FINAL THESIS REPORT 2019

Prevalence of Acute and Moderate Malnutrition among Under-Five Children in Three Counties of Western Lakes State, South Sudan

Nebiyu Lera Alaro, Bezatu M. Alemu

Texila American University

Published November 2026

Abstract

Background: The prevalence of global acute malnutrition (SAM and MAM) of under-five children, in south Sudan is considerably high and is being aggravated by various internal conflicts and food insecurity ravaging the country. The situation has attracted the attention of various international organizations like World Food Programme (WFP), United Nations Children Emergency Fund (UNICEF), and other international Non-governmental Organizations (INGOs), for possible interventions. However, the success of the nutrition therapy programme in reducing the prevalence of SAM and MAM among under-five children, as implemented by these humanitarian organizations is hinged on many factors. The success of intervention programmes in this direction, can be well felt if the mothers/caregivers feed their affected under-five children appropriately with the supplementary foods being provided at the therapeutic centres. Their overall perception about the nutrition therapy programmes is equally important if the maximum success is to be achieved.

Method: A combination of retrospective cohort and descriptive cross-sectional survey study designs was used. Data for the retrospective cohort study was obtained through recruiting each category of Severe Acute Malnourished (SAM) and Moderate Acute Malnourished (MAM) in under-five children who have been previously recruited into the nutrition therapy program, as reported in the District Health Information software (DHIS) across the three years 2015, 2016 and 2017. In the cross sectional survey study, the number of mothers/caregivers served with questionnaires to assess their perception on the efficacy of the nutrition program on their children was selected through simple random sampling,

Results: Findings revealed significant differences in SAM and MAM within counties and among counties across the three years. It was also revealed that there was rising prevalence of SAM and MAM (poor impact) among the counties as the nutrition therapy programme progressed across the three years in the three counties. The results further showed that more than 90% of mothers/caregivers in Cueibet and Yirol West counties have varying degrees of poor feeding practices and perceptions about the nutrition therapy programme, while in Rumbek North county, over 50% of the mothers/caregivers have good feeding practices but more than 50% of them also have varying degrees of poor perception about the nutrition therapy programme. Chi-square test revealed significant association between the marital status and feeding practice of the mothers/caregivers in the three counties, and a significant association between their level of education and perception on the nutrition therapy programme.

Conclusion: The overall results showed that despite the huge investment by all stakeholders in the intervention programme to ameliorate the status of the global acute malnutrition in the three counties, in Lakes state of south Sudan, there is a need for total overhaul of the programme for effective and efficient nutrition therapy programme.

Keywords: severe acute malnutrition; moderate acute malnutrition; under-five children; nutrition therapy programme; feeding practice; South Sudan

1 Introduction

In a developing country like south Sudan, various socio-economic problems are common, and this is always associated with negative effects like food scarcity with consequential malnutrition effect on the people especially the most vulnerable groups-women and the under-five children. According to World Food Program (2013), the situation in south Sudan is worsened by the continuous insecurity which has caught the attention of various world-acclaimed donors and international Non-Governmental organizations (INGOs) The term "malnutrition" is actually a category of diseases that includes any illness resulting from an imbalance of calories or micronutrients (e.g. vitamins), either in dearth or excess. This study focused on Global Acute Malnutrition (GAM) especially in under-five children, i.e. the combination of Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) in under-five children in South Sudan. The main purpose was to evaluate the efficacy of the nutrition therapy program on the GAM rate in Lakes state of south Sudan using the three counties where the program has been implemented, as study areas The nutritional status of women and children is particularly important, because it is through women and their off-spring that the pernicious effects of malnutrition are propagated to future generations.

A malnourished mother is likely to give birth to a low birth-weight (LBW) baby susceptible to disease and premature death, which only further undermines the economic development of the family and society, and continues the cycle of poverty and malnutrition. Although child malnutrition declined globally during the 1990s, with the prevalence of underweight children falling from 27% to 22% (de Onis et al., 2004a), national levels of malnutrition still vary considerably (0% in Australia; 49% in Afghanistan)(WHO, 2003). The largest decline in the level of child malnutrition was in eastern Asia where underweight levels decreased by one half between 1990 and 2000.

Underweight rates also declined in South-Eastern Asia (from 35% to 27%), and in Latin America and the Caribbean the rate of underweight children decreased by one third (from 9% to 6%) over the last 10 years. In contrast, South-Central Asia still has high levels of child malnutrition, even though the rate of underweight children declined from 50% to 41% during the 1990s. In Africa, the number of underweight children actually increased between 1990 and 2000 (from 26 million to 32 million), and 25% of all children under five years old are underweight, which signals that little changed from a decade earlier. The projection for 2005 is that the prevalence of child malnutrition will continue to decline in all regions in Africa, especially in sub-Saharan Africa (de Onis et al., 2004b). The World Food Program (WFP) estimates that 842 million people worldwide do not have access to enough food, approximately 146 million of which are children. Those included in this estimate range from simply too little food to extreme malnourishment. Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) have been recognized as the most serious type of hunger, with 20 million and 35 million respective cases each year occurring in children less than 5 years of age (Edesia, 2012). According to WHO (2009), SAM is defined as a child having a weight-for-height ratio >3 standard deviations below the mean for their age, and MAM is a weight-for-height ratio >2 but <3 standard deviations. A notable point is that the majority of these cases occur in South Asia and Sub-Saharan Africa.

This study was therefore directed towards unraveling the efficacy of nutrition therapy program, supported by WFP and UNICEF, on the SAM and MAM rate among under-five children who are recruited into the nutrition therapy program in three counties (Rumbek North, Yirol West, and Cueibet) of war-torn Lakes State of south Sudan. This study also evaluated the feeding practice and

perspective of the mothers/caregivers on the efficacy of the nutrition therapy program on their children, in the three counties across three years-2015 to 2017.

1.1 Statement of the problem

The World Food Program (WFP) estimates that 842 million people worldwide do not have access to enough food, approximately 146 million of which are children. Those included in this estimate range from simply too little food to extreme malnourishment. Severe Acute Malnutrition (SAM) and Moderate Acute Malnutrition (MAM) have been recognized as the most serious type of hunger, with 20 million and 35 million respective cases each year occurring in children less than 5 years of age (Edesia, 2012). According to WHO (2009), SAM is defined as a child having a weight-for-height ratio >3 standard deviations below the mean for their age, and MAM is a height-for-weight ratio >2 but <3 standard deviations. A notable point is that the majority of these cases occur in South Asia and Sub-Saharan Africa.

The prevalence of global acute malnutrition among under-five children, in south Sudan is reportedly high (UNICEF, 2012). Effective intervention in terms of nutrition therapy programme from the humanitarian organizations has always been playing a pivotal role in addressing the situation. However the impact of the much needed programme may be confronted with various challenges which may serve as threats to the overall success of the interventions and hamper the achievement of the set goals in this regard (Neitzel, 2012). One of such problem is the internal wars besieging south Sudan, and food insecurity. Conducting an impact study on the efficacy of the various therapeutic programmes as sponsored by UNICEF and WFP in south Sudan is therefore an important step to unravel the state of the programme, and to determine the possible challenges that may be confronting the system.

In the same vein, in spite of the huge investment on the provision of the food supplements and other costs involved in this humanitarian service, the feeding practice of the mothers/caregivers, ranging from the issues regarding hygiene to the possibility of sharing the foods among other non-malnourished children, and their perception regarding the whole programme are possible impediments towards the achievement of the set goals in reducing the acute malnutrition among these vulnerable population-the under-five children. Conducting a survey study on the feeding practice of the food supplements and the perception of the mothers/caregivers will not be out of place in order to unravel salient information, whether there is a need for improvement on the modules operandi of the nutrition humanitarian programme, by both the donors and the implementers. Hence, this study aimed at unraveling the impact of the nutrition therapy programme on the global acute malnutrition among under-five children, in three counties of the war-torn Lakes State of south Sudan.

1.2 Justification of the study

Implementing nutrition therapy programme has become important in controlling the acute malnutrition level especially among under-five children, in sub-sahara Africa countries with poor resources, and low level of income with many people earning below one U.S dollar per day. But it is not without its challenges in which having the knowledge about its impact during the programme will be of great importance. Hence this study was intended to bridge this gap in knowledge regarding the impact of the nutrition therapy programme on the Global Acute Malnutrition (SAM and MAM) in the war-torn Lakes state of south Sudan.

In tandem to the foregoing, it almost impossible for the nutrition feeding programme not to have the presence of associated challenges on the part of the mothers/caregivers who are administering the food supplements on their wards, in which having the knowledge about how these mothers/caregivers who are the 'final implementers' are administering the food supplements on their wards, and their overall perception on the programme, will serve as a good source of information to improve the system. Hence this study was also intended to bridge this gap of knowledge regarding the food supplements feeding practice of mothers/caregivers, and their perception on the efficacy of the humanitarian nutrition therapy programme in south Sudan. It will serve as a compass to guide in the next line of action for all stakeholders involved in the implementation of the nutrition therapy services for this vulnerable group –the under-five children, especially in the youngest nation of the world-south Sudan.

1.3 Objectives

Goal. To determine the impact of nutrition therapy programme on the global acute malnutrition among under-five children in three counties of Lakes state of south Sudan.

The specific objectives were:

1. To determine the impact of the nutrition therapy programme in each county across three years-2015, 2016 and 2017.
2. To determine the impact of nutrition therapy programme among the three counties across the three years-2015, 2016 and 2017.
3. To determine the feeding practices of the mothers/caregivers towards administering the food supplements on their malnourished under-five children in the three counties.
4. To determine the perception of the mothers/caregivers on the nutrition therapy programme on their malnourished under-five children across the three counties.
5. To determine probable factors that determine the feeding practices and the perception of the mothers towards the nutrition therapy programme across the three counties.

1.4 Hypotheses

1. H_0: There will be no significant differences in Global Acute Malnutrition (SAM and MAM) values in each of the three counties, across the three years in Lakes State of south Sudan; H_1: There will be significant differences in Global Acute Malnutrition (SAM and MAM) values in each of the three counties, across the years in Lakes State of south Sudan.
2. H_0: There will be no significant differences in Global Acute Malnutrition (SAM and MAM) values among the three counties, across the three years in Lakes State of south Sudan; H_1: There will be significant differences in Global Acute Malnutrition (SAM and MAM) values among the three counties, across the three years in Lakes State of south Sudan.
3. H_0: There will be no difference in the feeding practices of the mothers/caregivers towards administering the food supplements on their under-five children across the three counties; H_1: There will be difference in the feeding practices of the mothers/caregivers towards administering the food supplements on their under-five children across the three counties.
4. H_0: There will be no differences in the perspectives of the mothers/caregivers on the nutrition therapy program on their under-five children across the three counties; H_1: There will be differences in the perspectives of the mothers/caregivers on the nutrition therapy program on their under-five children across the three counties.

5. H_0: There will be no significant association between the socio-demographic variables and feeding practice and perception of mothers/caregivers on the nutrition therapy programme; H_1: There will be significant association between the socio-demographic variables and feeding practice and perception of mothers/caregivers on the nutrition therapy programme.

Level of significance $\alpha = 0.05$.

2 Literature review

2.1 Concept of malnutrition

Malnutrition can be defined as the lack of a sufficient quantity or quality of nutrients to maintain the body system at some definable level of functioning. It has been estimated that 37-80 per cent of all pre-school children in the developing countries suffer from protein calorie malnutrition as assessed by the manifestation of syndromes, nutritional indexes, and weight deviations(Bengoa 1974). Nutrition encompasses processes leading to and involved with the utilization of nutrients for growth, development, maintenance and activity. Malnutrition results from the inadequate intake of nutrients, or from disease factors that affect digestion, absorption, transport and the utilization of nutrients. (UNICEF, 1992).World Health Organization (WHO, 2000) defines malnutrition as the cellular imbalance between supply of nutrients and energy and body's demand to ensure growth, maintenance and specific function (WHO, 2000).

The nutrition status in Sudan is poorly characterized by high level of underweight and chronic malnutrition, well persistently elevated level of acute malnutrition. Therefore, the available data about nutritional status of children under 5 years in Sudan reflects the worse and miserable situation, especially in the marginalized rural areas but the situation is extending to urban area of Sudan. (Abdalla et al., 2009)

The terms `malnutrition' and `undernutrition', however, tend to be used interchangeably in the literature (Lehmann, 1991).

2.1.1 Critical attributes

Attributes are defining characteristics or salient features that assist in identifying the occurrence of a concept. After reviewing the literature, five critical attributes emerge, including insufficient dietary intake, muscle wasting, weight loss, poor appetite, and downward trajectory.

Malnutrition is either caused by lack of adequate food intake containing the essential nutrients or by an adequate intake in the face of illness or medical treatment, where nutrients cannot be ingested, absorbed, or metabolized adequately, or the rate of utilization of external losses is excessive (Rudman 1987).

Insufficient dietary intake. Malnutrition is characterized by an insufficient dietary intake to meet requirements for energy or protein needs (Roy 1994).

Muscle wasting. Skeletal muscle comprises approximately 30% of the lean body mass and atrophies progressively in protein-energy malnutrition. From the MAC and the width of the adipose layer (equal to one-half the triceps skinfold), mid-arm muscle and fat areas can be calculated. The mid-arm muscle and fat areas are indicators of the body's mass of skeletal muscle and adipose tissue, respectively (Rudman 1987). When an individual has less than required nutrition intake, particularly in protein, the muscles are going to be wasted, and subcutaneous fat will reduce (Latham 1997).

Poor appetite. It is now well established that with advancing age, humans experience a physiologic reduction in food intake. This has been designated as the anorexia of ageing (Morley 1997). The physiologic anorexia of ageing places the elderly at a greater risk for developing a marked decrease in energy intake and the subsequent development of malnutrition when a disease process develops. Loss of appetite, as an item, has been assessed in many nutritional assessment tools (Guigoz et al. 1996).

Downward trajectory. Studies have shown that malnutrition, once established, places patients at increased risk of developing subsequent adverse health outcomes. Malnutrition leads to increased susceptibility to infection, delayed wound healing, reduced rate of drug metabolism, and impairment of both physical and cognitive function (Sullivan 1995). Malnourished elderly often get into a cycle of progressive clinical deterioration. Additionally, deterioration in nutritional status appears to be a rapid and hard-to-reverse process (Abbasi et al., 1992).

2.1.2 Malnutrition and child psychopathology

Some authors, like Guédeney et al., 2000, go further and investigate on the psychopathology of malnutrition. Actually, feeding disorders are the main motivations for child psychiatry consultations in western countries. Infants and toddlers, who do not, or rarely, use words to express themselves, do express through their body their pain, their suffering; they show feeding and sleeping disorders, dermatological problems. Symptoms showed by severely malnourished children turn out to be very similar to symptoms of depressive children (Geber et al., 1989).

2.1.3 Malnutrition in women and children

The nutritional status of women and children is particularly important, because it is through women and their off-spring that the pernicious effects of malnutrition are propagated to future generations. A malnourished mother is likely to give birth to a low birth-weight (LBW) baby susceptible to disease and premature death, which only further undermines the economic development of the family and society, and continues the cycle of poverty and malnutrition. Although child malnutrition declined globally during the 1990s, with the prevalence of underweight children falling from 27% to 22% (de Onis et al., 2004a), national levels of malnutrition still vary considerably (0% in Australia; 49% in Afghanistan)(WHO, 2003). The largest decline in the level of child malnutrition was in eastern Asia where underweight levels decreased by one half between 1990 and 2000.

Underweight rates also declined in South-Eastern Asia (from 35% to 27%), and in Latin America and the Caribbean the rate of underweight children decreased by one third (from 9% to 6%) over the last 10 years. In contrast, South-Central Asia still has high levels of child malnutrition, even though the rate of underweight children declined from 50% to 41% during the 1990s. In Africa, the number of underweight children actually increased between 1990 and 2000 (from 26 million to 32 million), and 25% of all children under five years old are underweight, which signals that little changed from a decade earlier. The projection for 2005 is that the prevalence of child malnutrition will continue to decline in all regions in Africa, especially in sub-Saharan Africa (de Onis et al., 2004b).

2.2 Epidemiology of global acute malnutrition

A recent analysis estimated that 32 out of 134 countries with available data had a prevalence of acute malnutrition of 10% or more, a burden commonly recognized as a “public health emergency requiring immediate intervention”. Globally, these estimates equate to about 33 million children suffering

moderate acute malnutrition and a further 19 million suffering severe acute malnutrition (UNICEF et al., 2012).

Prevalence of acute malnutrition may increase substantially with high levels of severe acute malnutrition and excess child mortality. For instance, global acute malnutrition (GAM) rose to around 40% in Southern Somalia during the famine in 2011, where an estimated 258,000 deaths occurred, over half of which were children (Checchi and Robinson, 2013).

The prevalence of under-nutrition is highest in rural areas, particularly on commercial farms and in informal (urban and peri-urban shack) settlements. HIV Contributes to an increased prevalence and severity of under-nutrition and micronutrient deficiency in children. More than 50% of children with HIV-infection become stunted or underweight; and at least 1 in 5 develop wasting (HST, 2007).

Malnutrition contributes to between 35 and 55 percent of all childhood deaths. In acute emergency situations, malnutrition can account for even more.

There are currently a number of classification systems related to nutrition related emergencies, most including reference to crude mortality rate (CMR), under-five mortality rate (U5MR), and levels of acute malnutrition. The WHO classification system provides simple guidance using thresholds for rates of global acute malnutrition (GAM). These thresholds are a reasonable starting point in assessing the severity of a crisis. (WHO, 2003)

In the world, annually, over three million deaths occur from protein energy malnutrition (PEM) in the children under five (Stephan et al., 2000). Currently, 195 million under-five children are affected by malnutrition; 90% of them live in sub-Saharan Africa and South Asia. At least 20 million children suffer from severe acute malnutrition and another 175 million are undernourished (Black et al., 2008).

2.3 Causes of malnutrition in under-five children

Malnutrition is common all over the world and it is estimated to contribute to more than one third of all child deaths, although it is rarely listed as the direct cause (Luchuo et al., 2013). Malnutrition contributes more than half of deaths in children worldwide (Paschal et al., 2013), child malnutrition was associated with 54% of deaths in children in developing countries in 2001 (Luchuo et al., 2013). Malnutrition literally means “bad nutrition” and technically includes both over- and under- nutrition (Yelena et al., 2013). The *World Food Programme* (WFP) defines malnutrition as “a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily performance process such as growth, pregnancy, lactation, physical work and resisting and recovering from disease” (Luchuo et al., 2013).

So, the aim of this research is to examine causes of under nutrition in children less than five years of age in the case of South Sudan and contribute with suggestions to interventions that can turn the tide and reach the goal of eradicating child under nutrition.

Malnutrition affects physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity, and it consequently impacts on human performance, health and survival (Salah et al., 2006). The continuous increase in the world population has conspicuous impart on the growth of hunger in the world, particularly in the under developed and developing nations (Hoddinot et al., 2012).

Recent estimates suggest that there are approximately 925 million hungry people in the world as 180million of this population are pre-school children featured with stunted growth due to chronic

under-nutrition (Torero et al., 2012). This deprivation is not because of insufficient food production (Rosegrant et al., 2012). *Poverty remains the major contributor to this ill* (Ngia eta l, 2013). The vicious cycle of poverty, disease and illness aggravates this situation of malnutrition (Paschal et al., 2013).

The nutritional status of under five children is a sensitive pointer of a country's health status vis a vis the economic condition (Israt and Sekander, 2006). Analyses of a study by the Bangladesh Demographic and Health Survey between 1999-2000 revealed that 45% of the children under age five were suffering from chronic malnutrition, 10.5% were acutely malnutrrished and 48% were underweight (Israt and Sekander, 2006).

Socio-economic inequalities in health manifest in all age groups (Eyob and Diane, 2003). Studies have revealed wide socio-economic differences in rates of morbidity and mortality among children which certainly has an indirect relationship with malnutrition (Eyob and Diane, 2003). The nutritional status of under-five children is one of the indicators of household well-being and one of the determinants of child survival and child malnutrition is one of the most important causes of infant and child mortality (Eyob and Diane, 2003). Malnutrition is an underlying factor in many diseases in both children and adults, and it contributes immensely to the Disability-Adjusted Life Years (DALYs) worldwide (Salah et al., 2006). In sub-Saharan Africa, malnutrition accounts for about 2 percent of deaths and about 3 percent of disability-adjusted life years in under-five children.

Malnutrition may adversely affect the child's intellectual development and consequently, health and productivity in later life (Eyob and Diane, 2003).

Malnutrition is not an isolated problem but caused by a series of complex, multiple and interactive causes (Beaudry, 1999) and therefore must be treated in a broad multi-spectral approach. There is a general consensus today that a complex set of causes determines malnutrition. These complex etiologies have being generally classified into two groups.

They are direct or immediate causes, and indirect or long-term causes.

2.3.1 Direct causes

The *World Food Programme* (WFP) defines malnutrition as "a state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily performance process such as growth, pregnancy, lactation, physical work and resisting and recovering from disease" (Luchuo et al., 2013).

Inadequate and/or inappropriate dietary intake, food insecurity and infectious diseases are the immediate/direct causes (Gugsa, 2000). The primary determinants of malnutrition, as conceptualized by several authors relate to unsatisfactory food intake, severe and incessant infections, or a combination of the two (Salah, 2006). A large part of the underlying causes of malnutrition are related to inadequate childcare practices: breastfeeding, weaning, feeding, hygiene, and health seeking (Luther, 2003).

Poor health service is another direct cause of malnutrition. When it comes to child under nutrition caused by lack of health services, it is the primary health service level that functions insufficiently (UNICEF 2008). The job of the primary health service is to deliver treatment to all children for simple infections as pneumonia, malaria and diarrhea, as well as deliver advice and education to caretakers about care practices. Thereby they could prevent and treat diseases and secure sound child development and avoid the development of child under nutrition (UNICEF 1998).

Number of antenatal care visit a mother has during pregnancy and vaccination status of a child are indicators of contact with health services during infancy and childhood (Gugsa, 2000). Poor environmental conditions may increase infections and also contribute to environmental deficiencies in micronutrients (Yelena et al., 2013). Therefore, effective sanitation and hygiene must be in vogue to subvert malnutrition caused by infections. The direct correlation between personal hygiene, sanitation, clean water and malnutrition is well documented especially in young children (Tharakhan and Suchindran 1999; Golden et al. 2000; Checkley et al. 2004; Fewtrell et al. 2006). Better hygiene decreases the percentage of children with diarrhea and other forms of infections that impair the intake and uptake of nutrients (Fewtrell et *al.* (2006).

Food insecurity is another reason for the lingering direct cause of malnutrition. There are conspicuous distinctions between transitory food insecurity -when the inability to meet food needs is of a temporary nature and chronic food insecurity -the inability to meet food needs on an ongoing basis (Maxwell and Frankenberger, 1992).

Food security is said to exist if at all times, people have a physical and economic access to sufficient, safe and nutritious food that meet their dietary and food preferences, for an active and healthy life (Luchuo et al., 2013). Inverse of this often result to malnutrition. Food availability at the household level is not a major concern, however, prolonged milk and cereals shortage can rapidly deteriorate the nutritional status (ACF), 2014. A household should at all times have enough food immediately available, have the sufficient resources to acquire it and be able to consume it, in order to have an active and healthy life (Smith et al. 2000, FAO, WHO).

2.3.2 Indirect causes

The direct causes have relationship with socio-economic, demographic, child care, and environmental factors which constitutes the indirect causes (Gugsa, 2000). Among the socio-economic variables, household income is one of the germane factors to be considered very imperative in determining children's nutritional status (Gugsa, 2000). However, income does not always have direct contribution to improving the nutritional well-being of children. Lack of knowledge regarding the nutritional needs of children may lead to the withholding of needed food, even when it is available (Gugsa, 2000). Overpopulation, more commonly seen in developing countries, can reduce food adequacy, leading to inadequate food intake or intake of foods of poor nutritional quality and quantity (Yelena et al., 2013).

Inadequate care is often an underlying cause of child undernutrition. Care for children is defined as: “The practices of caregivers that affect nutrient intake, health and cognitive and psychosocial development of the child”(Engle, et al. 1999). Care practices include feeding practices, psychosocial care, care for women, food preparation, hygiene, and home health practices (Engle, et al. 1999).

Political factor is another vital indirect factor that can lead to food shortage. Even if the government has political will to exercise pro-poor policies and somewhat well-functioning institutions, the sectors to go through ere getting to the communities battling under-nutrition often challenge the structures in the line ministries, making coordination and access to information hard to obtain (Gibrill et al. 2004). Weak states also suffer from weak institutional arrangements, and therefore often do not have the capacity to actually govern the state (Buzan, 1991).

Poor environmental conditions may also contribute to environmental deficiencies in micronutrients (Yelena et al., 2013). Therefore, effective sanitation and hygiene must be in vogue to subvert malnutrition caused by infections. The direct correlation between personal hygiene, sanitation, clean

water and malnutrition is well documented especially in young children (Tharakhan and Suchindran 1999; Golden et al. 2000; Checkley et al. 2004; Fewtrell et al. 2006). Better hygiene decreases the percentage of children with diarrhea and other forms of infections that impair the intake and uptake of nutrients (Fewtrell et *al.* (2006).

2.4 Complications of malnutrition in under-five children

Children suffering under-nutrition often come down with these complications:

Kwashiorkor, marasmus, bilateral pitting edema, hypothermia (axillary temp. less than 35 °C or rectal less than 35.5 °C), fever (temp. greater than 39 °C), severe anemia, severe dehydration, extensive skin lesions or infections, jaundice (The Mother et al., 2016). These children could either be very weak or unconscious with convulsion or lethargy. They also have bleeding tendencies (The Mother et al., 2016).

According to Kessler and Daeson, (1999), Protein Energy Malnutrition (PEM) is seen as the leading cause of death in children in developing countries. Though, some of these complications are trailers of Kwashiorkor and/or marasmus. (Noah, 2015). Most often, malnutrition comes with shortage of proteins energy diets. This explains why a good population of children shows signs and symptoms of kwashiorkor and marasmus or a combination of the two-marasmic-kwashiorkor (Noah, 2015).

Other complications are growth failure, delayed motor, cognitive and behavioral development, diminished immune competence and increased morbidity and mortality (Reynaldo, 1999) clinical pneumonia (Igor et al., 2004), diarrhea and malaria (Agozie et al., 2012), reduce adult size and capacity for physical work and in turn, low economic productivity (Samson and Lakech, 1997). Dwarfism also ensue in problems with vitamin A deficiency and anemia (Reynaldo, 1999). Maternal deficiency of vitamin A may, because of the resultant poor fetal storage, predispose the infant to vitamin A deficiency in late infancy and early childhood (Timmer, 1961)

2.4.1 Kwashiorkor

Kwashiorkor is all the sadder especially of the protein related malnutrition, therefore, when a child is weaned, which may be at 12 months in some parts of Africa, and at 24 months or even later in others, (Agozie et al., 2012). He is often a puny creature with hair that is brown instead of black, skin that is paler than it should be, thin arms and legs, and a protruded belly (Agozie et al., 2012). It is not unusual to find that such children, at the age of 18 months, weigh no more than they did at nine months (Yusuf et al., 2014).

Nevertheless, a comparison with children of the same tribe who are known to have been given a well-varied and full diet containing adequate amounts of fresh cow's milk will reveal not merely discrepancies in hair and skin but an extensive degree of "dwarfing"(Agozie et al., 2012). There is little doubt that nutrition is the chief cause; and little doubt, too, that in the majority of cases the deficiency is not in the caloric value of the diet but in its protein (Agozie et al., 2012). The shortage of protein may reduce appetite, so that even if the food offered is adequate to satisfy calorific requirements, the child takes less than he would do if it included more protein (Patwardhan, 1959). The period of poor growth in children who are faultily nourished in the way described lasts until about the fourth year. The acute disease kwashiorkor should perhaps be regarded as the logical extension of the dwarfing (Ellis and Mitchell, 2000).

It occurs in all degrees, of which the slightest, like the dwarfing, have been unsuspected until recent years (Patwardhan, 1959). The children affected are nearly always not only small for their age, with

hair and skin of a pale colour, but also exhibit feet and legs swollen from an accumulation of excess fluid, their appetites are capricious, and they are easily liable to digestive upsets (Patwardhan, 1959). In the most advanced state the hair is so loosely embedded that it can be pulled 21 out in tufts without causing pain; the eyes may be closed with the swelling which occurs in nearly every part of the body, and the skin may break down as though it had been burnt (Patwardhan, 1959). At this stage the child appears to be desperately unhappy or sunk in apathy. The chief cause of kwashiorkor is almost certainly a diet that is lacking in protein (Mark, 2015).

Kwashiorkor may be initiated by:

- excess of starches and sugars over proteins in the diet;
- lack of proteins of high nutritional value;
- the reduction or absence of some other part of the diet that might be protective;
- Infection that increases the need for nutrients beyond the capacity of the diet to supply them.
- There is even the possibility that the state of mind of the child may play some part by translation of unhappiness into a reluctance to eat well. (Mark, 2015).

Once the stage of gross swelling, severe skin lesions and apathy has been reached, kwashiorkor is fatal unless it is skillfully treated, and even where the best care and attention can be given the mortality may be as high as 30% (Fardus Ahmed, 2014). On the other hand the mortality in early cases, where the child can be given a week or two of the correct feeding, is almost negligible. So, infections, especially septicemia or pneumonia, gastroenteritis, tuberculosis, measles and AIDS often precipitate kwashiorkor (Fardus Ahmed, 2014). Sometimes the daily addition to the home diet of a suitable concentrated food, rich in protein, suffices without admission of the child to hospital.

2.4.2 Marasmus

In addition to the many children who suffer from nutritional dwarfing and from kwashiorkor (WHO), many a child also develop marasmus even sometimes more than kwashiorkor, a form of starvation that is less specifically related to a shortage of protein (WHO). It can be caused by almost complete absence of food but, except in times of famine, this is rare (Sims, 1967). Much more frequently it develops when breast-feeding fails for one reason or another, or when the child suffers from some disease that prevents the utilization of the food eaten, or renders the diet inadequate for the maintenance of health (Robinson and Shepherd, 1970). Such a disease is most often one of the type causing diarrhoea, and the greater proportion of the victims are children under a year old (Amy et al., 2000).

In European countries in which marasmus caused by summer diarrhoea used to be a severe problem (Shimeles and Lulseged, 1994), it was noticed that the majority of the children affected had been bottle-fed or inadequately breast-fed, and in Africa and elsewhere there is a fairly close relationship between marasmus and poor breastfeeding (Robinson and Shepherd, 1970). In many countries today, breast-feeding is on the decline and marasmus is increasing (Jelliffe, 1977). The child is given some unsuitable, inadequate and often contaminated concoction, highly-diluted dried or sweetened condensed milk, rice-water, or gruels made of corn-flour, arrowroot or sago, coloured with milk (Sharma et al., 1992). Marasmus also occurs after the first year of life; diarrhoeal diseases are most commonly in the background but respiratory diseases-not only tuberculosis but other infections that have long-lasting effects are also important (Cherry, 2012).. Severe epidemics of the usual childhood diseases, such as whooping-cough and measles, increase its incidence (Cherry, 2012).

Marasmus differs from kwashiorkor in various ways; The marasmic child is wasted, not swollen (Manary and Broadhead, 1998), His hair is dull and dry, but not discoloured (Manary and Broadhead, 1998), the skin is thin and wrinkled and has lost its elasticity, but it does not break down (Manary and Broadhead, 1998). The child does not refuse food and does not show the same resentful apathy as in kwashiorkor (Manary and Broadhead, 1998).The terrible wasting makes the eyes look enormous and staring, and there may be, in some cases, a stiffness in the limbs, due to muscle spasm (Manary and Broadhead, 1998).

Why marasmus develops, rather than kwashiorkor, is not understood but it seems that in kwashiorkor something happens that starts a series of changes in the chemistry of the body-perhaps in the complex process of the constant renewal of proteins that causes the characteristic signs to appear (Stewart, 2010). The child who has marasmus is much likely to be depleted of proteins, and dies chiefly because his diarrhoea and vomiting, or the other causes of his condition, have brought about great losses of body fluids, and such gross wasting of all the tissues, fat, muscles, intestinal walls, etc. that they can no longer perform their various biological functions (Simon, 2014). Only too often marasmic children are brought to hospital in such a moribund state that nothing can be done to save them (Simon, 2014).

2.5 Malnutrition and health in developing countries

Malnutrition continues to be a major public health problem throughout the developing world, particularly in southern Asia and sub-Saharan Africa. (WHO, 2002). Diets in populations there are frequently deficient in macronutrients (protein, carbohydrates and fat, leading to protein–energy malnutrition), micronutrients (electrolytes, minerals and vitamins, leading to specific micronutrient deficiencies) or both (Millward and Jackson, 2004) and (Brabin et al., 2003).

Globally, approximately 33 million children under five years of age are affected by moderate acute malnutrition (MAM), defined as a weight-for-height z-score (WHZ) between -2 and -3, and at least 19 million children under five by severe acute malnutrition (SAM), defined as a WHZ of <-3 (UNICEF et al., 2012). For children with SAM, the risk of death is approximately 10-fold higher compared to children with a z-score ≥ – 1. Based on an analysis by UNICEF, WHO and the World Bank (WHO, 2013), 32 of 134 countries for which there was data on prevalence of acute malnutrition (WHZ <-2) had a prevalence of 10% or more – a threshold that represents a "public health emergency requiring immediate intervention" (UNICEF et al., 2012)

In children, protein–energy malnutrition is defined by measurements that fall below 2 standard deviations under the normal weight for age (underweight), height for age (stunting) and weight for height (wasting) (Pinstrup–Andersen et al. 1993).

Wasting indicates recent weight loss, whereas stunting usually results from chronic weight loss. Of all children under the age of 5 years in developing countries, about 31% are underweight, 38% have stunted growth and 9% show wasting. Protein–energy malnutrition usually manifests early, in children between 6 months and 2 years of age and is associated with early weaning, delayed introduction of complementary foods, a low-protein diet and severe or frequent infections (Stoltzfus RJ et al., 2003).

In emergency settings, this prevalence of acute malnutrition may increase substantially with high levels of severe acute malnutrition and excess child mortality. For instance, global acute malnutrition (GAM) rose to around 40% in Southern Somalia during the famine in 2011, where an estimated 258,000 deaths occurred, over half of which were children (Checchi and Robinson, 2013). Compared

to non-acutely malnourished children, MAM and SAM children have a three and nine times greater risk of dying, respectively (Black et al., 2008). These high risks of mortality are often increased during humanitarian emergencies where their situation is worsened by food shortages, an increased risk of infectious diseases, and a reduction in access to essential services due to conflict and insecurity. As well as this, vulnerable children who are wasted are often stunted (Richard et al., 2012) and these children have an even greater risk of mortality (Khara and Dolan, 2014).

The high prevalence of bacterial and parasitic diseases in developing countries contributes greatly to malnutrition there. (FAOUN, 2004). Similarly, malnutrition increases one's susceptibility to and severity of infections, and is thus a major component of illness and death from disease. (Stoltzfus RJ et al. 2004). Malnutrition is consequently the most important risk factor for the burden of disease in developing countries, it is the direct cause of about 300 000 deaths per year and is indirectly responsible for about half of all deaths in young children (WHO, 2013). A systematic review of 22 studies from developing countries published between 1990 and 2011 highlights a strong link between maternal autonomy and child nutritional status (Carlson et al., 2014). Women with low autonomy often share characteristics that are associated with poor nutrition status in children, e.g. lower maternal age, lower socio-economic status (SES), lower levels of education, and poor nutritional status (especially low BMI, low stature and micronutrient deficiencies) (Sethuraman et al., 2006, Chakraborty and Anderson, 2011, Simon et al., 2002, Ahmed et al., 2014).

Poverty is the main underlying cause of malnutrition and its determinants (FAOUN, 2004). The degree and distribution of protein–energy malnutrition and micronutrient deficiencies in a given population depends on many factors: the political and economic situation, the level of education and sanitation, the season and climate conditions, food production, cultural and religious food customs, breast-feeding habits, prevalence of infectious diseases, the existence and effectiveness of nutrition programs and the availability and quality of health services (Brabin, 2003). The risk of death is directly correlated with the degree of malnutrition (Pinstrup–Andersen et al., 1993).

2.6 Management of acute malnutrition

General food distribution (GFD) is a common food intervention used in humanitarian emergencies. GFD rations usually aim to meet the immediate food needs of the whole population, but may provide inadequate nutritional content to prevent or treat acute malnutrition in children or pregnant and lactating women (PLW). Fortified blended foods (FBF) are often included in the GFD to improve the nutrient intake of vulnerable sub-groups within the general population, but these may still fail to meet their needs (Seal, 2007, Perez-Exposito and Klein, 2009) although recent advances have improved their formulation (de Pee and Bloem, 2009).

There is growing interest on the use of more specialized products like lipid-based nutrient supplements (LNS) instead of FBF within the GFD for children and PLW in emergency settings (Chaparro and Dewey, 2010). However, there is little evidence to suggest that adding LNS to the GDP will result in an improvement in child growth. To date, there is only one published study using this approach. This study found no impact on the incidence of wasting among children 6-36 months old, but observed improvements in haemoglobin status and linear growth, as well as an apparent reduction in morbidity (Huybregts et al., 2012). Evidence also suggests that adding LNS to a GFD greatly increases the cost of the overall intervention (Chaparro and Dewey, 2010, Puett et al., 2013b) and could be less cost-effective (Puett et al. 2013b).

"Lipid-based nutrient supplements" (LNS) refer generically to a range of fortified lipid-based products, including RUTF and highly concentrated supplements such as Nutributter. LNS formulations and doses can be tailored to suit the nutrient needs of specific groups (e.g., children under 2 years of age) and particular programmatic contexts (e.g., preventive or therapeutic programs).

Sustained concerns about the adequacy of GFD rations for vulnerable groups have led to a widespread use of supplementary feeding programmes (SFP) by many humanitarian agencies. SFPs that aim to treat MAM among children aged 6-59 months and PLW are known as targeted supplementary feeding programmes (TSFP), while SFPs that aim to prevent and potentially also treat MAM are known as blanket supplementary feeding programmes (BSFP). For prevention a variety of nutrition products have been used over the years, ranging from FBF such as Corn Soya Blend (CSB) and super cereal, to LNS such as Ready-to-Use-Supplementary Foods (RUSF).

Nonetheless, SFPs have raised concerns and attracted debate. For instance, the efficacy of TSFPs for the treatment of MAM has been questioned in certain contexts (Navarro-Colorado, 2008). Evidence on the effectiveness of available strategies to treat MAM remains inconclusive, however. A recent review assessing the effectiveness of interventions for treating MAM identified five robust studies, all of which compared the effect of treatment with RUSF vs CSB. The review showed that "children in the RUSF group were significantly more likely to recover and less likely to be non-responders than in the CSB group" (Lenters et al., 2013).

Another systematic review that included eight randomized control trials (RCTs) concluded that for treating MAM, provision of LNS produced significant improvements in weight gain compared with CSB. However, the authors also concluded that whilst LNS showed significant nutritional benefits above CSB, there were no differences between the two groups in terms of mortality, progression from MAM to SAM, or defaulting rates (Lazzerini et al., 2013).

Despite the positive evidence on MAM treatment outcomes in some studies, children successfully treated for MAM remain at risk for malnutrition (MAM and SAM) and death in the 12 months after recovery (Chang et al., 2013). There is scant evidence about the longer-term impact on children treated for acute malnutrition although there is a suggestion that "the rapid weight gain associated with the use of energy dense supplements may lead to adult adiposity, obesity, and metabolic syndrome especially in malnourished subjects" (Adair et al., 2013). No studies that measured nutrition outcomes in PLW were found.4.

The treatment of SAM was revolutionized in humanitarian contexts by the introduction of community-based management of acute malnutrition (CMAM), an approach in which the majority of beneficiaries are treated as outpatients and receive nutritional therapy at home in the form of ready to use therapeutic foods (RUTF) (Collins et al., 2006). Despite the success of this new treatment approach and its demonstrated cost-effectiveness5 (Lenters et al., 2013, Puett et al., 2013a, Wilford et al., 2012, Bachmann, 2009, Tekeste et al., 2012), the prevention of undernutrition is still preferable (Ruel et al., 2008) not only to reduce suffering, but also to capitalise on the simultaneous effect it can have on wasting, stunting and micronutrient deficiencies, if implemented effectively. Yet, until prevention of acute malnutrition is 100% effective, treatment of acute malnutrition will be needed alongside preventative interventions and there is a great need for advances in both.

Studies assessing the inclusion of specialised nutrition products in BSFPs to prevent malnutrition (e.g. LNS such as RUTF, RUSF, whey and milk-based spreads) have shown positive results in children (Isanaka et al., 2009, Isanaka et al., 2010, Defourny et al., 2009, Grellety et al., 2012, Ruel et al., 2008) although one systematic review suggested a limited impact (Sguassero et al., 2012). It is acknow-

ledged that prior receipt of a nutrition intervention (Isanaka et al., 2010), as well as other contextual factors, such as changing access to or use of health and social services and improved diets (Neufeld, 2009, Roberfroid et al., 2009) and the age of the children and the duration of their enrolment (Ruel et al., 2008) may all influence study outcomes. None of these studies measured impact on PLW. In addition, two recent programme evaluations and an observational study highlight the practical difficulties of programme implementation, with two of these studies reporting a high incidence of acute malnutrition among programme beneficiaries. These results raise questions about the effectiveness of BSFPs in 'real-life' situations (Oriere, 2010, CDC, 2013, ENN, 2013a).

Whilst the evidence described above illustrates some of the positive impacts of food-based approaches to prevent and treat acute malnutrition in children, there are still critical challenges that need consideration. For instance, common logistical challenges in operationalizing food-based interventions, such as pipeline breaks, can limit the effectiveness of GFDs and SFPs (Chaparro and Dewey, 2010, CDC, 2013, Oriere, 2010, ENN, 2013a). Also, the selling of rations may decrease the efficiency of food-based responses (Jaspars and Young, 1995) and the food-commodities distributed may be unfamiliar and unacceptable to beneficiaries in certain contexts (Violette et al., 2013). The cost effectiveness of food-based approaches have also been recently questioned (Defourny et al., 2009, Isanaka et al., 2009, Hendricks, 2010, Puett et al., 2013a, Oriere, 2010, Hoddinott et al., 2013b); although a recent study has highlighted the costs that can be saved by reformulating RUTFs (Bahwere et al., 2014).

At present there is insufficient evidence of the potential negative effects of the use of specialised nutrition products on body composition and food consumption patterns (Hendricks, 2010). These limitations and concerns highlight the importance of continuing to explore alternative forms of food assistance and the role of non-food interventions, whilst they also illustrate the need to produce robust evidence on the effects of these interventions on acute malnutrition in both children and PLW.

2.6.1 Differences between moderate and severe acute malnutrition and implications for management

The treatment and rehabilitation for moderate and severe acute malnutrition in children differ in important ways, though the weight gain criteria per day are the same. Children who are moderately wasted could be treated with locally available and hygienically prepared fortified rations that meet their nutrition needs; children who are severely wasted but do not have medical complications ideally should be treated with RUTF through an outpatient approach, which can reach more children and can help children recover more quickly; children who are severely wasted with medical complications should be treated in inpatient facilities. The majority of global and regional experiences in the management of wasting focus almost exclusively on the use of RUTF, most recently through Community-Based Management of Acute Malnutrition (CMAM) (Kavita et al., 2014)

In the past, severe wasting was treated with intensive care in inpatient facilities. Specific diets were designed and shown to be effective for each phase of treatment for severe wasting: A therapeutic milk called F-75 (providing 75 kcal per 100 g) was used to stabilize the patients and restore metabolic functions, and then a therapeutic milk called F-100 (providing 100 kcal per 100 g) was used for rapid weight gain in the second phase. A key finding of the early research on formulating the right mix to treat SAM was that a severely malnourished child whose nutrient stores are depleted cannot return to a healthy weight and good nutritional status using home foods alone; they need a specific profile of added micronutrients to help absorb protein, energy, and fat calories (Golden, 2010).

2.6.2 How and why the CMAM approach was endorsed

These initial efforts to treat severely wasted children through inpatient care in facility-based settings achieved high recovery rates but largely have failed to lower the mortality rates associated with wasting, partly because they achieved very poor coverage, reaching relatively few of the children in need (Briend and Collins 2010). This is because in many countries there are few inpatient facilities close enough for families in need to access. In addition, a family member, usually the mother, must accompany the child to inpatient care and stay with the child during treatment, which can take several weeks. To overcome these obstacles, a new community-based management approach for treating SAM on an outpatient basis using a nutrient-dense, lipid-based RUTF has been used over the past 10 years and has dramatically increased coverage rates (Collins 2001).

This new model of community-based care was endorsed by the United Nations in 2005 under the name Community-Based Management of Acute Malnutrition (CMAM) and has been adopted by over 25 national governments and all major relief agencies. This approach also was endorsed in 2007 through the joint statement on the community-based management of severe acute malnutrition (WHO et al., 2007).

2.6.3 Current standards and criteria for CMAM

The core components of CMAM programs are universal and encompass all aspects of inpatient and outpatient treatment, strong community-based sensitization and involvement in screening and referral of children, and activities around prevention and nutrition education. CMAM refers to the management of acute malnutrition through: 1) inpatient care for children with SAM with medical complications and all infants under 6 months old with SAM, 2) outpatient care for children with SAM without medical complications, 3) community outreach, and 4) services or programs for children with MAM that may be provided depending on the context (WHO et al. 2007, WHO and UNICEF 2009). The CMAM framework includes the management of SAM through outpatient and inpatient care, the management of MAM through prevention and treatment, and community outreach that supports both.

2.6.4 Treatment of MAM through targeted supplementary feeding programmes

Children with MAM have nutritional requirements that differ from non-malnourished and severely malnourished children. Their requirements for energy and essential nutrients exceed that of non-malnourished children but are lower than the intake required in outpatient treatment of SAM. Diets for treating moderately malnourished children should have an energy density (when they are ready to be consumed) of no less than 0.8 kcal/g and should support rates of weight gain of at least 5g/kg/day (Golden 2009). The recommended composition for supplementary food products is 20–43g protein per 1,000 kcal and 25–65g of fat per 1,000 kcal (WHO 2012).

Moderate malnutrition traditionally has been and continues to be treated at home by provision of supplementary rations children should consume in addition to the traditional family meals.

Diets based largely on plant sources with few animal-source and fortified foods generally do not meet these requirements. In addition, poverty and food insecurity restrict access to nutritious diets with high protein quality, adequate micronutrient content and bioavailability, macro minerals and essential fatty acids, low anti-nutrient content, and high nutrient density (de Pee and Bloem 2009). Options for supplementary food include: Ready-to-use supplementary foods (RUSF), such as biscuits and pastes, which are similar to the therapeutic foods used for SAM but with a different formula.

Complementary food supplements such as micronutrient powders (MNP) or powdered complementary foods containing micronutrients, protein, amino acids, and/or enzymes, or lipid based nutrient supplements (LNS) which typically contain milk powder, high-quality vegetable oil, peanut paste, sugar, and micronutrients. Fortified blended food (FBF), such as CSB that is meant to be mixed with oil and sugar. For feeding young or malnourished children, FBF with improved formulas exist (e.g., CSB++, which has added milk powder).

The WHO technical note on supplementary foods (2012) provides an ideal formula for supplementary food products but also recognizes the need for further research on the composition, acceptability, and use of supplementary foods for the management of MAM to further validate the efficacy and effectiveness of the recommended formula (WHO 2012):

Results of ongoing and future research trials using the proposed composition of supplementary foods will be drawn on to build the evidence base for the World Health Organization (WHO) evidence-informed guidelines on the benefits and harms of the use of supplementary foods in the management of children with moderate acute malnutrition. Pending further research, supplementary foods used in the management of moderate acute malnutrition should conform to the above principles and the proposed nutrient composition …".

The dietary management of MAM ideally should be based on the optimal use of locally available nutrient-dense foods to improve the nutritional status of children and prevent them from becoming severely acutely malnourished or failing to thrive (Ashworth and Ferguson 2009). Intake of nutrients that are not inadequately supplied by the habitual diet can be increased through a number of approaches, including dietary diversification and fortification of certain staple foods with vitamins and minerals.

Supplementary foods with varying nutrient compositions have been used to treat children with MAM, but their efficacy and effectiveness have been suboptimal (WHO 2012).

Evidence for the effectiveness of different commodities comes mainly from research conducted in African countries. A clinical trial conducted in Malawi showed that locally produced fortified blended flour (Super cereal Plus /CSB++) was not inferior to a ready-to-use product in rates of recovery for children treated for MAM (LaGrone et al. 2011). Other research cited by WFP, as showing strong evidence, for the use of new products include;

- In Malawi, children receiving milk/peanut or soy/peanut based fortified spreads (RUSF) showed significantly higher recovery rates (80 percent) after only 8 weeks of treatment, compared to fortified corn/soy blended flour (72 percent) (Matilsky 2009).
- In Niger, children receiving LNS showed higher weight gain, higher recovery rates (79 percent vs. 64 percent), a shorter length of stay, and lower transfer rates to inpatient care compared to CSB (Nackers, 2010).
- In WFP operations in Ethiopia, children receiving RUSF showed higher recovery rates (73 percent), compared to CSB (67 percent).

As most of the studies have been conducted in emergency settings in Africa, a common concern among policymakers is that the results may not be applicable in a different context. To gather local evidence on the use of locally available products for management of MAM, a number of countries in Asia have initiated research comparing the effectiveness of different approaches. Several studies have been conducted using different approaches to rehabilitate children with moderate malnutrition using local food recipes, complemented with nutrition education or other interventions focusing on infant

and young child feeding (IYCF), but none achieved the target weight gain rate of 5 g/kg/day used as a standard for supplementary feeding products (Golden 2009).

However, a Cochrane Systematic Review by Lazzerini and Pani (2013) pooled data from eight randomized trials, seven studies from Africa and one from Asia (Bangladesh), and found that MAM could be effectively treated by using either fortified CSB flours (CSB ++) or LNS. The authors found that the use of any specialized foods improved the recovery rate by 29 percent, decreased defaulting by 70 percent, and improved WFH, compared to standard care. The authors noted that the most recent formulation of CSB++ appeared to perform as well as LNS and, given the cost of LNS, the cost effectiveness of newly formulated blended foods could be a good alternative to treating MAM at scale.

Of the 11 countries reviewed, two were using a locally produced RUSF (Pakistan, Vietnam), three used imported products (Afghanistan, Cambodia, Sri Lanka), four were producing local FBF used in SFPs for MAM (Bangladesh, Indonesia, Laos, Myanmar), and one was not providing supplementary food (Nepal). In Bangladesh, the supplementary food is used only for children with MAM living in food-insecure areas; food-secure families are encouraged to treat children with family foods (Institute of Public Health Nutrition, 2011).

Of the countries reviewed, only Pakistan had data on the performance of MAM treatment, which showed good results for all indicators except for the average weight gain that was below the expected rate (95.3 percent cured, 4.2 percent defaulted, 0.5 percent non-cured, no deaths, 71.5 length of stay, 1.75 g/kg/day weight gain). In Myanmar, pilot research on management of MAM was conducted in Rakhine State in 2009 by Action Contre la Faim (ACF) France (Salpéteur, 2013), comparing three different supplementary rations provided to children with MAM: a local food ration consisting of rice, beans, sugar, and oil fortified with vitamin A and D; Supplementary Plumpy (RUSF); and Plumpy'Doz (LNS).

2.7 Current intervention strategy and prevention of acute malnutrition

Acute malnutrition is a rapid onset condition characterized by bilateral pitting oedema or sudden weight loss caused by a decrease in food consumption and/or illness. There are different levels of severity of acute malnutrition: moderate acute malnutrition (MAM) and severe acute malnutrition (SAM). Severe acute malnutrition (SAM) is characterized by the presence of bilateral pitting oedema or severe weight loss. A client with SAM is highly vulnerable and has a high mortality risk (UNICEF, 2013).

The Community-Based Management of Acute Malnutrition (CMAM) is one of the approaches used in the management of acute malnutrition. CMAM approach enables community volunteers to identify and initiate treatment for children with acute malnutrition before they become seriously ill. Caregivers provide treatment for the majority of children with severe acute malnutrition in the home using Ready-to-Use-Therapeutic Foods (RUTF) and routine medical care. When necessary, severely malnourished children who have medical complications or lack an appetite are referred to in-patient facilities for more intensive treatment. CMAM are designed to reduce the incidence of malnutrition and improve public health and food security in a sustainable manner. CMAM is a highly effective approach to rehabilitating malnourished children and reducing the rate of mortality among children suffering from acute malnutrition. CMAM are mostly implemented in any area where 10% of children under five are moderately malnourished with the presence of aggravating factors such as generalized

food insecurity, widespread communicable diseases and high crude death rate (UNICEF, 2013). . There are four components of CMAM approach which include:

1. **Community mobilization:**

Building relationship and fostering active participation of the community Identifying and mobilizing community volunteers for CMAM.

Volunteers' measurement of Mid-Upper Arm Circumference (MUAC) of all children under five to identify those with acute malnutrition. (UNICEF, 2013)

2. Supplementary feeding programme (SFP):

To provide take-home food rations and routines basic treatment for families of children with moderate malnutrition but no medical complications.

To provide support for other groups with special nutrient requirements, including pregnant and lactating mothers. (UNICEF, 2013)

3. Outpatient therapeutic programme (OTP):

To provide home-based treatment and rehabilitation using RUTF for children with severe acute malnutrition but no medical complications (usually 80-85% of children).

To monitor children's progress through regular outpatient clinics.

To provide food rations to the whole family of each severely malnourished child.

4. Stabilization centre/inpatient care:

To provide intensive in-patient medical and nutrition care to acutely malnourished children with complications such as anorexia, severe medical issues or severe oedema.

To connect with OTP to allow early discharge and continued treatment in the community (UNICEF, 2013).

The Integrated Management of Acute Malnutrition (IMAM) is also another approach in the management of acute malnutrition. IMAM focuses on the integration of the management of acute malnutrition into the on-going routine health services at all levels of the health infrastructure. It focuses on secondary and tertiary treatment with specific reference to supplementary feeding programmes (SFP) and therapeutic feeding programmes (TFP), collectively described as selective feeding programmes services.

2.7.1 Supplementary feeding programmes

Moderately acute malnourished children are typically treated in SFPs. The aim of SFPs is to reduce the risk of death by restoring nutritional status through provision of foods or rations to supplement the child's home diet. Fortified foods typically distributed in SFPs include corn-soy blends (CSB), wheat soy blends and more recently, Ready to use Supplementary Foods (RUSF). SFPs may be targeted to at risk groups in a population, e.g. all children six to 59 months, or restricted to those children who are moderately acute malnourished. Supplementary feeding has long been a component of emergency food aid interventions, mostly implemented by non-governmental and United Nations agencies to treat moderately malnourished children or to prevent a deterioration of nutrition among at-risk popualtions.17 They are sometimes also implemented in non-emergency contexts where rates of MAM and SAM are found to be unusually high. There are two types of Supplementary Feeding Programme: blanket and targeted supplementary feeding (GNCT, 2012):

Blanket Supplementary Feeding Programmes (BSFP) involves the distribution of supplementary foods to all target vulnerable families in food insecure situations. This approach has been used to

address MAM when prevalence rates exceed 20% (or when it is >15% in the context of aggravating circumstances, such as epidemics). The objective of a BSFP is to prevent widespread malnutrition (or to control its spread) and to reduce excess mortality among those at risk through the provision of food rations and/or micronutrient supplements for vulnerable groups (such as children, pregnant and lactating women, the elderly and chronically ill in the affected areas) (UNHCR/WFP, 2009).

Targeted Supplementary Feeding is implemented in food insecure situations, including in emergencies, in order to treat MAM and to prevent children with MAM from becoming severely malnourished. Targeted Supplementary Feeding is usually indicated when MAM and SAM prevalence rates are between 10-14% or 5-9% with aggravating circumstances. Targeted Supplementary Feeding involves the provision of food supplements for children between 6 months and 5 years, pregnant and lactating women and other individuals with MAM. Targeted SFPs should ideally be run in conjunction with a general food distribution (GFD) (GNCT, 2012).

2.7.2 Therapeutic feeding programmes

Severely acute malnourished children are clinically more compromised and require more intensive medical and nutritional treatment than is possible in SFPs. Such treatment can take place in therapeutic feeding centres, nutrition rehabilitation units or paediatric wards.

2.8 Challenges associated with the management of acute malnutrition in under-five children

2.8.1 Challenges associated with the management of moderate acute malnutrition

Challenges associated with management of moderate acute malnutrition (MAM) include the following:

Low profile and lack of consensus. The key constraint in the management of MAM is the lack of attention that this problem currently receives compared with SAM despite its large global caseload and associated mortality risk. This lack of attention is attributed partly to the fact that the current methods in managing MAM include products with a high unit cost, programmes that often have low coverage, a focus on generalized prevalence rates rather than season-specific incidence rates, and frequent high defaulting. This is coupled with a lack of consensus around programmatic guidance on issues such as definitions, admission and discharge criteria, products to use and treatment protocol, evident from the diverse practices and approaches being implemented(Bhutta, Z.A. et al., 2013).

Focus on products. Approaches to address MAM have tended to focus predominantly on targeted and blanket supplementary feeding, although both approaches have limitations. Both forms of supplementary feeding are product focused and do not always take into consideration the underlying causes of malnutrition, nor do they always pay adequate attention to institutional and system capacity-building or to the training and education needed for professionals as well as for carers of malnourished children. Beneficiaries of these programmes often return to the same conditions which caused them to become malnourished in the first instance, and so are at risk of relapse (Matilsky DK et al., 2013).

Inconsistent definitions in MAM management programmes. A variety of definitions and classifications are still used across different MAM management programmes. For example, some SFPs include underweight (low weight-for-age, WFA) or stunted (low height-forage, HFA), children in MAM programmes, while others use MUAC. This leads to confusion over inclusion and exclusion criteria, and difficulty in evaluating the effectiveness of MAM programmes and associated products. Agreement is still needed on terminology, reporting approaches, monitoring of actual programmatic

use of various entry and exit criteria, and methods used to assess incidence, coverage and effectiveness (De Pee S and Bloem M.W. 2009).

Evidence gaps. Empirical evidence remains scarce in several key areas. First, on the effectiveness of nutrition counseling (separately or combined with products and medical interventions) in both facility and community management of MAM. Nevertheless, most guidance materials continue to recommend counselling within MAM interventions. CMAM was predicated on empowerment of mothers in the process of treatment, requiring high quality and intensive behavior change communication as part of any intervention. Research is required to generate appropriate evidence of best practice within such approaches. Second, cost-effectiveness remains poorly documented for most interventions and contexts. Third, comparing products appropriately (using study designs that allow for iso-caloric and iso-nutrient density comparisons, with comparable packaging, programming and promotion) remains the exception rather than the rule.

More care is required in drawing conclusions from studies that claim to be comparing a variety of foods, when their delivery, dosage and associated Behavior Change Communication (BCC) are all different. Fourth, most large-scale, empirically valid studies on MAM derive from only a few countries, mostly in Africa. A wider variety of settings and contexts should be explored. Fifth evidence on sharing of products remains at the anecdotal level. Evidence is needed on how products are actually used within community interventions, and how this affects measured outcomes (Reginald A.A. et al., 2014).

Limited understanding of nutrient requirements for MAM. Nutrient requirements for children with MAM, living in unhealthy, insanitary and often insecure environments, are still being defined, building on the WHO guidelines proposed in 2009. Discussions on food formulations, dosages (supplement size in relation to overall diet), and alternatives to nutrient deliveries (small dose lipids, micronutrient powders, etc.) continue. Further research is needed to define the effectiveness and cost-effectiveness not of individual products, but of a variety of interventions that have clearly-defined goals in terms of nutrients delivered and outcomes expected. There is a need to better understand the nature of weight gain (fat and lean mass accretion) associated with treatment for MAM with different products, and further work is expected on the optimal content of poly-unsaturated fatty acids (PUFA). The effects of different levels of fibre intake in children with MAM also need to be studied; this is important in ensuring that nutrients can be properly digested and absorbed (Michaelsen K.F. et al., 2014).

Gaps in consensus around MAM management protocols. There are a number of areas where there is a lack of consensus on MAM management protocols, as well as some questions around the management of MAM in specific population groups (Reginald A.A. et al., 2014).

Lack of provision of basic medical treatment. MAM management programmes do not always include provision of basic medical treatment and children who are referred for primary health care services may need to travel long distances to access treatment and therefore are likely to be lost to follow-up. This absence of essential attendant care can compromise effective MAM management in the long-run. Institutional and professional capacity-building are essential, and the integration of MAM within national systems and protocols is essential (Reginald A.A. et al., 2014)..

Constraints in monitoring and reporting of MAM management data. A major challenge is how MAM treatment information is aggregated and analysed at a central level. As MAM management is often implemented by NGOs, these programmes are not always linked to formal health information systems, and therefore data relating to MAM admissions and treatment is not recorded or analysed at

a level where decision-making for programme and policy formulation takes place (Reginald A.A. et al., 2014)..

2.8.2 Challenges associated with the management of severe acute malnutrition

Policy level. SAM not always recognized as problem (not identified in surveillance systems) – requires identification of the problem and advocacy. Uncertainty on the global burden of SAM: Calculation of incidence not measured in surveys and fluctuating prevalence. Lack of consensus on associated mortality especially in the Asian context: Gap in cost effectiveness data for advocacy, reluctance on use of imported foods and Criticism that treatment takes focus from prevention.

Programming challenges:

- Capacity of health systems to take on treatment of SAM in terms of staffing, logistics, monitoring and supervision requires that a more holistic systems strengthening approach be taken.
- Focus on product rather than programme leading to poor quality implementation due insufficient attention to training and the above.
- Difficulties in evolving from a new treatment approach to one which forges links and reinforces wider preventative interventions.
- Integration of training in the approach into national and international health worker training curricula.
- Monitoring of progress on reaching children with SAM (numbers admitted, effectiveness of treatment and coverage). Challenges of monitoring many sites compared to few hospitals and multiple implementers.
- New simpler coverage monitoring methods yet to be integrated into national programmes.
- Increase in numbers with the adoption of new WHO growth standards. (Reginald A.A. et al., 2014).

Supplies and logistics challenges:

- Maintaining supply chain in a decentralized programme is more challenging than previously supplying hospitals for inpatient care.
- Poor communications, transport challenges and stock control systems leading to stock outs at clinic level.
- Expansion of local production, maintaining quality, Surges in requirements leading to lack of global Supply.
- No consolidated view of funds to programming (divided within UNICEF budget codes and with NGOs, government etc.).
- Difficult to analyse what spent for results.
- Unpredictable funding – large proportion still from emergency budgets doesn't allow for multiyear planning.
- Tension between prevention and treatment competing for resources. (Reginald A.A. et al., 2014).

2.9 Global acute malnutrition in under-five children in South Sudan

South Sudan is a country where a brutal civil war has displaced millions of people, destroyed basic services, increased disease and exacerbated hunger and this has made malnutrition a chronic problem in South Sudan. According to World Food Programme (WFP, 2015) report, "every two minutes in South Sudan, another child becomes severely malnourished hence rates of Global Acute

Malnutrition (GAM) are alarmingly high in the country. The scourge is well above the emergency threshold of 15 percent in most parts of the country, especially in the Greater Upper Nile States, Warrap and Northern Bahr el Ghazal and about a quarter of a million children have been reported to be severely malnourished (WFP, 2015); a recent report by the United Nations Children's Fund (UNICEF) (Voice of America (VOA), 2016) specifically submitted that seven out of the 10 states in South Sudan have reached the emergency threshold of 15 percent global acute malnutrition, while in Northern Bar el Ghazal the malnutrition rate is 33 percent. Tens of thousands of South Sudanese children under the age of five have remained at the risk of malnutrition-related death in spite of temporary improvements in the food security situation as reported by the Integrated Food Security Phase Classification (IPC) group of experts (UNICEF, 2014).

Unfortunately, high rates of disease, lack of safe water and lack of access to basic health care have actually hampered efforts being made to reduce malnutrition among under-five children through improvements in food security (UNICEF 2014). Diarrhoea and other illnesses prevent children from absorbing nutrients, so even in places where there is improved access to food; children can still be dangerously malnourished and those in conflict-affected areas, especially the 1.4 million people who are internally displaced – more than half of whom are children – are the most at risk (UNICEF, 2014). Malnutrition rates for children in South Sudan were reported to be at critical or serious levels in most parts of the country. In some areas where large numbers of people displaced by the conflict have gathered, the rates of acute malnutrition for children are over 30 per cent; this is more than double officially recognized emergency levels.

2.10 Organizations and actions involved in the management of acute malnutrition in South Sudan

The World Food Programme (WFP) and the United Nations Children's Fund (UNICEF) are intensifying their efforts to reverse the scourge of malnutrition in South Sudan. UNICEF and WFP have launched an enhanced joint nutrition response plan, in which it is expected that both agencies and their partners will assist over two million people – children, pregnant women and new mothers – for the treatment and prevention of acute malnutrition in the country until May 2017. The two agencies began the joint nutrition approach in 2013, and have embarked on their lifesaving work for two years.

A report by a representative of UNICEF (UNICEF, 2014) indicated that the renewed joint strategy by both agencies in one year has helped to avert famine and save lives by reaching one million people across the country through innovative methods, including joint rapid response teams in the conflict-affected states and ramping up the response in non-conflict states. The joint nutrition response plan covered all states in South Sudan and engaged more local and government partners, and improve their capacity to treat malnutrition. The nutrition response plan is also targeted at addressing the root causes of malnutrition, such as poverty, adequate water and sanitation, and infant and young child feeding practices. Malnutrition in South Sudan is a very serious chronic problem as well as the current acute emergency; hence these agencies are focusing on prevention in order to deliver quality life-saving management of acute malnutrition to ensure the health of the next generation.

United Nations Children's Fund (UNICEF) promotes the rights and wellbeing of every child; together with their partners they work in 190 countries and territories to translate their commitment into practical action, focusing special effort on reaching the most vulnerable and excluded children, to the benefit of all children, everywhere. World Food Programme (WFP) on the other hand is the world's largest humanitarian agency fighting hunger worldwide, delivering food assistance in emergencies

and working with communities to improve nutrition and build resilience. Each year, WFP assists some 80 million people in around 80 countries.

These agencies' lifesaving nutrition programme in South Sudan is funded by donors including the European Commission, Japan, Norway, Switzerland, the United Kingdom, and the United States (UNICEF, 2014). Evidence abounds in magazines and other media on the efforts of the aforementioned international organizations at reducing the scourge of malnutrition in South Sudan; however, there have been acute scarcity of published empirical studies on the impact of these agencies' intervention on the nutritional status of under-five children in the nation, hence the need for this study.

3 Materials and methods

3.1 General outline

This study was carried out in three counties (Cueibet, Yirol West and Rumbek North) where there are health facilities offering nutrition therapy programme for the under-five children who are diagnosed of having Severe Acute Malnutrition (SAM) or Moderate Acute Malnutrition (MAM). They included all the Primary Health Care Centres (PHCC) and Primary Health Care Units (PHCUs) present in all the three counties, where these essential services are being rendered. This study aimed at determining the level of impact of the nutrition therapy programme on the global acute malnutrition in these three counties.

3.2 Study area

Western Lakes State was one of the ten states of south Sudan. It has an area of 40,235 km^2. Rumbek was the capital of the state. Lakes State was in the Bahr el Ghazal region of South Sudan, in addition to Northern Bahr el Ghazal, Western Bahr el Ghazal, and Warrap states. Bahr el Ghazal itself was a former province which was split from the Anglo-Egyptian or province of Equatoria, in 1948. The eastern border was the White Nile with Jonglei on the opposite bank. To the northeast lied the Unity State. Other borders included Warrap State towards the northwest, Western Equatoria to the south and west, and Central Equatoria to the south.

According to the population census conducted in 2008, Lakes state comprises of eight (8) counties, with their respective population thus; Cueibet (47,041), Rumbek North (43,410), Rumbek Central (153,550), Wulu (40,550), Rumbek East (122,832), Yirol West (103,190), Yirol East (67,402), Awerial (47,041). This study was conducted in the three of the eight counties namely; Cueibet, Rumbek North and Yirol West.

3.3 Study population

The two study populations were the under-five children with either SAM or MAM, diagnosed by measuring Middle Upper Arm Circumference (MUAC) using MUAC tape, and the mothers/caregivers of under-five children with SAM or MAM, whose children are undergoing nutrition therapy services in the three counties.

3.4 Study design

This study is a combination of retrospective cohort study and cross sectional survey study.

3.5 Inclusion criteria

Only children diagnosed of either SAM or MAM, as reported in the District Health Information software (DHIS), were included in the retrospective cohort study, while only participants who gave written consent was included in the cross sectional survey study. Those who were not able to read or write but were willing to participate were assisted by the volunteers, who read and interpreted the information on the consent form to them and signed as a witness.

3.6 Exclusion criteria

Children diagnosed of other ailments apart from SAM or MAM, and participants who were not willing to give their written consent were excluded.

3.7 Sampling technique

With respect to the retrospective cohort study, each category of Severe Acute Malnourished (SAM) and Moderate Acute Malnourished (MAM) in under-five children who have been previously screened and enrolled into the nutrition therapy program was recruited, as reported in the District Health Information software (DHIS) across the three years 2014, 2015 and 2016. In the cross sectional survey study, the number of mothers/caregivers served with questionnaires was selected through simple random sampling,.

3.8 Sample size

In order to have a large representation for the retrospective cohort study, each of Severe Acute Malnutrition (SAM) and the Moderate Acute Malnutrition (MAM) under-five children, registered in the program and as reported in the DHIS, was recruited into the study.

The minimum sample size for the number of mothers/caregivers who were interviewed was calculated using the formula of Kish (1965) for descriptive studies:

$$N = \frac{P(1-P)Z^2}{D^2} \tag{1}$$

where N is the minimum sample size needed, D is the level of error that can be tolerated (0.05), P is the estimated prevalence rate (0.2) of mothers with malnourished children, and Z is the standard variate corresponding to the confidence level (1.96 at the 95% confidence level). Hence:

$$N = \frac{0.2(1-0.2)\times 1.96^2}{0.05^2} \approx 246 \tag{2}$$

To allow for a non-response rate of 10% (25 respondents), the sample size was increased by 25 to make 271 respondents. The sample size was consistent and realizable when compared with the target population.

3.9 Data management

3.9.1 Method of data collection

Data was obtained from the District Health Information Software (DHIS) of south Sudan, for the retrospective cohort study, and through administering a structured questionnaire on the mothers/caregivers for the cross sectional survey study, after a due pilot study was conducted with it, and appraised by qualified researchers. The questionnaire comprised of three sections. Section A was on

socio-demographic data, section B was on feeding practice and section C was on the perception of mothers/caregivers. Each of section B and C comprised of ten questions, with responses as 'Yes' or 'No'. Three research assistants-one from each county, were trained on how to administer the questionnaire, and were fully involved in the data collection process.

3.9.2 Tool for data collection

A structured questionnaire for the mothers/caregivers was used to assess their feeding practice and perception.

3.9.3 Data screening

The collated DHIS data and questionnaires were screened for completion.

3.9.4 Data analysis

Data analysis was done using the Statistical package for Social Science (SPSS) version 21. For data obtained from DHIS, Friedman Analysis Of Variance (ANOVA) was used to compare SAM and MAM Middle Upper Arm circumference (MUAC) values of under-five Children across the three years in each of the three counties, while Wilcoxon Signed Rank Test was used as post hoc analysis for Friedman ANOVA comparison of MUAC values for SAM and MAM across the three years. Kruskal Wallis was used to test for comparison of under-five children MUAC values for SAM and MAM across the three counties (in general), while Mann–Whitney U Test was used as the post hoc analysis for Kruskal Wallis of MUAC values for SAM and MAM of under-five children across the three counties in the three years- 2015, 2016 and 2017.

Data obtained through questionnaire were analyzed using descriptive statistics of frequencies, percentages, and pie charts. Inferential statistics of Chi-square was used to test for significant associations between socio-demographic variables and the feeding practices of the mothers/caregivers, and their perception on the efficacy of the nutrition therapy programme across the three counties, in general. Respondents answered "Yes" or "No" to questions on feeding practice and perception towards the nutrition therapy programme. Each right response was scored 1, while each wrong response was scored 0. Summated scores were used to arrive at each respondent's feeding practice and perception, with a possible score range of 0 to 10. Higher scores indicate higher level of good feeding practice or perception, with score of 10 as the highest score for good feeding practice or perspective. Statistical level of significance was set at P-value <0.05.

3.10 Ethical considerations

An approval to conduct the study was obtained from Health Research Ethics Committee of the State Ministry of Health (SMoH) of Lakes state in south Sudan, with endorsement of the Director General of the ministry.

3.11 Limitations of the study

Although this study was carefully conducted to achieve its objectives, there are certain limitations that affected the study.

1. The time for application of the questionnaires was originally planned to be for two months, but the time was extended to three months to accommodate adequate number of participants to participate so as to have good representation of the majority of the intending participants.

2. The protocol of getting ethical approval was too cumbersome in State Ministry of Health (SMoH) which also caused delay in application of questionnaires.
3. Difficulty in getting volunteers in some remote health facilities, hence posing some constraint in the data collection process.

4 Results

The results of the comparison of SAM and MAM values across the three years in each county are given in Tables 1-4.

Table 1. Friedman ANOVA comparison of SAM middle upper arm circumference of under-five children across 2015, 2016 and 2017 in each of the three counties.

County	2015, Median (MUAC)	2016, Median (MUAC)	2017, Median (MUAC)	Chi-square	*p*-value
Cueibet	134.00	315.00	200.00	5.167	0.076
Rumbek North	18.00	27.00	51.00	8.167	0.017*
Yirol West	45.00	71.50	243.50	0.500	0.779

*Significant at $\alpha = 0.05$.

Table 1 revealed a significant difference in SAM MUAC values in Rumbek North County only, across the three years. It also showed rising median values across the three years in the three counties.

Table 2. Wilcoxon signed rank test post hoc analysis for the Friedman ANOVA comparison of SAM MUAC across 2015, 2016 and 2017 in Rumbek North.

Time period	Chi-square	*p*-value
2015 vs 2016	0.863	0.388
2015 vs 2017	2.511	0.012*
2016 vs 2017	1.490	0.136

*Significant at $\alpha = 0.05$.

Table 2 revealed that the significant difference in SAM MUAC values in Rumbek North is between 2015 and 2017.

Table 3. Friedman ANOVA comparison of MAM middle upper arm circumference of under-five children across 2015, 2016 and 2017 in each of the three counties.

County	2015, Median (MUAC)	2016, Median (MUAC)	2017, Median (MUAC)	Chi-square	*p*-value
Cueibet	67.50	409.50	344.50	10.50	0.005*
Rumbek North	43.50	70.00	103.00	6.50	0.039*
Yirol West	72.50	143.50	654.50	17.167	<0.001*

*Significant at $\alpha = 0.05$.

Table 3 showed significant differences in MAM MUAC values in each of the three counties across the three years. It also showed rising median values in Rumbek North and Yirol West across the three years.

Table 4. Wilcoxon signed rank test post hoc analysis for the Friedman ANOVA comparison of MAM MUAC across 2015, 2016 and 2017.

County/time period	Chi-square	*p*-value
Cueibet		
2015 vs 2016	1.465	0.075
2015 vs 2017	2.353	0.019*
2016 vs 2017	−0.157	0.875
Rumbek North		
2015 vs 2016	1.569	0.117
2015 vs 2017	2.589	0.010*
2016 vs 2017	1.020	0.308
Yirol West		
2015 vs 2016	1.726	0.084
2015 vs 2017	3.059	0.002*
2016 vs 2017	2.981	0.003*

*Significant at $\alpha = 0.05$.

Table 4 revealed that the significant difference in MAM MUAC values across the three years in Cueibet is between 2016 and 2017, in Rumbek North between 2015 and 2017, and in Yirol West both between 2015 and 2017 and between 2016 and 2017.

The comparison of SAM and MAM values among the three counties is given in Tables 5 and 6.

Table 5. Kruskal–Wallis test comparison of SAM and MAM MUAC of under-five children across the three counties.

Malnutrition type/ year	Cueibet (n = 36), median	Rumbek North (n = 36), median	Yirol West (n = 36), median	*H*	*p*-value
SAM 2015	134.00	18.00	45.00	12.933	0.002*
SAM 2016	315.00	27.00	71.00	25.891	0.001*
SAM 2017	200.00	51.00	243.50	19.344	0.001*
MAM 2015	67.50	43.50	72.50	3.090	0.213
MAM 2016	409.50	70.00	143.00	20.701	0.001*
MAM 2017	344.50	103.00	654.50	16.740	0.001*

*Significant at $\alpha = 0.05$.

Table 5 showed significant differences in SAM MUAC values among the three counties in each of the three years (2015, 2016 and 2017). It also showed significant differences in MAM MUAC values among the three counties in 2016 and 2017.

Table 6. Mann–Whitney U test post hoc analysis of SAM and MAM MUAC of under-five children across the three counties in 2015, 2016 and 2017.

Counties compared	*Z* score	*p*-value
SAM 2015		
Cueibet vs Rumbek North	−2.890	0.004*
Cueibet vs Yirol West	−1.559	0.119
Rumbek North vs Yirol West	−3.062	0.002*
SAM 2016		
Cueibet vs Rumbek North	−4.158	<0.001*
Cueibet vs Yirol West	−4.042	<0.001*
Rumbek North vs Yirol West	−2.599	0.009*
SAM 2017		
Cueibet vs Rumbek North	−3.984	<0.001*
Cueibet vs Yirol West	−0.404	0.686
Rumbek North vs Yirol West	−3.580	<0.001*
MAM 2016		
Cueibet vs Rumbek North	−3.811	<0.001*
Cueibet vs Yirol West	−3.522	<0.001*
Rumbek North vs Yirol West	−2.225	0.026*
MAM 2017		
Cueibet vs Rumbek North	−2.656	0.008*
Cueibet vs Yirol West	−2.367	0.018*
Rumbek North vs Yirol West	−3.580	<0.001*

*Significant at $\alpha = 0.05$.

Table 6 revealed significant differences in SAM MUAC in under-five children between all three pairs of counties (Cueibet vs Rumbek North, Cueibet vs Yirol West, and Rumbek North vs Yirol West) in the three years, except between Cueibet and Yirol West in 2015 and 2017. It also showed significant differences in MAM MUAC between all three pairs of counties in 2016 and 2017.

The socio-demographic characteristics of the mothers/caregivers are given in Table 7.

Table 7. Socio-demographic characteristics of the mothers/caregivers in the three counties.

Variable	Cueibet, n	Cueibet, %	Yirol West, n	Yirol West, %	Rumbek North, n	Rumbek North, %
Age (years)						
21–30	35	43.00	36	41.90	60	60.00
31–40	33	40.00	37	53.00	27	27.00
41–50	14	17.00	13	15.10	13	13.70
Total	82	100	86	100	100	100

Variable	Cueibet, n	Cueibet, %	Yirol West, n	Yirol West, %	Rumbek North, n	Rumbek North, %
Marital status						
Married	55	67.00	58	67.40	93	93.00
Separated	10	12.00	15	17.40	3	3.00
Divorced	8	10.00	6	7.80	2	2.00
Widowed	9	11.00	7	8.10	2	2.00
Total	82	100	86	100	100	100
Level of education						
None	53	65.00	55	64.00	73	73.70
Primary	25	30.00	25	29.10	18	18.20
Secondary	4	5.00	6	7.00	9	8.10
Total	82	100	86	100	100	100
Religion						
Christian	80	98.00	86	100	100	100
Others	2	2.00	0	0	0	0
Total	82	100	86	100	100	100
Ethnic group						
Dinka	73	89.00	81	94.20	100	100
Nuer	9	11.00	5	5.80	0	0
Total	82	100	86	100	100	100

Table 7 shows the characteristics of the respondents to the cross-sectional survey: 82 from Cueibet, 86 from Yirol West and 100 from Rumbek North.

Table 8. Chi-square test of association between socio-demographic variables and the feeding practice of mothers/caregivers in the three counties.

Variable	χ^2 value	df	*p*-value
Age	1.817	2	0.403
Marital status	14.024	3	0.003*
Level of education	1.080	2	0.583
Religion	0.281	1	0.596
Ethnic group	2.393	1	0.122

*Significant association at $\alpha = 0.05$.

Table 8 shows a significant association between the feeding practice of the mothers and their marital status.

Table 9. Chi-square test of association between socio-demographic variables and the perception of mothers/caregivers of the nutrition therapy programme in the three counties.

Variable	χ^2 value	df	*p*-value
Age	2.535	2	0.282
Marital status	1.157	3	0.763
Level of education	12.877	2	0.002*
Religion	0.143	1	0.705
Ethnic group	2.953	1	0.086

*Significant association at $\alpha = 0.05$.

Table 9 shows a significant association between the perception of the mothers of the nutrition therapy programme and their level of education. The feeding practices and perceptions of the mothers/caregivers in the three counties are shown in Figure 1.

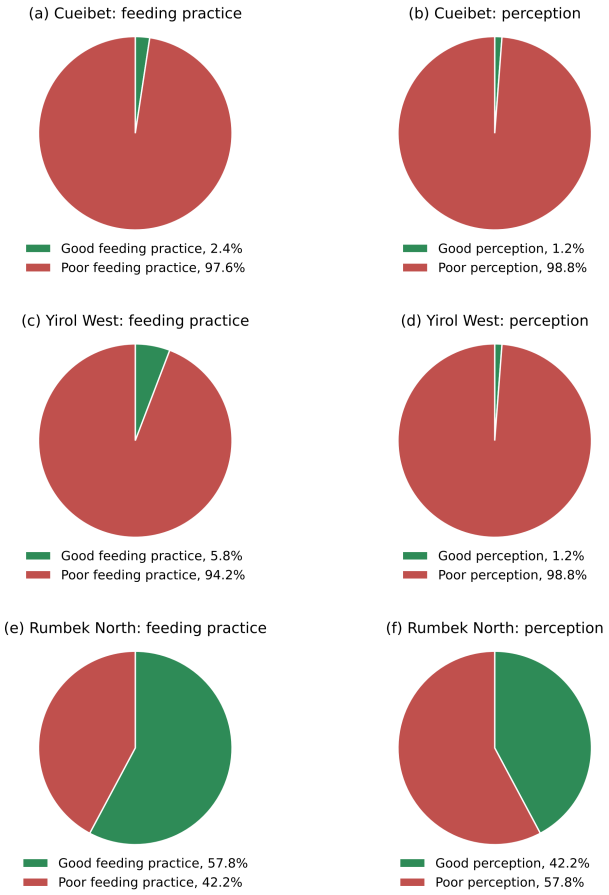


Figure 1. Feeding practices and perceptions of mothers/caregivers: (a) feeding practice, Cueibet; (b) perception, Cueibet; (c) feeding practice, Yirol West; (d) perception, Yirol West; (e) feeding practice, Rumbek North; (f) perception, Rumbek North.

5 Discussion

5.1 Impact of the nutrition therapy programme within each county

This study aimed to determine the impact of nutrition therapy programme on the global acute malnutrition (SAM and MAM) in three counties of war-torn Lakes State of south Sudan. In the results, and considering each county, there was a significant difference in SAM MUAC values of Rumbek North County only, across the three years 2015, 2016 and 2017. . It was also discovered that, there was a rising median values of SAM MUAC across the three years in the three counties The post-hoc analysis further reveal that the significant difference of SAM MUAC values in Rumbek North was between the 2015 and 2017.

The possible reasons for these significant differences, in conjunction with rising median values of SAM cases (poor outcome) across the three counties, were as suggested by the report of a similar study (Mwanza et al., 2016) on the outcome of the Outpatient Therapeutic Program (OTP), which is the nutrition therapy programme for SAM cases of under-five children, in three districts of eastern province in Zambia. These include; dependence on donor-funds, consistent stock outs of ready-to-use therapeutic food and other supplies, high volunteer dropout, and inadequate monitoring and feedback on defaulters, all of which are applicable in the three counties under this study.

Taking the MAM MUAC values into consideration, the result revealed significant differences in each of the three counties across the three years. It also showed a rising median values of MAM MUAC (poor outcome) in Rumbek North and Yirol west across the three years. The result of the post-hoc analysis further revealed that, the significant difference in MAM MUAC values, across the three years, in Cueibet and Rumbek North is between 2015 and 2017, while in Yirol west are both between 2015 and 2017, and 2016 and 2017. This may be attributed to possible reasons, as suggested by Neitzel (2011) in a study conducted in five regions in Ethiopia (Tigray, Afar, Amhara, Oromia and SNNPR), to determine the impact of Targetted Supplemetary Feeding Programme (TSFP), which is the therapeutic program for MAM cases in under-five children, across five years, 2007-2011. The study suggested large proportion of children enrolled were not acutely malnourished, poor compliance, which is food sharing among other non-malnourished children, and increased food insecurity during the follow-up, all of which are closely applicable in the context of this study, as possible reasons.

5.2 Impact of the nutrition therapy programme among the three counties

Considering the relationship among the three counties, this study results showed that, there are significant differences in SAM MUAC values, among the three counties, across the three years-2015, 2016 and 2017. It also showed significant differences in MAM MUAC values, among the three counties in 2016 and 2017. The post-hoc analysis further revealed that, the existing significant differences of SAM MUAC values in under-five children, are among the three possible combinations of the three counties (Cueibet vs Rumbek North, Cueibet vs Yirol West, and Rumbek North vs. Yirol West) across three years except in 2015 SAM MUAC and 2017 SAM MUAC between Cueibet and Yirol West.

The results of this study also showed significant differences in MAM MUAC among the three possible combinations of the counties, across 2016 and 2017. The significant differences in SAM MUAC values among the three counties, in the three possible combinations, across the three years, and MAM MUAC values among the three possible combinations, among the three counties, across 2016 and 2017, may not be unconnected with the fact that, each county do not get supplies of the food supplements in the same simultaneous periods and that the differences in the distances, in conjunction with variations in

the non-pliability of the roads to each county, for food supplement distribution, may be responsible reasons. Additional factors like the variations in diagnosis according to standard by the Community Nutrition Volunteers (CNVs) and Community Health Workers (CHWs) in each county using MUAC tapes, and political sentiments in health policy implementation as it relates to nutrition therapy programme, may also be responsible for these significant differences.

5.3 Feeding practice and perceptions of mothers/caregivers across the three counties

Three hundred (300) questionnaires were administered while two hundred and sixty eight (268) mothers/caregivers (Cueibet-82, Yirol West-86, Rumbek North-100) fully responded during the collection of data through questionnaire, giving 89% response rate. The results showed that 80 (98%) and 81 (94%) of mothers/caregivers have varying degrees of poor feeding practices, while 81(99%) and 85(99%) have varying degrees of poor perceptions about the nutrition therapy programme in Cueibet and Yirol West counties respectively. In Rumbek North county, 58 (58%) of the mothers/caregivers have good feeding practices but more than 58% of them also have varying degrees of poor perception about the nutrition therapy programme.

The results from Cueibet and Yirol West counties are not in agreement with Neitzel (2011) who reported a large proportion (over 90%) of the beneficiary mothers having appropriates child feeding practices and perception, in a study conducted in five regions in Ethiopia (Tigray, Afar, Amhara, Oromia and SNNPR) where nutrition therapy programme was being implemented, in which the study population have been well exposed to different education and community orientation about the nutrition therapy, even before the commencement of the programme. The duration of the intervention program (2007-2011) in the study areas in Ethiopia is also considerably higher than the counties under consideration in this present study. These might have positive effects on the outcome of the study conducted in those regions of Ethiopia, unlike those of the three counties, in this study.

The possible reason for a slightly better feeding practice in Rumbek North may be associated with a more intensified and frequent health education sessions on nutrition program for under-five children, carried out at the nutrition therapy centres, than in Cueibet and Yirol West counties. In the same vein, the high percentage of poor perception about the program, most especially in Cueibet and Yirol West counties may be due to the haphazard nature of nutrition supplement supplies to the two counties, probably inconsistent in nature, hence causing high number of days of unavailability of food supplements for the malnourished children at the nutrition therapy health centers. This factor may serve as a source of negative feeling for the mothers/caregivers about the whole nutrition intervention programme.

5.4 Associations of socio-demographic variables with feeding practice and perceptions of mothers/caregivers

Chi-square test in this study revealed significant association between the marital status and feeding practice of all the mothers/caregivers across the three counties, and there is significant association between their level of education and the mothers'/caregivers' perception on the nutrition therapy programme, across the three counties. This is in agreement with the report of a similar study of Abuya et al. (2012) in Nairobi which reported marital status of mothers, as a strong determinant of nutritional status of under-five children, but do not agree with the result of the same study which reported mothers' educational status to be significantly associated with the feeding practice and nutritional status of the under-five children, as the level of education of mothers/caregivers has no significant association with the feeding practice in this study. The significant association of the

marital status and the feeding practice of all the mothers in the three counties (put together) may be due to the fact that most of the women in south Sudan, and especially in these war-torn counties, have lost their husbands to death during wars, or the nomadic (pastoral) nature of their husbands' occupation, which keeps them away from home for a long time. The significant association of mothers' level of education and perception on the nutrition programme is in agreement with a close related study of Khunga et al. (2014) conducted in Kanchele, Kalomo district, in Zambia which reported that mothers' and caregivers' education is directly linked to the perception of mothers and caregivers regarding the detection and treatment of malnourished children in the study area.

The significant association between the level of education and the perception of the mothers/caregivers about the nutrition therapy programme in this study, is quite obvious, because many women in the three counties are either uneducated in its entirety, or receive half-baked education. This can be attested to, during the administration of the questionnaire in which the content of the document was interpreted to many mothers/caregivers in the local language before responses were given.

6 Conclusion

It is not a doubt that humanitarian services rendered towards reducing the spate of global acute malnutrition among under-five children, in south Sudan, is very essential, as a consequence of the high prevalence of acute malnutrition among this vulnerable group. It is also not contestable that these interventions should continue, in this 'baby nation' of the world.

However, this study has shown that, despite the various interventions of international organizations, like United Nations Children Fund (UNICEF) as the major donor for OTP programme for SAM cases, and World Food Programme (WFP) as the major donor for TSFP programme, for MAM cases, in south Sudan, with the duo working in collaboration with other International Non-governmental Organizations (INGOs), to implement nutrition therapy programme, the impact of the nutritional therapy programme in the three counties, in Lakes State of south Sudan, as revealed in this study, is still at abysmal level.

Complete overhaul of the programme, including intensive health education of mothers/caregivers, training and re-training of CNVs and CHWs, timely availability of food supplements, enactment of every possible policy to ensure food security, unwavering adherence to the principle of neutrality and impartiality on the part of INGOs and government, and conduct of pre and post-intervention surveys coupled with any other useful approaches may serve as the panacea towards the present state of the nutrition therapy programme in the war-torn Lakes State of south Sudan.

7 Contribution to the body of knowledge

The outcome of this study has revealed the degree (in a retrogressive manner) of impact of the nutrition therapy program on the Global Acute Malnutrition in the three counties of Lakes State of south Sudan, within three years-2015, 2016 and 2017. It also revealed the poor state of feeding practice of food supplements by the mothers/caregivers to their malnourished under-five children. Furthermore, this study has also determined the predictors of appropriate practices of mothers/caregivers towards feeding the under-five children with the food supplements, and their perception towards the efficacy of the nutrition therapy program on their under-five children.

It is an indisputable fact that under-five children are easily exposed to various preventable health conditions depending on the various implicating factors. These, among others, include; parental social and economic status, education, race, ethnicity, cultural beliefs and other associated factors. Malnutrition in under-five children can result in many complications, including low Intelligent Quotient, easy exposure to opportunistic infections, severe wasting and even death.

The contribution of this study to the body of knowledge, is associated with the implication of increasing global acute malnutrition, in any population, even in the face of interventions, which connotes a poorly developing society, and a poorly implemented nutrition therapy programme, because a well nourished population (especially under-five children) will be a healthy population. This has therefore exposed the need for every stakeholder who is involved in the intervention programmes related to nutrition, to have a paradigm shift towards the planning and execution of these laudable programmes. The result of this study is a pointer to the fact that, holistic approach of implementations should be employed in ensuring that, focus is not only directed towards the eagerness to implement such programmes, but also towards salient pre and post-interventions questions such as 'what', 'who', 'where' 'how' and 'but why', for a more scientifically implemented nutrition therapy programme, void of avoidable flaws, for the malnourished under-five children. The systematic consideration of the results of this study, and reasonable actions taken towards the lesson learnt therein, will go a long way in facilitating more positively impactful outcomes of the sensitive nutrition therapy programme in an unstable country like south Sudan.

8 Suggestions for future research

Further researches are needed on the relationships between the donors' perceptions and government's dispositions towards nutrition therapy programme. The tentacle of research should also be extended to comparison among multiple countries' impact of the nutrition therapy programmes on malnourished under-five children, for the purpose of cross fertilization of ideas.

References

[1] Abdalla MA, Saad A, Abdullahi HE, AbdulGader H (2009). Socio-economic aspects influencing food consumption patterns among children under age of five in rural area of Sudan. *Pak*. J. Nutr. 8:653-659.

[2] Abuya B, Ciera J, Kimani-Murage E (2012). Effects of mothers' education on child's nutritional status in the slums of Nairobi.

[3] Adair LS, Fall CH, Osmond C, Stein AD, Martorell R, Ramirez-Zea M, Sachdev HS, Dahly DL, Bas I, Norris SA, Micklesfield L, Hallal P, Victora CG (2013). Associations of linear growth and relative weight gain during early life with adult health and human capital in countries of low and middle income: findings from five birth cohort studies. *Lancet*, 382, 525-34.

[4] Agozie C Ubesie NS (2012). Malnutrition Admitted at the University of In Nigeria Teaching HOSPITAL, Enugu: 10years retrospective review. . *NutritionJournal*, 1.

[5] Ahmed F (2014). Effects of malnutrition under five years of age and its complications. *Carechallenge* .

[6] Ahmed T, Auble D, Berkley JA, Black R, Ahern PP, Hossain M, Hsieh A, Ireen S, Arabi M, Gordon JI (2014). An evolving perspective about the origins of childhood undernutrition and nutritional interventions that includes the gut microbiome. *Annals of the New York Academy of Sciences*. 1749-6632. http: //dx.do i.org/10. 1111/nya s.12487

[7] Amy L Rice LS (2000). Malnutrition asa aan underlying cause of childhood deaths associated with infectious diseases in developing countries. *Bulletin of the World Health Organisatioon*.

[8] Ashworth A, Ferguson E (2009). Dietary counselling in the management of moderate malnourishment in children. *Food and Nutrition Bulletin*, 30(Suppl. 3), S405–S433.

[9] Bachmann MO (2009). Cost effectiveness of community-based therapeutic care for children with severe acute malnutrition in Zambia: decision tree model. *Cost EffResourAlloc*, 7, 2.

[10] Bahwere P, Banda T, Sadler K, Nyirenda G, Owino V, Shaba B, Dibari F, Collins S (2014). Effectiveness of milk whey protein-based ready-to-use therapeutic food in treatment of severe acute malnutrition in Malawian under-5 children: a randomised, double-blind, controlled non-inferiority clinical trial. *Maternal and Child Nutrition Jul*;10(3):436-51. doi: 10.1111/mcn.12112. Epub 2014 Feb 13.

[11] Bank U-W-TW (2012). Levels and Trends in Child Malnutrition: UNICEF-WHO-The World Bank Joint Child Malnutrition Estimates. *Washington D.C*.

[12] Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost?

[13] Black RE, Allen LH, Bhutta ZA, Caulfield LE, De Onis M, Ezzati M, Mathers C, Rivera J (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*, 371, 243-60.

[14] Black RE, Allen LH, Bhutta ZA, Caulfield LE, Onis M, Ezzati M, Mathers C, Rivera J (2008). Maternal and child under nutrition: global and regional exposures and health consequences. *Lancet* 371:243-260.

[15] Brabin BJ, Coulter JBS (2003). Nutrition-associated disease. In: Cook GC, Zumla AI, editors. *Manson's tropical diseases*. London: Saunders;. pp. 561-80.

[16] Briend, A; Collins S (2010). "Therapeutic Nutrition for Children with Severe Acute Malnutrition: Summary of African Experience." Indian Pediatrics. *Indian Academy of Pediatrics*; 47:655–659.

[17] C L (2003). Meeting the challenge to improve complementary feeding. *POPLINE*, 4-9.

[18] Cairncross Sandy JB (2010). Hygiene, Sanitation and Water: What needs to be done? . *PLOS Medicine* .

[19] Carlson GJ, Kordas K, Murray-Kolb LE (2014). Associations between women's autonomy and child nutritional status: a review of the literature. *Matern Child Nutr*..

[20] CDC (2013). Evaluation of a Blanket Supplementary Feeding Program in Two Counties in Kenya, August 2011–March 2012.US Centers for Disease Control and Prevention.

[21] Chakraborty P, Anderson AK (2011). Maternal autonomy and low birth weight in India. *J Womens Health (Larchmt)*, 20, 1373-82

[22] Chang CY, Trehan I, Wang RJ, Thakwalakwa C, Maleta K, Deitchler M, Manary MJ (2013). Children successfully treated for moderate acute malnutrition remain at risk for malnutrition and death in the subsequent year after recovery. *J Nutr*, 143, 215-20.

[23] Chaparro CM, Dewey KG (2010). Use of lipid-based nutrient supplements (LNS) to improve the nutrient adequacy of general food distribution rations for vulnerable sub-groups in emergency settings. *Maternal and Child Nutrition*, 6, 1-69.

[24] Checchi F, Robinson WC (2013). Mortality among populations of southern and central Somalia affected by severe food insecurity and famine during 2010-2012. *Rome*, Washington.

[25] Checkley W, Childhood Infection, Malnutrition Network (2012). Wasting Is Associated with Stunting in Early Childhood. *Journal of Nutrition* 142:1291–1296

[26] Cherry J (2012). Epidemic Pertusis in 2012- the resurgence of a vaccine preventable disease. *New England Journal Medicine*.

[27] Collier P (2009). The political economy of fragile states and implications for european development policy. *Department of Economics, Oxford University , London*.

[28] Collins S (2001). "Changing the Way We Address Severe Malnutrition during Famine." Lancet. Vol. 358, pp. 498–501. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11513936

[29] Collins S, Dent N, Binns P, Bahwere P, Sadler K, Hallam A (2006). Management of severe acute malnutrition in children. *Lancet*, 368, 1992-2000

[30] D Shimeles, S l (1994). Clinical Profile and Patern of Infection in Ethopia. *East African Medical Journal*.

[31] DB Jelliffe EJ (1977). The Infant Food Industry and International Child Health. *International Journal of Health Services*.

[32] DC Robinson JS (1970). The Prevalence and Natural History of Cleft Lip and Palate in Uganda. *Developmental Medicine and Child Neurology*, 636-641.

[33] De Onis M, Blössner M, Borghi E, Frongillo E, Morris R (2004). Estimates of global prevalence of childhood underweight in 1990 and 2015. *Journal of the AmericanMedical Association*, 291:2600–2606.

[34] De Onis M, Blössner M, Borghi E, Morris R, Frongillo E (2004a). Methodology for estimating regional and global trends of child malnutrition. *International Journalof Epidemiology* (in press).

[35] De Onis M, Monteiro C, Akré J, Clugston G (1993). The worldwide magnitude of protein–energy malnutrition: an overview from the WHO Global Database on Child Growth. *Bull World Health Organ*.71:703-12.

[36] De Pee S, Bloem MW (2009). Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6- to 23-month-old children and for treating moderate malnutrition among 6- to 59-month-old children. *Food and Nutrition Bulletin*, 2009; 30(3) supplement, The United Nations University.

[37] De Pee S, Bloem MW (2009). Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6-to 23-month-old children and for treating moderate malnutrition among 6-to 59-month-old children. *Food and Nutrition Bulletin*, 30, S434-S463.

[38] Defourny I, Minetti A, Harczi G, Doyon S, Shepherd S, Tectonidis M, Bradol JH, Golden M (2009). A large-scale distribution of milk-based fortified spreads: evidence for a new approach in regions with high burden of acute malnutrition. *PLoS One*, 4, e5455.

[39] Dickson R, Awasthi S, Williamson P, Demellweek C, Garner P (2000). Effects of treatment for helminth infection on growth and cognitive performance in children: systematic review of randomized trials. *BMJ* 2000;320:1697-701

[40] Engle RW TS (1999). Working Memory,Short-tren memory and general fluid intelligence- A latent variable approach. *Journal of Experimental Psychology*, 309-331.

[41] ENN (2013a). The effectiveness of blanket supplementary feeding programmes in preventing acute malnutrition: Evidence from research carried out in Chad.

[42] Food and Agriculture Organization of the United Nations (2004). Undernourishment around the world. In: *The state of food insecurity in the world 2004*. Rome: FAO.

[43] Geber M (1955). Psychological factors in the etiology of kwashiorkor. *Bulletin of the World Health Organization*, 471.

[44] Geber M (1989). Psychothérapie d'un enfant atteint de kwashiorkor. *Psychopathologie Africaine*, 22, 171–190.

[45] Global Nutrition Cluster MAM Taskforce (2012). Moderate Acute Malnutrition; a decision tool for emergencies.

[46] Golden MH (2009). Proposed recommended nutrient densities for moderately malnourished children. *Food and Nutrition Bulletin*, 30(Suppl. 3), S267–S344.

[47] Golden MH (2010). "Evolution of Nutritional Management of Acute Malnutrition."Indian Pediatrics. Vol 47: 667-675.

[48] Grellety E, Shepherd S, Roederer T, Manzo ML, Doyon S, Ategbo EA, Grais RF (2012). Effect of mass supplementation with ready-to-use supplementary food during an anticipated nutritional emergency. *PLoS ONE*, 7, e44549

[49] Guigoz Y, Vellas B, Garry PJ (1996). Assessing the nutritional status of the elderly: the mini-nutritional assessment as part of the geriatric evaluation. *Nutrition Review* 54, s59±s65.

[50] Guédeney A (2000). Psychopathologie du kwashiorkor: des pionniers aux directions actuelles de recherche. In: *MSF News: special psy n°1*. Paris: MSF-F.

[51] Hendricks KM (2010). Ready-to-use therapeutic food for prevention of childhood undernutrition. *Nutr Rev*, 68, 429-35.

[52] Huybregts L, Houngbe F, Salpeteur C, Brown R, Roberfroid D, Ait-Aissa M, Kolsteren P (2012). The Effect of Adding Ready-to-Use Supplementary Food to a General Food Distribution on Child Nutritional Status and Morbidity: A Cluster-Randomized Controlled Trial. *PLoS Medicine*, 9, e1001313.

[53] Institute of Public Health Nutrition (2011). National Guidelines for Community Based Management of Acute Malnutrition in Bangladesh. *September* 2011.

[54] Isanaka S, Nombela N, Djibo A, Poupard M, Van Beckhoven D, Gaboulaud V, Guerin PJ, Grais RF (2009). Effect of Preventive Supplementation With Ready-to-Use Therapeutic Food on the Nutritional Status, Mortality, and Morbidity of Children Aged 6 to 60 Months in Niger A Cluster Randomized Trial. *JAMA*, 301, 277-285

[55] Isanaka S, Roederer T, Djibo A, Luquero FJ, Nombela N, Guerin PJ, Grais RF (2010). Reducing wasting in young children with preventive supplementation: a cohort study in Niger. *Pediatrics*, 126, e442-e4

[56] Jaspars S, Young H (1995). General Food Distribution in Emergencies: from Nutritional Needs to Political Priorities. *In:* NETWORK, R. A. R. (ed.) Good Practice Review 3. Overseas Development Institute.

[57] KavitaSethuraman, David Doledec, Ferdousi Begum, Mohammed ZahidulManir (2014). Managing Acute Malnutrition: A Review of the Evidence and Country Experiences in South Asia and a Recommended Approach for Bangladesh. *USAID from American people*January 2014

[58] Khan MI (2006). Factors Causing Malnutrition Among Under Five Children in Bangladesh. . *Pakistan Journal*, 1000.

[59] Khara T, Dolan C (2014). Technical Briefing Paper: Associations between Wasting and Stunting, policy, programming and research implications. *Emergency Nutrition Network (ENN)*.

[60] Khunga H, Okop K, Poane T (2015). Perception of mothers and caregivers regarding the detection and treatment of malnourished children in Kanchele, Kalomo district, Zambia.

[61] Kish, Leslie (1965). Survey Sampling, New York: Wiley. *ISBN* 978-0471109495.

[62] LaGrone LN, et al. (2011). A novel fortified blended flour, corn-soy blend "plus-plus," is not inferior to lipid-based ready-to-use supplementary foods for the treatment of moderate acute malnutrition in Malawian children. *American Journal of Clinical Nutrition*. https://doi.org/10.3945/ajcn.111.022525

[63] Latham MC (1997). Human Nutrition in the Developing World. *FAO*, Rome.

[64] Lazzerini M, Rubert L, Pani P (2013). Specially formulated foods for treating children with moderate acute malnutrition in low- and middle-income countries. *Cochrane Database Syst Rev*, 6, Cd009584.

[65] Lazzerini, RLM; Pani P (2013). Specially Formulated Foods for Treating Children with Moderate Acute Malnutrition in Low- and Middle-Income Countries (Review). *The Cochrane Collaboration (Lazzerini et al.*, 2013).

[66] Lehmann AB (1991). Nutrition in old age: an update and questions for future research: part I. *Reviews in Clinical Gerontology* 1, 135-145.

[67] Lenters LM, Wazny K, Webb P, Ahmed T, Bhutta ZA (2013). Treatment of severe and moderate acute malnutrition in low- and middle-income settings: a systematic review, meta-analysis and Delphi process. *BMC Public Health*, 13 Suppl 3, S23

[68] Levin HM, Pollitt E, Galloway R, McGuire J. *Micronutrient deficiency disorders*.

[69] Lisa C Smiith LH (2000). Explaining Child Malnutrition in Developing Countries. Washington DC:. *International Food Policy Research institute*.

[70] Martorell R (1999). The Nature of child malnutrition and its long-trem implications. *Food and Nutrition Bulletin*.

[71] Matilsky, DK et al (2009). "Supplementary Feeding with Fortified Spreads Results in Higher Recovery Rates Than with a Corn/Soy Blend in Moderately Wasted Children." Journal of Nutrition. *April* 2009. 139(4): 773–778.

[72] Millward DJ, Jackson AA (2004). Protein/energy ratios of current diets in developed and developing countries compared with a safe protein/energy ratio: implications for recommended protein and amino acid intakes. *Public Health Nutr* 2004;7:387-405.

[73] Mitchell, E a (2000). Proten Energy Malnutrition Among Children. *Project and Research Work*.

[74] MJ Manary RB (1998). Whole-Body Protein Kinetics in Marasmic and Kwashiorkor During Acte Infection. *The American Journal*.

[75] Morley JE (1997). Anorexia of aging: physiologic and pathologic. *American Journal of Clinical Nutrition*, 66(4), 760–773.

[76] Mwanza KM, Okop J, Puoane T (2016). Evaluation of outpatient therapeutic programme for management of severe acute malnutrition in three districts of the eastern province, Zambia

[77] Nackers, F et al (2010). "Effectiveness of Ready-to-Use Therapeutic Food Compared to a Corn/Soy-Blend-Based Pre-Mix for the Treatment of Childhood Moderate Acute Malnutrition in Niger." Journal ofTropical Pediatrics.56(6):407–13.

[78] Navarro-Colorado C (2008). Measuring the effectiveness of Supplementary Feeding Programmes in emergencies.

[79] Neitzel J (2011). The targeted supplementary feeding programme

[80] Neufeld LM (2009). Ready-to-Use Therapeutic Food for the Prevention of Wasting in Children. *Jama-Journal of the American Medical Association*, 301, 327-328.

[81] Noah S Scheinfeld AL (2015). Protein-Energy Malnutrition. *Medscape* .

[82] Oldewage-Theron Wilna EG (2010). Poverty,household food insecurity and nutrition:Coping strategies in an informal settlement in the Vaal TRIANGLE,South Africa. *Science direct*, 795-804.

[83] Oriere MH, A And Ndumi A (2010). Evaluation of the Emergency Blanket Supplementary Feeding Programme in five districts of Northern Kenya. *Save the Children UK*, London, UK. .

[84] Perez-Exposito AB, Klein BP (2009). Impact of fortified blended food aid products on nutritional status of infants and young children in developing countries. *Nutrition Reviews*, 67, 706-718

[85] Petersdorf RG, Wilson JD, Martin JB, Fauci AS (2004). McGraw-Hill, New York, pp. 393±397

[86] Pinstrup–Andersen P, Burger S, Habicht JP, Peterson K (1993). Protein–energymalnutrition. In: Jamison DT, Mosley WH, Measham AR, Bobadilla JL, editors. *Disease control priorities in developing countries*. 2nd ed. Oxford (UK): Oxford University Press; 1993. pp. 391-420.

[87] Puett C, Sadler K, Alderman H, Coates J, Fiedler JL, Myatt M (2013a). Cost-effectiveness of the community-based management of severe acute malnutrition by community health workers in southern Bangladesh.Health Policy Plan, 28, 386-99.

[88] Rao KS (1959). Malnutrition and Disease. . *Freedom from hunger Campaign*.

[89] Richard SA, Black RE, Gilman RH, Guerrant RL, Kang G, Lanata CF, Mølbak K, Rasmussen ZA, Sack RB, Valentiner-Branth P (2014). Malnutrition in develoing nations

[90] Roberfroid D, Huybregts L, Kolsteren P (2009). Effect of Preventive Supplementation on Young Children in Niger. *Journal of the American Medical Association*, 301, 2208-2208.

[91] Robinowitz SS (2014). Marasmus.

[92] Roy BV (1994). The role of malnutrition in the failure to thrive syndrome. In *Handbook of Nutrition in the Aged (Watson R.R*. ed.), CRC Press, Boca Raton, FL, pp. 303±308.

[93] Rudman D (1987). Protein and energy undernutrition. In *Harrison's Principles of Internal Medicine (Braunwald E*., Isselbacher K.L.,

[94] Ruel MT, Menon P, Habicht JP, Loechl C, Bergeron G, Pelto G, Arimond M, Maluccio J, Michaud L, Hankebo B (2008). Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial. *Lancet*, 371, 588-95.

[95] Salpéteur (2013). Cécile. *ACF France*. January 2013. Personal communication.

[96] Schofield C, Ashworth A (1996). Why have mortality rates for severe malnutrition remained so high? *Bulletin of the World Health Organization*, 74, 223–229.

[97] Seal A, Prudhon C (2007). Assessing micronutrient needs in emergencies. *Current practice and future directions*. Nutrition Information in Crisis Situations. October 2007. UNS SCN.

[98] Seiler WO, Stahelin HB (1999). Malnutrition in the Elderly. *Springer*, New York.

[99] Sen (1989). Poverty and Famine- An essay on entilement and deprivation. *Bangladesh: Oxford University Press*.

[100] Sethuraman K, Lansdown R, Sullivan K (2006). Women's empowerment and domestic violence: the role of sociocultural determinants in maternal and child undernutrition in tribal and rural communities in South India. *Food Nutr Bull*, 27, 128-43.

[101] Sguassero Y, De Onis M, Bonotti AM, Carroli G (2012). Community-based supplementary feeding for promoting the growth of children under five years of age in low and middle income countries. *Cochrane Database of Systematic Reviews*, 114.

[102] Sharma M MK (1992). Should cow milk be diluted for young infants. *Indian Journal of Paediatrics*, 643-644.

[103] Simon D, Adams AM, Madhavan S (2002). Women's social power, child nutrition and poverty in Mali. *J BiosocSci*, 34, 193-213.

[104] Stephan LS, Lathum MC, Ohesen EA (2000). Global malnutrition. *Parasitology* 121:55-22.

[105] Stoltzfus RJ, Chway HM, Montresor A, Tielsch JM, Jape JK, Albonico M, et al. (2004). Low dose daily iron supplementation improves iron status and appetite but not anemia, whereas quarterly antihelminthic treatment improves growth, appetite and anemia in Zanzibari preschool children. *J Nutr*2004;134:348-56.

[106] Suchindran, T a (1999). Determinant of Child Malnutrition- An Intervention Model for Botswana. *Nutrition Research*, 843-860.

[107] Sullivan DH (1995). The role of nutrition in increased morbidity and mortality. *Clinics in Geriatric Medicine* 11, 661±674.

[108] Tekeste A, Wondafrash M, Azene G, Deribe K (2012). Cost effectiveness of community-based and in-patient therapeutic feeding programs to treat severe acute malnutrition in Ethiopia. *Cost EffResourAlloc*, 10, 4.

[109] Truswell S (2010). ABC of Nutrition.

[110] TYusuf JH (2014). CD4+ T-Lymphocyte Counts Among Under 5 Children with Protein Energy Malnutrition seen in Usmanu Danfodiyo University Teaching Hospital, Sokoto, Ngeria. *National Journal of Paediatrics*.

[111] UNICEF (2014). Chief of Strategic Communication, UNICEF South Sudan. www.unicef.org

[112] UNICEF WHO, World-Bank (2012). UNICEF-WHO-World Bank Joint Child Malnutrition Estimates. *(UNICEF*, New York; WHO, Geneva; The world Bank, Washington, DC).

[113] VOA (2016). Child malnutrition crisis deepens in South Sudan http://www.voanews.com/a/child-malnutrition-crisis-deepens-in-south-sudan/3451608.html

[114] WFP (2015). UNICEF and WFP resolve to defeat malnutrition in South Sudan [Internet]. Available from: https://www.wfp.org/news/news-release/unicef-and-wfp-resolve-defeat-malnutrition-south-sudan [Accessed 29 August 2016].

[115] WHO (2000). World Health Organization, Dept of Nutrition for Health and Development. *Nutrition for health and development: A global agenda for combating malnutrition*. WHO

[116] WHO (2003). "The Management of Nutrition in Major Emergencies"

[117] WHO (2012). Technical Note: Supplementary Foods for the Management of Moderate Acute Malnutrition in Infants and Children 6–59 Months of Age. *Geneva: WHO*.

[118] WHO (2013). Guideline update: Technical aspects of the management of severe acute malnutrition in infants and children. *Geneva: World Health Organization*; 2013.

[119] WHO UNICEF (2009). WHO child growth standards and the identification of severe acute malnutrition in infants and children: A Joint Statement by the World Health Organization and the UnitedNations Children's Fund. *Geneva: WHO*.

[120] WHO WFP, UN/SCN UNICEF (2007). Community-Based Management of Severe Acute Malnutrition. *AJoint Statement by the World Health Organization*, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund (UNICEF). New York:UNICEF. May 2007.

[121] Wilford R, Golden K, Walker DG (2012). Cost-effectiveness of community-based management of acute malnutrition in Malawi. *Health Policy Plan*, 27, 127-37.

[122] World Health Organization (2002). The world health report 2002. *Geneva: WHO*.

[123] World Health Organization, United Nations Children's Fund (2004). Joint statement on the management of acute diarrhoea. *Geneva: The Organization*; 2004.