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ASSESSMENT OF LOCALLY-SOURCED THERAPEUTIC FOODS FOR CHILDREN RECOVERING FROM SEVERE ACUTE MALNUTRITION IN KARAWA, DEMOCRATIC REPUBLIC OF THE CONGO

by

Ariane S. Ngo Bea Hob
Degree to be awarded: Master of Public Health

Hubert Department of Global Health

_____

Dr. Deborah McFarland

Committee Chair

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by

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2010

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
In Hubert Department of Global Health
2018

ABSTRACT

Acute malnutrition impacts an estimated 92,000 children within IMA's Access to Primary Healthcare Project and 11% of all children under five in the Democratic Republic of the Congo (IMA-World Health, 2017). Treatment of malnourished children is often aided by imported ready to use therapeutic foods (RUTFs) such as plumpy nut. However, availability of RUTFs are sporadic and a more sustainable approach using locally-sourced therapeutic foods is desired (IMA-World Health, 2017).

The study objectives were 1) to monitor the recovery rates of children recovering from severe acute malnutrition (SAM) and moderate acute malnutrition MAM) at the Nutritional Rehabilitation Center (NRC) of Hospital de reference de Karawa and in the community; 2) to analyze the nutritional content of therapeutic feeding recipes promoted by the ASSP project at both sites, and 3) to assess the acceptability and barriers of using therapeutic feeding recipes from locally sourced ingredients for both caregivers and children.

We collected anthropometric measurements over a 7-week period from 42 children aged 5-63 months recovering from SAM at the NRC (32) and from MAM in the communities (10). We analyzed the nutritional content of 4 locally-sourced therapeutic recipes: 2 recipes served at the NRC (locally milled corn-soy blend and rice-peanut blend) and 2 experimental recipes (hand-milled corn-peanut-coconut blend and corn-peanut-sugar cane blend). In addition, caregivers of each participant children received three short surveys: 1) a 24-hr recall diet, 2) an initial interview assessing knowledge and awareness of therapeutic foods served at the NRC and proposed in the communities, and 3) a follow-up interviews assessing acceptability to therapeutic foods given to children and willingness to continue prepare therapeutic foods at home.

In total, 32 children (76.19%) completed the study. The adjusted mean (95% CI) change in weight (kg) from baseline for male children recovering from SAM was statistically significant irrespective of the enrollment location: -0.55 kg (-0.98; -0.11) $p < 0.05$. Conversely, the adjusted mean (95% CI) change in weight (kg) from baseline for female children recovering from SAM was statistically insignificant irrespective of the enrollment location: -0.20 kg (-0.918, 0.518)

p > 0.05. Energy intake requirements of locally-sourced therapeutic foods served at the NRC/UNTI were found to be lower than the recommended energy intake for recovery: locally milled corn-soy blend at 241.9 kcal/serving and rice-peanut blend at 267.9 kcal/serving. at baseline, children had a history of eating fruits and vegetables (94.9%), starch and tubers (71.7%), legumes and pulse (66.7%), cereals and grains (61.5%), animals (28.2%) and other processed foods (15.3%). Also, at baseline, the average of number of meal per day being served to children was two meals with 100% of children receiving weaning foods. 39.4% of caregivers reported to have heard of the locally-sourced foods served at the NRC and 21% of participating caregivers reported to like those recipes. 76.3% reported to have cook a similar recipe and a higher proportion (94.7%) reported to be willing to cook the recipes. At the end of the study, 18 caregivers reported to have put into practice at least one recommended recipes.

The analysis of the recovery rate of children recovering from SAM at the NRC and from MAM in the communities showed no significant improvement over the period of treatment, the nutritional content of locally-sourced foods served in the NRC did not fulfilled the daily energy requirement for children recovering from SAM and MAM.

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AKNOWLEDGEMENTS

I would like to express my deepest appreciation to my academic advisor, Dr. Deborah McFarland, who tirelessly believed in me and pushed me to do well and finish this work. Without her guidance and persistent help this dissertation would not have been possible.

I also wish to thank IMA World Health and my field supervisor, Mrs. Inge Sthreshley, Ms. Mr. Larry Sthreshley, Deborah Lithander, Mr. John Fumana, Ms. Marta Klein. Thank you to every caregiver who participated in this study, to Bokpassi and Bogon villages whose members welcome me into their community. Thank you as well to every member of Karawa NRC staff who participated in this study, your resilience, resourcefulness, positive attitude, generosity and hard work inspired me.

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LIST OF ABBREVIATIONS

ANJE.....*Alimentation du Nourisson et du Jeune Enfant*

ASSP….....*Accès aux Soins de Santé Primaires*

DRC.....Democratic Republic of the Congo

FAO.....Food and Agriculture Organization of the United Nations

MAM..... Moderate Acute Malnutrition

MOH..... Ministry of Health

MUAC..... Mid-Upper Arm Circumference

PAHO.....Pan American Health Organization

PCIMA..... *Protocol national de prise en Charge Intégréee de la Malnutrition Aiguë*

PI..... Principal Investigator

PRONANUT..... *Programme National de Nutrition*

PROPAN..... Process for the Promotion of Child Feeding

NRC..... Nutritional Rehabilitation Center

RECOs..... *Relai Communautaires*

RUTF..... Ready-to-Use Therapeutic Food

SAM..... Severe Acute Malnutrition

UN..... *Unité Nutritionelle*

UNS..... *Unité Nutritionelle Supplémentaire*

UNTA..... *Unité Nutritionelle de Traitement Ambulatoire*

UNTI..... *Unité Nutritionelle de Traitement Intensif*

UNICEF..... United Nations International Children's Emergency Fund

WFP..... World Food Programme

WHO..... World Health Organization

CHAPTER ONE

1. INTRODUCTION

1.1 The Problem of Malnutrition

1.1.1 Definition and Global Burden

Malnutrition is an imbalance between nutritional intake and the body's nutritional requirements (WHO, 2013). When the first is less than the second, the body begins to waste away; the lower the nutritional intake, the more acute malnutrition is. Children aged 6-59 months suffering from acute malnutrition have "a very low weight for height (below -3z scores of the median WHO growth standards), visible severe wasting, the presence of nutritional edema, and a mid-upper arm circumference (MUAC) less than 115 mm" (WHO, 2010). Acute malnutrition remains the leading cause of death among children aged 6-59 months. In fact, 20 million of children worldwide suffer from severe acute malnutrition (SAM) with, sub-Sahara African and South Asia bearing the greatest burden (Figure 1.1).

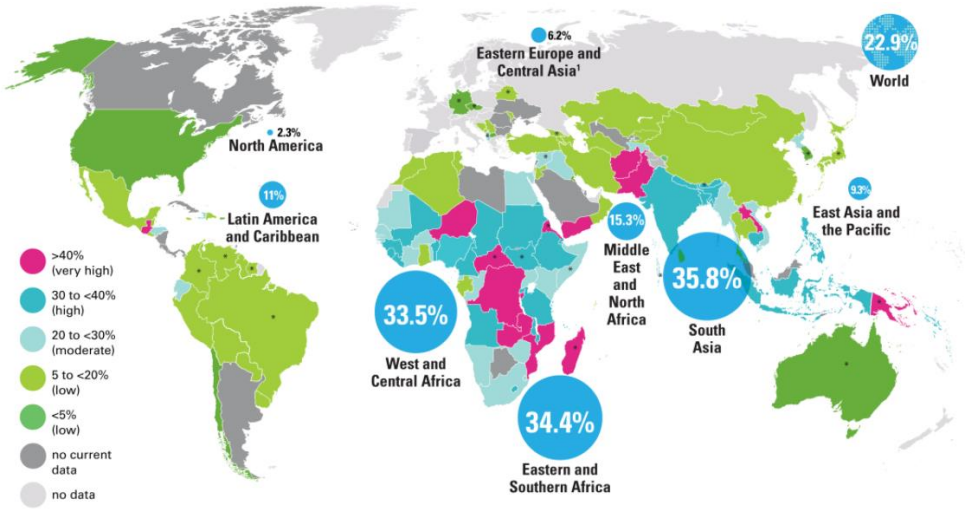

Figure 1.1 World Regions Stunting Prevalence of Children under 5 years old (UNICEF, 2017)

The implications of acute malnutrition on the child's health depends on the type of acute malnutrition: severe acute malnutrition (SAM) compromises the child's immune system, leaving the child exposed to common infections and diseases (UNICEF, 2010); moderate acute malnutrition (MAM) on the other hand indicates children with a 70%-80% weight less than the average (UNICEF 2010). According to the Joint Child Malnutrition Estimates of 2017, "Africa is the only region where the number of stunted children has risen" going from 50.4 million in 2000 to 59 million in 2016.

1.1.2 Developmental Consequences of Childhood Malnutrition

Children suffering from acute malnutrition face short and long term negative consequences, the primary of which is growth failure and even death without improved interventions. Growth hormones are at their peak during the child's first 2-3 years of growth making the child vulnerable to growth retardation with poor dietary intakes. These risks are exacerbated when children live in violence-stricken regions or are subjected to mass displacement due to violence or natural disasters. The short-term consequences of malnutrition are children that are underweight, disease-prone and chronically stunted which is an irreversible condition. Long-term consequences are far direr and include "delayed motor development, general effects on cognitive development resulting in lower IQ, and more behavioral problems and deficient social skills at school age, as well as decreased attention, deficient learning, and lower educational achievement" (Martorell R., 1999).

1.2 Responding to Childhood Malnutrition

1.2.1 Global Response

It is estimated that only 15-20% of the children with SAM currently receive adequate treatment (WHO, 2017). Joint efforts between national Ministries of Health and UN agencies (UNICEF, WHO, and/or WFP) have been made to improve nutritional status among malnourished children worldwide. These efforts include the provision and distribution of ready-to-use therapeutic foods (RUTF) such as plumpy nuts through nutrition program interventions. However, in some instances such efforts offer no tangible nor long-lasting results. Provision of RUTF to address acute malnutrition has proven to be cost-effective for households and implementing program partners, provided the RUTF is continually supplied. When RUTF is no longer made available, afflicted regions are left even more vulnerable than before.

1.2.2 Local Interventions

While treatment of SAM is often aided by imported RUTFs such as plumpy nut, its availability is sporadic, so a more sustainable approach is desired. To remedy the issue of shortage or lack of RUTF, some interventions include the use of fortified foods based on locally available ingredients. This approach needs, however, a close monitoring due to the challenges of providing adequate quantity of nutrients (UNICEF 2017).

1.3 Malnutrition in the Democratic Republic of Congo

1.3.1 Current Situation

Acute malnutrition impacts an estimated 43% of children under 5 years old in the Democratic Republic of the Congo (DRC); about 92,000 of these children live within IMA

World Health's Access to Primary Healthcare Project areas (IMA-World Health, 2017; Ministry of Planning, National Institute of Statistics, UNICEF, 2017). For several years, the nutrition rehabilitation center (NRC) of Karawa hospital in North Ubangi Province (one of IMA's primary healthcare areas) has been rehabilitating malnourished children using porridges/recipes developed from locally available ingredients. Recovery rates have not been officially documented and reporting has been variable over time.

1.3.2 Country's Health System

In the Democratic Republic of the Congo, the National Nutrition Program (PRONANUT) within the Ministry of Health, in partnership with the World Health Organization (WHO), developed a protocol for treating children suffering from acute malnutrition. Acute malnutrition cases are managed either at the health center or at the hospital depending on the severity of the case. When a child has no complications, he/she is treated at the community health center with community based therapeutic care via either *l'Unite Nutritionnelle Therapeutique Ambulatoire* (UNTA) where patients go weekly or daily to the center to receive care or via *l'Unite Nutritionel Supplémentaire* (UNS) where patients receive a ration of RUTF to be eaten at home for the duration of recovery. If, the child has accompanying complications, he/she is treated at the district or regional hospital through *l'Unite Nutritionnelle Therapeutique Intensive* (UNTI) (PCIMA, 2012) where patients are hospitalized until they are released

1.3.3 Country's Guidelines for Treating Malnutrition

Admission for treatment follows a passive screening at the community health center which helps identifies children suffering from either moderate or severe acute malnutrition as show in Figure 1.2 below. Children identified with either a mid-upper-arm circumference

(MUAC) ≤ 115 mm, with severe to moderate bilateral edema without appetite and/or medical complications, are referred directly to the UNTI; children with similar conditions as those referred to the UNTI but with a -3 z-score below WHO median growth standards, with appetite and without medical complications are referred to the UNTA; whereas children with a MUAC between 115-125 mm, with no edema and a -3 z-score above WHO median growth standards are referred to the l'UNS.

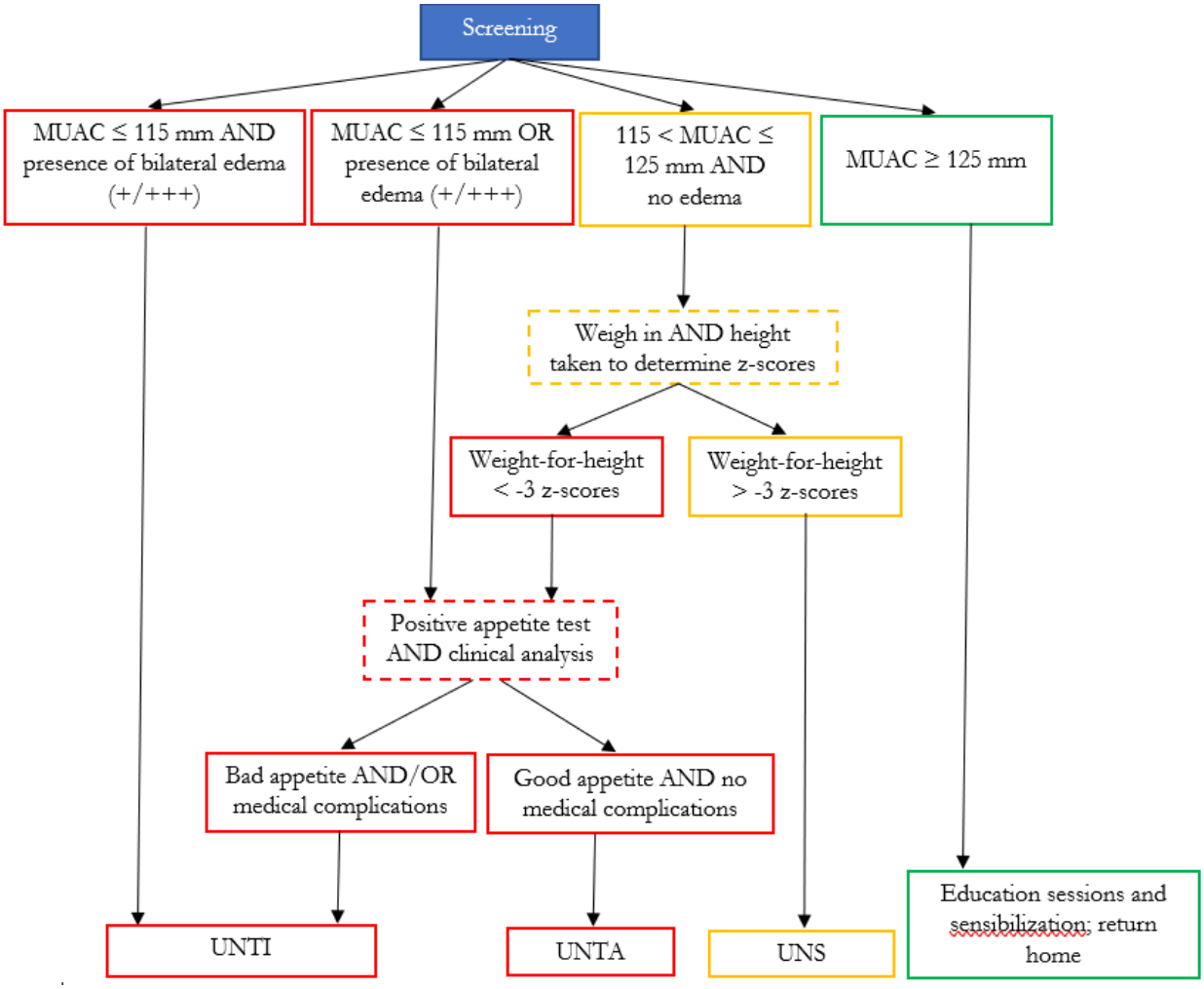

Figure 1.2 Admission criteria for Treating Acute Malnutrition in DRC (Adapted from PCIMA)

IMA World Health is embedded in the treatment of malnutrition protocol through the deployment of community volunteers or RECOs who search and identify cases of malnutrition. IMA World Health uses this community screening approach to achieve its goal in finding a more sustainable solution to malnutrition, to develop local ownership and capacity to improve nutrition through the promotion of therapeutic feeding recipes using locally-sourced foods (IMA-World Health, 2017). Locally-sourced therapeutic foods currently include ingredients such as soya flour, dried fish, peanuts and moringa, which are all easily found in the region the study is taken place, Karawa, and have known nutritional benefits. However, no formal research has been conducted to increase knowledge and awareness among hospital staff of the nutritional composition of the recipes being promoted. This study aimed to obtain nutritional information on the locally sourced therapeutic foods being promoted in Karawa so to enable hospital staff and community volunteers (or RECOS) to optimize the recipes they are promoting and allow children to recover as quickly as possible.

1.4 Thesis Hypothesis and Objectives

The hypothesis of this study is that the locally sourced therapeutic foods IMA World Health promotes in Karawa communities and those prepared and served at Karawa UNTI, UNTA, and UNS, fulfill the energy and nutritional requirements to help children recover from SAM and MAM. The main objectives of this study are: (1) to monitor recovery rates of children recovering from severe acute malnutrition in the community and at the nutrition rehabilitation center of Karawa hospital using locally sourced therapeutic foods promoted by IMA-World Health; (2) to analyze the nutritional content of the therapeutic recipes used at the nutritional

rehabilitation center and those promoted by ASSP in the community while proposing and testing modifications to recipes and; (3) to assess the acceptability of and barriers of using enriched porridges from locally available ingredients with regards to both child and their caregivers.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Malnutrition

2.1.1 Overview of Malnutrition

Malnutrition is a broad term for abnormal conditions affecting children under the age of 5 years. The World Health Organization (WHO) defines it as "deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients" (WHO, 2016). More recently, the broad definition of malnutrition has been intended to cover two types of conditions: undernutrition and wasting. The first includes stunting, meaning a child is too short for his/her age, and the second includes wasting, meaning the child does not weigh enough for his/her height (WHO, 2016). Sadly, malnutrition still affects a vast number of children under 5 years around the world: WHO estimates the number of children under 5 years of age suffering from stunting and wasting at 159 million and 50 million respectively (WHO, 2016). This paper intends to focus on the management of the acute form of severe malnutrition (SAM) without medical complication with locally sourced ingredients and to some extent on the management of the acute form of moderate malnutrition (MAM). The following paragraphs review the literature on official guidelines and recommendations for managing SAM. This chapter will also describe and compare some examples of managing malnutrition in different countries including the Democratic Republic of the Congo using locally sourced ingredients. The literature review further explores the use, acceptability and cost of locally produced therapeutic foods compared to imported foods.

2.1.2 Severe Acute Malnutrition

"Severe Acute Malnutrition or SAM is defined by a very low weight for height (below -3z scores of the median WHO growth standards), by visible severe wasting, or by the presence of edema" (WHO, 2016). According to the same source, SAM "affects an estimated 19 million children under 5 years of age worldwide and is estimated to account for approximately 400,000 child deaths each year" (WHO, 2016). In DRC, an estimated "2.2 million children aged 6-59 months old are affected by SAM in non-conflict areas representing 12% of the global caseload of SAM" (UNICEF, 2017). Despite a substantial funding gap, UNICEF nutrition interventions benefitted some 242,929 SAM-affected children aged 6-59 months admitted for therapeutic care through the provision of Ready-to-Use Therapeutic Food (RUTF) in 2017 (UNICEF, 2017).

2.1.3 Causes of Severe Acute Malnutrition

Two independent studies assessed key determinants of stunting in DRC. One study used the 2013-14 data from DRC Demographic Health Survey to identify contributing factors to the high stunting prevalence (Kismul, Acharya, Mapatano, & Hatloy, 2017) and the second study identified predictors of malnutrition among children under 5 years old living in a suburb of Lubumbashi, DRC (Mukatay et al., 2010). Both studies identified contributing socio-economical and anthropometric factors to malnutrition: male gender, age, residence place, mother's education level and wealth status as well as access to safe water and to hygienic toilet. However, unlike previous researches which explored the macro level of social determinants of malnutrition, another study examined the micro level of the social context of malnutrition in rural part of DRC. This research described "how some households succeed in ensuring that their children are well-nourished while others do not" (Kismul et al., 2015). The research identified

four social fields explaining why some rural households do better than other at keeping their children well-nourished; the study uses various forms of qualitative data collection methods in households with children under 6 years of age who had a recent history of SAM, and another set of households with children under 6 years of age without a recent history of malnutrition (Kismul et al., 2015). The four social fields identified were: "household size and composition,… inter-household cooperation,… the village associated with usufruct rights to land, and the local NGO providing access to agricultural support, clean drinking water and health care" (Kismul et al., 2015). The studies, while taking different lenses, indicate the importance providing to the community opportunities to work in synergy when addressing or implementing issue of malnutrition which also addresses contributing social-economic factors to malnutrition.

UNICEF developed a comprehensive conceptual framework (Figure 2.1) that helps understand the interactions of the macro and micro analysis of factors associated with malnutrition mentioned above. This framework broken down into three levels, can be adapted to fit any specific context. The causes of malnutrition, spanning across societal levels are: immediate, underlying and basic causes.

2.1.3.1 Immediate causes

These causes of malnutrition are those operating at the individual level such as eating behaviors with its inadequacy to maintain a healthy dietary intake and being exposed to diseases which further deter individual's health without good eating behaviors.

2.1.3.2 Underlying causes

The underlying causes of malnutrition are those that influence households and communities. Those causes include household food insecurity, inadequate foods eating, poor feeding and care practices, as well as poor house, environment and health services.

2.1.3.3 Basic causes

The basic causes of malnutrition address structure and processes of societies and include inadequacy in access to services, financial and human resources and the prevalent sociocultural, economic and political context (e.g. unrest, unstable government, corruption, poor governance)

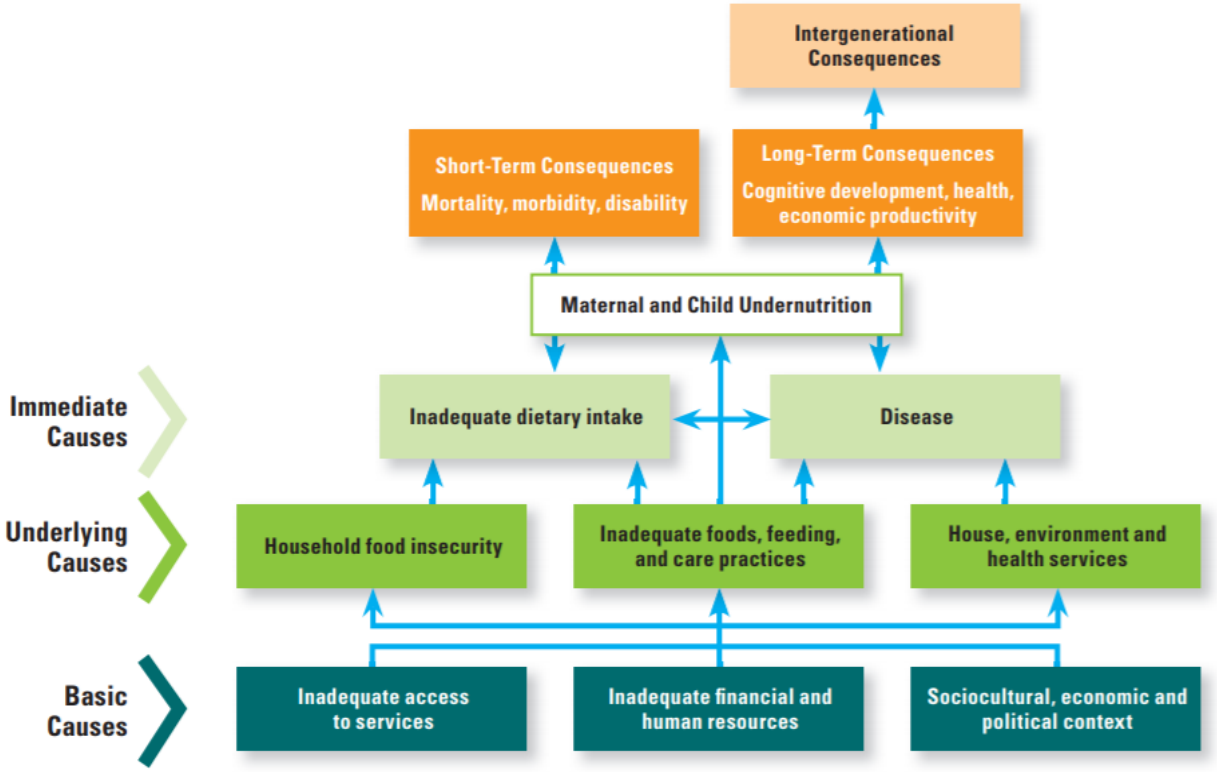

Figure 2.1 Conceptual Framework of Malnutrition (adapted) (UNICEF, 2017)

2.2 Country Nutrition Program

UNICEF estimates there are 2.2 million children under 5 years of age in DRC who will suffer from severe acute malnutrition (SAM) in 2018 (UNICEF, 2017). DRC is "one of the countries with the greatest burden (> 90%) of children with chronic malnutrition and the 15th in terms of prevalence, 43% of children under five suffer from chronic malnutrition, i.e. almost 1 child out of 21" (UNICEF, 2012). To address the magnitude of child malnutrition in DRC, the country elaborated in 2001 an initial five-year plan (2001-2005) to expand the coverage of the national nutrition program through *le Programme National de Nutrition* (PRONANUT) (DRC MoH, 2015). Subsequent annual plans continue to be elaborated and adjusted to tackle, with the support from countless international stakeholders, the growing and alarming issue of child malnutrition.

PRONANUT is the department of the Ministry of Health that implements and develops protocol (*Protocole de prise en Charge de la Malnutrition Aiguë* or PCIMA) for managing acute malnutrition. Since PROANUT has been part of the integrated national health system, DRC has seen an increase in treatment coverage and in capacity building of nutrition services providers across the country. This was translated from its onset by a decrease in malnutrition prevalence from 16% in 2007 to 9% in 2014 (PCIMA, DRC 2016). Management of acute malnutrition is now handled, along with all other diseases, within community health structures. Still, the country faces multiple supply shortages of RUTF and lack of coverage in other areas which had put a halt to the treatment of severe malnutrition with RUTF in some localities and has slowed down coverage since 2013 at 15%-20% (PCIMA, 2016).

2.3 Guidelines for Admission Criteria of Malnutrition

2.3.1 International Guidelines

WHO recommends hospital admission of any child under 5 years of age who presents one of the following criteria: mid-upper arm circumference < 115 mm, any degree of bilateral edema (moderate to severe), weight-for-height < -3 z-score, failure of the appetite test, presence of medical complications or severe bilateral pitting edema (Figure 2.2). Admission into outpatient care is recommended for children under 5 years of age with signs of SAM who pass the appetite test and who are alert and present no clinical complications (WHO, 2013).

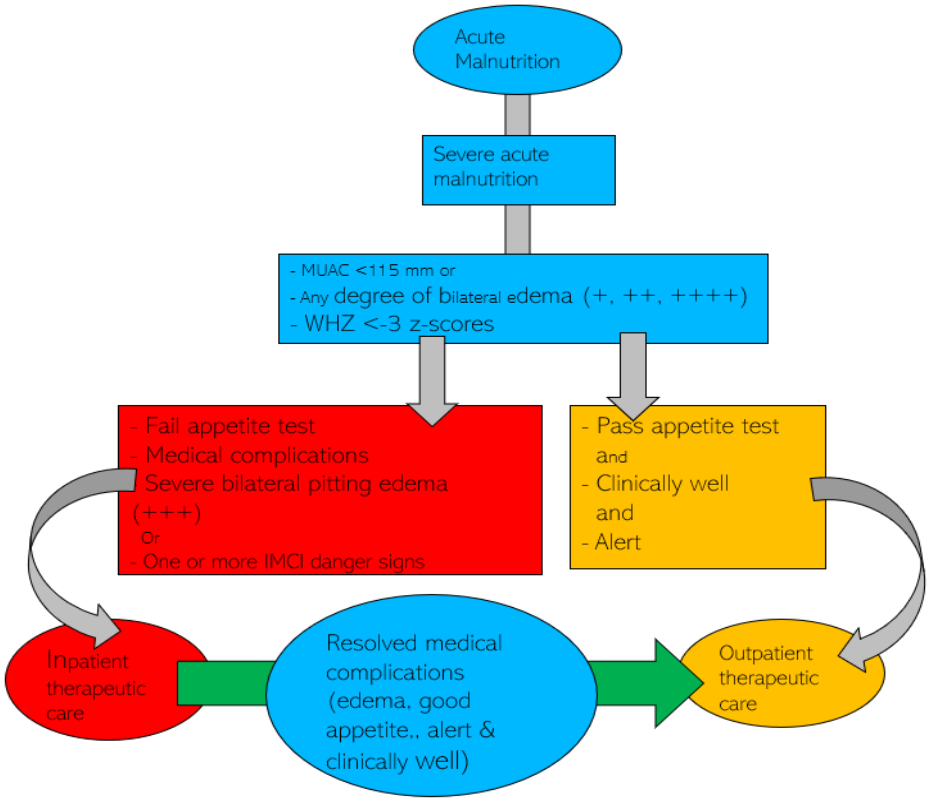

Figure 2.2 WHO Admission Criteria for Children 6-59 months old with SAM (WHO, 2013)

2.4 Therapeutic Foods

Ready-to-use Therapeutic Food (RUTF) is an enriched food based on peanut butter mixed with dried skimmed milk and vitamins and minerals. It provides foods that are safe and easy to use at home (no need to mix with water) and ensure rapid weight gain in severely malnourished children. Another benefit to RUTF is its ability to be preserved for a long time (3-4 months) without refrigeration, even at tropical temperatures (WHO, 2007). The December 2017 situation report from UNICEF highlights the response of the nutrition program in DRC where "171,825 children aged 6 to 59 months were admitted for nutrition treatment" (UNICEF, 2017) and "11,367 children of the same age with SAM were admitted in health centers" (UNICEF, 2017) and were provided with RUTF. The standard therapy of treatment of SAM in accordance with PCIMA follows the recommendations put forward by WHO (Figure 2.3). While local production (i.e. laboratory manufacture, packaging and marketing) of RUTF with local ingredients is an increasingly common practice and has been well documented, the subject is outside the scope of this paper. This thesis focuses on the home-made production of enriched therapeutic foods using locally-available ingredients and without the purchase of vitamins or minerals pre-mix as these ingredients are not typically obtainable by rural households.

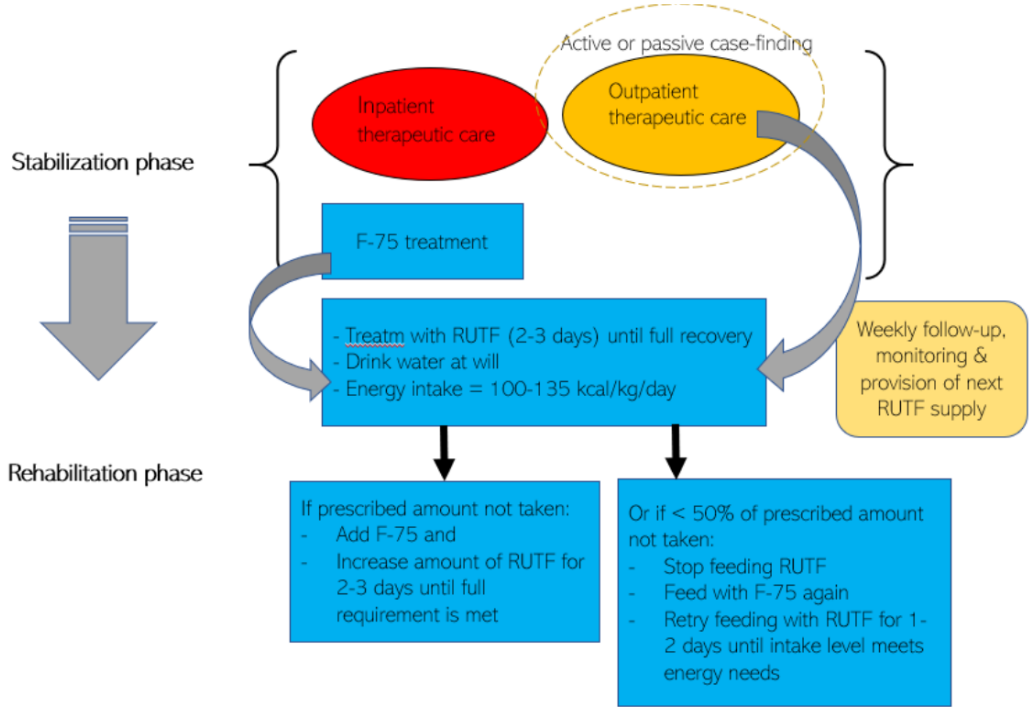

Figure 2.3 WHO Guidelines for Management of SAM (adapted)

2.4.1 Community-Based Management of Severe Acute Malnutrition

2.4.1.1 Standard Therapeutic Foods or RUTF

RUTF is a lipid-based nutrient-rich product. It consists of a lipid matrix with a complex of vitamins and minerals. The lipid-based matrix is constituted of peanut paste (or chickpea paste), vegetable oil, sugar and milk powder and a complex of vitamins and minerals (WHO, 2017). Some articles compare the efficacy of home-based therapy with RTUF in treating malnourished children. For instance, in the study "*Home-based Treatment of Malnourished Malawian Children with Locally Produced or Imported Ready -to-Use Food*" (Sandige, Heidi et al., 2004), the authors showed that locally produced and imported RTUF were similar in efficacy in treating severe childhood malnutrition.

2.4.1.2 Locally-Sourced Therapeutic Foods

Several studies have examined and cited merits of adopting enriched therapeutic foods made with locally-available ingredients to treat children of various age between 6-59 months suffering with SAM. Some ingredients mentioned in the literature such as fish, banana, legumes, wild edible plants, or beans are readily available in DRC while other good alternatives ingredients such as whey protein is not commonly used or found in DRC. For instance, one study tested the effectiveness of a new RUTF formulation using whey instead of milk powder to treat SAM (Bahwere, P., et al. 2014) in a blinded, parallel group RCT. The research shows that RUTF containing whey protein concentrate (similar quality to dry skimmed milk) is cheaper than RUTF that uses milk powder and as effective as standard RUTF to treat SAM, hence a good alternative. Whey is a by-product of cheese making and despite its low-cost, is not part of the food landscape in DRC and therefore may be inaccessible to rural households. Another study still in progress in Cambodia examines the superiority of RUTF that uses non-milk animal source foods like fish (a common food in DRC); an initial trial had demonstrated this novel RUTF to be already acceptable among children and caregivers (Borg, B., et al., 2018). A third study in India examined the acceptability and energy intake of RUTF with cereal legume-based *khichri* (rice and green gram gruel) among malnourished children (Dube B., et al., 2009); the study concluded that RUTF with cereal legumes-based *khichri* was well accepted among the studied children aged 6-36 months and it energy intake was higher due to the extra density (Dube B., et al., 2009); Another RCT conducted in rural Nigeria revealed that feeding children aged 6-11 months old with "unripe banana porridge mixed cereals with *turn brown* and proper preparation of beans for infants can provide cheap complementary foods that are high in protein and energy, and nutrient-dense to meet the nutritional needs of infants and young children." (Adepoju and Etukumoh

2014). One article discussed the importance of introducing wild edible plants into food dietary diversification and development for enhanced food security (Ngome P., et al., 2017). In this study, while presenting no nutritional evidence, the author makes the case for maximizing the utilization of already naturally and abundantly occurring plants especially in regions such as those in DRC.

2.4.2 Nutritional Interventions

Beyond the use of alternative local available ingredients, there are claims in the literature that interventions such as volunteer women's groups, food basket experts, and community self-teaching can also significantly contribute toward reducing burden of severe malnutrition. Calling for field experts to help manage household food baskets, Parlesak A., et al., (2014) argued that if investigators can select appropriate foods meeting micronutrient requirements, households with micronutrient gaps can diversify their diet "using local, low-cost, nutrient-dense foods that meet all the micronutrient recommendations". Roche et al. (2017) on the other hand, aiming at maintaining local grain bank interventions to improve inadequate infant and young child feeding in Ethiopia showed "how integrated agricultural and health interventions leveraging local production i.e. grain bank, can appeal to diverse stakeholders as an acceptable approach to improve IYCF" (Roche et al. 2017). In a different study, the same author showed that when involving community peers' mothers as example for others to follow, bonding, confidence level, uptake and prolonged adherence to promoted enriched foods soared and are maintained in the treatment of SAM and MAM. The study "evaluates the effectiveness of a community-based Positive Deviance (PD)/hearth infant and young child feeding intervention to improve growth and nutrition in infants and young children in the Ecuadorian highlands" (Roche, M., Leslie. 2011).

2.5 Study Methodology

Sources for the literature review were first obtained by conducting search in PubMed using the term “malnutrition locally therapeutic foods Africa”; 14 of the 17 results were found relevant then added to Endnote. Additional sources for country specific publications were found by importing publications from PubMed online database. Using the term “DRC Malnutrition”, we obtained 17 results of which 8 were imported into Endnote. The same iterative process was used with two other online databases, first within BioMed Central using the key words “DRC malnutrition locally sourced food” from which 3 of the13 results were exported to Endnote. From the online database journal PLOS, we used the key words “DRC malnutrition locally sourced therapeutic food” then applied a filter resulting in 12 articles. We also filtered by the following subject area in: PLOS Medicine, PLOS ONE, Nutrition, Malnutrition, Children, Children health, Africa. Using another online database, CABI Direct, 49 results were initially found after typing the terms “malnutrition, locally available food, Africa” then after filtering by publication year between 2007 and 2018, we had 30 results but only 8 were selected as relevant. Some publications (12) could not be exported to Endnote and were saved in a personal folder. Of those exported in Endnote, 4 were redundant and 7 were found to be out of the scope of this paper. In all, 85 articles were found relevant to the topic of this thesis.

2.6 Knowledge Gap

While limited literature has been published on enriched therapeutic foods using locally-sourced ingredients such as plant (root-like plants such as taro, sweet potatoes, etc.) sources which are a main source of diet in countries like DRC where cereal and milk products are more inaccessible

than any other products. Most literature addresses community-based treatment of SAM and MAM where communities have some sort of production capability and easy access to vitamins and micronutrients mix. Some literature mentioned the nutritional benefits of the plant moringa oleifera found in DRC and elsewhere; however, the literature addresses the benefits of using the plant to treat children and individuals suffering with diarrhea or HIV (Tshingani, K., 2017), not its use in enhancing fortified foods to treat malnutrition. More research needs to be made concerning the practice of making (and documenting) home-made enriched therapeutic foods using local available ingredients such as those mentioned above including moringa oleifera to treat SAM and MAM.

CHAPTER THREE

3. METHODS

3.1 Aim and Study Site

The aim of this study is to assess the nutritional content of locally-sourced therapeutic foods for children recovering from severe acute malnutrition in Karawa health zone over a 7-week period (June 2nd – July 27th, 2017). Karawa is made up of 147 villages and is one of the three sectors of Businga territory (estimated population: 28,919) (DR Congo population, 2016) of Nord-Ubangui province in the northern region of the Democratic Republic of Congo (DRC), near the border with Central African Republic. The study took place at two sites: at the nutritional rehabilitation center (NRC) of Karawa Hospital and in households of two surrounding communities.

Figure 3.1 Study Site, Karawa in Democratic Republic of the Congo (CIA World Factbook, 2011)

3.2 Qualitative Research Approach

The researcher used a grounded theory research approach to collect field data. A "grounded theory is a qualitative research design where the inquirer generates a general explanation (a theory) of a process, action, or interaction shaped by the views of many participants" (Strauss & Corbin, 1998). In other words, a grounded approach enables the researcher to describe a phenomenon and generate a theory.

Grounded theory is a qualitative research methodology developed in the late 1960's by two sociologists, Barney Glaser and Anselm Strauss. Grounded theory is a fitting approach for this study because it allows the researcher to observe and gather information directly from participants' actions and interactions in their natural setting. The researcher collects data via

semi-structured interviews and extensive field notes from observations that are subsequently coded and analyzed using MAXQDA software.

The researcher expects to assess three main outcomes: 1) the recovery rates of children recovering from moderate and severe acute malnutrition at the Karawa nutrition rehabilitation center (NRC) and at home using locally sourced therapeutic foods; 2) the nutritional content of therapeutic feeding recipes used at the nutrition rehabilitation center (NRC) and those promoted in the community by *Access aux Soins de Santé Primaires* (ASSP), a nutrition program of IMA World Health; and 3) the acceptability of and barriers to therapeutic foods produced with locally available ingredients among children and their caregivers.

3.3 Participants

Karawa is a rural area whose population lives mainly on agricultural activities and to some extent on small animal husbandry (poultry, pigs, etc.) and fishing. While Christianity is predominantly practiced in the locality, people also practice animism. The population to be studied is mainly of one tribe, Ngbaka, which account for 90% of the Karawa population. The two most spoken languages in Karawa are Lingala (85%) and Ngbaka (100%) and some French.

Participants of the study are children aged 6-60 months that have been diagnosed either at the community health center or at Karawa hospital with SAM or MAM, then been referred to the UNTI/UNTA of the nutritional rehabilitation center (NRC) of the hospital. NRC staff determines a child's nutrition status by the child's weight for height score (-2 z-score for MAM, < -3 z-score for SAM) or mid-upper arm circumference (MUAC <125 mm for MAM and ≤115 for SAM) in accordance with PCIMA's and WHO recommended management of children aged 6-60 months with severe acute malnutrition (SAM). Depending on the severity of malnutrition, treatment

occurs either at the NRC (UNTI) or at the household (UNTA), with more severe forms typically managed in the NRCs. Children formally diagnosed with SAM or MAM and recovering either at the NRC or at home are eligible to participate in analysis of all three objectives. Treatment of diagnosed children with SAM consists of feeding them with enriched therapeutic foods at the UNTI made from locally-sourced ingredients; for children recovering at home, treatment consists of feeding to the child, similar enriched therapeutic foods served at the UNTI and that ASSP proposes and teaches in the community through their community health volunteers or RECOs.

Primary caregivers of all participating children recovering at home (UNTA) and in the NRC (UNTI) were engaged in semi-structured interviews; anthropometric measures were recorded during the initial interview then weekly over the 7-week study period (June 2 – July 27, 2017). A 24-hr dietary recall of children was also collected during the initial interview as well as the type, texture and portion size of foods (with all ingredients) served at the UNTI or cooked at home, as well as other types of foods children typically eat. We also conducted a follow-up interview during the last visit where information similar to the initial interview was collected. 49 children were initially recruited for this study with 39 receiving treatment at the NRC and 10 recovering at home (Figure 3.2) for the duration of the study. The standardized semi-structured interview has several advantages: it allows "respondents to answer the same questions, thus increase comparability of responses; data are complete for each person on the topics addressed in the interview; reduces interviewer' effects and bias when several interviewers are used; makes data organization and analysis easier" (Tolley, Elizabeth E., et al., 2016). Still, this data collection method also has one major weakness: its "standardized wording of questions may constrain and limit naturalness and relevance of questions and answers" (Tolley, Elizabeth E., et al., 2016).

Purposive sampling is the technique of sampling best suited for this study because it helps the researcher "identify cases and gain access to participants who can typify or shed light on the study objective" (Tolley, Elizabeth E., et al., 2016). The study used the number of children diagnosed for malnutrition from health centers and from a record of admitted children diagnosed with malnutrition (within the past 1-2 weeks of the study) at the NRC as the sampling frame. In our sampling strategy, we used five different admission criteria for the study: 1) children aged 6-60 months old; 2) MUAC ≤ 115 mm; 3) presence of moderate edema; 4) no medical complications; and 5) located ≤ 10 km from Karawa hospital for children followed weekly at home. A cohort study was used for the analytical component of the study and the study was conducted between June 2 - July 27, 2017 with the support and collaboration of IMA World Health and Karawa health zone nutrition team.

One nurse, two community health volunteers (RECOs), two health center managers from the communities as well as the Karawa health zone nutritionist and health community coordinator participated in the data collection process alongside the researcher and her translator. Data were first collected in French then translated into English for analysis.

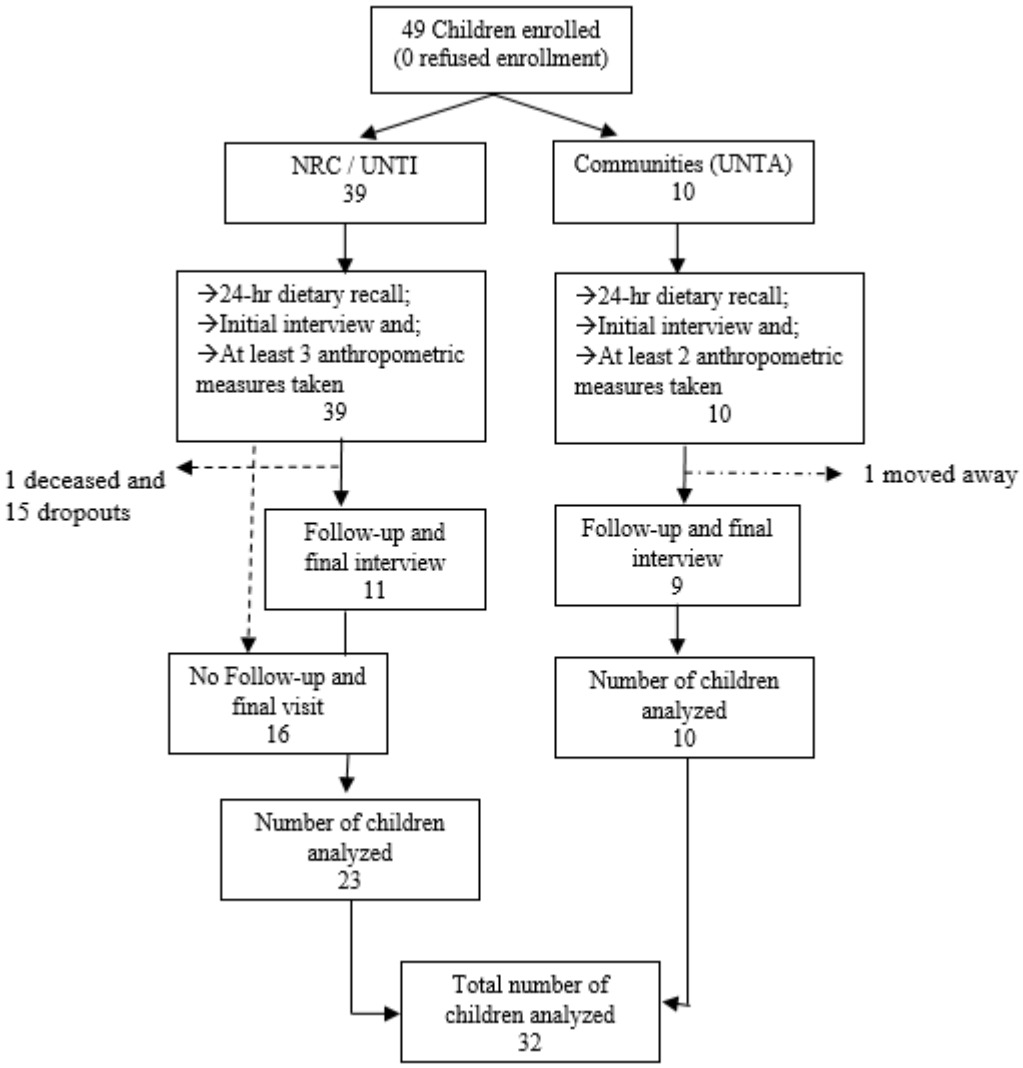

Figure 3.2 Study Enrollment Flowchart of Participants aged 6-60 months old at Karawa

3.4 Data Collection Tools

To achieve the first objective of the study, the principal investigator (PI) and hospital/health community staff collected anthropometric data of children recovering in the NRC and at home. For this objective, a total of 49 children diagnosed with malnutrition was recruited: 39 admitted at the NRC and 10 in two villages (Bokpassi and Bogon located within 10 km from Karawa hospital) between May 19th – July 1, 2017. Anthropometric data, including height,

weight, and mid-upper arm circumference (MUAC) were collected initially daily for one week then weekly for both children staying at the NRC and in the villages throughout the remaining 6-week period of the study. Each visit took approximately 10-15 minutes. A sample anthropometric data collection form can be found in Appendix A. Data were entered into the WHO AnthroPlus tool, a software program that allows for easy database entry, construction and analysis.

The PI used a combination of PAHO/WHO's Process for the Promotion of Child Feeding (ProPAN) and NutriSurvey tools to achieve the second study objective. Using the ProPAN Testing Recommendations and Recipes Module, the PI conducted a series of three interviews with the primary caregivers of children aged 6-60 months that were diagnosed and treated with SAM or MAM at the NRC then referred for treatment at home. These interviews were conducted with the presence of RECOs following their weekly household visits schedule in their respective communities; at the NRC the interviews were conducted by one NRC staff and two hospital staff. Each interview lasted approximately one hour, for a total participant burden of three hours over the course of the study. The interviews focused around assessing diet history, feasibility of replicating promoted and served food at the NRC, compliance, and impact criteria as laid out in the ProPAN field manual. The interview tools were validated by both the academic advisor at Rollins School of Public Health and by the IMA World Health nutrition field supervisor; also, several pilot tests were conducted to assess the validity of the tools. Versions of the interview guides can be found in Appendices B, C and D. The desired sample size for this objective are all primary caregivers of the 49 children. The sample size was influenced by the number of acute malnutrition cases that were referred to treatment at home at the start of the study.

Interviews were found to be the best data collection tool to achieve our objectives. However, the main practical constraint involved with this method was the language barrier. Some nuances of the languages spoken by the caregivers (Lingala and/or Gnbaka) may have been lost in translation during the interviews. To minimize errors, the PI corroborated information gathered and translated with several independent local health workers.

3.5 Data Analysis

Data analysis began at Karawa Hospital and continued in Kinshasa and Atlanta after the project conclusion. Data was entered to a password-protected computer and backed up on Emory's secure cloud, Box. After hard copies of the data were entered and backed up, the physical copies were destroyed. Data were entered and analyzed in the ProPAN, NutriSurvey (nutritional analysis) AnthroPlus (anthropometric analysis) and MAXQDA (acceptability and 24-hr dietary recall) data analysis software as outlined in the field methods section.

3.6 Ethical Considerations

Minor discomfort among children may have occurred from taking routine anthropometric measurements. To minimize these discomforts anthropometric measurements were taken as quickly as possible, while still ensuring accuracy. There was also the risk of loss of privacy or a breach of confidentiality. Physical data was stored in a locked location at the PI's place of residence. Electronic data were stored on a password-protected computer and backed up using Emory Box. Whenever possible, efforts were taken to ensure that data was collected in a private space. Additionally, the only identifying information that was collected was participants' name and address. This information has been removed and codified upon data entry.

Consent was obtained in-person. To ensure comprehension of the informed consent information, a member of the hospital staff, or the community health volunteer verbally summarized the material with the participants' caregivers. For participants engaged in objective one, the informed consent discussion took place in a private area of the hospital. For participants engaged in objective two, the informed consent discussion took place in the participants' homes. To help ensure that the consent process was free from undue influence, the person who did not have a personal relationship with the participants' caregiver did the informed consent process. To protect the participants, verbal consent was obtained from the child's primary caregiver.

3.7 Potential Research Bias & study limitations

The researcher's personal background as a native from a similar country may have influenced the study. Some biases the PI had identified and tried to manage throughout the study were cultural bias where similarities in culture easily lead the PI to make erroneous assumptions, and confirmation bias, where the PI may have the tendency to focus mainly on salient points of the study without examining the variation of the information (Kenny, M., & Fourie, R., 2014). Another bias to look for is selection bias: some participants in the study, while initially illegible to take part in the study because they did not meet one or any selection criteria, may have been selected from the hospital records by a health staff member based on affinity for instance under the belief of differential treatment. To overcome those biases, the researcher continuously re-evaluated her impressions of familiar contexts and challenged pre-existing assumptions as well as those of the team.

Another sort of biases that influenced this study were those from the participants' caregivers. Put in a vulnerable position in front of a perceived expert and individual of authority,

some caregivers had the tendency to be friendly and agreeable (acquiescence bias and social desirability bias) or unfriendly and uncooperative (sponsor bias for instance); social desirability bias is another respondent bias to look for during the study (Kenny, M., & Fourie, R., 2014). To avoid those biases affecting the study, the interviewers carefully asked questions that focus on the respondent's point of view instead of a supposed right answer. Asking questions about what a friend or family member of the caregiver thought or felt helped lessen the effect of respondents' bias in the study.

The time constraint of the study (7 weeks), anthropometric measures taken by multiple investigators, language barrier, and participant drop out are the four main challenges the study faced. The first did not allow a continued follow-up on nutrition counseling messages, monitoring and observation of significant changes in diet or anthropometric measures of the participants. While participation of local health staff was instrumental in the conduct of the study, it is not entirely certain the study overcame the second barrier of slight inconsistent anthropometric measurements collected by each team member despite having conducted a three days training session. Some did better than others in staying consistent in the way data were collected; end of the day feedback was used to go over incomplete or mis-filled interviews. The third limitation, language barrier, was an intrinsic and expected challenge during the initial interview phases (food description in the 24-hour dietary recall, initial interview) of the study. As the study progressed, the researcher's food vocabulary in the local language improved enough to understand some of the nuances in food preparation. Dropouts during the study was the fourth and final unusual challenge difficult to address. To minimize dropout, the PI and her team ensured that addresses of each participant were recorded and when necessary, accompanied by the community health coordinator, the PI tried to track down accessible caregivers.

CHAPTER FOUR

4. RESULTS

4.1 Introduction

This chapter describes analysis made and results from a 24-hour diet recall, an initial interview that assessed caregivers' awareness and knowledge of enriched porridge, a follow-up interview which assesses caregivers' acceptability of the proposed recipes and willingness to adopt the recipes. A nutritional content analysis of the enriched porridge served at the Nutritional Rehabilitation Center (NRC) of Karawa hospital and a nutritional (or anthropometric) status of participants' children are also described in this chapter.

Table 4.1 describes the distribution of the children participating in the study age groups, gender and enrollment location. 23 children in total were enrolled from the UNTI and 9 from UNTA; overall, the ratio of boy to girl was 2.2 with 19 boys (59.4%) and 13 girls (40.6%); children aged 25-35 months old were the age group with the highest number of children at 11 (34.4%); the second highest age group with number of children was 12-24 months old with 7 children (21.9%); age groups of 6-11 and 36-47 months old were the third and fourth highest in number of children with 6 (18.7%) and 5 (15.6%) respectively; 48-63 months old is the age group with the least number of children with 3 (9.4%).

Table 4.1: Distribution of Participants at Karawa by Gender and Age

Age (months)	n	%	Girls % (n)	Boys % (n)	Ratio Boy: Girl	Enrollment location
6-11	6	18.7	16.7 (1)	83.3 (5)	5	UNTI (5); UNTA (1)
12-24	7	21.9	42.9 (3)	57.1 (4)	1.3	UNTI (3); UNTA (4)
25-35	11	34.4	36.4 (4)	63.6 (7)	1.7	UNTI (10); UNTA (1)
36-47	5	15.6	60 (3)	40 (2)	0.7	UNTI (3); UNTA (2)
48-63	3	9.4	66.7 (2)	33.3 (1)	0.5	UNTI (2); UNTA (1)
Total	**32**	**100**	**40.6 (13)**	**59.4 (19)**	**2.2**	**UNTI (23); UNTA (9)**

4.2 Interviews

4.2.1 24-hour Recall Diet

In total, we collected 32 surveys on 24-hour diet recall for children age 7-63 months old. We asked caregivers to recollect their child's intake of foods and liquids for the most recent 24-hour period. Table 4.2 presents an inventory of food types by food groups that is most commonly available and consumed in the geographic area. The foods are organized according to FAO's International Network of Food Data Systems-Africa. Noted that vegetable names in this table spelled in italic correspond to English name (in parenthesis) in the local language.

Table 4.2: Inventory of Food Consumed During the 24-hr Dietary Recall by Group

Group	**Plant Origin**	
1	Cereals and Grain Products	Corn, Rice
2	Starchy Roots and Tubers	Cassava, Taro, Plantain, Sweet potatoes
3	Grain Legumes and Legume Products	White beans, soybeans
4	Nuts and Seeds	Pumpkin seeds, peanut
5	Vegetables and Vegetable Products	*Bitekuteku* (Amarath), *Fekefeke* (Okrah) and *Poundou* (Cassava leave)
6	Fungus	Mushroom
7	Fruits	Pineapple, mango, avocado, banana, passion fruit, cucumber, orange, papaya, coconut, ambarella, mangosteens, and jack fruit
8	Sugars and Syrups	Sugar
	Animal Origin	
9	Meats, Poultry, and Insects	Fresh and dry caterpillars
10	Fish and Shellfish	Fresh and dry fish and snails
11	Oils and Fats	Palm oil
	Miscellaneous	
12	Processed	Candies and biscuits

Figure 4.1 below shows an overview of the number of children who consumed selected food origin. In all, 31 children (96.87%) reported to have consumed (non-exclusively) foods of plant origin whereas one child (3.1%) recalled consuming food from animal source (exclusively) and 7 children (21.87%) reported consuming food of both animal and plants origin.

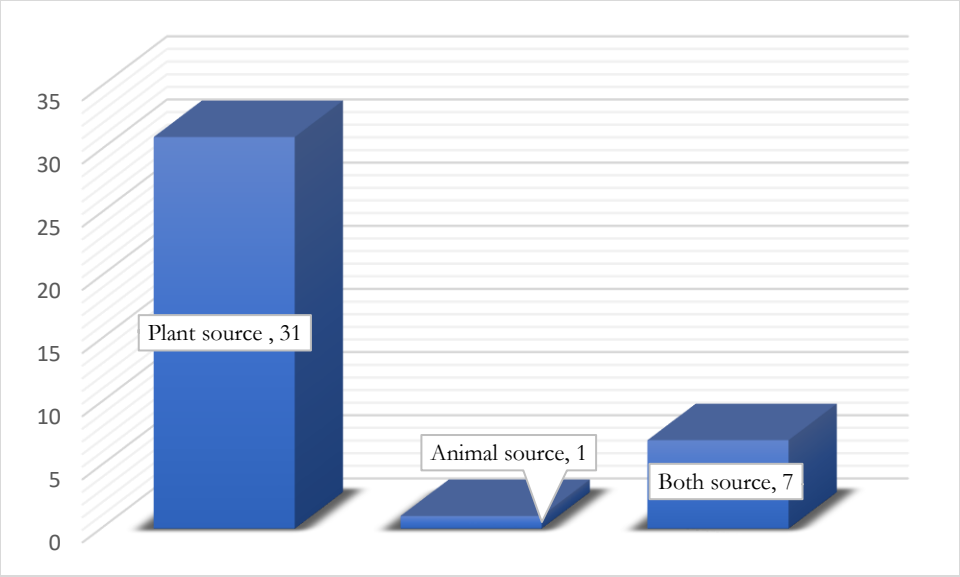

Figure 4.1: Number of Children Consuming Food by Source

Table 4.3 below describes the reported the range of number time caregivers fed their child with the respective food types within the 24-hr diet recall. Overall, caregivers reported to feed their children 1-3 times per day.

Table 4.3: Daily Number of Meal Eaten During the Most Recent 24-hr Recall by a Child by Food Type

	# of reported meal a child eats/day by food group (n=32)
Legumes & pulses	2-3
Cereals & grains	1-2
Starchy fruits & tubers	2
Fruits & vegetables	2
Animals	1-2
Fungus	3
Processed foods	1.91

4.2.2 Initial Interviews

The researcher used a survey to assess caregivers' awareness, knowledge acceptability and practice of enriched porridges at study baseline. The survey also assessed caregivers' perceptions of the nutritional services offered at the rehabilitation center of Kara hospital. In all, 32 surveys were administered and analyzed. The average age of children enrolled in the study is 25.6 months.

We asked caregivers whether they had heard of enriched porridge served at the hospital, 47.3% reported that they had heard of the porridge. In response to where they had heard of the porridge, 39.4% who reported hearing of the porridge, said they heard of the porridge from at least one source among the following: hospital, community volunteers, family member, church or health center. When asked what they thought of the recipe, 55.2% reported they liked the recipe. A small number of caregivers (13.1%) reported they would like to change the recipe but a significant number of them (94.7%) reported that they were able to put the recipe into practice at home. Most caregivers (76.3%) claimed to have cooked a similar recipe as the one served at Nutritional Rehabilitation Center (NRC).

Table 4.4: Caregivers' Perception of Therapeutic Foods Served at the UNTI

Questions from Initial interview	# of (positive) responses from caregivers (n=38[1])	Percent
Have you heard of the enriched recipe before?	18	47.3%
Where have you heard of the recipe?	15	39.4%
What do you think of the recipe?	21	55.2%
Would you like to change the recipe?	5	13.1%
Could you put this recipe into practice?	36	94.7%
Have you done something like this recipe?	29*	76.3%

*6 different types of porridge recipes were identified, see Figure 4.2

Figure 4.2 below describes in detail the 6 types of porridge caregivers reported to have cooked at home in the past. Almost half (14) of participants' caregivers reported to have cook a porridge

like that served at the UNTI using corn flour with soy or peanut flour (fresh corn and peanut pounded by themselves) with palm oil and salt. Other reported porridges included the use of any of the following starch roots like plantain, taro or sweet potato with a combination of peanut and sugar or peanut with palm oil and salt. A significant number of caregivers (9) reported never to have cooked a porridge before and a small number of them (3) did not provide any answers.

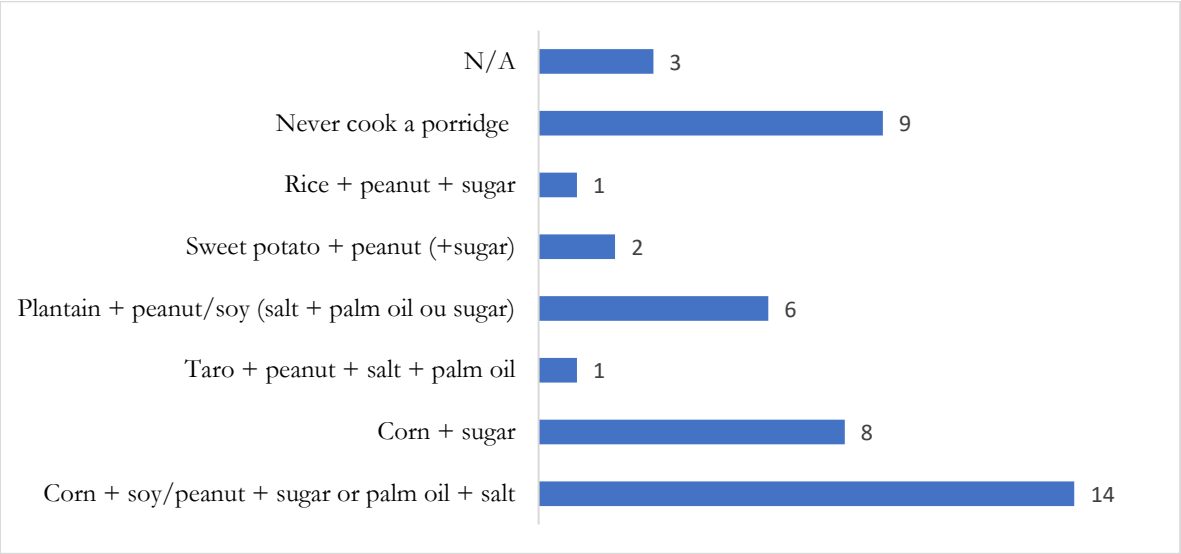

Figure 4.2: Number of Caregivers Reporting Preparing a Type of Porridge

Figure 4.3 below describes the different source of information caregivers reported to have heard of the therapeutic enriched foods. The majority of caregivers (37%) reported to have never heard of the therapeutic foods before the interview while health centers (14%), family (14%) and UNTI (14%) were reported to be a good source of information. Few caregivers reported hearing of the therapeutic foods from the community volunteers, RECOS (5%) and even fewer from other sources like churches.

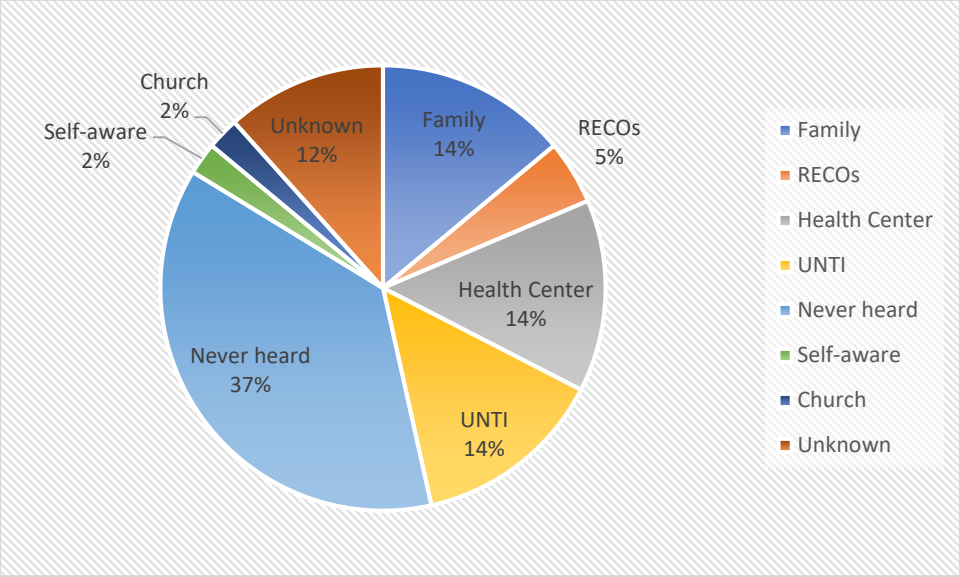

Figure 4.3: Reported Source of Information by Caregivers on Therapeutic Foods

4.2.3 Follow-up and Final Visit

At the study end line (after 7 weeks), the researcher conducted a follow-up survey to assess caregivers' practice of porridge at home (Table 4.5). We collected and analyzed surveys from 20 respondents due to attrition rate over the 7-week study period. Among the respondents, 18 (90%) reported they put a recipe of enriched porridge into practice at home. When asked which recipes were put into practice 17 (85%) reported to have tried corn and peanut porridge, 8 (40%) reported to have cooked plantain and peanut porridge, 4 (20%) reported to have cooked other type of porridges and 2 (10%) reported to have not put any porridge into practice (Table 4.5)

Table 4.5: Caregivers' Practice of Porridge at Follow-up and Final Visit

Questions	# of Responses (n=20)	Percent
Have you put the recipe into practice?	18	90%
What recipe did you put into practice?		
Corn and peanut porridge	17	85%
Plantain and peanut porridge	8	40%
Other type of porridge	4	20%
No recipe cooked	2	10%
How many recipes did you make?		
One recipe	5	25%
Two recipes	11	55%
Three recipes	2	10%
How many times per day did you feed your child with this recipe?		
Recipe 1 (1-3 times)	7	35%
Recipe 2 (1-3 times)	13	65%
Recipe 3 (≥ 3 times)	2	0.1%

4.3 Nutritional Content Analysis of Therapeutic Foods Served at UNTI

We used NutriSurvey software to conduct nutrients analysis and calculate energy requirements of two recipes daily served at the NRC using local and commonly used ingredients: 1) corn and soy flours and 2) rice and peanut flours. The software uses a food database commonly found in the Central Africa region.

The nutritional analysis of the corn and soy flour porridge is described below and organized by type of nutrients. Children eating one serving portion of this recipe at the UNTI receive 241.9 kcal in energy intake fulfilling only about ~ 12% of the daily energy requirement; this recipe contains 5.8 grams of protein, 4.8 grams of fat, 43.3 grams of carbohydrates and 3.4 grams of dietary fibers (Table 4.6).

The nutritional analysis of the second porridge with rice and peanut flours is not much different. Children eating one serving portion of this recipe at the UNTI receive 267.9 kcal in energy intake, fulfilling 13.2% of their daily energy requirement; the recipe also contains 4.4 grams of protein, 7.2 grams of fat, 45.9 grams of carbohydrates and 1.5 grams of dietary fibers (Table 4.6).

Table 4.6: Nutritional Analysis and % Fulfilled of Two Therapeutic Foods Served at UNTI

	Corn porridge		Rice Porridge	
Nutrient	**Amount**	**%Fulfilled**	**Amount**	**%Fulfilled**
energy	241.9 kcal	11.9	267.9 kcal	13.2
water	4.0 g	0.3	3.5 g	0.3
protein	5.8 g	10	4.4 g	7.3
fat	4.8 g	17	7.2 g	24
carbohydrates	43.3 g	73	45.9 g	70
dietary fiber	3.4 g	0	1.5 g	0
alcohol	0.0 g	0	0.0 g	0
PUFA	1.2 g	13.8	1.5 g	16.9
cholesterol	0.0 mg	0	0.0 mg	0
Vitamins				
Vit. A	60.0 µg	10	0.0 µg	0
carotene	0.3 mg	0	0.0 mg	0
Vit. E (eq.)	1.3 mg	23.6	1.7 mg	30.2
Vit. B1	0.2 mg	32.4	0.1 mg	24.4
Vit. B2	0.1 mg	12.5	0.0 mg	3.2
Vit. B6	0.2 mg	38.8	0.2 mg	37.7
total folic acid	13.5 µg	6.8	15.8 µg	7.9
Vit. C	3.4 mg	5.7	0.0 mg	0
Minerals				
sodium	2.2 mg	0	2.8 mg	0
potassium	152.4 mg	10.2	120.6 mg	8
calcium	38.9 mg	6.5	13.4 mg	2.2
magnesium	38.9 mg	48.6	26.2 mg	32.7
phosphorus	122.2 mg	24.4	71.7 mg	14.3
iron	1.2 mg	15.6	1.1 mg	13.7
zinc	0.8 mg	25.1	0.8 mg	27.2

The amount of serving in grams per child per day contained in each ingredient of the two recipes described above are depicted in Table 4.7. The amount was calculated from the measured quantities of ingredients UNTI staff used to prepare daily therapeutic foods for 49-50 people. To prepare a recipe of corn or rice porridge to feed one child, UNTI staff used 27 grams of corn flour (dried and milled at the local market), 10 grams of soy flour, interchangeably used with peanut flour (both dried, grilled and milled at the local market), 23 grams of sugar purchased in Gemena, a town 7-hour south of Karawa, and 2 grams of palm oil, locally available. Once prepared, every child receives one serving (one cup) of therapeutic foods per day.

Table 4.7: Amount of serving/g/day of Ingredients Used in Foods Served at UNTI

Ingredients	Serving/child
Corn flour	27
Soy flour	10
Sugar	23
Palm oil	2
Total	**63**

4.4 Participants Nutritional Status

The researcher also assessed the nutritional status of children in the study by looking at the aggregate measures of height and weight at baseline and at end line using WHO AnthroPlus software. End line nutritional status of all participating children recovering at the UNTI and in the communities by gender is presented in Table 4.8. By the end of the study, 100% male participants aged 6-11 months old still experienced severe stunting and wasting while the only female participant of the same age group experienced moderate stunting; among the age group of 12-23 months 100% male participants experienced severe stunting and wasting while 75% of the group had severe wasting. Only 33.3% female of the same age group experienced severe and

moderate stunting and wasting; Among children aged 24-35 months old, 100% male participants experienced severe and moderate wasting and stunting while 75% female experienced severe and moderate stunting and wasting; However, 50% male children aged 36-47 months old had severe and stunting and wasting while the only male participant between 48-63 months old experienced moderate stunting only. Female of the same group also had one case of moderate stunting (Table 4.8).

Table 4.8: Nutritional Status of Children by Gender and Age groups at End of Study

Age groups		**Wasted (%)**			**Stunted (%)**			**Underweight (%)**		
(months)	**N**	**< -3**	**< -2**	**SD (Mean)**	**<-3**	**< -2**	**SD (Mean)**	**<-3**	**<-2**	**SD (Mean)**
Male	**19**									
(6-11)	5	100	100	1.19 (-4.63)	80	100	1.53 (-3.51)	60	100	1.39 (-3.51)
(12-23)	4	75	100	1.86 (-4.90)	100	100	1.34 (-4.57)	75	75	2.64 (-3.76)
(24-35)	7	100	100	0.57 (-4.31)	100	100	0.89 (-4.90)	14.2	42.8	0.88 (-2.33)
(36-47)	2	50	50	1.82 (-2.75)	50	50	3.01 (-2.75)	0	0	0.4 (-1.39)
(48-63)	1	0	0	0 (-1.82)	0	100	0 (-2.46)	0	0	0 (-0.24)
Female	**13**									
(6-11)	1	0	0	0	0	100	5.43 (-1.31)	100	100	0 (-4.23)
(12-23)	3	33.3	33.3	1.61 (-1.82)	33.3	33.3	1.96 (-1.4)	0	0	0.52 (-1.32)
(24-35)	4	75	75	1.43 (-3.56)	50	75	1.51 (-3.1)	25	75	1.72 (-2.31)
(36-47)	3	100	100	1.46 (-4.16)	66.7	100	0.55 (-3.26)	50	50	0 (-0.78)
(48-63)	2	0	0	0	0	100	0.23 (-2.41)	0	0	0
TOTAL	**32**	**71.8**	**75**		**65.6**	**87.5**		**32.8**	**51.5**	

4.5 Recovery rates of children by gender

The statistical analysis of recovery rates of both male and female children recovering from SAM and MAM used initial and final weight and height from the first and last measurement taken at the start and at the end of the study respectively. Using a paired t-test analysis to perform a statistical analysis of the two sets of groups we found that among male, the adjusted

mean (95% CI) change in weight (kg) from baseline was significant at -0.55 kg (-0.98, -0.11), $p < 0.05$. In other words, male participant shown a significant recovery rate from baseline (Figure 4.4).

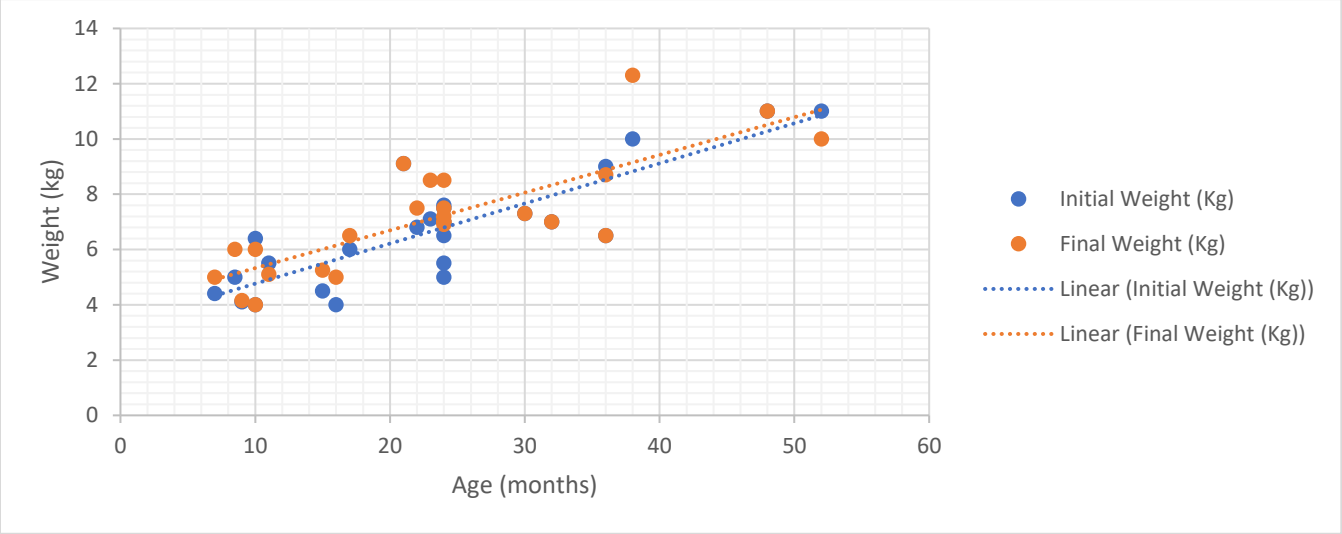

Figure 4.4: Recovery Rate of Male Children Across Enrollment Location

Among female, the adjusted mean (95% CI) change in weight (kg) from baseline was not significant at -0.20 kg (-0.918, 0.518), $P > 0.05$. In other words, female participants did not show a significant recovery rate from baseline (Figure 4.5).

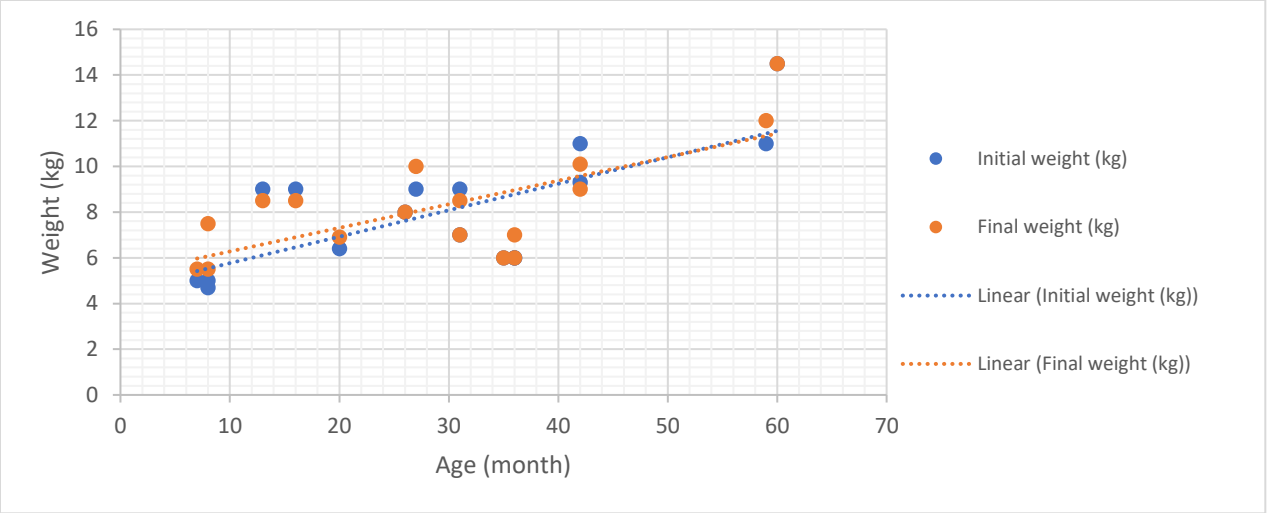

Figure 4.5: Recovery Rate of Female Children Across Enrollment Location

CHAPTER FIVE

5. DISCUSSION

5.1 Key Findings

The study hypothesized that locally sourced therapeutic foods which IMA World Health promotes in Karawa communities and those prepared and served at Karawa UNTI, UNTA, and UNS fulfill the energy and nutritional requirements needed to help children recover from SAM and MAM. The analysis of the two enriched foods served at the UNTI along with recovery rates analysis among male and female children showed that our hypothesis was not confirmed by our results. This study is unique in the fact that it is the first to extensively document the effect of locally-sourced therapeutic food prepared and served in an NRC in Nord Ubangui, DRC to treat children < 6 years old. While the results are from a specific geographic setting, other areas of DRC where there is high prevalence of stunting can learn from the results to benefit similar populations.

Overall, the nutritional status of the children did not improve as much as expected, especially among female participants. We found some children's status deteriorated and some other improved over the study period, as WHZ and HAZ (Figure 4.4, Figure 4.5, and Table 4.8). Indeed, among males aged between 36-47 months (2), one child was observed to have gained 82.1 g/day over a 28-day period follow-up going from severe wasting (-3 z-score) to almost normal weight (-1.46 z-score). One child aged between 48-63 months reported weight gained of 33.3 g/day over a 60-day period follow-up going from severe wasting (-3.16 z-score) to moderately wasting (-1.82 z-score). Among female participants, two-thirds of the children aged

12-23 months reported no severe malnutrition. However, no weight gain was recorded for the same children over a 48 and 21-day period follow-up respectively. One quarter of children aged 24-35 months reported weight gain (34.5 grams) over a 29-day period, going from moderate malnutrition (-2.48 z-score) to malnutrition (-1.58 z-score).

These inconsistent changes in weight across age groups throughout the study period can be attributed to many factors: 1) inconsistent measuring technique among different investigators; 2) participant children becoming sick during the study preventing them from eating adequately; 3) mother not breastfeeding enough as recommended (due to needs of other children, farm activities, the belief that feeding the child with therapeutic foods may replace breastfeeding, or introducing weaning foods too early; or caregivers' becoming sick); 4) some caregivers reported that their child ate with other children in the same place, increasing competition for foods; 5) caregivers' dropout and inconsistent visits to the UNTI; and 6) inconsistency in the number of days that the children were followed. Caregivers would sometimes dropout when they judged their child had fully recovered and did not need to continue going to the UNTI. Another reason for dropout observed was the caregivers' obligation to her family which often lived more than 20 km away from the hospital. Lack of motivation and, other perceived competing occupations were also factors of dropout. Occupied caregivers with multiple children would at time send the child participating in the study on his/her own to the UNTI for treatment or some would be ill, stay at home or keep a sick child at home.

Golden M. H. (2009) estimated daily "rates of weight gain required to achieve different degrees of catch-up over periods of 14 to 40 days". The rates were estimated for children of 60-85 cm in height suffering from severe to moderate wasting considering that rate of weight gain depends on the severity of malnutrition. Children with weight deficit between -2 z-score and -1

z-score recovered faster than children with weight deficit of -3 z-score and over 14-40 days by gender (Golden H. Michael, 2009). According to the same author, rate of weight gain for moderately malnourished children should be 5 g/kg/day.

For the management of SAM and MAM, the recommendation from WHO 21st Expert Committee on the Selection and Use of Essential Medicines is 150-220 kcal/kg/day of RUTF for a maximum of 8-week period for children from 6 months of age who have SAM without medical complications (WHO, 2017). Golden M. H. (2009) recommends an intake of 673-1,242 kcal/day of RUTF for children 7-60 months of age who have MAM. Energy requirements from therapeutic foods served at the UNTI clearly did not fulfill the recommendations proposed by WHO or by Golden. There are several reasons for this. Sometimes there were insufficient funds to purchase enough ingredients to feed 50 individuals daily in the UNTI. Therapeutic foods being served at the UNTI were not well rationed as hospital personnel and visitors took advantage of the free foods to get fed. UNTI staff is also at times overwhelmed by the number of cases referred to the hospital. Many cases that are supposed to be treated at the UNTA (community health center) are referred to the UNTI to receive the therapeutic foods. We also observed a high rate of death and morbidity among other patients (older children and adults) with different medical complications suffering from SAM or MAM, making the UNTI staff workload heavier.

Acceptability of therapeutic foods served at the UNTI was not reported as an obstacle. Money or the lack of it was a perceived insurmountable obstacle that stopped caregivers' ability to replicate the recipes at home with enough (or alternative) ingredients to make it nutritionally adequate.

Protocol for admission criteria were followed at the UNTI but not at the health centers. Health centers of the two communities participating in the study did not screen for malnutrition. Cases were mostly self-identified or not identified at all. Community-based treatment of SAM or MAM through the UNTA was practically absent as UNTI received and treated all reported cases of malnutrition.

This study showed that therapeutic foods served, while acceptable, at Karawa UNTI did not meet the nutritional requirements to help participant children aged 6-60 months fully recovery from SAM or MAM over the 7-week period of the study. The study also revealed caregivers have the willingness and the initiative to prepare recommended therapeutic foods for their sick children provided resources and information are made available.

In sum, this study had significant design and implementation flaws. The results do provide some impetus for IMA World Health to continue its nutrition interventions coupled with rigorous monitoring of children and care givers. Conducting a research study in the dynamic environment of an ongoing program is difficult but implementation research is the future of global health. Studies like the one reported on in this thesis are crucial to pushing nutrition interventions into the real world of programs.

5.2 Limitations

One of the biggest limitations the study faced is that the study did not have the opportunity to compare the feeding practices of the UNTI to those recommended by IMA's interventions in the communities, ASSP via ANJE program. No activities from the program were ever observed by the researcher and only 40% of RECOs were active within the communities

participating in the study. Prevalence of malnutrition in Karawa health zone (comprised of 31 health centers) is high and hospital staff recorded hundreds of cases of SAM and MAM monthly. Communities had limited input, lacked motivation, and human and logistical resources to tackle the issue. Despite the strong support from IMA World Health, and that of the local health community, the study faced a time constraint. A study period of 7 weeks was not enough to get a full picture of recovery rates of the study population and at the same time address long-lasting solutions. As expected, also due to the time frame of the study, little to no effect was observed on height gain. Local language and high dropout rate were two other limiting factors which prevented the researcher from accurately recording data.

5.3 Recommendations

We recommend maximizing the use of seasonal fruits, legumes and vegetables to serve a diverse source of therapeutic foods. The region is rich with coconut, banana, sugar cane and moringa leaves. We also recommend recruiting more women as RECOs to volunteer helping their communities as 80% of RECOs, in the communities which participated in the study, are men. Having women as RECOs, will increase both the level of awareness on home-made therapeutic foods among caregivers and of knowledge on family feeding and food. Success will also motivate many to emulate those who have succeeded, as positive-deviance theory would suggest. We also recommend to continue raising the awareness level in as many ways as possible as the study identified several sources of information caregivers hear on recipes of enriched therapeutic foods. Health centers and hospital are the primary source of information for caregivers, therefore creating the opportunities to educate and instruct women, men and children

who spend hours and days at those locations being treated or caring for a sick relative would be a natural place for engagement with care givers and families of malnourished children. Complementary research is still needed in the region to test the ability and willingness of households recovering from SAM or MAM to be able to either produce or purchase ingredients necessary for a therapeutic food recipe. A case control study is recommended to compare children recovering from SAM or MAM at home using the positive deviance theory against children recovering at the UNTI. An intervention focusing on increasing and improving caregivers' knowledge and practice of therapeutic foods in households with a case of SAM or MAM may significantly improve the outcome of children suffering from SAM and MAM.

APPENDIX A: Anthropometry Data Collection Tool

Anthropometric Data Collection Form

*Adapted from ProPAN (2013) 24hr Dietary Recall and Anthropometry form (Module I, Exhibit A)

General Information

Child's Code: ___ ___ ___ ___

Date of Interview: ___ (Day) __ (Month) 20__ (Year)

Location _____

Child's Sex: M (1) F (2) Circle

Child's Name: _____ (Last Name) _____ (First Name)

Caregiver's Name: _____ (Last Name) _____ (First Name)

Date of Birth: ___ ___ (Day) ___ ___ (Month) 20 ___ (Year)

Age: __ __ (Years) __ __ (Months)

Anthropometry Measurements

Child weight in kilograms ___ ___ ___ .___

Child height in centimeters __ __ ___ .___

Child MUAC in millimeters ___ ___ ___ .___

APPENDIX B: 24-hour Dietary Recall

24-hour Dietary Recall Form

Caregiver's name:

Date"

Pregnant? ☐ Yes ☐ No Nursing? ☐ Yes ☐ No

MEAL TYPE

1 = Morning
2 = Afternoon
3 = Evening

SERVING ABBREVIATIONS:

Plate	pl
Tablespoon	TBSP
Cup	c
Teaspoon	tsp
Slice	sl
Serving	ser
Handful	hf
Pieces	Pcs

What did the child eat and drink in the last 24 hours? (Be thorough)

Describe in detail (with texture) foods consumed. List one food per line	AMOUNT EATEN	MEAL TYPE

APPENDIX C: Initial Visit Form

Initial Visit Form

**Adapted from ProPAN Initial Visit Form (Form II-2.1)

1. Date of Interview: __ __ / __ __ / 20 __ __

2. Accompanying RECO's Name: _____

3. Primary Caregiver's Name: _____

4. Location: _____

5. Evaluation of whether or not recipe is currently being used:

_____
_____
_____

6. Recipe that will be proposed:

_____
_____
_____

7. What do you think of the recipe?

_____
_____
_____

8. Would you like to change it in some way? How?

_____
_____
_____

9. Have you heard anything about a recipe like this before? Where?

_____
_____
_____

10. Have you done something similar to this recipe before? What did you do?

_____
_____
_____

11. Do you think you could put this recipe into practice? Why? Why not?

_____
_____
_____

12. Do you have any doubts about this recipe?

_____
_____
_____

13. General Observations

_____
_____

APPENDIX D: Follow-Up and Final Visit Form

Follow-Up and Final Visit Form

*Adapted from ProPAN (2013) Follow-Up and Final Visit Form (Form II-2.2)

1. Date of Interview: __ __ / __ __ / 20 __ __

2. Accompanying RECO's Name: _____

3. Participant's Name: _____

Question	Response for Recipe 1	Response for Recipe 2	Response for Recipe 3
4. Recipe tested:			
5. Do you remember the recipe? What did it say?			
6. Evaluate if the participant has been practicing the recipe including frequency, or whey they have not practiced it.			
7. How did you feel practicing the recipe?			
8. What did you like about the recipe?			
9. What did you dislike or find difficult about the recipe?			
10. Do you think the child liked it? Why or why not?			
11. Did anyone say anything to you about the recipe? Who? What did they say?			
12. Did you change the recipe? What did you change? Why did you change it?			
13. Are you willing to continue practicing this recipe? Why? Why not?			
14. Note: The following question should only be asked during the final visit: What would you say to your neighbor/friend to recommend that she follow this recipe?			

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