |  |  |  |
| Porridge |  |  |  |  |
| Feed |  |  |  |  |
| otherc |  |  |  |  |
| Prepare Soybean for children | Yes |  |  |  |  |
| No |  |  |  |  |
| Community & Society factors | |  |  |  |  |
| Production increased |  |  |  |  |  |
| Extension services accessed |  |  |  |  |  |
| Income increased |  |  |  |  |  |
| Hired labor |  |  |  |  |  |
| Food price increase experience |  |  |  |  |  |
| Cash for inputs availability |  |  |  |  |  |
| Imported Food  Substitution |  |  |  |  |  |
| Alternative food option |  |  |  |  |  |
| Low input agriculture option |  |  |  |  |  |
| Irrigation water access |  |  |  |  |  |
| Social Protection |  |  |  |  |  |
| Social Protection was for Covid 19 |  |  |  |  |  |

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