EFFECT OF MALTED SORGHUM-BASED PORRIDGE ON NUTRITIONAL STATUS OF MODERATELY MALNOURISHED BREASTFED INFANTS AND YOUNG CHILDREN AGED 6 TO 18 MONTHS IN ARUA, UGANDA

BY

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SUBMITTED IN FULLFILLMENT OF THE REQUIREMENT OF THE DEGREE DOCTOR OF PHILOSOPHY IN HUMAN NUTRITION DIETETICS AND HUMAN NUTRITION SCHOOL OF AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE UNIVERSITY OF KWAZULU-NATAL PIETERMARITZBURG

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ABSTRACT

Moderate acute malnutrition (MAM) among infants and young children (IYC) has a negative impact on their immature digestive system and requires an energy rich, nutrient dense supplementary food to reverse the condition and promote catch up growth and development. In this study, a malted sorghum-based porridge (MSBP) was formulated using locally available ingredients. It was subsequently used as a supplementary food in the management of IYC with MAM to determine whether it could serve as an alternative supplementary porridge when compared to fortified corn soy blend (CSB+), the standard care for managing IYC with MAM in Uganda. The effect of MSBP supplementation, in conjunction with nutrition education, on the nutritional status of IYC with MAM was determined. In addition, maternal knowledge regarding appropriate complementary feeding and hygiene practices were determined before the supplementation intervention commenced (baseline), as well as after the completion of the three month intervention period. In addition, the study also determined maternal perceptions regarding the MSBP versus CSB+, as well as perceived barriers encountered in the course of the intervention.

Hence the study developed an acceptable energy rich and nutrient dense MSBP for managing MAM. The MSBP was formulated (using estimated values generated by NutVal software) from malted sorghum flour and extruded soy-maize flour. Four formulations estimated to meet the specifications of a supplementary food for treatment of IYC with MAM (in accordance with World Health Organisation criteria), were subsequently assessed for consumer acceptability. Analysis of variance was used to compare the acceptability scores and viscosity level of four different MSBP formulations to test for significant differences between mean scores. The four formulations had significantly different ($p<0.05$) acceptability scores for flavour, taste, mouth feel, sweetness and overall acceptability. The best formulation had significantly ($p<0.05$) higher mean acceptability scores. In addition, the best MSBP formulation had a significantly ($p<0.05$) higher energy and nutrient content than CSB+. At a flour rate of 25%, this formulation also had the best energy density, protein density and viscosity of 1.6kcal/g, 4g/100kcal and 2809cP respectively. The results showed that a quarter sorghum malt mixed with three quarters of extruded soy-maize, produced an energy rich, nutrient dense MSBP with acceptable sensory

attributes at optimal viscosity. The best formulated MSBP met the energy, protein and viscosity level requirements for the management of IYC with MAM.

To evaluate the efficacy of MSBP in alleviating malnutrition among IYC with MAM, the intervention component of the study established maternal socio-demographic characteristics and associated complementary feeding practices at baseline. A cross sectional community assessment was conducted among 204 randomly sampled breastfeeding mothers of IYC aged 6 to 18 months with MAM in four out of eighteen sub counties in Arua district, Uganda. Multivariate logistic regression analysis showed that maternal level of education as well as that of the head of the household, were significantly associated with IYC minimum meal frequency ($p=0.003$) and ($p=0.023$) respectively. In addition, maternal care, determined in terms of the preparation of food such as porridge especially for the IYC, was also significantly associated with minimum meal frequency ($p<0.001$) and with the IYC food intake meeting that of a minimum acceptable ($p=0.004$). These findings suggested that optimal complementary feeding practices in terms of minimum dietary diversity, minimum meal frequency and minimum acceptable diet were not met by the majority of IYC with MAM.

The baseline study was followed by evaluating the effect of MSBP and CSB+ in combination with nutrition education, on the anthropometric status and blood haemoglobin levels of IYC aged 6 to 18 months diagnosed with MAM. A double blind cluster randomised control trial was conducted with 204 mother-IYC pairs, with a cluster consisting of nine to ten pairs per parish where mothers consented to participate (Appendix B, p197). A daily ration of 150g of either MSBP or CSB+ was fed to IYC for ninety days. Weekly anthropometric measurements (weight, length and mid-upper arm circumference) of IYC were conducted, whereas haemoglobin levels were determined only at baseline and at the end of the study. A comparison between mean anthropometric outcomes namely weight gain, length gain, length-for-age z-scores, weight-for-age z-scores, length-for-weight z-scores, and mean blood haemoglobin levels in the treatment (MSBP) and control (CSB+) groups were determined using the independent t-test. Proportions of the anthropometric and haemoglobin levels in the treatment and control groups were determined using the z-test. At three months, the mean weight-for-age z-score of IYC in the treatment group was significantly higher than in the control group ($p=0.01$). The change in mean blood haemoglobin levels was significantly smaller in the treatment group when compared to that of

the control group (p=0.01). No significant difference was observed in the proportion of IYC who recovered from MAM between the treatment group and control group (p=0.055). Thus, MSBP supplementation of IYC with MAM resulted in comparable recovery rates to CSB+ in terms of weight-for-length and improved blood haemoglobin levels. Therefore, MSBP could be considered as an alternative to CSB+ in the management of breastfed IYC with MAM.

The effect of nutrition education on the feeding and hygiene practices of mothers with IYC with MAM being supplemented with either MSBP or CSB+, was also determined. A cross-sequential study using a pre-test-post-test design was used among the 204 mothers in the 24 clusters. Mothers' knowledge, complementary feeding and hygiene practices were analysed as mean scores before and after the intervention. The paired t-test was used to determine the differences between baseline and end line mean scores for knowledge and practices. Mothers' mean knowledge scores regarding complementary feeding in terms of dietary diversity and meal frequency were significantly higher at end line compared to baseline ($p<0.001$). Maternal practices regarding food safety and water quality was significantly higher at end line compared to baseline ($p<0.001$). Thus, nutrition education of mothers in combination with supplementing their IYC with either MSBP or CSB+, improved meal frequency, dietary diversity, water quality, and food safety.

Lastly, maternal perceptions and barriers experienced while using either MSBP or CSB+ to manage their IYC with MAM was determined via qualitative research techniques. A qualitative study using, focus group discussions (FGD) and in depth interviews (IDI) was conducted among mothers a week after completion of the three months supplementation period. One hundred eight mothers were purposively sampled to participate in 12 focus group discussions. This was followed by selecting 48 mothers to participate in IDI. Five FGD were conducted with mothers whose IYC were fed CSB+, while the remaining seven FGD included mothers whose IYC were fed with MSBP. The qualitative data on maternal perceptions and barriers were analysed using an inductive approach. The results showed that both MSBP and CSB+ were perceived as being responsible for IYC weight gain, reduction in illness, improved appetite, glowing healthy skin, and improved active play. Hence, mothers had positive attitudes towards using MSBP and CSB+. Collectively, the perceived barriers mothers encountered during the supplementary feeding intervention included household chores, limited time to feed IYC regularly, limited

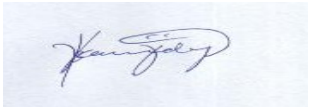
household income and household food insecurity in addition to minimal social support from household members. Mothers believed in the use of MSBP and CSB+ in the management of their IYC with MAM and were satisfied with the health benefits such as weight gain and improved appetite observed among their IYC. However, factors contributing to maternal stress should be addressed by improving household food security status and the distribution of an even workload among household members so that IYC with MAM can reap maximum benefits from supplementary food interventions.

Overall, this study provided an opportunity to gather additional evidence regarding the use of a locally formulated energy rich, nutrient dense supplementary porridge MSBP with suitable consumer acceptability, energy content and nutrient density in the management of IYC with MAM. Nevertheless, nutrition service providers of supplementary foods in the management of IYC with MAM should endeavour to educate mothers on potential barriers they may encounter in the course of intervention strategies for the management of MAM. This should include potential socio-care barriers, in addition to emphasising the health and nutrition benefits of the supplementary foods for their IYC.

PREFACE

The work described in this thesis was carried out in the School of Agricultural, Earth and Environmental Sciences, College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg under the supervision of Dr Susanna Maria Kassier and Professor Frederick Johannes Veldman.

This study represents the original work of the author and has not otherwise been submitted in any form for any degree or diploma to any university. Where applicable, the work of others is acknowledged in text.



Signed: ……6th March, 2018……..
Kajjura Richard Stanley Bazibu (Candidate)

I, **Susanna Maria Kassier**, as Supervisor, and I, **Frederick Johannes Veldman** as Co-supervisor, approve the release of this thesis for examintation.

Signed: …… Date: …6th March, 2018……..
Dr Susanna Maria Kassier (Supervisor)

Signed: …… Date: ……6th March, 2018...……..
Professor Frederick Johannes Veldman (Co-supervisor)

DECLARATION

I **Kajjura Richard Stanley Bazibu**, declare that:

1. The research reported in this thesis, except where otherwise indicated, is my original research.
2. This thesis does not contain another persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
3. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source (s) being detailed in the thesis and in the reference section.
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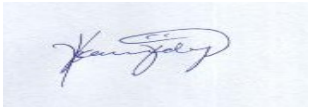

Signed _____ Date: ___6th March, 2018_____

Kajjura Richard Stanley Bazibu

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ABBREVIATIONS

AOAC	Association of Analytical Chemists
cRCT	Cluster randomised control trial
CSB+	Corn soy blend plus
DDS	Dietary diversity scores
DHS	Demographic and Health Survey
DRI	Dietary reference intake
FAO	Food and Agriculture Organization
GDP	Gross domestic product
GoU	Government of Uganda
HBM	Health Belief Model
IMAM	Integrated Management of Acute Malnutrition
IYC	Infants and young children
LNS	Lipid-based nutrient supplement
MAM	Moderate acute malnutrition
MDG	Millennium Development Goal
MFPED	Ministry of Finance, Planning and Economic Development
MoH	Ministry of Health
MSBP	Malted sorghum based porridge
MUAC	Mid upper arm circumference
NGOs	Non-governmental organizations
PEM	Protein Energy Malnutrition
SAM	Severe acute malnutrition
UBOS	Uganda Bureau of Statistics
UN	United Nations
UNAP	Uganda Nutrition Action Plan
UNICEF	United Nations International Children's Education Fund
WHO	World Health Organization

DEFINITION OF OPERATIONAL TERMS

- **Complementary feeding:** The feeding of IYC other foods (liquid, semi-solid or solid) in addition to breast milk to meet their nutrient needs from 6 months up to 23 months of age (WHO, 2008).
- **Infants and young children:** For the purpose of this study, it is defined as IYC aged 6 to 18 months.
- **Knowledge:** For the purpose of this study, is defined as facts, information and skills acquired by breast feeding mothers through experience or education regarding appropriate feeding of infants and young children to prevent or treat MAM.
- **Moderate acute malnutrition:** A weight-for-height between -3 and -2 z-scores from the mean, without the presence of oedema (WHO, 2012).
- **Nutritional status:** For the purpose of this ssytudy, it refers to anthropometric measures (weight, height, mid-upper arm circumference), dietary intake (dietary diversity and meal frequency) and biochemical measure (blood haemoglobin level).
- **Practice:** For the purpse of this study, is defined as observable actions taken by breast feeding mothers to prevent or treat MAM among infants and young children (6 to 18 months).
- **Stunting:** For the purpse of this study, is defined as child's height-for-age below -2 z scores from the WHO reference z score value.
- **Supplementary porridge:** For the purpose of this study, supplementary porridge referred to MSBP and CSB+ boiled in the correct amount of water, making it suitable for IYC feeding.
- **Supplementary feeding:** The provision of additional food to IYC beyond the normal ration of their home diets (WHO, 2002).
- **Underweight:** For the purpse of this study, is defined as child's weight-for-age below -2 scores from the WHO reference z score value.
- **Wasting:** For the purpse of this study, is defined as child's weight-for-height below -2 z scores from the WHO reference z score value.

CHAPTER 1: INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 Introduction

Undernutrition, classified as mild, moderate or severe, contributes to 35% of the global burden of disease [World Health Organization (WHO) 2012]. In 2014, global statistics indicated that 7.5% (50 million) of infants and young children (IYC) younger than five years of age were wasted, with 5.1% (34 million) being moderately wasted (WHO, 2015b). In low and middle-income countries, moderate acute malnutrition (MAM) affects about 10% (47.5 million) of children under five years of age (Lazzerini, Rubert, & Pani, 2013), while in developing countries, about 20 million children under five are severely wasted (Khan & Bhutta, 2010). In addition, the WHO (2015b) estimated that globally, about 43% (273 million) IYC aged 6 to 59 months suffered from anaemia. Moreover, iron deficiency anaemia affected about 85 million IYC aged 6 to 59 months in Africa (WHO, 2015a).

In sub-Saharan Africa, IYC between 6 to 23 months with moderate acute malnutrition (MAM) are more vulnerable to inadequate food intake due to inappropriate feeding and hygiene practices (Negash et al., 2014), resulting in high morbidity and mortality rates (Annan, Webb, & Brown, 2014). A review by Ashworth and Ferguson (2009) regarding information obtained from the United Nations (UN), international non-governmental organizations (NGOs), paediatric associations, and national programmes, showed that the dietary advice given to breastfeeding mothers of IYC with MAM is often nonspecific. Nutrition education on appropriate feeding and hygiene practices targeting mothers of IYC have been reported to significantly improve knowledge, nutritional status, and minimise disease when combined with the provision of supplementary foods in the management of MAM (Imdad, Yakoob, & Bhutta, 2011; Lassi, Das, Zahid, Imdad, & Bhutta, 2013). The management of MAM in Uganda also includes nutrition education combined with the provision of supplementary foods (MoH & WHO, 2013; MoH, 2010).

In Uganda, the prevalence of malnutrition among IYC is 13.8% for underweight and 4.7% for wasting [Uganda Bureau of Statistics (UBOS)2018]. The prevalence of underweight (19.1%) and wasting (13.6%) of infants aged 6 to 8 months in North Western Uganda, including the Arua

district, is very high (UBOS, 2018). Nearly three quarters (74.1%) of infants aged six to eight months of age consume complementary foods in addition to breast milk to meet their nutrient requirements (UBOS 2018). The remaining quarter (25.9%) that does not receive complementary foods could be explained by household food insecurity, inadequate maternal care and inappropriate feeding practices (Dossa, Ahouandjinou, & Houngbe, 2011). Over half of IYC aged 6 to 59 months (52.8%) in Uganda are anaemic with infants aged 9 to 11 months having the highest prevalence at 78%, while the West Nile region has a prevalence of 56.4% (UBOS, 2018). Iron deficiency is estimated to be responsible for half of all IYC anaemia in Uganda, whereas the remainder is caused by helminths, malaria, other nutritional deficiencies, chronic infections, and genetic conditions. Among IYC aged 6 to 23 months, iron deficiency is aggravated during the period when indigenous complementary foods are being introduced in the form of bulky family diets (UBOS, 2018; Shaw & Friedman, 2011).

Previous studies have shown that food supplementation results in malnourished IYC recovering from MAM with reduced levels of mortality (Lazzerini et al., 2013). For example, fortified corn soy blend (CSB+), the standard care for MAM in Uganda, has been reported to be effective in the management of MAM. However, in some intervention studies, no significant effect on nutritional status was found after supplementation with CSB+ (Lazzerini et al., 2013). Despite the above, IYC with MAM in Uganda are being treated using CSB+, with an energy density of 0.7 kcal/g below the recommended range of 1.5 to 2.0 kcal/g for feeding IYC aged 6 to 23 months with MAM (Tizazu, Urga, Abuye, & Retta, 2010; Golden, 2009). At household level, indigenous complementary foods or commercially available cereal porridges with varying nutrient densities per 100 kcal are being used in various parts of the country. Furthermore, the efficacy of complementary supplemental feeding interventions using blended flours has been repeatedly raised as a concern (de Pee & Bloem, 2009).

As an estimated 400,000 IYC under five years of age in Uganda are wasted (UBOS, 2018), it suggests that the current Integrated Management of Acute Malnutrition (IMAM) strategy of 2010 is seemingly not effective in combating the prevalence of malnutrition in the country [Ministry of Health (MoH) 2010]. The challenge behind resolving this high prevalence of malnutrition (29%), is related to limited access to quality energy rich, nutrient dense complementary

supplements, coupled with targeted nutrition education among mothers (Namugumya et al., 2014).

In addition, many mothers feed their IYC bulky starch-based complementary foods with a low nutrient density that does not promote catch up growth of malnourished children (WHO, 2012). The common gruels and porridges used in Uganda are mainly carbohydrate based foods such as maize, sorghum, millet, rice and cassava (Ickes, Adair, et al., 2015; Acheng, 2014). The practice of cooking these none malted foods with water result in gelatinization that yields a porridge that is soft and more easily digested, although bulky and with a low nutrient density. Sorghum malt use has remained low in rural areas of Uganda (Mukisa, Ntaate, & Byakika, 2017), although its consumption is increasing through value addition of sorghum-based food products as a result of its attractive white colour and diastatic activity (Mukisa, Byaruhanga, Muyanja, Langsrud, & Narvhus, 2017). However, the use of malted supplementary foods is limited. Currently, there is lack of published data regarding studies conducted in Uganda that investigated the effectivity of using indigenously formulated malted supplementary foods to treat IYC with MAM.

1.2 Background

Although Uganda has made progress in terms of nutrition policies and a reduction in the prevalence of malnutrition, such as the prevalence of wasted children having decreased to 5% in 2011 (UBOS, 2018), there are still significant challenges that need to be addressed. For example, the prevalence of wasting among IYC in Uganda is 4% (0.4 million) (UBOS, 2018) and un-malted fortified corn-soy blends such as CSB+ are used for the management of IYC with MAM, despite malnourished IYC having compromised digestive systems.

Wasting (low weight-for-height) due to inadequate nutrition is typically caused by recent episodes of illness such as diarrhoea or a rapid decrease of food intake in certain regions of Uganda (UBOS, 2018). Moderate wasting accounts for 3% of IYC aged 6 to 59 months. Underweight (low weight-for-age), reflects the effects of both acute and chronic undernutrition. Moderate underweight among IYC 6 to 59 months had a prevalence of 11% (UBOS, 2018).

In North Western Uganda, including the Arua district, the prevalence of underweight and MAM among infants aged 6 to 8 months was 19.1% and 13.6% respectively (UBOS, 2018), whereas

the prevalence of anaemia in the same region was 56.4% (UBOS, 2018), with 52.8% of IYC aged 6 to 59 months being anaemic. Of the IYC that were anaemic, 78% were aged 9 to 11 months (UBOS, 2018). If undernutrition amongst IYC is not prevented or adequately managed, it results in growth failure, delayed motor, cognitive, and behavioural development; a compromised immune response; as well as increased risk of morbidity and mortality (Cichon et al., 2016; Rytter, Kolte, Briend, Friis, & Christensen, 2014). Addressing malnutrition requires a concerted effort from the Ugandan government, development partners, civil society organisations and the private sector [Government of Uganda (GoU) 2011].

In order to reduce the national prevalence of malnutrition, the Ugandan government has outlined clear strategic objectives to reduce the prevalence of malnutrition and food insecurity, with nutrition being one of the outcome indicators of national development. The Ministry of Health (MoH) updated the Integrated Management of Acute Malnutrition (IMAM) guidelines to incorporate global recommendations regarding the management of MAM. This guideline was developed to provide a framework for ensuring appropriate preventative interventions, early identification and treatment of IYC with MAM (MoH 2010b). The IMAM comprehensive strategy is focused on the integrated management of MAM, combining and linking the management of IYC with MAM to comprehensive community mobilisation and involvement activities. Hence, it includes a referral system for inpatient treatment (if the IYC develops severe acute malnutrition (SAM) with complications), as well as outpatient care (if the IYC develops SAM without complications). Furthermore, the IMAM guideline outlines the fact that IYC diagnosed with MAM should be provided with appropriate medical care, nutritional rehabilitation and follow up (MoH 2010b). Often, the link between food access and utilisation among IYC are aligned with nutrition interventions that strengthen food and nutrition security (Faber, Witten, & Drimie, 2011). As food supplementation is used to provide nutrients that are not consumed in sufficient quantities, it is the most widely practiced intervention in the management of undernutrition (Bhutta et al., 2013) in Uganda. However, one of the main contributors to the limited impact of previous nutrition interventions has been the lack of an institutionalised coordinating mechanism, a lack of technical expertise, as well as a lack of appropriate supplementary food for IYC (MoH & WHO, 2013; GoU, 2011; MoH, 2010a).

The 2010 introduction of the IMAM strategy in Uganda has yielded positive results in the management of MAM among local IYC. The reduction of wasting by nearly 6% from 2012 to 2016 (UBOS, 2018), has been attributed to nutrition education regarding IYC feeding practices offered to breastfeeding mothers, as it is an accepted and sustainable model for IYC growth promotion and the prevention of malnutrition in Uganda (MoH, 2010). However, malnourished IYC may not always be receiving adequate treatment, care and support from rehabilitation providers as well as their mothers (Imdad et al., 2011; Ashworth & Ferguson, 2009). As a result, IYC sometimes fail to respond to treatment or relapse due to mothers that are unable to provide complementary feeding in addition to breastfeeding, and/or having encountered difficulties with the implementation of the nutrition rehabilitation model for the management of their malnourished IYC (MoH & WHO, 2013; Imdad et al., 2011). In addition, Uganda lacks an indigenous energy rich and nutrient dense acceptable supplementary food such as a malt-based porridge that can be provided in conjunction with appropriate, targeted nutrition education to manage MAM among IYC at household level. Previous studies conducted in Uganda have yielded inconclusive results regarding the management of IYC aged 6 to 59 months with MAM (Alowo, Muggaga, & Ongeng, 2018; Amegovu et al., 2014).

Inappropriate complementary feeding practices have contributed to the under-five mortality rate of 90 per 1,000 live births (MoH & WHO, 2013). Consequently, malnutrition costs Uganda around 5.7% of its gross domestic product (GDP), estimated at an annual cost of US $899 million (Namugumya et al., 2014). In addition, it was estimated that malnutrition is likely to cost Uganda US $7.7 billion in lost productivity by 2025 if no action is taken (Anushree, Joanna, Kawuki, Kikomeko, & Keith, 2015). As a result, the consumption of nutrient dense supplementary foods is one of the interventions that the Ugandan government has endorsed to scale up adequate nutrition among IYC with MAM. In event of IYC aged 6 to 18 months with MAM not being provided adequate, energy rich and nutrient dense supplementary foods in addition to breast milk to meet their developmental and catch up growth needs, their nutritional status deteriorates to SAM (WHO, 2012). Often supplementary foods given to IYC with MAM are bulky, with inadequate nutrient density, offered infrequently or diluted, in addition to inadequate and inappropriate nutrition education being given to mothers (WHO, 2002).

Despite national nutrition interventions such as a food supplementation programme, the prevalence of MAM among IYC aged 6 to 18 months has remained a major public health problem, as efforts to manage MAM has focused on a health facility based curative approach, using fortified blended foods instead of indigenous malt based foods to prevent and treat MAM (MoH, 2010). For the past two decades the protocol for the management of MAM in Uganda has remained unchanged, with the number of IYC that progress to SAM increasing (UBOS, 2018). Supplementation of IYC with MAM with CSB+ is implemented at government institutions, IGNO and UN agencies in emergency settings (Amegovu et al., 2014; Annan et al., 2014; Lenters, Wazny, Webb, Ahmed, & Bhutta, 2013). As a result, there is a need to develop an alternative energy rich and nutrient dense supplementary food as an alternative to the current standard care for the management of the increasing number of IYC with MAM in stable communities (Annan et al., 2014; Lenters et al., 2013; WHO, 2012).

Although MAM responds to dietary interventions that contain an appropriate percentage of the Dietary Reference Intakes (DRIs) for age or at a lower level if given as supplementary to the usual diet, there are still reservations regarding the ability of indigenous food blends to manage MAM and a lack of consensus on the most effective way to treat this form of malnutrition among IYC (Lazzerini et al., 2013; WHO, 2012). Limited research has been conducted in order investigate the effect of hydrolyzed (pre-digested) supplementary foods using active malts to manage MAM among breastfed IYC aged 6 to 23 months (Alowo et al., 2018). It was against this background that a clustered randomized controlled trial (cRCT) was planned to determine the effect of a malted sorghum based porridge (MSBP) as supplementary food, in addition to appropriate nutrition education, on the nutritional status of IYC aged 6 to 18 months with MAM.

The rationale of this study was to formulate an energy rich, nutrient dense MSBP made from locally grown legume and cereal foods and evaluate its impact on the nutritional status of IYC diagnosed with MAM as an alternative to the standard care CSB+ for the management to MAM in Uganda. The reason for the development of MSBP was that it contains alpha amylase, protease, lipase, and phytase to digest the carbohydrate, protein, fat and phytate in the porridge into glucose, amino acids, short chain peptides, monoglycerides, free fatty acids, minerals and vitamins during cooking (Herlache, 2010). The pre-digestion increases the nutrient density of the supplementary porridge which is beneficial for malnourished children whose digestive

system could have been compromised as a result of their malnutrition. It was anticipated that the formulated MSBP would have a higher nutrient density and lower dietary fibre content when compared to the standard care CSB+, by providing a pre-digested porridge for the management of IYC with MAM.

1.3 Study setting

The Arua distinct in the West Nile region of Northern Uganda is predominantly rural with about 7% of the population living in an urban or peri-urban setting (UBOS, 2018). The majority of the population belongs to the Lugbara ethnic tribes that are mostly reliant on subsistence farming. The backbone of Arua district's economy is agriculture, with the main food and cash crops grown being maize, millet, and sorghum in addition to beans, ground nuts and soy-beans. Nutrition services in the district are provided by a government regional hospital, two non-profit hospitals and three health centres. Figure 1.1 illustrates the location of the Arua district in relation to the rest of Uganda.

For the purpose of this study, the Arua district was conveniently selected as being representative of the West Nile region, due to its population predominantly consuming sorghum, maize and soy beans that were used in the formulation and development of the supplementary porridge MSBP that was evaluated in this study. In addition, the use of a cereal-legume-based porridge is a common weaning food among IYC counselled at health centres and in communities in the Arua district. Furthermore, the Arua district hosts the regional referral hospital (ARRH) with vast expertise in the management of IYC with MAM.

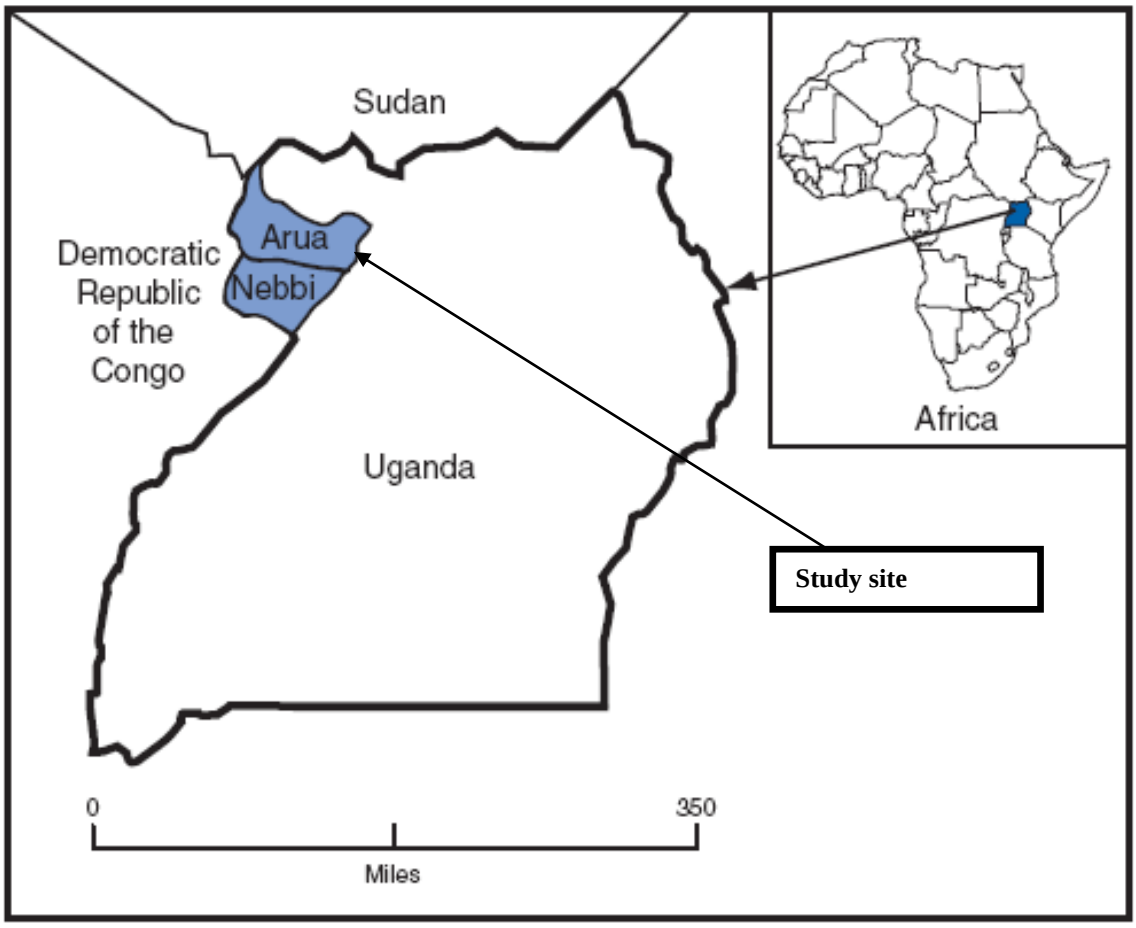

Figure 1.1: Location of study site

Source: Center for Disease Control and Prevention (CDC)[1]

1.4 Study aim

The aim of this study was to formulate a culturally acceptable energy rich, nutrient dense MSBP supplementary porridge made from locally grown and processed cereal-legume-based foods for use in conjunction with other home based foods as an alternative to CSB+, the standard care for treating IYC with MAM in Uganda. In addition, the study evaluated the effect of MSBP in conjunction with targeted nutrition education of mothers compared to the standard care (CSB+) on the nutritional status of breastfed IYC aged 6 to 18 months diagnosed with MAM in Arua district, Uganda. Subsequently the effect of nutrition education on knowledge, hygiene and

[1] Center for Disease Control and Prevention (CDC) Morbidity and Mortality Weekly Report (MMWR)@2009.

complementary feeding practices, as well as an investigation into maternal perceived barriers during the management of IYC with MAM with MSBP and CSB+ for a period of three months, were assessed.

1.5 Study design

An experimental study using a factorial randomised block design was conducted to formulate MSBP from sorghum grains, soy-beans and corn. This was followed by a cross-sectional descriptive survey among breastfeeding mothers of IYC aged 6 to 18 months who were diagnosed with MAM. Subsequently a double blind cRCT (Brestoff & Broeck, 2013) with a duration of three months was conducted to compare the effect of MSBP as a supplementary porridge (treatment) to CSB+ (control), in addition to the provision of targeted nutrition education of mothers included in both arms of the study, on the anthropometric status and haemoglobin levels of breastfed IYC aged 6 to 18 months diagnosed MAM. The nutrition education intervention was implemented based on the premise of the Health Belief Model (HBM) (Bandura, 1977), to improve maternal complementary feeding and hygiene practices (Glanz, Rimer, & Viswanath, 2015; French et al., 2012). Qualitative research techniques namely focus group discussions (FGDs) and in depth interviews (IDIs) (Marshall & Rossman, 2014; Maxwell, 2012) were conducted among mothers a week after completion of the intervention to explore maternal perceptions and barriers to feeding their IYC the respective supplementary porridges.

1.6 Study conceptual framework

Feeding IYC aged 6 to 18 months diagnosed with MAM with energy rich, nutrient dense supplementary foods while continuing with breastfeeding could result in an improvement of nutritional status. However, supplementation with an appropriate hydrolyzed supplementary porridge in addition to home foods, requires adequate care of the IYC and the necessary support of their mothers to facilitate weight gain, catch up growth and an improvement in haemoglobin levels (Lassi et al., 2013; WHO, 2012). Often, optimal complementary feeding of IYC with MAM is not adequately supported by the health care system through targeted nutrition education of mothers.

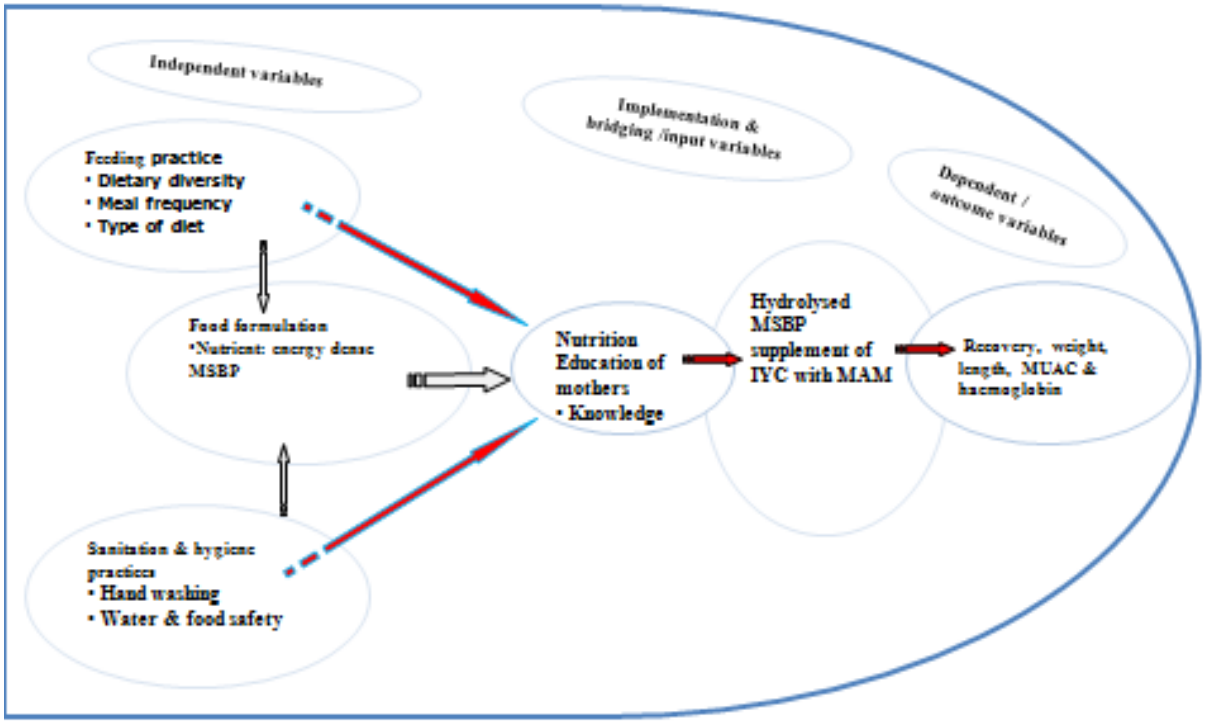

Figure 1.2: Study conceptual framework

The study conceptual framework illustrated in Figure 1.2 suggests that the nutritional status of breastfed IYC with MAM can be improved if they are supplemented with a culturally acceptable energy rich, nutrient dense supplementary porridge (MSBP) in addition to their mothers receiving appropriate, targeted nutrition education (Briend et al., 2015; Lassi et al., 2013; Lazzerini et al., 2013; Phuka et al., 2012). An improvement in weight, length, mid-upper arm circumference (MUAC) and haemoglobin levels among IYC diagnosed with MAM, can be achieved if the IYC does not suffer from medical complications (WHO, 2012; MoH, 2010).

1.7 Objectives

- To determine the ideal MSBP ingredient proportion to yield an energy rich, nutrient dense supplementary porridge with acceptable sensory attributes and viscosity levels.
- To determine the socio-demographic characteristics and complementary feeding practices of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM.

- To determine the anthropometric measurements and haemoglobin level of breast fed IYC aged 6 to 18 months supplemented with MSBP or CSB+ porridges for a period of three months.
- To determine knowledge, complementary feeding and hygiene practices of breastfeeding mothers before and after receiving nutrition education in conjunction with MSBP or CSB+ supplementary porridge for a period of three months.
- To determine breastfeeding mothers' perceptions and barriers to IYC feeding during the management of their IYC with MAM with MSBP or CSB+ supplementary porridge for a period of three months.

1.8 Study Hypotheses

- There will be no statistically significant difference between the anthropometric status, namely weight, length and mid-upper arm circumference (MUAC), and haemoglobin levels of breastfed IYC aged 6 to 18 months diagnosed with MAM, irrespective of whether they were fed MSBP or CSB+ supplementary porridge for a period of three months.
- There will be no statistically significant difference between the hygiene and complementary feeding practices (dietary diversity and meal frequency) of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM before and after they received targeted nutrition education in conjunction with their IYC receiving MSBP or CSB+ supplementary porridge for a period of three months.

1.9 Reliability and validity

1.9.1 Reliability

Reliability refers to precise results, achieved by using a large sample size. A study sample with low statistical power has a reduced chance of detecting a true effect, thereby undermining reliability (Button et al., 2013). In this study, sample size was calculated with a desired power (Z_α) of 1.96 calculated using the fixed clusters and flexible cluster size equation (Brestoff & Broeck, 2013; Hemming, Girling, Sitch, Marsh, & Lilford, 2011) to detect differences at the power (β) of 95%. This yielded a sample size of 220 mother-IYC pairs. To avoid participant

variation, breastfeeding mothers with IYC diagnosed with MAM recruited at baseline, were followed up throughout the cRCT period of three months. Purposive sampling for FGDs and IDI was also done from the sample of mothers who participated in the cRCT.

Use of a conceptual framework [United Nations Children's Fund (UNICEF) 1998] and the HBM (Bandura, 1977) provided the necessary theoretical framework for developing some of the questions included in the research instruments, FGD guides and IDI schedules. In addition, the FGD guides and IDI schedules were also developed with reference to the relevant literature. To further enhance reliability, trained research assistants and focus group facilitators were used for data collection, conducting FGDs and IDIs. All research instruments and IDI guides were piloted prior to data collection. Anthropometric measurements were repeated and measured according to WHO guidelines (WHO, 2008b), while haemoglobin levels were measured according to standard procedures (WHO, 2010). Double data entry limited data entry errors.

1.9.2 Validity

For assessment of socio-demographic variables, the Uganda Demographic and Health Survey (UDHS) questionnaire (UBOS, 2018) was used. To classify complementary feeding practices (dietary diversity and meal frequency), the WHO classification for complementary feeding practices using a 24-hour recall (WHO, 2008a) was adopted. The questions for measuring maternal nutrition knowledge regarding complementary and hygiene practices, were adapted from Marías and Glasauer (2014). It was subsequently modified after consultation with experts. Construct, content, and face validity of the research instruments were ensured by the construction of a theoretical framework and consultation with experts.

Quantitative data analysis provides an estimate of uncertainty arising from systematic errors, thereby combating overconfidence in the research results (Lash et al., 2014). Many effect estimates may be biased by failure to adjust for outcome confounding (Garabedian, Chu, Toh, Zaslavsky, & Soumerai, 2014). Therefore, a good study design and appropriate statistical analysis, minimises bias and confounding respectively, thereby yielding accurate data. In this study, the role of chance (random error) was addressed by performing statistical tests appropriate to the measured effect sizes. Effect sizes such as Odds Ratios were reported together with a 95% CI. Chi-square tests were reported with the relevant p-values, where the cut off for statistical

significance was set at < 0.05. In order to understand the effect of MSBP on the nutritional status of IYC with MAM, a cRCT design was used to minimise confounding, as well as to determine the association between the independent and dependent variables. Multivariate logistic regression analysis was used to control for possible measured confounders.

The participant recruitment phase had a 98% response rate with the majority of breastfeeding mothers with IYC 6 to 18 months who were diagnosed with MAM accepting to participate. The male to female ratio of IYC was 1:1, therefore being indicative of no selection bias in terms of IYC gender. Only the mothers of IYC, as opposed to caregivers and the father, were recruited for participation, as they were responsible for the complementary feeding of their IYC.

Measurement bias can occur as a result of measurement error occurring during data collection. In this study, measurement error related to IYC weight, length, MUAC and haemoglobin levels, was minimised by using the same calibrated equipment, trained research assistants and supplementary foods throughout the study. Nutrient analysis of the best MSBP formulation was conducted in accordance with standard reference protocols (AOAC, 2012). The survey questionnaires were translated into the local language (Lugbarati) and back translated into English by professional translators to ensure that the data collected was an accurate reflection of the variables they intended to measure. Construct, concept and face validity was confirmed by ensuring that the research instruments measured the study objectives, related hypotheses and corresponding study variables (Table 1.1)

Research assistants with a social or health sciences background as well as being fluent in the local language Lugbarati and resident in the area where the study was conducted, were recruited and trained for a period of three days. This ensured that they were familiar with the research instruments and the constructs they measured, as well as acquiring the necessary interview skills and how to accurately complete the research instruments. Subsequently the research instruments were piloted among 24 breastfeeding mothers in an area with similar characteristics to the study, but did not fall under the sampled study area prior to commencement of data collection. Based on the outcome of the pilot study, survey questionnaires did not require modification.

In addition, research assistants were trained on how to take accurate anthropometric measurements, i.e. IYC weight, length and MUAC using calibrated instruments in accordance

with WHO standards (WHO, 2008b). All measurements were repeated twice and the mean calculated. If the two measurements differed by more than 200g for weight or 20mm for height respectively, a third measurement was taken and the mean of the two closest values recorded. Trained research assistants also measured IYC haemoglobin levels by means of a finger prick using a WHO standard procedure (WHO, 2010). A Hemocue Hb301 analyser 121805 was used to determine IYC haemoglobin levels.

In order to minimise measurement bias, the trained research assistants were blinded as to whether mother-IYC pairs were randomised into the intervention (MSBP) versus the control (CSB+) group, including the food rations they were issued with, as the packaging of both supplementary porridges were similar and were not labelled.

In an effort to enhance validity during the qualitative phase of the study, the researcher was present while FGDs took place, as per the suggestion from Marshall and Rossman (2014). Follow-up questions and probes were used to validate participant responses during the IDI and FGDs. In addition, the FGD facilitator regularly confirmed the content of discussions with participants to determine assertion, as well as the meaning of their non-verbal cues. At the end of every FGD, the results of the discussion were always confirmed with participants for validation purposes.

1.10 Research objectives, variable and data analysis

Research objectives, related variables and statistical analysis are presented in Table 1.1.

Table 1.1: Objectives, variables and data analysis matrix

Objective	Variables		Statistical analysis
	Independent	Dependent	
To determine the ideal MSBP ingredient proportion to yield an energy rich, nutrient dense supplementary porridge with acceptable sensory attributes and viscosity levels.	Soy, maize, and sorghum malt ingredients for MSBP formulation	Energy, nutrient composition, viscosity level and sensory attributes of MSBP	Analysis of variance, and independent t-test
To determine the socio-demographic characteristics and complementary feeding practices of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM.	Mother's age, parity, marital status, level of education, and care in food preparation	Minimum dietary diversity, minimum meal frequency, and minimum acceptable diet	Univariate, and Multivariate logistic regression anal
To determine the anthropometric measurements and haemoglobin level of breast fed IYC aged 6 to 18 months supplemented with MSBP or CSB+ porridges for a period of three months.	Energy rich, and nutrient dense MSBP and CSB+ supplementary porridges	Weight, length, MUAC, haemoglobin level, length-for-age weight-for-age & weight-for-length	Independent t-test, and z-test
To determine knowledge, complementary feeding and hygiene practices of breastfeeding mothers before and after receiving nutrition education in conjunction with MSBP or CSB+ supplementary porridge for a period of three months.	Nutrition education to mothers, MSBP and CSB+ supplementary porridges to IYC	Knowledge, meal frequency and dietary diversity	Independent t-test, and z-test
To determine breastfeeding mothers' perceptions and barriers to IYC feeding during the management of their IYC with MAM with MSBP or CSB+ supplementary porridge for a period of three months.	Nutrition education of mothers, MSBP and CSB+ supplementary porridge to IYC	Maternal perceptions and barriers	Content analysis based inductive approach

1.11 Study assumption

For the purpose of this study, the following assumptions were made:

- The mixing of MSBP ingredients was maintained throughout batch production with no adulteration.
- The mothers of IYC included in the study were truthful in their responses to the survey questionnaires.
- Interviews conducted by trained research assistants were done in a standardised manner as per the training they received.
- The mothers included in the study fed their IYC the daily ration of MSBP and CSB+ that was provided under appropriate standards of hygiene as was taught to the mothers during the nutrition education sessions that formed part of the intervention.

1.13. Study schema

In order to realise the research objectives, this study was conducted in the phases illustrated in Figure 1.3

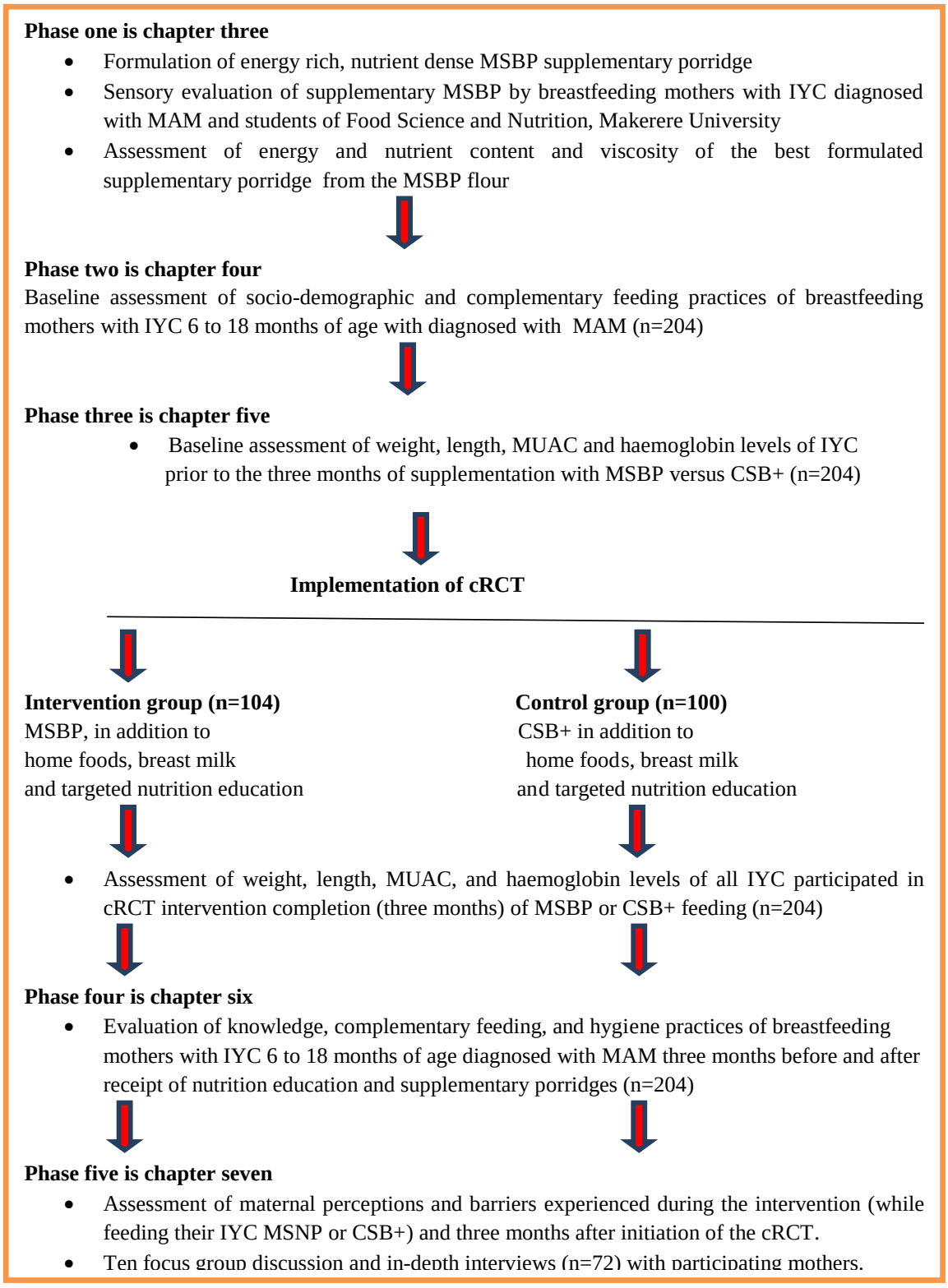

Figure 1.3: Study schema

1.12 Summary

The focus of this study was to develop an energy rich, nutrient dense MSBP supplementary porridge, determine the effect of MSBP versus CSB+ supplementary porridge on the nutritional status of IYC diagnosed with MAM as part of a cRCT, determine the socio-demographic characteristics and complementary feeding practices of breastfeeding mothers with IYC diagnosed with MAM that were included in the cRCT prior to its implementation, determine the knowledge and complementary feeding practices of mothers with IYC diagnosed with MAM after conclusion of the cRCT, and determine maternal perceptions and barriers to feeding their IYC with MAM the respective supplementary porridges MSBP (intervention) versus the standard care CSB+ (control) used for treating IYC with MAM in Uganda.

1.13 Structure of the thesis

This thesis is presented as eight chapters with chapter three to seven being presented in the form of research papers that address the respective study objectives:

- Chapter one introduces the study topic, its background at both a global and regional level, including Uganda where the study was conducted. In addition, the importance of the study, guidelines for the management of MAM, the study aim and related research objectives, hypotheses, reliability and validity of data, assumptions, definition of terms and abbreviations are presented.
- Chapter two presents a review of the related literature by reporting on theoretical frameworks and constructs that were consulted in the development of the study. In addition, related literature on the causes, consequences and management of MAM are presented, as well as considerations that need to be taken into account when formulating supplementary foods to treat MAM.
- Chapter three presents the formulation and assessment of the sensory attributes, viscosity and nutrient quality of MSBP for suitability in the management of IYC with MAM.
- Chapter four is devoted to reporting the socio-demographic characteristics, complementary feeding and hygiene practices of breastfeeding mothers with IYC diagnosed with MAM.

- Chapter five presents the anthropometric and haemoglobin outcome measures among IYC with MAM as a result of supplementation with MSBP versus CSB+ porridge.
- Chapter six reports on the effect of nutrition education on breastfeeding mothers' knowledge, feeding and hygiene practices during the treatment of their IYC diagnosed with MAM with MSBP as well as CSB+ supplementation.
- Chapter seven describes the assessment of breastfeeding mothers' perceptions and barriers experienced while feeding their IYC diagnosed with MAM the MSBP and CSB+ supplementary porridges in the course of implementing the cRCT.
- Chapter eight concludes the study with a discussion of the main study findings, a conclusion and recommendations for future investigations.

1.14 Ethical considerations

The study obtained ethical approval from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (BE218/18), the Higher Degrees, Research and Ethics Committee of the School of Public Health, Makerere University, Uganda (REC/11353/394), and the Uganda National Council of Science and Technology (SS 4705). A detailed explanation of the study objectives, materials and methods were given to key members of the community where the study took place to facilitate field mobilization. The study did not pose any economic and physical risk to participating mothers or IYC with MAM included in the study sample. Mothers of IYC diagnosed with MAM were issued a weekly ration of MSBP and CSB+ supplementary porridges. They also received a bar of soap once a month to improve their personal hygiene, thus preventing their IYC from contracting infectious disease such as diarrhoea. Mothers were also educated on how to avoid contamination of IYC food and to practice appropriate complementary feeding practices.

The researcher had no personal, social, financial and professional conflict of interest in conducting this study among IYC aged 6 to 18 months diagnosed with MAM. The funders of this study did not have any input into the study design, data collection, statistical analysis, decision to publish, presentation of the study finding, or preparation of manuscripts for publication in peer reviewed journals. The intellectual property of this study belongs to the University of KwaZulu-Natal.

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CHAPTER 2: REVIEW OF THE RELATED LITERATURE

2.1 Introduction

In Sub-Saharan Africa, including Uganda, the management of MAM among IYC has remained virtually unchanged for the past thirty years (Annan et al., 2014). It is therefore appropriate to review the efforts scholars have made to investigate and improve the efficacy of management strategies that have been employed to address this form of malnutrition. Hence, this chapter presents an overview of studies that have investigated the management of MAM among IYC, by highlighting where a paucity of data exists. Methodological considerations of these studies were also indicated, by referring to aspects such as study design, sample size, study location, statistical analysis and key findings. Operational considerations as well as advantages and disadvantages associated with a cRCT are also discussed.

In addition, the importance of using malt in relation to the nutrient density and energy content of supplementary foods are reported, as well as the importance of using malted foods in the treatment of MAM. This is followed by a critical discussion of studies that investigated the effect of malted supplementary foods on the nutritional status of IYC with MAM. Finally, mother's perceptions and knowledge regarding the use of supplementary foods and feeding practices in the management of IYC diagnosed MAM is reported.

2.2 Theoretical models used in planning nutrition education programmes

2.2.1 Intervention theory

Intervention theory describes the process of health promotion through scientific analysis of factors that contribute to the problem; methods and practical solutions that can be used to change health behaviour; designing and planning appropriate interventions; anticipated beneficiaries of an intervention, as well as implementation, sustainability and generation of evaluation plans (Merritt, Katz, Mojtabai, & West, 2015; Kulwa et al., 2014; Michie, Johnston, Francis, Hardeman, & Eccles, 2008).

Thus, the application of intervention theory includes a needs assessment, selection of appropriate methods, developing objectives, implementation of the intervention and evaluation thereof as detailed in the following case scenario with reference to the current study:

- Conducting a needs assessment: Conducting a baseline assessment to determine the association between maternal socio-demographic variables and complementary feeding practices. Search the literature to establish what is known about complementary feeding practices and nutrition interventions targeting IYC with MAM. Information on IYC feeding practices provides the background for the next step of the intervention.
- Developing objectives: To improve the nutritional status of IYC diagnosed with MAM; each mother-IYC pair receive a supplementary food and targeted nutrition education, mother-IYC pairs followed up, and assessment of IYC nutritional status at end line.
- Selection of appropriate theories, conceptual frameworks and methods: The Health Belief Model and the UNICEF conceptual framework were used as the main focus for behavioural change regarding complementary feeding and hygiene practices and implementation of the cRCT supplementation intervention.
- Implementation of intervention: Formulation of an energy rich, nutrient dense MSBP flour, screening for IYC with MAM, sourcing equipment for determining IYC nutritional status and haemoglobin levels, developing nutrition education aids, training research assistants and FG facilitators, provision of supplementary foods, provision of nutrition education, and intervention monitoring.
- Evaluation: Effect of MSBP supplementation on the nutritional status of IYC with MAM in conjunction with nutrition education evaluated using a cRCT design, three months after implementation of the intervention with CSB+ as the control and MSBP the treatment supplementary porridges.

2.2.2 Health Belief Model

The Health Belief Model (HBM) predicts an individual's motivation to undertake a health behaviour, depending on their perception regarding the required behaviour and likely course of

action (Glanz et al., 2015; Bandura, 1977). The model is often utilised as a conceptual framework for designing and implementing interventions that involve perceptions (French et al., 2012; Lytle, 2005). Individual perceptions refer to factors that affect perceptions of illness, prioritisation of health and health problems, beliefs regarding the causes of health problems and what the symptoms mean. Usually, the factors that require modification include demographic variables, perceived threats, and cues to action. According to the HBM, the likelihood of action being taken refers to the probability of adopting appropriate health behaviours. The main constructs of the model would be the perceived threat of MAM to IYC morbidity/mortality, perceived benefit of taking action, perceived negative outcomes associated with a particular intervention if any, and conviction that the intervention can be executed to completion in order to obtain the desired outcome. Therefore, an intervention that gives supplementary foods to IYC in conjunction with nutrition education of their mothers based on the Health Belief Model, could effectively manage MAM in low income settings (Mulualem, Henry, Berhanu, & Whiting, 2016). For example, a study conducted in Ethiopia that assessed the effect of nutrition education using the HBM in promoting the use of legumes for complementary feeding in 160 mother-child pairs, a significant improvement in maternal knowledge and nutritional status of children was found (Mulualem et al., 2016).

2.2.3 UNICEF conceptual framework

The United Nations Children's Fund (UNICEF), conceptual framework (1998) for IYC malnutrition, provides a guide for assessment, intervention, analysis and action (Balz, Heil, & Jordan, 2015; Menon, 2012) in rehabilitating IYC with MAM (Gillespie, van den Bold, Hodge, & Herforth, 2015; Dangour, Kennedy, & Taylor, 2013). In addition, the framework draws attention to the multisectoral challenges faced in the development and implementation of nutrition intervention strategies (Menon, 2012). Hence, the framework is used as a first step towards finding common ground in the management of MAM, as well as an approach to policy response (Gillespie et al., 2015).

The UNICEF conceptual framework illustrated in Figure 2.1 includes three levels (Requejo & Bhutta, 2015). These levels refer to the basic causes of malnutrition in a society (with reference to the community and country), underlying causes (related to families and households), and

immediate causes (affecting individuals). At the most immediate level, nutrition outcomes are determined by the consumption of nutrients by an IYC, as well as nutrient losses incurred as a result of acute or prolonged illness. Therefore, the immediate causes of MAM among IYC are inadequate dietary intake and disease, which if left untreated, can result in IYC mortality. In addition, basic causes of malnutrition include poverty and other inequalities such as household income (Latham, 2014; Steyn & Temple, 2008).

The underlying causes of malnutrition include inadequate access to food at household level, inadequate care of IYC, inadequate health services, an unhealthy environment, as well as a lack of maternal education and nutrition knowledge (Gillespie et al., 2015; Menon, 2012). Care is conceptualised as a set of behaviours at household level that converts resources into food and caring practices. Mothers are an important caregiver when it comes to health, hygiene and the provision of complementary foods to their IYC (Komro, Flay, Biglan, & Consortium, 2011). Hence, the framework recognises the fact that food security alone is not sufficient to sustain an optimal nutritional status, health status as well as IYC care has to complement adequate food intake (Latham, 2014; Hanson, 2013). Inadequate or inappropriate knowledge of mothers, limit household access to vital resources (WHO, 2012). In addition, the use of available resources is determined by the cultural, religious, economic and social systems of a specific country or community (Nnakwe, 2012).

Thus, the UNICEF conceptual framework has been adapted[2] and expanded to align more closely with emerging literature in terms of immediate, underlying and basic causes of malnutrition (Latham, 2014; Menon, 2012). Supplementary feeding of malnourished IYC can contribute to IYC developing to their full growth potential (Lenters et al., 2013) through improved dietary diversity and meal frequency (Gillespie et al., 2013; Shonkoff, Richter, van der Gaag, & Bhutta, 2012). Unfortunately there is a paucity of data regarding the impact of supplementary foods in conjunction with nutrition education to address MAM among IYC in Uganda.

[2] Adapted from UNICEF (1998). The State of the World's Children 1998. Oxford University Press, Oxford.

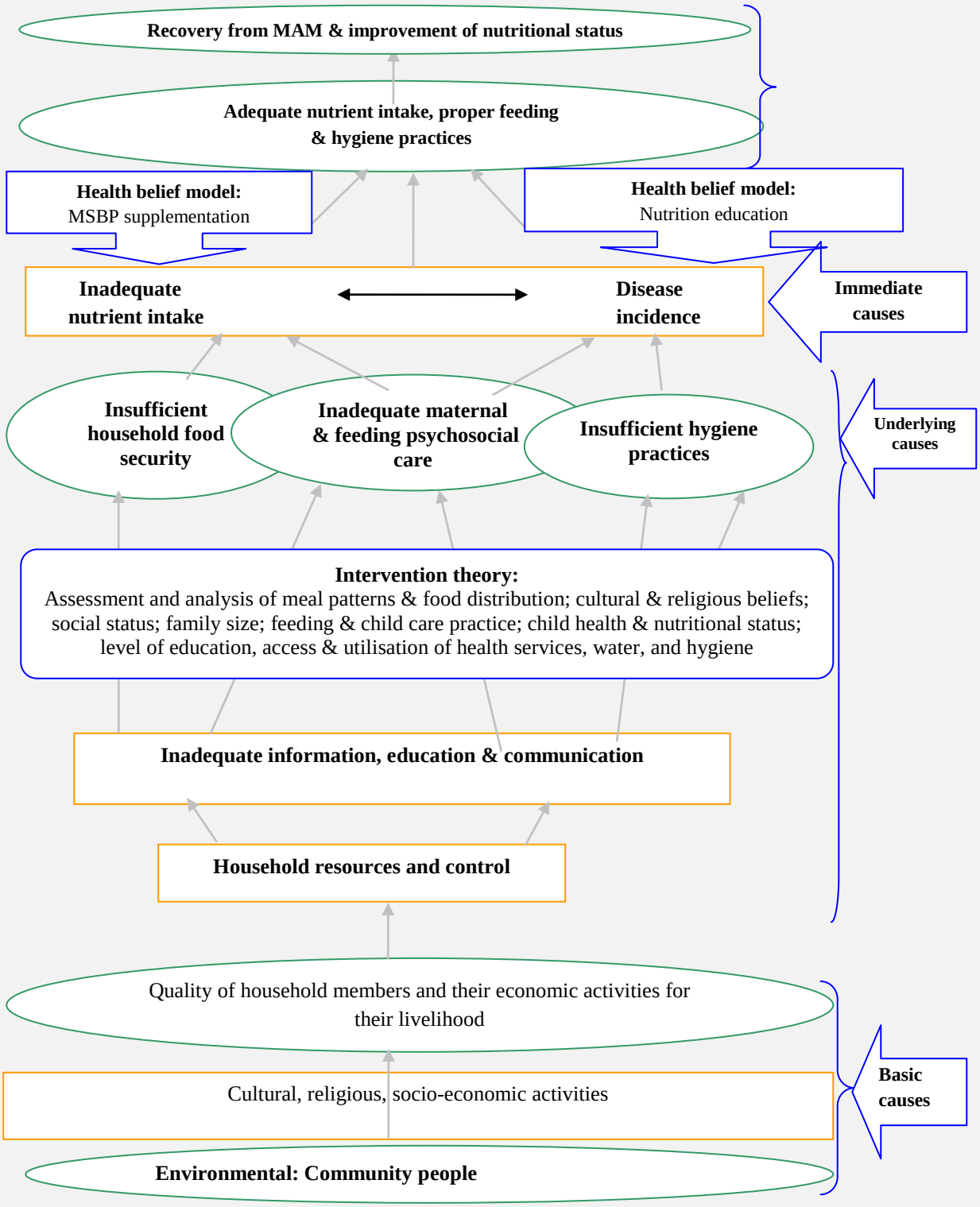

Figure 2.1: Adapted UNICEF (1998) conceptual framework grounded in the HBM (1977)

2.3 Public health importance of IYC with MAM

Data generated by UNICEF, WHO and the World Bank in 2016, shows that globally, about 5.2% of IYC under five are wasted, with nearly 35 million reported to suffer from have MAM (UNICEF, 2017). The same report indicates that more than two thirds (69%) of all wasted IYC under five lives in Asia, while more than a quarter (27%) reside in Africa. Data from several studies suggest that IYC younger than two years with MAM that progress to SAM, and seldom achieve their full potential in terms of physical, intellectual, or cognitive development (Cichon et al., 2016; Rytter et al., 2014).

There is consensus that diets in low income Asian and African countries are often deficient in macronutrients, micronutrients or both (Annan et al., 2014; WHO, 2012; Dewey & Adu-Afarwuah, 2008). These reports further emphasise that the low energy density of food often coexists with low nutrient density of complementary foods made from cereals fed to IYC. The WHO (2012) and Briend et al. (2015) indicate that an inadequate nutrient intake of IYC in sub-Saharan Africa is of public health concern (Briend et al., 2015; WHO, 2012). As a result, there is a definite need for the development of an energy rich, nutrient dense supplementary food to mitigate the high level of malnutrition among IYC.

2.4 Causes of MAM among IYC

The causes of MAM have remained the same for the last two and half decades and are no different from those described in the UNICEF (1998) conceptual framework (Menon, 2012). A considerable amount of literature alludes to the multi-factorial nature of undernutrition (Kinyoki, Berkley, Moloney, Kandala, & Noor, 2015; Prasad & Kochhar, 2015; Namugumya et al., 2014; Lenters et al., 2013; WHO, 2012; Hien & Hoa, 2009). Collectively, these studies have shown that poverty and food insecurity are significant constraints for gaining access to nutritious diets containing high quality protein, adequate micronutrients that are bioavailable, macronutrients and essential fatty acids. It is also important that nutritious diets should have a low anti-nutrient content, and high nutrient density (Ali Naser et al., 2014; Lenters et al., 2013; de Pee & Bloem, 2009). However, evidence suggests that diets that primarily consist of plant sources with a limited amount of animal sources and fortified foods, do not meet the abovementioned requirements and need to be improved through processing such as de-hulling, germination,

fermentation, fortification, as well as the addition of animal sources such as milk (Briend et al., 2015; de Pee & Bloem, 2009). Similarly, reports that insufficient access to nutritious food**,** a lack of care regarding appropriate IYC feeding practices, and inadequate access to clean safe water contribute to MAM among IYC (Anushree et al., 2015).

Immediate causes of MAM among IYC are diseases such as diarrhoea and inadequate food intake (WHO, 2012). On the other hand, Ashworth and Ferguson (2009) stated that a lack of purchasing power and nutrition knowledge may compound the situation. Furthermore, even if food is available, it is often not consumed in adequate quantities and the quality may be inferior. In addition, IYC are not always in a state of optimal health due to frequent illnesses such as malaria, diarrhoea and acute respiratory tract infections. The latter diseases often result in an impairment of their ability to optimally digest, absorb and utilise the nutrients in food. Immediate causes of MAM are in turn influenced by underlying causes that include a lack of food security, inadequate health services, a lack of maternal education, low incomes and inadequate care of IYC (WHO, 2012). These aspects are underscored by UNICEF (2013), indicating that an optimal nutritional status is the result of IYC having access to an affordable, diverse, nutrient dense food; adequate maternal and child care practices; adequate health services; and a healthy environment that includes safe water, and good hygiene practices. The combination and relative importance of these factors differ from country to country. Therefore, it would seem that an understanding of the immediate and underlying causes of MAM within a given context is crucial to delivering an appropriate, effective, and sustainable solution to adequately meet the nutritional needs of IYC with MAM.

2.5 Consequences of MAM among IYC

If undernutrition amongst IYC is not prevented or adequately managed, it will result in growth failure; delayed motor, cognitive, and behavioural development; a compromised immune response; as well as increased risk of morbidity and mortality (Kerac et al., 2014; Rytter et al., 2014; Victor, Baines, Agho, & Dibley, 2014; Bain et al., 2013; Martorell, 1999). In a review conducted in Sub-Saharan Africa by Bain et al. (2013), it was shown that IYC malnutrition was associated with 54% of deaths in developing countries (Bain et al., 2013). This finding seems to suggest that malnutrition contributes to disease, disability and mortality (Kuper, 2017). In

addition, IYC stunting, wasting, and underweight have individually been associated with increased mortality (McDonald et al., 2013). This association is echoed by Rytter et al. (2014) who reported that the impairment in immune function as a result of malnutrition among IYC, may contribute to increased mortality. Conversely, IYC with MAM may benefit from nutrition and other IYC survival interventions. Should these interventions not be implemented, MAM often progresses to SAM. Nevertheless, available literature seems to suggest that strategies that only involve the screening and treatment of malnourished IYC without the inclusion of a nutrition education component targeting their mothers and other caregivers, have a limited ability to address its impact on morbidity and mortality (Imdad et al., 2011).

Studies have documented the profound long term impact of undernutrition on morbidity (Bain et al., 2013; Chakravarty, Hazarika, Goswami, & Ramasubban, 2013). For example, malnourished Korean orphans adopted into American families showed residual poor performance in cognitive tests based on their nutritional status at the time of adoption (Schoenmaker et al., 2015; UNICEF, 2012; Pomerleau et al., 2005). Similarly, a series of longitudinal South African studies that assessed the impact of malnutrition before the age of two on physical growth and intellectual ability in adolescence, documented that these adolescents suffered from irreversible intellectual impairment (Black et al., 2013; Walker et al., 2007).

2.6 Supplementary food formulation for managing IYC with MAM

Legumes and cereals are most often used in the formulation of nutrient dense supplementary foods for IYC with MAM (WHO, 2012), especially because soy is a legume that is rich in protein, and maize is rich in energy (Lazzerini et al., 2013). Studies that have investigated the formulation of supplementary foods for the management IYC diagnosed with MAM is Sub-Saharan Africa, have reported that imported supplementary foods used for the management of MAM, are expensive and unaffordable by mothers with malnourished children (Briend et al., 2015; Nur & Mirghani, 2015; Muhimbula, Issa-Zacharia, & Kinabo, 2011). However, recent reviews reported the development of acceptable formulations from legumes and cereals that met the nutritional needs of IYC with MAM (Annan et al., 2014; Lazzerini et al., 2013). These formulation studies have shown that extruded and malted flours from cereals and legumes have

acceptable sensory attributes and efficacy in terms of increasing the weight of IYC. Furthermore, porridge formulations made from roasted soy, maize or both have been reported to be more acceptable than an unroasted soy-maize blend (Muhimbula et al., 2011). In contrast, use of unroasted soy based formulations has been reported to be acceptable from a nutrient perspective (Nur & Mirghani, 2015). Nevertheless, roasted soy improves the sensory attributes of soy based formulations, especially in terms of the aroma and smell (Muhimbula et al., 2011). In addition, it would be important to roast soy ingredients as it would decrease the activity of trypsin inhibitor and improve flavour (Lazzerini et al., 2013). The dilemma related to supplementary porridges formulated from traditional ingredients, is that they have a dry matter content that range from 5 to 10%. This results in a formulation with a low energy and nutrient density that is less suitable to meet the nutrient needs of IYC with MAM (Lazzerini et al., 2013).

2.6.1 Malted and /or extruded supplementary formulations for treating IYC with MAM

In most Sub-Sahara African countries, CSB+ supplementation is used to treat IYC with MAM in government institutions, IGNO and UN agencies, as well as IYC in emergency settings (Annan et al., 2014; Michaelsen et al., 2009). The need to develop an alternative energy rich, nutrient dense supplementary food to the current standard care for the management of the increasing number of IYC with MAM in stable communities (i.e. non-emergency situations), has been recommended (Lenters et al., 2013; WHO, 2012). Accordingly, developing supplementary foods from malted and extruded locally available raw ingredients is one approach that can be used to meet the nutritional needs of IYC with MAM (WHO, 2002). However, the extrusion process of producing CSB+ is very expensive (Ali, Singh, & Sharma, 2017). Therefore, it would seem that substitution of a portion of corn flour with enzyme active sorghum malt would be beneficial to IYC whose digestive function is often impaired due to malnutrition. The production cost would also be reduced, by rendering a more cost effective supplementary food.

However, currently there is a lack of consensus regarding the formulation protocol for a cereal based supplementary food for the management of IYC diagnosed with MAM (Anushree et al., 2015; Briend et al., 2015; Lazzerini et al., 2013; WHO, 2012; Muhimbula et al., 2011). Briend et al. (2015) reported that the formulation of an alternative, more affordable and more effective food supplement poses many challenges, as there are uncertainties regarding protein quality,

anti-nutrient content, and ingredients that contribute to an energy rich and nutrient dense supplementary food for IYC with MAM. However, several studies have shown that both extrusion and malting of local cereals and legumes reduce the bulkiness of starch based formulated foods (Briend et al., 2015; Lazzerini et al., 2013), and improve the protein ratio and quality of the product (Muhimbula et al., 2011).

2.6.2 Nutrient density of malted and/or extruded formulations for treating IYC with MAM

Often, the formulation of supplements from unprocessed cereals and legumes yields a product with a low nutrient density due to the gelatinization of starch during cooking (Nur & Mirghani, 2015). The problem associated with cereals and legumes that have a low nutrient density is addressed by the application of either extrusion or malting techniques, as it results in nutrient dense foods that are beneficial to IYC with MAM (Lazzerini et al., 2013; Lin, Manary, Maleta, Briend, & Ashorn, 2008).

Recent studies have reported that the energy density of formulated supplementary foods were between 0.7 and 1.1kcal/g (Annan et al., 2014; Lazzerini et al., 2013). Conversely, complementary foods of a poor quality that are high in fibre and have a low nutrient-density, contribute to IYC undernutrition (Kahsay, 2016). In a study conducted by Kahsay (2016), it was shown that a higher fibre content of foods formulated for IYC often compromises its nutrient density. In addition, Tizazu et al. (2010) suggested that IYC with moderate wasting would require the consumption of food with an energy density ranging between 1.5 and 2.0kcal/g. Previous studies have shown that nutrient density is a key aspect of appropriate supplementary feeding and needs to be improved if it is used in the management of IYC with MAM in low income countries (De Carvalho, Granfeldt, Dejmek, & Håkansson, 2015; Ndagire, Muyonga, Manju, & Nakimbugwe, 2015; Kayodé, Nout, Bakker, & Van Boekel, 2006).

Numerous studies have demonstrated that malting and extrusion processes increase the nutrient density of cereal-legume based foods (Lazzerini et al., 2013; Khader & Maheswari, 2012; Dossa et al., 2011; King, Prawitz, Umoren, & O'Gorman, 2007). Muhimbula et al. (2011) demonstrated that supplementary foods formulated from malted staple cereals such as corn, sorghum and finger millet, and legumes such as beans, cowpeas and green peas, had an improved protein content and energy density. It is therefore evident that the extrusion and malting

processes reduce bulkiness and improves nutrient density (Lazzerini et al., 2013; WHO, 2012; Tizazu et al., 2010; Golden, 2009). Therefore the formulation of supplementary foods based on a combination of extrusion and malting techniques could result in a product with a higher nutrient density, thereby making it appropriate for the treatment of IYC with MAM.

2.6.3 Nutrient specifications of supplementary foods used for treating IYC with MAM

The WHO (2012) estimates that the mean energy requirement of breast fed IYC with MAM is about 1,055 kcal per day. In addition, it is recommended that IYC with MAM would need to consume a supplementary food with a protein content of at least 14% and an energy content of 380 kcal/100 grams on a daily basis with a maximum fibre content of 4% (WHO 2012). A recent study by Kahsay (2016) recommends that in order to meet a fibre intake of not more than 0.5g/ kg body weight per day, its content in cereal-legume formulations should not exceed 2.5%. The estimated increase in energy and protein requirements according to age to allow twice the normal growth of IYC with MAM is presented in Table 2.1.

Table 2.1: Estimated energy and protein requirements of IYC with MAM

Age (months)	Estimated energy requirement		Estimated protein requirement	
	Normal IYC (kcal)	IYC with MAM (kcal)	Normal IYC (%)	IYC with MAM (%)
6-9	810	928	14.0	21
9-12	950	1,030	14.0	21
12-18	1150	1,208	13.5	20.3

Source: Food and Agriculture Organisation (FAO). Estimates of energy and protein requirements of IYC[3]

Therefore, a malted sorghum based supplementary porridge formulation could be one approach used to meet the nutritional requirements of IYC diagnosed with MAM. However, there is a need to evaluate the effect of this formulation on the nutritional status of IYC diagnosed with MAM. As there has been a lack of consensus regarding an optimal formulation protocol for cereal-legume based diets, contributions to feasible and practical recommendations to improve the development of supplementary foods made from indigenous foods will contribute to the paucity of data on the topic.

[3] Accessed at: http://www.fao.org/docrep/003/aa040e/AA040E05.htm

2.7 Socio-demographic characteristics, complementary feeding practices and morbidity of IYC with MAM in developing countries

2.7.1 Socio-demographic characteristics of IYC with MAM

It has been reported that a mother's level of education is a strong predictor of the nutritional status of her offspring (Ickes, Hurst, & Flax, 2015; Abuya, Ciera, & Kimani-Murage, 2012; Semba et al., 2008). In addition, the most consistent indicators of inappropriate complementary feeding practices are a lack of maternal education and lower household income (Senarath et al., 2012). A study conducted in Bangladesh found that a low level of maternal education was associated with lower meal frequency, lower dietary diversity, and minimum acceptable diet of IYC compared to mothers with a secondary level of education or higher (Kabir et al., 2012). In addition, a study conducted in the slums of Nairobi, Kenya that included infants younger than 12 months of age, found that maternal level of education was associated with an improved IYC nutritional status (Abuya et al., 2012). In the latter study, mothers whose IYC were well nourished were more likely to have been fed more regularly than those with MAM. These findings are supported by Iuel-Brockdorf et al. (2016) who documented that IYC feeding behavioural change of educated mothers is related to embracing appropriate complementary feeding practices. In order to address complementary feeding practices, strategies should include behavioural change, communication on the consumption of a diverse diet, along with providing families with the necessary support to produce a variety of foods (Saha et al., 2008b). In a systematic review conducted by Lass et al. (2013) on the impact of a maternal level of education on IYC complementary feeding practices and the provision of complementary foods, it was recommended that nutrition education should be combined with the provision of appropriate complementary foods (Lassi et al., 2013). This implies that mothers with low levels of education may find it difficult to adopt and implement educational instructions (Iuel-Brockdorf et al., 2016). It is therefore evident that there is a relationship between a mother's level of education and the nutritional status of her IYC.

Data from previous studies have shown that household food security is associated with complementary feeding practices of IYC (Macharia, Ochola, Mutua, & Kimani-Murage, 2018; Saha et al., 2008a; Saha et al., 2008b), and that the consumption of foods with a low energy density, have implications regarding nutrition security (Golait & Pradhan, 2016). The results of

a study conducted by Saha et al (2008a) in Bangladesh, found that household food security was associated with the age at which complementary foods were introduced to IYC. In addition, a study that assessed the food security of IYC aged 6 to 36 months, found that the household dietary diversity score and food consumption score was associated with stunting but not wasting (Saaka & Osman, 2013). Compared to children in food insecure households, children in food secure households are protected from stunting by 46%, thereby implying that food security is strongly associated with IYC nutritional status (Saaka & Osman, 2013).

2.7.2 Complementary feeding practices of IYC with MAM

Inappropriate complementary feeding practice is one of the major causes of undernutrition among IYC (Victor et al., 2014). It has been established that improving IYC complementary feeding practices in terms of meal frequency and dietary diversity, improves health and reduces child mortality (Ickes, Hurst, et al., 2015; Victor et al., 2014; Senarath et al., 2012). Recent findings from Bangladesh, Ethiopia, India, and Zambia, reported that the WHO indicators of dietary diversity and meal frequency were positively associated ($p<0.05$) with height-for-age z-scores (Jones et al., 2014). However, these IYC complementary feeding indicators did not show a consistent relationship with IYC stunting (height-for-age) among those aged 6 to 23 months (Jones et al., 2014).

Several studies have shown how inadequate nutrition due to inappropriate complementary feeding practices in terms of a lack of dietary diversity and low meal frequency, results in a poor nutritional status of IYC (Irene Olmedo & Valeggia, 2014; Aemro, Mesele, Birhanu, & Atenafu, 2013). A study conducted in Ethiopia investigated the dietary diversity and meal frequency among IYC aged 6 to 23 months. Findings were that those who attainted an adequate dietary diversity score and meal frequency were 10.8% and 44.7% respectively. In addition, a low nutrient density of staple foods and a lack of traditional supplementary foods in low income countries have made a significant contribution to a poor nutritional status among IYC (Lassi et al., 2013; WHO, 2012). IYC are often fed starchy household foods with basic texture modifications like mashing. Furthermore, an inadequate feeding frequency and low dietary diversity resulting in a low score for acceptable diets have also been reported to affect the nutritional status of vulnerable IYC (Sunguya et al., 2014). Various studies have established that the predominant factors associated with suboptimal complementary feeding practices among

IYC aged 6 to 23 months include: low socio-economic status, low level of maternal education, and poor maternal nutrition knowledge (Issaka et al., 2015; Victor et al., 2014; Senarath et al., 2012). A study conducted in rural Malaysia concluded that household food insecurity was associated with a poor nutritional status of IYC (Ali Naser et al., 2014), whereas a cross sectional study conducted in India, found that dietary diversity, meal frequency, and an acceptable diet were respectively adequate among 32.6%, 48.6% and 19.7% of IYC between six months and two years of age (Khan, Kayina, Agrawal, Gupta, & Kannan, 2012). The studies presented thus far provide evidence that a poor nutritional status among IYC is often exacerbated by a lack dietary diversity and infrequent feeding.

2.7.3 Prevalence of morbidity among IYC with MAM

Numerous studies have investigated the relationship between Protein Energy Malnutrition (PEM) and morbidity among IYC under two years of age (Batool, Butt, Sultan, Saeed, & Naz, 2015; Sood & Sood, 2015; Kavosi et al., 2014). In a study that was conducted to determine the prevalence of PEM and its association with common morbidities among children aged one to five years residing in urban slums in India, Sood and Sood (2015) documented a 60.2% prevalence of PEM with children included in the study sample having a history of acute respiratory tract infections. Over a third (33.8%) children were underweight, 66.0% were stunted and 29.9% were wasted. Furthermore, 33.7% had a history of diarrhoea, thereby indicating an inverse relationship between infectious disease and poor nutritional status.

The impact of supplementary foods coupled with nutrition education on the morbidity and appetite of IYC with MAM after a period of supplementation is not known (Lassi et al., 2013; Lutter & Rivera, 2003). In a study that assessed the morbidity and nutritional status of preschool children before and after supplementation with malted foods in India, it was found that after supplementation, morbidity decreased by 50% (Khader & Maheswari, 2012). Malaria, diarrhoea, and acute respiratory tract infections frequently co-exist with MAM and are related to a decline in nutritional status of IYC (Kulkarni, 2016; Sood & Sood, 2015).

2.8 Management of IYC with MAM

Several reviews have reported a paucity of data regarding the optimal nutrient needs of IYC with MAM (Briend et al., 2015; Annan et al., 2014). However, some recommendations have been proposed (WHO, 2012; Golden, 2009; Michaelsen et al., 2009). The current WHO guidelines for the treatment of MAM recommends that IYC aged 6 to 23 months diagnosed with MAM are eligible for receiving energy rich and nutrient dense supplementary feeding (Lenters et al., 2013; WHO, 2012). In an analysis of the management of MAM in Sub-Sahara Africa, Annan et al. (2014) found a range of practices being implemented on admission and discharge of IYC with MAM among different organisations. For example, nearly half of the organisations included in the review included stunted non-wasted IYC in the supplementation programme. In addition, the majority of organisations used the National Centre for Health Statistics growth reference charts instead of the recommended WHO growth standards (Annan et al., 2014). These findings are supported by that of Tappis et al. (2012) who evaluated the coverage and effectivity of a supplementary feeding programme for malnourished IYC under five in Kenyan and Tanzanian refugee camps. It was concluded that appropriate management on admission and enrolment in supplementary feeding programmes was successful in preventing cases of acute malnutrition as well as mortality (Tappis et al., 2012).

Numerous studies have reported a corn and soy blend as the predominant supplementary food used in management of MAM (Briend et al., 2015; Lazzerini et al., 2013; Michaelsen et al., 2009). Collectively it has been documented that supplementary feeding programmes targeting IYC with MAM provide fortified blended foods, such as corn and soy with the addition of oil and sugar, despite its limitations. However, for the appropriate feeding of malnourished IYC, fortified blended foods need to be improved or replaced with active malt based porridges (Annan et al., 2014; Michaelsen et al., 2009), as earlier studies indicated the need for data to compare the effectivity of modified supplementary foods to current fortified blended foods for treating IYC with MAM (Annan et al., 2014; Dewey & Adu-Afarwuah, 2008). Although there are several types of supplementary foods under development for the treatment of IYC with MAM, shortcomings include a high anti-nutrient content, bulkiness, high viscosity, poor absorption and a lack of essential vitamins and minerals (Lazzerini et al., 2013).

2.8.1 Effect of supplementary foods on the nutritional status of IYC with MAM

Several systematic reviews have been conducted to determine the efficacy of supplementary foods on the nutritional status of IYC with MAM (Annan et al., 2014; Lazzerini et al., 2013; Lenters et al., 2013). Numerous authors have alluded to the importance of conducting high impact studies in different settings to evaluate the management of IYC diagnosed with MAM in low and middle-income countries due to various approaches and formulas that have been implemented in different settings. These include the provision of lipid-based nutrient supplements or blended foods, either as a full daily dose or as a low dose to complement the usual diet (Lazzerini et al., 2013). In addition, the provision of commercially and locally processed supplementary foods are acceptable and recommended for the treatment of IYC with MAM (Annan et al., 2014; WHO, 2012).

Furthermore, the use of nutrient dense foods to treat IYC diagnosed with MAM without medical complications have been recommended (Lenters et al., 2013; Lin et al., 2008). Recommendations include an energy density of 1.5 to 2.0 kcal/g as being suitable (Tizazu et al., 2010). In view of the evidence provided, it could be argued that specially formulated supplementary foods increase recovery rates among IYC diagnosed with MAM (Matilsky, Maleta, Castleman, & Manary, 2009; Manary & Sandige, 2008). However, it would seem to be a lack of consensus regarding the most effective protocol to treat IYC with MAM.

Some studies have indicated that the provision of supplementary foods such as CSB+ for the treatment of IYC with MAM increases recovery rates and improves wasting (Lazzerini et al., 2013; WHO, 2012). A study conducted at a health facility in Uganda, used a sorghum peanut mixture with the addition of ghee and honey as supplementary food for the management of MAM among IYC aged 6 to 59 months. It resulted in a satisfactory recovery rate of 82.3%, thus meeting the Sphere Standards of ≥75% (Greaney, Pfiffner, & Wilson, 2011; Ochola et al., 2014). However, the recovery rate for IYC younger than two years was not reported seperately and the red sorghum variety was used in the formulation. Hence it contained the anti-nutrient tannin that was not reduced with processing techniques (Alowo et al., 2018). A study conducted among rural Malawian IYC aged 6 to 18 months, used a peanut-soy-based fortified spread and corn porridge fortified with fish powder as complementary foods. The intervention outcome

reported a significant improvement in weight and length (Lin et al., 2008). In addition, children (1362) supplemented with a fortified spread of milk/peanut and soy/peanut in the rural southern region of Malawi, had a recovery rate of 80% compared to 72% for those supplemented with CSB+, and the difference was statistically significant (Matilsky et al., 2009). Thus implying that fortified spreads were superior to CSB+ flour for the management children aged 6 to 60 months with MAM (Matilsky et al., 2009).

A systematic review that investigated the treatment of MAM in low and middle income countries, found that several studies using CSB+ to treat IYC, were less likely to result in recovery and a greater likelihood for non-response to treatment (Lenters et al., 2013). In another study, CSB+ did not exhibit any significant benefit over the use of locally produced blended foods in terms of the number of IYC that recovered, the number who died or gained weight (Lazzerini et al., 2013). Furthermore, a RCT conducted by Bisimwa et al. (2012) among rural Congolese infants, compared the effectivity of a fortified soybean-corn-sorghum ready-to-use complementary food paste to a fortified corn soy blend. The finding was that there was no significant difference in terms of infant stunting and underweight when comparing the two arms of the trial. Thus, the effectivity of these supplementary foods in improving the nutritional status of undernourished children depends on household use of the supplementary foods by caregivers (Ickes et al., 2012). Based on the above evidence, it would seem that the use of CSB+ as a supplementary food had a modest effect on the improvement of anthropometric measurements such as MUAC, weight and wasting of IYC with MAM.

2.9 Nutrition education, complementary feeding and hygiene practices of mothers with IYC diagnosed with MAM

A systematic review conducted by Imdad, Yakoob and Bhutta (2011), concluded that the provision of appropriate complementary foods in conjunction with nutrition education resulted in a significant improvement in weight and length of IYC aged 6 to 24 months. In addition, studies have shown that nutrition education regarding appropriate complementary feeding practices can effectively treat MAM, but that interventions targeting MAM often include inadequate nutrition education or lack a nutrition education component (Ashworth & Ferguson, 2009). Furthermore, a review using the results from various meta-analysis concluded that the effect of nutrition education on complementary feeding practices resulted in a significant reduction in the

prevalence of stunting and underweight, although a significant impact on length and weight gain among IYC younger than two years of age was not found (Jones et al., 2014; Lassi et al., 2013; Imdad et al., 2011). A study conducted in India found that the promotion of appropriate complementary feeding practices of IYC generated results similar to the above study in terms of IYC length (Bhandari et al., 2004). Hence, there seems to be some evidence that nutrition education in conjunction with the provision of appropriate complementary food results in an improvement of nutritional status among IYC with MAM, although empirical data is lacking.

Additional evident suggests that if appropriate complementary feeding practices, including proper hygiene practices as part of nutrition education strategies are implemented, an IYC with MAM recover more rapidly (Jones et al., 2014). However, the practice of handwashing after contact with excreta is poorly practiced, with an overall average of 19% globally (Freeman et al., 2014), despite the likely positive health benefits. This result seems to suggest that much promotional work is still needed to increase the frequency of this practice (Freeman et al., 2014).

Further, nutrition education on appropriate complementary feeding and hygiene practices that target mothers of IYC have been reported to significantly improve knowledge, nutritional status, and minimise disease when combined with the provision of supplementary foods in the management of MAM (Lassi et al., 2013; Imdad et al., 2011).

A recent study reported that appropriate dietary diversity, defined as the consumption of food from four food groups, was found to have the potential to improve linear growth of IYC and should therefore be incorporated in tailored interventions (Onyango, Borghi, de Onis, del Carmen Casanovas, & Garza, 2014). In addition, it is seems that nutrition education has the ability to improve a mother's attitude towards appropriate complementary feeding practices, especially in terms of the number of meals IYC should be fed, as well as the variety of foods that should be consumed on a daily basis (Negash et al., 2014; Flax et al., 2009). For example, a Malawian study found that a positive attitude towards complementary feeding has a significant impact on the nutritional status of IYC diagnosed with MAM (Flax et al., 2009). Overall, these studies support the idea that nutrition education with the emphasis on feeding a diverse diet, regular meal frequency while preparing IYC meals, resulted in an improvement of nutritional status.

An analysis of IYC factors associated with complementary feeding practices in Ethiopia and Uganda, reported that mothers of IYC who were given nutrition education regarding appropriate complementary feeding practices, attained improved feeding practices (Diddana, Kelkay, Dola, & Sadore, 2018; Mokori, Schonfeldt, & Hendriks, 2017; Negash et al., 2014). Nutrition education regarding an improvement in the consumption of nutrient dense foods by undernourished IYC is essential among mothers who are willing to change their existing IYC feeding practices. A nutrition education intervention conducted by Negash et al., (2014) over a period of six months in Ethiopia, showed an improvement in the complementary feeding practices of mothers with a concomitant improvement in the nutritional status of their IYC. Similarly, a randomised control trial conducted in Peru, reported an improvement in the complementary feeding practices of mothers and the nutritional status of their young children at 18 months after nutrition education had been implemented since birth (Penny et al., 2005). A nutrition education intervention using a longitudinal, prospective, randomised design with a duration of six months that was implemented in Vietnam, found that children aged 5 to 25 months in the intervention group, received more frequent meals when compared to those in the control group (Pachón et al., 2002). Therefore, the evidence presented in this section suggests that nutrition education is effective in facilitating an improvement in complementary feeding practices.

2.10 Maternal perceptions and barriers regarding supplementary feeding

There are relatively few studies that have investigated mothers' perceptions, barriers to implementation and experiences regarding complementary feeding practices of their IYC with MAM before and after the introduction of supplementary food in conjunction with nutrition education. However, a study conducted by Ickes et al. (2012) that investigated the barriers to home-based supplementary feeding with ready-to-use supplementary food for underweight children in Uganda, found that caregivers perceived an intervention of this nature as having a positive effect on the health of malnourished IYC (Ickes et al., 2012).

In the study conducted by Flax et al. (2009) in Malawi that examined the efficacy of lipid-based nutrient supplements (LNS) versus CSB+ in the promotion of growth among IYC with MAM, mothers demonstrated a positive attitude toward LNS and CSB+. Contrary to both supplements

being acceptable, it was found that mothers in the LNS group were more likely to withhold supplements from their IYC when coughing, due to its sweetness (Flax et al., 2009). Thus implying that the provision of supplementary foods for malnourished IYC children requires a positive attitude from mothers, as well as appropriate nutrition education (Nor et al., 2012; Flax et al., 2009). In practice, efforts to improve the nutritional status of IYC should not assume that the provision of a supplementary food to mothers of IYC with MAM will automatically result in IYC being fed with it. As per the HBM, if an individual does not deem an intervention to be of value/importance, the required behaviour will not be implemented (Bandura, 1977). Nutrition education has created an awareness of mothers' experiences while caring for their malnourished IYC with supplementary foods (Ashworth & Ferguson, 2009). Under certain circumstances, IYC fail to recover from MAM, may progress to SAM, while others default, and some die (Lazzerini et al., 2013). As a result, the provision of nutrition education regarding the importance of IYC feeding practices should be a mandatory component of any food supplementation strategy.

Furthermore, in an Ethiopian study that examined caregivers' and health workers' perception regarding the use of ready-to-use therapeutic food in a chronically food insecure area, it was reported that caregivers used the food to meet household food and economic needs (Tadesse, Berhane, Hjern, Olsson, & Ekström, 2015a). Thus suggesting that breast feeding mothers of IYC diagnosed with MAM, might use the supplementary food in ways that compromise its impact on the nutritional status of the IYC it was intended for (Tadesse et al., 2015a). In addition, a review of the role that food insecurity plays in adherence to appropriate IYC care and treatment, it was found that interventions addressing adherence to a care treatment protocol might improve recovery rates (Young, Wheeler, McCoy, & Weiser, 2014). However, it is evident that there remain several aspects of mothers' perceptions and experiences regarding the use of supplementary foods that requires further investigation, as it is often assumed that mothers will feed their malnourished IYC with the food rations supplied. However, it is possible that some mothers may not comprehend the importance of feeding their malnourished IYC with the food rations provided.

In low-middle-income countries, the most commonly reported barriers to appropriate IYC feeding practices are a lack of time, household food insecurity, and a lack of social support from

household members (Nankumbi & Muliira, 2015; Jones, Agudo, Galway, Bentley, & Pinstrup-Andersen, 2012; Nor et al., 2012). It is therefore evident that many IYC could be receiving inadequate supplementary food (Lazzerini et al., 2013), compounded by social and care issues as a result of socio-economic status (Nankumbi & Muliira, 2015; Nor et al., 2012). In addition, some mothers might be seeking complementary treatment options such as traditional and spiritual healers as an adjunct to mainstream treatment options including supplementary foods (Nor *et al*., 2012). It is also evident that the decision of mothers to feed their IYC the supplementary foods they are issued with, is based on whether they believe in the ability of these foods to treat MAM (Diddana et al., 2018) However, little is known about how mothers perceive the dietary treatment of their IYC diagnosed with MAM (Lenters et al., 2013). Furthermore, the barriers experienced by mothers of IYC with MAM using the prescribed supplementary foods are unknown as research by others (Langlois, Suri, Walton, & Rogers, 2017; Nakumbi and Muliira, 2015) have not investigated this phenomenon in relation to malnourished children expect with care givers with healthy IYC, as health workers often assume that mothers will feed their malnourished children the supplementary foods issued to them.

2.11 Summary

The review has focused on supplementary food formulation, maternal socio-demographic characteristics and their relationship to IYC feeding practices, theories and conceptual frameworks that guided the development and implementation of intervention studies, policies regarding the management of MAM among IYC, conducting nutrition education on complementary feeding practices, as well as maternal perceptions regarding supplementary feeding. The literature review showcased what would seem to be a need for the development of an energy rich and nutrient dense supplementary food for the management of IYC diagnosed with MAM. Several lines of evidence suggest that supplementary foods fed to IYC are largely plant-based or fortified. As a result, IYC with MAM might not be meeting their nutrient requirements. The latter can be improved by the use of appropriate processing techniques in the manufacture of nutrient dense supplementary food, as the literature highlights the need to control the bulkiness and fibre content of supplementary foods. Therefore, formulations of food based on a combination of extrusion and malting techniques, would render a supplementary food with a higher nutrient density for the treatment of IYC with MAM.

Thus far, literature has shown that there is no definitive consensus on the most effective treatment protocol for managing IYC with MAM. Considering all the evidence presented, it is evident that a number of supplementary foods that are currently used in the management of MAM, including CSB+, have a modest potential to improve the anthropometric status of IYC with MAM. As a result, these studies highlight the need for developing an alternative IYC supplementary food with an appropriate nutrient density to improve nutritional status. However, despite a paucity of empirical data, there seems to be some evidence indicating that nutrition education in addition to the provision of supplementary food improves the nutritional status of IYC with MAM. Overall, studies support the notion that nutrition education guided by the HBM and the UNICEF conceptual framework improves the complementary feeding and hygiene practices of mothers, resulting in an improved IYC nutritional status. The evidence presented in this literature review, suggests that nutrition education is effective in improving complementary feeding practices. However, little is known about mothers' perceptions, barriers, and experiences to implementation of supplementary feeding interventions in the management of IYC with MAM. In addition, there is lack of published findings of studies conducted in Uganda that investigated the effectivity of using indigenously formulated malted supplementary foods for the management of IYC with MAM.

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CHAPTER 3: FORMULATION, SENSORY ATTRIBUTES AND NUTRIENT DENSITY OF A MALTED SORGHUM BASED PORRIDGE FOR THE MANAGEMENT OF MODERATE ACUTE MALNUTRITION[4]

Abstract

The limited number of energy rich, nutrient dense supplementary food in low socio-economic settings has hampered efforts to provide mothers of malnourished infants and young children (IYC) with appropriate foods to complement household foods. Often, the swelling of starch in the presence of water and heat, in un-malted porridges used as supplementary food among IYC suffering from moderate acute malnutrition (MAM) is not addressed as reduces the nutrient density of such foods. The aim of this study was to formulate and assess the nutrient content of the malted sorghum based porridge (MSBP) with the most acceptable sensory attributes for the management of IYC with MAM. The MSBP was formulated from malted sorghum flour mixed with extruded soy-maize flour in varying proportions using the NutVal 4.0 software program. Four MSBP formulations (F617, F93, F892 and F940) met the specifications of a supplementary food suitable for feeding IYC with MAM. These formulations were subsequently assessed for consumer acceptability. The extruded soy-maize was combined in a ratio of 3:7 for F617 and F593 formulations, and 1:1 for F892 and F940. For the F617 and F892 formulations, 25% sorghum malt was added; while for the F593 and F940 formulations, 30% sorghum malt was added. The corn soy blend (CSB+), the standard care for managing MAM in Sub-Saharan countries, combined in a ratio of 4:1 (maize: soy) was used as a reference. The rationale of using extrusion in the formulation of MSBP was that the process would pre-digest the starch component of the soy-maize mixture, thereby reducing the bulkiness of the product. Analysis of variance was used to compare the acceptability scores and viscosity of the different MSBP formulations to test for significant differences between the means scores. The formulations had significantly different ($p<0.05$) acceptability scores for flavour, taste, mouth feel, sweetness and overall acceptability. F617 had significantly ($p<0.05$) higher mean acceptability scores than F93, F892, while F940. F617 had significantly ($p<0.05$) higher energy and nutrient contents than

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CSB+. F617 at a flour rate of 25%, had an energy density, protein density and viscosity of 1.6kcal/g, 4g/100kcal and 2809 cP respectively. Hence, a quarter (25%) of sorghum malt mixed with three quarters (75%) of extruded soy-maize (F617) produced an energy rich and nutrient dense MSBP with acceptable sensory attributes at optimal viscosity. It is therefore recommended that the effect of MSBP on IYC nutritional status (as an alternative to CSB+) in the management of MAM should be investigated.

3.1 Introduction

The prevalence of MAM was estimated to be 7.4% (14 million) among IYC younger than five years in Africa, and 6.5% (4.2 million) in East Africa (Hayashi et al., 2017). Among African IYC younger than five years, the prevalence of MAM has remained largely unchanged over the past 25 years**,** despite considerable growth in the continent's economy (Lazzerini, Rubert, & Pani, 2013). Several reports and studies conducted in Sub-Saharan Africa cited a lack of nutrient dense complementary foods as an underlying factor contributing to the prevalence of MAM, as it compromises a mother's/caregiver's ability to provide an adequate energy and nutrient intake for their IYC (Briend et al., 2015; Lazzerini et al., 2013; WHO, 2012). The majority of complementary feeding porridges produced from cereals are low in energy and nutrient density (Muhimbula et al., 2011). Hence, the importance of processing local staple food blends with a high nutrient density and energy content for the management of IYC with MAM has been emphasised (Briend et al., 2015; Lazzerini et al., 2013), and recommended by several studies (Lazzerini et al., 2013; Tizazu et al., 2010; Golden, 2009; Lin et al., 2008).

To date, several techniques, including malting, have been developed to increase the nutrient density and energy content of cereal-legume based foods such as porridges that have an acceptable viscosity (2000-3000cP), thereby making them suitable for IYC feeding (Lazzerini et al., 2013; Khader & Maheswari, 2012; Dossa et al., 2011; King et al., 2007). A significant increase in the nutrient density of supplementary foods made from cereals can be achieved through the appropriate combination of malted cereals that have a high diastase power (Herlache, 2010, King et al., 2007). In addition, it has been suggested that nutritional quality is a key aspect that needs to be considered in the dietary management of IYC with MAM (Ndagire et al., 2015; De Carvalho et al., 2015; Lutter & Rivera, 2003). According to the WHO (2002), the development of supplementary foods from malted and extruded locally available raw ingredients

is one approach that can be used to meet the nutritional needs of IYC with MAM. For example, the current standard care for IYC with MAM in Uganda (CSB+) is a combination of fortified extruded maize and soy flour in a maize: soy ratio of 4:1, as it provides at least 380kcal per 100g, 14% protein, 6% fat, and 4% ash (WHO, 2002). However, the extrusion process is very expensive (Ali et al., 2017), and substitution of a portion of maize flour with enzyme active sorghum malt would be beneficial for IYC whose digestive function is often impaired due to malnutrition (Herlache, 2010). In addition, the production cost would also be reduced, by producing a more cost effective supplementary food.

As the prevalence of wasting among IYC in Uganda is 4% (0.4 million) (UBOS, 2018), un-malted fortified maize-soy blends such as CSB+ are used for the management of IYC with MAM, despite their compromised digestive system (Herlache, 2010). Conversely, malted active sorghum flour combined with extruded cereals and legumes for the production of nutrient dense pre-cooked supplementary foods have not been used in the management of IYC with MAM. In this study, a variety of supplementary porridge formulations were developed from malted sorghum and extruded soy. The energy content and nutrient density, sensory attributes and viscosity of the malted sorghum based porridge (MSBP) formulations were evaluated against reference nutrient specifications for the management of IYC with MAM.

3.2 Methodology

In this study, a hydration technique was used to develop an energy rich nutrient dense porridge from malted sorghum and extruded soy-maize flour to address the low energy content and nutrient density of available supplementary foods for IYC with MAM whose diets primarily consist of cereals and legumes (Briend et al., 2015; Lazzerini et al., 2013). The sorghum malt was primarily used as a source of enzymes to pre-digest the formulated porridge. A sensory attribute score analysis coupled with viscosity levels, were applied to determine the most acceptable MSBP formulation suitable for the management of IYC with MAM. Proximate analysis procedures were used to estimate the nutrient composition of the best formulated MSBP flour as per the sensory evaluation of a laboratory and community panels.

3.2.1 Study design

An experimental study was conducted to develop a MSBP supplementary food from fresh grains of sorghum, soy-bean and maize varieties. A factorial randomized block design was used to formulate the MSBP.

3.2.2 Study setting

The MSBP formulation and assessment of nutrient content was conducted at the Department of Food Technology and Nutrition, Makerere University in Kampala. Consumer acceptability studies were conducted among 51 breastfeeding mothers of IYC at Arua Regional Referral Hospital (ARRH), in Arua district, Northern Uganda who attended the outpatient clinic for routine health services.

3.2.3 Raw materials

Quality sorghum (*Sorgum bicolour L Moench*) grain of the Seso variety, maize (*Zea mays*) of the Longe variety and soy (*Glycine max*) of the Maksoy variety with acceptable aflatoxin levels of less than ten parts per billion and a germination power of 95% were procured from Farm Input Care Centre Limited, a certified seed company of the National Semi-Arid Resources Research Institute in Uganda. The raw materials were transported to the Department of Food Technology, Nutrition and Bio-engineering, Makerere University in Kampala and kept at room temperature until processing. Standard basic and analytical chemical Sigma reagents for laboratory proximate and chemical analysis were obtained from reputable and certified chemical firms in Kampala, Uganda.

3.2.4 Ingredient preparation for the development of a MSBP

Sorghum and malt preparation

Sorghum grains were sorted, winnowed to remove extraneous matter, dust and unwanted grains, and washed under running tap water until the water was clear. This was followed by steeping the grains at room temperature in a 0.2% NaOH solution, three times the volume (1:2 w/v) of the grains for 24 hours to enhance germination and reduce microbial load (Kanensi, Ochola, Gikonyo, & Makokha, 2013). At the end of alkaline steeping, the grains were thoroughly rinsed under portable running tap water to remove excess sodium hydroxide. The grains were then

further soaked in 0.05% sodium hypochlorite solution for two minutes to reduce the microbial load (Kanensi et al., 2013), and subsequently spread out (1 mm thickness) on clean and disinfected aluminium trays at an ambient temperature. The grains were germinated at an ambient temperature of about 25°C and relative humidity of 95% for 72 hours to produce optimal quality active malt. Once a day the germinating grains were sprinkled with fresh water and the grains turned to minimise the meshing of the roots and shoots. After three days (72 hours), germination was stopped by drying the sorghum malt grains for 24 hours at 50°C in a hot air oven (Tauro Essiccatori, B. Master SR12046, Camisano Vicentino (VI), Italy). The dried sorghum malt grains were cleaned of the sprout and hulls by rubbing it on the wire mesh, pounding and winnowing. The cleaned malt grains were ground using a Waring blender (Model 5011, Warring Products Corp. New Hartford, CT, USA) to refine the flour by passing it through a fine sieve of 300µm aperture for homogeneity and kept in an airtight container at ambient room temperature of about 25°C.

Preparation of soy flour

Soy was sorted to remove extraneous foreign materials, dust and spoiled beans. Soy beans were then washed and soaked in water (1:2) w/v for one hour (Stephany, Eckert, Bader-Mittermaier, Schweiggert-Weisz, & Carle, 2016), followed by the cleaned soy being sun dried for 12 hours to reduce the water content to about 13%. The treated clean soy was further dried at 50°C in a hot air oven (Tauro Essiccatori, B. Master SR12046, Camisano Vicentino (VI), Italy) until a moisture content of 9% was attained. The soy was then roasted in an oven at 90°C for 20 minutes with frequent turning to decrease the trypsin inhibitor activity and improve the soy flavour (Lazzerini et al., 2013). After cooling, the soy was milled using a Warring blender (Model 5011, Warring Products Corp., New Hartford, CT, USA) into flour by passing it through a 300µm sieve and stored in air tight plastic containers at room temperature (25°C).

Preparation of maize flour

Maize grains were manually cleaned to remove foreign materials and grains of an inferior quality. Compressed air was then applied for 30 minutes to remove dust. The grains were then de-hulled and milled into flour using a Warring blender (Model 5011, Warring Products Corp. New Hartford, CT, USA). The maize flour was subsequently sieved through a 300µm aperture

sieve for homogeneity and stored in airtight plastic containers at a mean room temperature of 25°C.

Extrusion process for maize and soy

The maize and soy flour with a moisture content between 6% and 8% respectively, combined in a ratio of 70:30, was fed into the extruder for extrusion. The latter extrusion ratio was different to that of CSB^+ (80:20) which is the standard care for the treatment of MAM among IYC in Uganda. The higher proportion of soy (30%) in the formulation than that of CSB^+ during extrusion allowed for subsequent mixing with malted sorghum to meet the formulation specifications. The extrusion process was carried out with a Brabender 20 DN single screw extruder, using a 4:1 compression ratio screw, a 3/20-mm (diameter/length) die and a screw speed of 150 rpm. The maize-soy in a ratio of 70:30 or 80:20, was extruded at a barrel temperature profile of 110°C to 150°C. The extrudes were dried in a hot air-dryer (Tauro Essiccatori, B. Master SR12046, Camisano Vicentino (VI), Italy) at 105°C for 15 minutes, and milled to a fine flour using a Waring blender (Model 5011, Waring Products Corp, New Hartford, USA) after cooling. The resulting flour was sieved through a 300 µm aperture sieve for homogeneity and stored in air tight plastic containers at room temperature for subsequent MSBP formulations.

3.2.5 Formulation of MSBP

The malted sorghum flour was blended with an extruded soy and maize flour to meet the recommended nutrient specification for the management of IYC with MAM (WHO, 2002). The maximum moisture content of 10% and dietary fibre together with an ash content of 4% were used as reference values (WHO, 2002). Using the NutVal 4.0 software, the excel calculator program provided the estimated nutrient content of the individual formulations coded F617, F593, F892 and F940 as detailed in Table 3.1. The proportions of each MSBP formulation provided an energy and protein content that met the dietary reference intake for IYC diagnosed with MAM. The four MSBP formulations generated were then assessed to determine the optimal MSBP formulation in terms of acceptable sensory attributes, coupled with optimal viscosity.

3.2.6 Sensory attributes, energy, nutrients, viscosity, pH, total solids of MSBP

Sensory evaluation of MSBP formulations

The formulated porridges were prepared by mixing 20g of the four different MSBP formulation flours with lukewarm water in a ratio of 1:2 (w/v) to form a smooth paste. The paste, without sugar added, was heated in a semi-closed cooking saucepan to boiling point (100°C) and held at this temperature for fifteen minutes with periodic stirring (Muhimbula et al., 2011). The effect of different ingredient proportions on the sensory attributes of the formulated hydrolysed MSBP was subsequently determined after serving the MSBP porridge samples hot (50°C) in randomly coded plastic cups.

A laboratory scale panel comprising of 37 undergraduate students from the School of Food Technology, Nutrition and Bio-Engineering Makerere, University was used to assess the flavour, taste, mouth feel, sweetness and overall acceptability of the different porridge formulations. Students recorded their respective sensory scores on an evaluation form developed for the purpose of the study (Appendix F, p229). Acceptability of the same MSBP formulations was determined in the field using a community panel of 51 breastfeeding mothers, visiting ARRH for routine health services. Trained research assistants informed the mothers in their local language about the aim of the study and the procedure for conducting the sensory evaluation of the MSBP formulation samples. Those who agreed to participate in the study signed informed consent forms. Trained research assistants helped each mother to record their responses on the sensory score evaluation form similar to that used by the student panel. In both cases, a nine point hedonic scale (where 1 = like extremely, 5 = neither like nor dislike, and 9 = dislike extremely) was used for scoring consumer acceptability of the different sensory attributes. The MSBP formulation sample that received the highest mean score for all sensory attributes by the two consumer panels was evaluated for pH value, total soluble solids, energy content, nutrient density and viscosity. The acceptability scores of the various formulations were analysed and compared to the control of CSB+, (a supplementary porridge manufactured by Reco industries limited, Kampala, Uganda), to determine the sensory attributes that are most acceptable for the MSBP formulation.

Determining energy content of MSBP flour

The energy content of the MSBP formulation with the highest mean score for consumer acceptability across all the sensory attributes was determined using a validated bomb calorimetric method [Association of Official Analytical Chemist (AOAC) 2012]. The combustion heat was quantified in triplicate with benzoic acid as a standard for calibration (AOAC, 2012; Urban et al., 2010). The mean energy content was reported in kcal per 100g of flour with standard deviations.

Proximate analysis of MSBP flour

The nutrient content of the MSBP formulation with the highest mean score and viscosity between 2000-3000cP was evaluated for moisture, ash, crude protein, crude fat, and fibre content. Moisture content was determined according to weight loss of the sample after heating in an oven (Gallenkamp Hotbox oven, size 1) at 105°C for twelve hours (AOAC, 2012). Protein content (calculated by multiplying total nitrogen by a factor of 6.25) was determined using the Kjeldahl method (AOAC, 2012), while fat content was determined by the ether extraction method (AOAC, 2012) using Soxhlet apparatus (Tecator Soxhlet System, HT6, Sweden). The dietary fibre content was determined using a Fibertec extraction technique (AOAC, 2012). Ash content was determined by heating the sample at 550°C for eight hours (AOAC, 2012).

Evaluation of viscosity of MSBP

The Brookfield viscometer (Brookfield Engineering Labs Inc., Stoughton MA, USA), equipped with spindle size number three was used to determine the apparent viscosities of MSBP at 50°C. MSBP flour samples of 20g, 25g, 30g and 40g, were all mixed with 100 ml of water. This resulted in flour rates (dry matter content) of 20%, 25%, 30%, and 40% respectively. Each flour rate was mixed and boiled in a pressure cooker at 100°C for 15 minutes. A 500ml MBSP sample at a temperature of 50°C was then placed in a 600ml insulated glass beaker. The viscometer spindle was allowed to rotate at 10rpm in the centre for two minutes after which viscosity in centipoise (cP) was determined and recorded. The spindle rotated five times before the viscosity reading was taken. The MSBP flour rate with a viscosity between 2000-3000cP was the preferred choice for IYC feeding (Yadav, Chhikara, Anand, Sharma, & Singh, 2014).

pH value

The pH value of the MSBP formulations was determined using a bench top pH meter (Oakton, 2100 series) according to the AOAC (2012) approved method. The pH meter was calibrated at room temperature with three different standard buffers of pH 4, 7, and 10 respectively. Twenty millilitres of the sample was placed in a beaker and stirred with a glass electrode for five minutes after which the pH was read off and recorded.

Total soluble solids of MSBP

An in-vitro experiment was conducted to evaluate the total soluble solid content of the MSBP formulations at a 25% flour rate by means of Brix scale refractometry (AOAC, 2012). A six percent sucrose solution was freshly prepared and used as the reference standard solution. Several drops of distilled water, sucrose solution, or MSBP samples were placed on the prism surface of the refractometer. Caution was taken to ensure that liquid on the prism plate was free from bubbles or floating particles. The refractive index of MSBP sample solutions was measured as the percentage of dissolved solids (total soluble solids).

3.2.7 Data analysis

Descriptive statistics including univariate, t-tests and variance test analyses were conducted using Stata /SE version 13.0 statistical software to analyse pH, total solids, nutrient content, sensory evaluation, and viscosity levels. The MSBP energy and nutrient content of the best MSBP formulation were calculated on a dry basis, and expressed as means and standard deviations. An independent t-test was used to determine the difference between the mean nutrient content and the viscosity levels of CSB^{+} to that of the optimal MSBP formulation. Analysis of variance was used to compare consumer acceptability scores of the four individual MSBP formulations and CSB+, as well as their respective viscosity levels. All results were considered significant at $p<0.05$.

3.3 Results

Malting was only performed on sorghum grains, while extrusion was done on soy and maize. The maize, malted sorghum and soy grains were all milled before the formulation trial

preparations. Sensory (organoleptic) attributes namely taste, colour, appearance, smell, and texture were performed on all the MSBP formulations, while energy, nutrient content, and viscosity analyses were conducted on the formulation that scored the highest in terms of sensory attributes.

3.3.1 MSBP formulations

The physicochemical characteristic showed that the mean total soluble solids at a 25% flour rate of the MSBP formulations was 20 ± 0.5, while the average pH of the formulations was 6.4 ± 0.4 with no statistically significant differences recorded between individual mean values of the total soluble solids and pH.

Ingredient combinations ratios, energy and nutrient content estimates of MSBP formulations and CSB+ (control) samples are shown in Table 3.1. Nutrient combination for each formulation satisfied the inequality of protein >14% and energy >380kcal for the management of IYC with MAM (WHO, 2002). The four different MSBP formulations (F617, F593, F892 and F940) were developed using combinations of raw maize, extruded soybean and maize flours, as well as roasted soy and sorghum malt. The extruded soy-maize was combined in a ratio of 3:7 for the F617 and F593 formulations; while for F892 and F940, half of the formulation was extruded maize flour. For all the formulations, sorghum malt was varied at 30% and 25% of the composition to reduce the viscosity of the gruel.

Table 3.1: Ingredient combinations ratios, energy and nutrient content estimates of MSBP formulations and CSB+

Formulations	Ingredient combination ratios (%)			Energy and nutrient content estimate (*NutVal*) per 100g dry weight			
	Extruded or raw maize	Extruded or roasted soy	Malted sorghum	Energy (kcal)	Protein (g)	Fat (g)	Iron (mg)
F617	52.5	22.5	25.0	412.0	15.6	7.9	2.8
F593	49.0	21.0	30.0	409.4	15.3	7.6	2.9
F892	50.0	25.0	25.0	412.7	16.2	8.4	2.8
F940	50.0	20.0	30.0	409.1	15.1	7.3	2.9
CSB+ (Control)	80.0	20.0	00.0	417.1	15.4	6.6	7.1

Formulations: F617= Extruded maize:soy+sorghum malt (75:25), F593= Extruded maize:soy+sorghum malt (70:30), F892= Roasted soy:raw maize:sorghum malt (25:50:25), F940= Roasted soy:raw maize:sorghum malt (30:50:20), CSB+ = fortified maize:soy blend (80:20)

3.3.2 Consumer acceptability of MSBP formulations and CSB+

Sensory evaluation by laboratory student panel

The different formulations of MSBP significantly affected consumer acceptability scores in terms appearance, colour, flavour, taste, thickness, consistency, mouth feel and sweetness ($p < 0.05$). Samples of MSBP formulations containing less malted sorghum flour were deemed more acceptable than those containing more soy flour. There was a statistically significant difference ($p < 0.05$) among the MSBP formulations in terms of flavour, taste, mouth feel, sweetness, and overall acceptability. However, there was no significant difference among the formulations in terms of appearance, colour, thickness and consistency. F940 had the lowest mean score for flavour, taste, mouth feel, sweetness, and overall acceptability (Table 3.2), whereas F617 had the lowest mean score for thickness but had the highest mean score for appearance, colour, taste, consistency, mouth feel and overall acceptability.

Table 3.2: Mean sensory attributes of MSBP formulations and CSB+ by students

MSBP formulations (N=37)	Sensory attributes (mean score)								
	Appearance	Colour	Flavour	Taste	Thickness	Consistency	Mouth feel	Sweetness	Overall acceptability
F617	7.9±1.6^{a}	7.5±1.8^{a}	6.9±1.5^{a}	6.7±2.0^{a}	7.51.3^{a}	6.9±2.0^{a}	6.2±1.7^{a}	6.3±1.8^{a}	7.1±1.6^{a}
F593	6.3±1.8^{b}	5.9±1.6^{b}	6.1±1.9^{a}	5.7±1.6^{a}	4.8±1.5^{b}	5.1±1.8^{b}	5.9±1.8^{a}	5.8±1.6^{a}	5.6±1.7^{b}
F892	7.5±2.0^{a}	7.3±1.5^{a}	7.2±1.4^{a}	6.5±1.5^{a}	7.0±1.6^{a}	6.3±1.7^{a}	6.2±1.5^{a}	6.0±1.9^{a}	6.4±1.7^{ab}
F940	7.4±1.9^{a}	7.0±1.4^{a}	6.7±1.8^{a}	6.2±1.7^{a}	6.71.9^{a}	6.4±1.6^{a}	6.6±1.5^{a}	6.9±1.8^{a}	6.6±1.4^{a}
CSB+ (Control)	7.6±1.5^{a}	7.2±1.6^{a}	7.0±1.4^{a}	6.7±1.3^{a}	7.4±1.7^{a}	6.6±1.5^{a}	6.4±1.2^{a}	6.5±1.9^{a}	6.9±1.8^{a}

Values depict mean ± standard deviations (N=51 mothers)
Values in a column with the same superscript do not differ significantly ($p>0.05$)
Scores 9-Like extremely; 8-Like very much; 7-Like moderately; 6-Like slightly; 5-Neither like nor dislike; 4-Dislike slightly; 3-Dislike moderately; 2-Dislike very much; 1-Dislike extremely.

Sensory evaluation by community panel of mothers

The results presented in Table 3.3 show that the F617 formulation was ranked the best for all sensory attributes, except for F593 where both F617 and F593 were slightly liked. The appearance, colour, thickness, and consistency of F617 were not significantly different from the other (F593, F892 and F940) MSBP formulations. The flavour, taste, mouth feel, sweetness and overall acceptability of porridges were significantly lower ($p<0.05$) than for the F617 formulation. The proportion of malted sorghum flour added to the extruded soy-maize composite flour in the ratio of 1:3 could have resulted in the recorded difference in sensory attributes. The flavour, taste, consistency, mouth feel, sweetness and overall acceptability of F940 were rated lowest. The sensory attributes of MSBP samples showed that the higher their flavour and taste scores, the higher the acceptability score. The trend recorded by the panel of mothers in the community was similar to that observed with the laboratory panel (Table 3.2).

Table 3.3: Mean sensory attribute scores of the MSBP formulations and CSB+ by mothers

MSBP formulations (N=51)	Mean sensory attributes scores								
	Appearance	Colour	Flavour	Taste	Thickness	Consistency	Mouth feel	Sweetness	Overall acceptability
F617	7.4±1.8 [a]	7. 0±1.7 [a]	7.1±1.8 [a]	7.2±1.4 [a]	6.7±1.1 [a]	6.9±1.8 [a]	6.5±2.2 [a]	6.4±2.2 [a]	7.0.8±1.5 [a]
F593	6.9±1.7 [a]	6.9±1.8 [a]	6.0±1.3 [b]	6.5±1.5 [ab]	6.9±1.9 [a]	6.7±1.6 [a]	6.2±1.7 [ab]	6.4±2.0 [a]	6.7±1.8 [ab]
F892	6.7±1.9 [a]	6.7±1.6 [a]	6.2±1.5 [b]	5.7±1.9 [bc]	6.2±1.8 [a]	5.9±1.9 [a]	5.3±2.0 [bc]	4.9±2.0 [b]	6.2±1.7 [b]
F940	6.3±2.2 [a]	7.0±1.8 [a]	5.8±1.7 [b]	4.97±1.6 [c]	6.3±2.0 [a]	6.1±2.0 [a]	4.6±2.0 [c]	4.3±2.0 [b]	5.3±1.7 [c]
CSB+ (Control)	7.1±1.4 [a]	7.2±1.5 [a]	7.0±1.6 [b]	6.9±1.3 [ab]	6.8±1.7 [b]	6.8±1.2 [a]	6.6±1.5 [ab]	6.3±2.1 [a]	6.8±1.6 [ab]

Values depict mean ± standard deviations (N=51 mothers)
Values in a column with the same superscript do not differ significantly ($p>0.05$)
Scores: 9-Like extremely; 8-Like very much; 7-Like moderately; 6-Like slightly; 5-Neither like nor dislike; 4-Dislike slightly; 3-Dislike moderately; 2-Dislike very much; 1-Dislike extremely

3.3.3 Viscosity of MSBP by flour rates

The viscosity level of the MSBP supplementary porridge formulations at the different flour rates (dry matter concentration) of 20%, 25%, 30% and 40% of MSBP flour, increased significantly ($p<0.001$) with an increase in dry matter as is shown in Table 3. The viscosity of the MSBP samples increased with flour rates ranging from 1235 to 7098cP. Only F617 at a flour rate of 25%, met the viscosity requirement (2000 – 3000cP) for IYC feeding. Formulations containing more maize flours had higher viscosity values.

Table 3.4: Viscosity of MSBP formulations by flour rate

Formulations & control	Viscosity (cP) at 50^0C			
	Flour rate (20%)	Flour rate (25%)	Flour rate (30%)	Flour rate (40%)
F617	1235±63[a]	2809±49[a]	4372±23[a]	5958±59[a]
F593	2528±47[b]	3100±80[b]	3579±12[b]	4244±84[b]
F892	3689±57[c]	4559±31[c]	5865±71[c]	6299±86[c]
F940	4039±83[d]	5059±96[d]	6176±64[d]	7098±44[d]
CSB+ (Control)	2875±32[e]	3220±28[e]	4657±82[b]	5742±54[e]
p-value*	p<0.001	p<0.001	p<0.001	p<0.001

Values depict mean ± standard deviations for triplicate measures.
Figures in a column with a different superscript differ significantly (p< 0.001)
* = analysis of variance. cP = centipoises.

3.3.4 Nutrient content of MSBP compared to CSB+

The nutrient content of the optimal MSBP formulation was compared to that of CSB+ values on a dry basis. These results in Table 3.5 show that MSBP differed significantly (p<0.001) from CSB+ for all nutrient comparisons, as MSBP contained significantly higher (p<0.01) energy and crude protein levels. The moisture content of MSBP flour was below the maximum recommended value of 10% for IYC supplementary foods used for the management of MAM (WHO, 2002).

Table 3.5: Nutrient content of MSBP flour compared to CSB+ flour

Nutrient content	Nutrient content per 100g dry matter		
	MSBP (mean ± SD)	CSB+ (mean ± SD)	p-value*
Moisture (g)	6.6±0.72[a]	8.9±0.16[b]	p<0.001
Ash (g)	2.1± 0.08[a]	4.1± 0.08[b]	p<0.001
Energy (kcal)	487.3±0.48[a]	380.0±0.75[b]	p<0.001
Crude protein (g)	19.1±0.09[a]	14.0±0.06[b]	p<0.001
Crude fat (g)	4.4±0.02[a]	6.0±0.12[b]	p<0.001
Crude fibre (g)	2.8± 0.04[a]	5.0± 0.08[b]	p<0.001
Iron (mg)	2.8± 0.05[a]	6.5± 0.14[b]	p<0.001

Values depict mean ± standard deviation (SD) for triplicate measures
Figures in a row with a different superscript differ significantly (p< 0.001)
* Independent t-test

3.4 Discussion

A key constraint regarding the management of IYC with MAM living under poor socio-economic circumstances is a lack of supplementary foods to facilitate catch up growth (Annan et al., 2014; Lazzerini et al., 2013; WHO, 2012). The study findings showed that the optimal MSBP formulation from malted sorghum and extruded soy-maize, resulted in a culturally acceptable energy dense and protein rich supplementary porridge that could be beneficial in terms of catch up growth in the management of IYC with MAM (Golden, 2009). The proportion of MSBP ingredients, sensory attributes, energy and nutrient content, and ideal viscosity of the optimal MSBP formulation are discussed in the subsequent sections.

3.4.1 Composition of the optimal MSBP formulation

The F617 formulation containing a quarter sorghum malt (25%) mixed with three quarters of extruded soy-maize (75%), met the energy (>387kcal) and protein (>14%) specifications for the management of IYC with MAM (Annan et al., 2014; WHO, 2002). The malted sorghum was a key ingredient, mainly providing active amylase enzymes that improved soy-maize dry matter consistency on cooking. Soy was used as the main source of protein, while maize provided the necessary energy required for the management of IYC with MAM. Dietary ingredients that are high in energy and also serve as a source of high quality protein, are recommended for the formulation of supplementary foods suitable for the management of IYC with MAM (WHO, 2012). The nutritional benefit of the optimal MSBP formulation is that the energy content and protein levels required for the management of MAM, can be provided as a single composite supplementary food that otherwise would be difficult to meet if individual food sources were used. Therefore, MSBP containing the recommended energy and protein levels, could potentially support catch up growth of IYC with MAM.

3.4.2 Consumer acceptability

The consumer acceptability results showed that the MSBP formulations were generally acceptable in terms of appearance, colour, thickness, consistency, flavour, taste and mouth feel. Sensory attributes of MSBP formulations were related to its ingredients, coupled with the combination of sorghum malt and soy-maize extrusion processes. The result of the current study concurs with that of previous studies reporting that sensory attributes of mouth feel, colour and

smell have been modified by roasting soy, followed by extrusion of soy-maize (Muhimbula et al., 2011). The malted sorghum flour contributed towards the sweet taste and flavour of the MSBP formulations, while its golden brown colour was related to the creamy white sorghum, cream yellowish soy and white maize flours. The malting, roasting and extruded products of maize kernels and soy have consistently been linked to good consumer acceptability when used in the formulation of composite flour for IYC feeding (Muhimbula et al., 2011). Thus, consumer sensory acceptability of MSBP F716 (as the most preferred) at a flour rate of 25% could be attributed to the above characteristics of the formulation.

3.4.3 Viscosity levels

The F617 formulation with the highest sensory attribute mean score at a flour rate of 25% (25g of MSBP in 100ml of water) produced a porridge with a viscosity of 2809cP, thus comparing favourably to the semi-solid complementary foods recommended for feeding IYC (WHO, 2002). Thus illustrating that a supplementary porridge prepared from cereal-grains mixed with legume flours involving extrusion and malting can be prepared at a higher dry matter ingredient concentration. The results of this study is in agreement with studies reporting that complementary foods from germinated sorghum flours could be prepared at a higher solids concentration of 15% (w/v) without exceeding the upper viscosity limit of 3000cP (Tizazu et al., 2010) for IYC feeding. Often, the formulation of diets from un-malted cereal-legume mixtures, results in flour rates of less than 15% to produce optimal viscosity levels due to the swelling of starch during cooking (Lazzerini et al., 2013). Overall, combining malting and extrusion increased the dry matter content of MSBP up to 25% within the WHO (2012) recommended viscosity range. The findings of this study showed that the F617 formulation had better optimal viscosity suitable for IYC porridges when compared to CSB+. The optimal viscosity attained with the F617 formulation flour rate could be attributed to active enzyme hydrolysis of protein and starch present in the sorghum malt.

3.4.4 Energy and nutrient profile of MSBP flour

Energy content

The energy content of MSBP per 100g was 487kcal, thus contributing nearly a third (28.2%) more than the WHO recommendation of 380kcal per day to reverse MAM among IYC. The high energy content of the MSBP formulation would therefore be suitable for IYC with MAM whose digestive system is compromised due to malnutrition, coupled with a limited stomach capacity and relatively high energy and nutrient needs to facilitate catch up growth. The main source of energy in MSBP was carbohydrate and fat, although the fat was below the minimum quantity of 6.6% recommended by the WHO (2012) for IYC with MAM. However, the low fat content of MSBP could be favourable for improving shelf-life of MSBP, since cereal-legume foods with a low fat content have a longer shelf life than similar composite fours with a higher fat content (Serrem, de Kock, & Taylor, 2011).

Protein content

The nutrient content of MSBP included 19.1g of protein per 100g, making it comparable to the 20g required by IYC with MAM on a daily basis (Golden, 2009). The amount of protein in MSBP was higher than that of CSB+ and the minimum WHO specification value recommended for the treatment of IYC diagnosed with MAM. Results generated by the current study showed that the protein content of 39.2g per 1000kcal was 1.5 times higher when compared to the recommended daily intake of 26g/1000kcal and 10.4% for IYC with MAM (WHO, 2012). Thus, the protein content in MSBP could contribute to catch up growth, as the soy used in the formulation of MSBP has all the essential amino acids, particularly leucine, lysine and alanine required for IYC recovery from MAM (Lazzerini et al., 2013).

Fibre content

The dietary fibre content of MSBP at 2.8% was 42.9% lower than the recommended maximum content for IYC with MAM. A possible explanation could be that the action of sorghum malt's active enzymes during the cooking process could have reduced the dietary fibre content of MSBP to a level that makes it suitable for consumption by IYC with MAM. The results of this study suggests that the MSBP formulation with a fibre content below the maximum of 4% could

be beneficial for IYC with MAM, as it is in accordance with the WHO (2012) recommendation that results in a reduction of bulk and gastrointestinal transit time. A recent study recommended that to achieve a fibre intake of not more than 0.5g per kilogram body weight per day, its fibre content in a cereal-legume composite flour should not exceed 2.5% (Kahsay, 2016; WHO, 2002).

3.4.5 Energy and nutrient density of MSBP

Energy density

The energy content of MSBP (F617) at 487 kcal/100g was high, compared to that of CSB+ at 387 kcal/100g. If used, MSBP therefore has the potential to contribute to nearly a third of the daily recommended kcal/100g of the daily energy requirements to reverse MAM among IYC (WHO, 2012). In addition, the energy density of F617 at 1.6kcal/g, was 23% higher when compared to that of CSB+. In this study, energy density was increased by pre-digestion of MSBP through enzyme active malt, particularly amylase, which increased the energy density of the porridge. This was possible because the MSBP flour was mixed with water and gradually cooked to pre-digest the starch. The energy density of the MSBP (F617) formulation is higher than the values previously reported where the addition of amylase increased the energy density of Super Cereal Plus (previously known as CSB+) porridge from 0.7 to 1.1kcal/g (Lazzerini et al., 2013). In addition, the energy density of the MSBP (F617) formulation fell within the recommended range of 1.5 to 2.0 kcal/g for feeding IYC aged 6 to 23 months with MAM (Golden, 2009; Tizazu et al., 2010) and was higher than that of CSB^{+}, the standard care of MAM in Uganda. Importantly, the extrusion and malting processes used in the development could have been responsible for the increased nutrient density. Thus, the energy density of the MSBP formulation would make it highly suitable for the management of IYC with MAM, despite their compromised digestive system.

Nutrient density

In this study, the protein content of MSBP (19.1g/100g) was higher than the minimum value (16g/100g) recommended for the management of IYC with MAM (WHO, 2002), resulting in a protein content of 39.2g/1000kcal. This is 1.5 times higher than the recommended daily intake of 26g/1000kcal for IYC with MAM (WHO, 2012). In addition, the nutrient density of MSBP was

higher than that of CSB+, the current standard care in Uganda. The extrusion and malting processes used in the development of MSBP could have been responsible for the increased nutrient density. However, the higher nutrient density could also be the result of ingredients such as malted sorghum that provided active enzymes for pre-digestion of protein, fat and carbohydrate, as well as the combination of malted sorghum mixed with extruded soy-maize. Thus, the nutrient density of MSBP could be beneficial for the management of IYC with MAM, as ingredients such as soy contain high amounts of all the essential amino acids that facilitate optimal growth (Lazzerini et al., 2013). In this study, the amount of malted sorghum mixed with extruded soy-maize reduced the bulkiness of the supplementary porridge. This could have contributed to the high nutrient density.

3.4.6 Overall discussion

This phase of the study formulated an energy rich, nutrient dense MSBP from malted sorghum flour combined with extruded soy and maize flour to produce a composite food with acceptable sensory attributes. The MSBP formulation containing 25% malted sorghum, 22.5% extruded soy and 52.5% extruded maize, yielded a supplementary porridge with optimal properties in terms its nutrient content, sensory attributes, viscosity levels, energy and nutrient density, thereby making it suitable for the management of IYC with MAM. The rationale of using extrusion in the formulation of MSBP was that the process would pre-digest the starch component of the soy-maize mixture, thereby reducing the bulkiness of the product. While the active enzymes in the sorghum malt digested the extrudates of soy-maize and sorghum dry matter, cooking of MSBP concentrated its nutrient content at an optimal acceptable viscosity level.

3.4.7 Study Limitation

For evaluation of the sensory attributes of MSBP, breastfeeding mothers and not the IYC the supplementary porridge was intended for. Hence it is possible that the porridge could be rejected by IYC and that it would be unsuitable for those suffering a soy allergy (Savage, Kaeding, Matsui, & Wood, 2009). However, as is often the case, if mothers accept a particular food, IYC are more likely to accept it or are gradually persuaded to consume the food (Muhimbula et al., 2011).

3.5 Conclusion and recommendations

3.5.1 Conclusion

This study established that sorghum malt can be used in the formulation of an acceptable energy rich and nutrient dense supplementary porridge suitable for managing IYC with MAM. The formulation (F617) containing 25% malted sorghum, 52.5% maize and 22.5% soy can be adopted for managing MAM in IYC, since it is acceptable and meets the energy, nutrient (protein) and viscosity requirements for feeding IYC.

3.5.2 Recommendations

MSBP could be a suitable supplementary food for the management of IYC with MAM due to its high energy content and nutrient density. However, there is need for the Ministry of Health in Uganda to evaluate the effect of MSBP on the nutritional status of IYC diagnosed with MAM to demonstrate its efficacy, and sanction cost effectives studies for potential scaling up.

3.6 References

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CHAPTER 4: SOCIO-DEMOGRAPHIC CHARACTERISTICS AND COMPLEMENTARY FEEDING PRACTICES OF MOTHERS WITH INFANTS AND YOUNG CHILDREN WITH MODERATE ACUTE MALNUTRITION[5]

Abstract

Introduction: Appropriate complementary feeding practices have the potential to improve the nutritional status of infants and young children (IYC) with moderate acute malnutrition (MAM). In addition, socio-demographics can potentially affect IYC complementary feeding practices. This study determined the socio-demographic characteristics and complementary feeding practices of mothers with IYC diagnosed with MAM in Aura district, Uganda.

Methods: A cross sectional descriptive survey involving face-to-face interviews was conducted with 220 breastfeeding mothers of IYC aged 6 to 18 months with MAM. Socio-demographic characteristics of mothers and their complementary feeding practices were determined using a structured survey questionnaire. Complementary feeding practices were evaluated in terms of minimum meal frequency (MMF), minimum dietary diversity (MDD), and minimum acceptable diet (MAD) using a 24-hour recall. Associations between socio-demographic characteristics and complementary feeding practices were determined using multivariate logistic regression analysis.

Results: Nearly two thirds of the households (58.8%) were recorded as food secure. Almost three quarters (70.1%) of the mothers had a primary school education, whereas 15% had no formal education. Foods especially prepared for the IYC, excluding foods forming part of the family diet, was provided by 42.6% of participants. The MDD and MMF of IYC was 13.2% and 41.2% respectively. Seven out of ten (6.9%) IYC met the MMF and MDD for MAD. Mothers' level of education ($p=0.003$), and that of the head of the household ($p=0.023$) was significantly associated with MFF. Provision of food especially prepared or purchased for the IYC was significantly associated with MMF ($p<0.001$), whereas mothers' BMI was significantly associated with MDD ($p=0.01$). Maternal care was significantly associated with MAD ($p=0.004$).

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Conclusion: Optimal complementary feeding practices were not met by the majority of mothers. Maternal level of education and care for IYC were strong predictors of MMF. Therefore, nutrition education and care should be promoted among mothers of IYC with MAM to improve MDD, MMF and MAD.

4.1 Introduction

Inadequate complementary feeding practices are associated with infant growth faltering and are an indirect cause of infant and young child (IYC) mortality in developing countries (Imdad et al., 2011). The dietary intake of breastfed IYC is often compromised by inappropriate complementary feeding practices (Lutter & Rivera, 2003) such as limited dietary diversity and low meal frequency, resulting in suboptimal diets that have an effect on IYC nutritional status (Irene Olmedo & Valeggia, 2014; Latham, 2014). In Uganda, cereal-based porridge is often diluted to enable feeding of IYC, thereby resulting in a dilution of nutrient content (UBOS, 2018).

Several studies have reported that factors associated with suboptimal complementary feeding practices among IYC aged 6 to 23 months include a lack of maternal education or/and limited nutrition knowledge (Issaka et al., 2015; Victor et al., 2014; Senarath et al., 2012). Moreover, the majority of IYC are not fed an age appropriate diet (Latham, 2014). Instead, adult household food is simply mashed to make it suitable for consumption.(Morison et al., 2018). Previous studies reported that dietary diversity and meal frequency were associated with factors such as maternal age, gender of the child, marital status, level of education, and social care of IYC (UBOS, 2018; Aemro et al., 2013; Kabir et al., 2012; Khan et al., 2012).

The available literature points towards a paucity of information regarding complementary feeding practices and associated maternal socio-demographic factors among IYC aged 6 to 18 months that are diagnosed with moderate acute malnutrition (MAM) in Sub-Saharan Africa (Abuya et al., 2012). It is against this background that maternal socio-demographic characteristics and complementary feeding practices of Ugandan breastfeeding mothers of IYC aged 6 to 18 months with MAM were assessed. The relationship between variables such as special food preparation, i.e. food especially prepared or purchased for IYC excluding adult household food, maternal level of education, minimum meal frequency (MMF), and minimum

dietary diversity (MDD) as indicators of complementary feeding practices were determined. This study provided baseline information that guided and facilitated the implementation of a cluster randomised control trial (cRCT) to determine the effect of MSBP (Chapter 3) in conjunction with nutrition education of mothers (Chapter 6) on the nutritional status of IYC diagnosed with MAM (Chapter 5).

4.2 Methodology

This section explains how maternal socio-demographic characteristics and complementary feeding practices were assessed by trained research assistants who administered a questionnaire consisting of close-ended questions (Appendix D, p204) by means of a face-to-face interview conducted at a gathering site in a parish.

4.2.1 Study design and setting

A cross-sectional descriptive survey was conducted among breastfeeding mothers of IYC aged 6 to 18 months who were diagnosed with MAM. Four sub-counties (Pajulu, Oluko, Oli River and Dadamu) out of a possible eighteen in the Arua district were randomly sampled for inclusion in the study. The four sub-counties consisted of thirty-five parishes of which twenty four were conveniently sampled. This resulted in the study sample that included seven parishes in Pajulu, five parishes in Oluko, five parishes in Oli River and seven parishes in Dadamu that were conveniently sampled based on IYC records where a high prevalence of MAM was recorded at the Arua Regional Referral Hospital. The IYC that were diagnosed with severe acute malnutrition (SAM) on screening for inclusion in the study sample were referred to Arua Regional Referral Hospital (ARRH).

In addition, Arua is a rural district where the majority of inhabitants are of a low socio-economic status (UBOS, 2018). The population predominantly belongs to the Lugbara ethnic tribe, and mostly reliant on subsistence farming.

4.2.2 Sample size

The fixed cluster size equation $\frac{2\left((Z_\alpha+Z_\beta)^2(\delta^2)(1+(m-1)\,\rho)\right)}{(\mu_1-\mu_1)2}$ was used to calculate the sample size for this study (Brestoff & Broeck, 2013; Hemming et al., 2011), where $(1+(m-1)\rho) = 1.5$ as design effect, $(\mu_1-\mu_1)^2$ = 0.4 as expected minimum difference between the desired power for clinical importance (Ciliberto et al., 2005), $(Z_\alpha+Z_\beta)^2$ =13 as a constant defined by a p-value and desired power, $Z_\alpha = 1.96\ and\ Z_\beta = 1.645$, δ = 0.92 as the expected standard deviation of the mean difference, and m = 10 as the mean cluster size.

4.2.3 Sampling procedure

The parish, from here on referred to as a cluster, contact persons were asked to assemble breastfeeding mothers with IYC aged 6 to 18 months from their households to gather at a convenient place within their parishes for potential recruitment for this study. Trained research assistants measured weight, length and MUAC to screen for IYC with MAM for inclusion into the study. If IYC who had a weight-for-length between -2 and -3 z-scores based on the 2006 World Health Organization (WHO) growth charts (WHO, 2008b), were recruited for inclusion into the study, their mothers completed a baseline questionnaire by means of a face-to-face interview conducted by a trained research assistant after signing an informed consent form (Appendix B, p196). The recruitment of mother-IYC pairs was repeated on a first come first enrolled basis within the parish until 10 mother-IYC pairs were recruited per parish. The IYC aged 6 to 18 months whose MUAC measurement was below 11.5 cm, were referred to the ARRH for appropriate management. The mothers of the IYC with a normal MUAC (greater than 12.5 cm) or normal weight-for-age (more than -2 z-scores), were given a copy of the anthropometric measurements and their interpretation, and told that their children are growing well. A bar of soap for was given to the mothers as compensation for their time, after which they were informed that they can return home.

Inclusion criteria

Breastfed IYC aged 6 to 18 months with a weight-for-length z-score between -2 and -3, hence diagnosed with MAM, were eligible for participation.

Exclusion criteria

Non-breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM were excluded from the study.

4.2.4 Measurement of study variables

Independent variables included the mother's marital status, body mass index and parity, whereas highest level of education attained and age were determined for both the mother and the head of the household. In order to determine living conditions, study variables included the type of walls, roof, floor, number of rooms, cooking fuel, source of fuel for lighting, running water, type of toilet, hand washing facilities, household food security, personal hygiene and treatment of drinking water. Dependent variables regarding complementary feeding practices included the number of meals and food groups consumed by IYC with MAM.

Assessment of food consumption pattern

The food consumption pattern of the IYC was assessed using a 24-hour recall (Appendix D, p204) questions from the Uganda Demographic and Health Survey following expert input (UBOS, 2018).

Assessment of dietary diversity

Dietary diversity was determined using a 24-hour recall. Mothers were asked to recall all foods consumed by the IYC with MAM during the 24 hours preceding the interview. However, if the previous 24 hours was not a reflection of habitual intake, a different day was selected for the interview. For mixed dishes, individual food items were separated and allocated to the relevant food groups. All food items consumed by the IYC were categorised into seven food groups (Appendix D, p204), based on the Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access developed by Swindale (2006). One mark was given for each food group consumed, tallied to a maximum score of seven points if all the food groups were consumed. The IYC diet was classified as diverse if four or more food groups were consumed, while a lack of dietary diversity was noted if three or fewer food groups were consumed.

Assessment of living conditions

Living conditions were assessed by means of face-to-face interviews and were scored out of ten. Variables included the availability of grid electricity, cooking fuel, source of lighting, type of toilet used, availability of a hand washing facility after toilet use, having access to running water, number of rooms in the house, house constructed of bricks, a cement floor, and a roof of iron sheets or tiles (Appendix D, p204). Households that scored seven or more for the above variables were categorised as having good living conditions, while households that scored three or less were recorded as having poor living conditions (UBOS, 2018).

Assessment of food security

Food security was assessed by using the Household Food Insecurity Access Scale (HFIAS) developed by (Coates, Swindale, & Bilinsky, 2007) (Appendix E, p228). The questions included anxiety and uncertainty about food supply, insufficient quality and insufficient quantity. The questions asked pertained to the previous four weeks. The mother was first asked an occurrence question, i.e. if the variable in the question happened at all in the past four weeks. If the response was "yes", a frequency-of-occurrence question was asked to determine if the condition happened rarely (once or twice), sometimes (three to 10 times), or often (more than 10 times) in the past four weeks. The mothers' responses were categorised into four levels as follows:

Food secure: mother rarely, in the past four weeks, worried about not providing enough food for the IYC.

Mild food insecure: mother worried about not providing the IYC with enough food sometimes or often, and/or was unable to provide the child with preferred foods, and/or provided a more monotonous diet than desired, and/or provided some foods considered undesirable but only rarely.

Moderately food insecure: mother sacrificed dietary quality more frequently by feeding a monotonous diet or undesirable foods sometimes or often, and/or had started to cut back on quantity by reducing the portion size of meals or the number of meals, rarely or sometimes.

Severely food insecure: mother had to often cut back on meal frequency or portion size of meals provided to IYC, and/or experienced any of the following three conditions (running out of food, the IYC going to bed hungry, or going a whole day and night without the IYC being fed any complementary food).

4.2.5 Data collection

In this study, face-to-face interviews using a structured questionnaire was used to collect quantitative that included socio-demographic characteristics, complementary feeding and hygiene practices and household food security status. Breastfeeding mothers of the IYC diagnosed with MAM were interviewed after signing an informed consent form (Appendix B, p196).

Training of research assistants

Research assistants with a social and health sciences background were trained for three days regarding the following aspects: gaining an understanding of the research questionnaire and related research objectives, approaching eligible study participants, and correctly completing the questionnaire. In addition, research assistants were trained by the researcher on how to measure MUAC, length, weight accurately, as well as appropriate interviewing techniques. Research assistants were also trained on how to obtain informed consent from mothers (Appendix B, p196), as well the importance of participant confidentiality, privacy and protecting the identity of all participants. On the third day, research assistants piloted the questionnaire in the field.

Piloting the research questionnaire and informed consent form

The research questionnaire, informed consent form (Appendix B, p196) and information sheet (Appendix C, p198) were piloted in an area with similar characteristic to that of the study area to determine whether the questions and content of the information sheet was clear and unambiguous. The area used for conducting the pilot study among mothers (10.9% of the calculated study sample) did not fall under the sampled clusters used for data collection. Following piloting, it was confirmed that the research questionnaire, informed consent form and information sheet did not require adjustments, as mothers did not find any questions or content form statements unclear or ambiguous. Piloting also enabled research assistants to understand

the questions and the variables it measured and familiarise themselves with completion of the questionnaire in the field as well as interact with study participants.

Data editing

The responses to questionnaires were checked by research assistants on a daily basis before leaving the field to ensure that all the questions were completed as well as correctly recorded. The researcher, in consultation with the research assistants, edited completed questionnaires to aid data capturing by an independent data capturer. Where necessary, participants were visited at their homes to correct any errors or missing data on the day of data collection or the following day. In addition, the researcher provided feedback to research assistants regarding completeness and accuracy with which questionnaires were completed the previous day before data collection commenced on the following day. All questionnaires found with missing data were not considered in data analysis.

4.2.6 Data management

The responses that fell into "other" please specify, were coded into categorical variables on a spread sheet developed for this purpose before data entry took place. Double data entry was performed to ensure accuracy of the data. Data was subsequently checked for accuracy and consistency using STATA /SE version 15 command sum where after data was backed-up and securely stored.

4.2.7 Data analysis

Data was analysed using STATA/SE version 13.0 statistical software packages. Univariate level analysis of IYC complementary feeding practice indicators namely MDD, MMF and MAD were analysed as defined in the analysis matrix (Table 4.1), and expressed as frequencies and percentages. For socio-demographic categorical variables, a forward multivariate logistic regression analysis was performed to determine the association between socio-demographic variables and complementary feeding practice indicator variables. Prevalence Risk Ratio (PRR) and Odds Ratio (OR) analyses were considered significant at a 95% confidence level (CI) to determine the factors associated with complementary feeding practices.

Table 4.1: Complementary feeding practices indictor measurement matrix

Feeding practices indicator	Indicator definitions
Timely introduction of foods	The proportion of IYC 6 to 8 months of age who received solid, semi-solid, or soft foods.
Minimum dietary diversity	The proportion of IYC 6 to 23 months of age who received foods from four or more food groups.
Minimum meal frequency	The proportion of breastfed IYC 6 to 23 months of age who received solid, semi-solid, or soft foods ≤ 2 times a day for infants 6 to 8 months and ≥ 3 times per day for IYC 9 to 23 months of age.
Minimum acceptable diet	The proportion of breastfed IYC 6 to 23 months of age who received a minimum acceptable diet (received solid, semi-solid or soft foods ≥ 2 times per day and received foods from four or more food groups apart from breast milk).

Source: WHO (2008)

4.3 Results

On the whole, 220 mother-IYC pairs were recruited for the study, of whom 204 (92.7%) had complete data sets for analysis.

4.3.1 Socio-demographic characteristics of IYC with MAM

The mean age of the IYC with MAM was 11.9 ± 5.3 months with a gender ratio of 1:1. The majority (81.5%) of IYC diagnosed with MAM had a normal birth weight (i.e. equal or greater than 2.5kg). Almost all households (97.5%) were caring for IYC younger than 59 months. Nevertheless, a third (30.4%) of the IYC was not being cared for by both their biological parents.

Table 4.2: Socio-demographic characteristics of IYC diagnosed with MAM

Child characteristics (N=204)	Frequency (n)	Percentage (%)
Age of IYC		
6-11 months	108	52.9
12-23 months	96	47.1
IYC's gender		
Male	103	50.7
Female	101	49.3
IYC's birth weight (kg)		
<2.5	36	18.5
≥2.5	159	81.5
Number of children younger than 59 months in a household		
≥3 children	5	2.5
<3 children	199	97.5
IYC living with their biological father		
Yes	142	69.6
No	62	30.4

The results obtained from the analysis of maternal socio-demographic characteristics are presented in Table 4.3. The majority of mothers (84.3%) were younger than 35 years, while less than half of household heads (43.6%) were in the same age category. Nearly a quarter of the mothers (24.5%) were not living with their partners and were therefore not able to provide joint parenting to their IYC. Close to two thirds of the households (58.8%) were food secure, while just over one fifth of the mothers (21.1%) were underweight with a body mass index of less than 18.5kg/m^2. In addition, 42.6% of the mothers prepared food such cereal porridge especially for IYC with MAM.

Table 4.3: Socio-demographic characteristics of mothers and household heads of IYC with MAM

Mother/household head (N=204)	Frequency (n)	Percentage (%)
Age of household head (years)		
• <20	6	2.9
• 20-34	83	40.7
• 35+	115	56.4
Age of mother (years)		
• <20	43	21.1
• 20-34	129	63.2
• 35+	32	15.7
Mother's BMI (kg/m^2)		
• <18.5	43	21.1
• 18.5-24.9	146	71.6
• ≥25	15	7.3
Mother's parity (number of children)		
• <3	75	36.8
• ≥3	129	63.2
Marital status of the mother		
• Living with a partner	154	75.5
• Not living with a partner	50	24.5
Household family size		
• <3	61	29.9
• ≥3	143	70.1
Household food insecurity	120	58.8
• Food secure	84	41.2
• Food insecure		
Mother's level of education		
• No formal education	31	15.2
• Primary school education	143	70.1
• Secondary and tertiary level of education	30	14.7
Head of household educational status		
• No formal education	14	6.9
• Primary education	128	62.7
• Secondary and tertiary level of education	62	30.4
Household living conditions		
• Poor living conditions	196	96.1
• Good living conditions	8	3.9
Specially prepared or bought food for IYC		
• Yes	87	42.6
• No	117	57.4

When comparing the two results, it can be seen that mothers with a primary school level of education and below (85.3%), was higher than that of the head of their households (69.6%). Almost all households (96.1%) had poor living conditions as measured by ten items on the questionnaire (UBOS, 2018).

4.3.2 Complementary feeding practices of IYC with MAM

Consumption of food groups

The proportions of food groups consumed by IYC based on the seven food group classification are depicted in Figure 4.1. Nearly two thirds (63.2%) of the mothers fed their IYC cereals and root tubers, while nearly 6/10 fed their IYC legumes and nuts (58.8%), and over half feeding them Vitamin A rich foods (51%). The consumption of iron-rich foods such as meat, eggs and fish (25.5%), as well as fruits and vegetables (14.2%) were low. Eggs (4.9%) and dairy products (3.4%) were the least frequently consumed food groups.

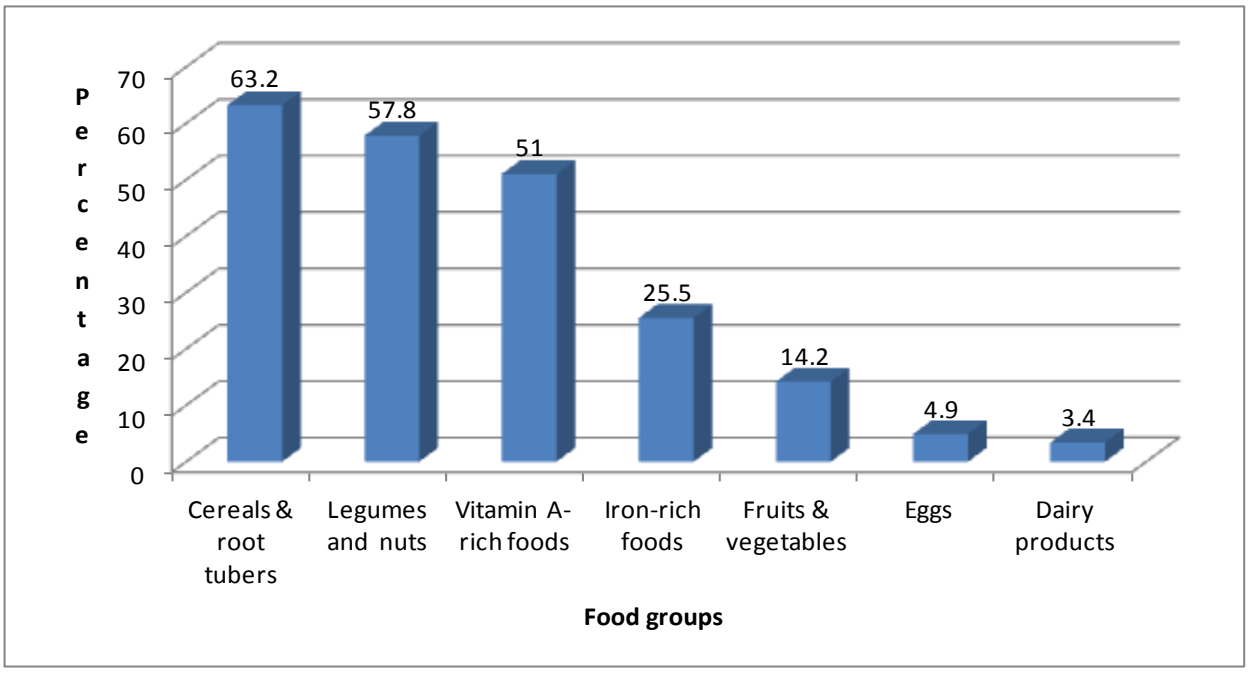

Figure 4.1: Proportion distribution of food groups

Complementary feeding practice practices of IYC with MAM

The percentage of mothers adhering to appropriate complementary feeding practices in terms of MDD, MMF and MAD are presented in Table 4.4. Overall, 41.7% of IYC diagnosed with were found to have been introduced to complementary foods either too early or too late. A small

proportion of IYC consumed four or more food groups (13.2%) to attain the MDD. Just over 4/10 (41.2%) met the MMF. Only 6.9% of IYC met the criteria for consuming a MAD.

Table 4.4: Complementary feeding practices of IYC diagnosed with MAM

Complementary feeding practice indicators (N=204)	**Frequency (n)**	**Percentage (%)**
Introduction of solid, semi-solid or soft foods		
• Timely introduction (6 to 8 months)	119	58.3
• Early (<6 months) or late (>8 months) introduction	85	41.7
Minimum dietary diversity (MDD)		
• ≥ 4 food groups	27	13.2
• < 4 food groups	177	86.8
Minimum meal frequency (MMF)		
• ≥ 2 meals for 6 to 8 months and ≥ 3 meals for 9 to 23 months	84	41.2
• <2 meals for 6 to 8 months and <3 meals for 9 to 23 months	120	58.8
Minimum acceptable diet (MAD)		
• Does meet the MMF and MDD	14	6.9
• Does not meet the MMF and MDD	190	93.1

4.3.3 Socio-demographic characteristics associated with complementary feeding practices

The results shown in Table 4.5, indicate that there was a significant association between the mother's level of education and MMF (p=0.003), and the head of the household's level of education was also found to have a strong association with the MMF (p=0.023). In addition, a significant association was found between maternal care in terms of especially preparing and purchasing food for IYC and MMF (p<0.001). Mothers with a body mass index (BMI) equal or greater than 18.5kg/m^2 had IYC who were less likely to have attained a MDD score by consuming four or more food groups (p=0.01). A significant association was found between MAD and especially preparing and purchasing food for IYC (p=0.004). These results show that maternal care and level of education were strong predictors of MMF. However, maternal age, parity and marital status were not.

Table 4.5: Socio-demographic characteristics associated with complementary feeding practices

Socio-demographic characteristics (N=204)	Total N (%)	Complementary feeding practices								
		Minimum dietary diversity			Minimum meal frequency			Minimum acceptable diet		
		n (%)	Unadjusted PRR (95% CI)	P - value	n (%)	Unadjusted PRR (95%CI)	P - value	n (%)	Unadjusted OR (95%CI)	P - value
Age of household head								1 (8.3)	1.00	
• <20	6(2.9)	2(7.4)	1.00		4(4.8)	1.00		7(58.3)	0.46 (0.05- 4.59)	
• 20-34	83(40.7)	12(44.4)	0.43(0.12-1.51	0.20	34(40.5)	1.19(0.89-1.59)	0.24	4(33.3)	0.18 (0.02-1.99)	0.12
• 35+	115(56.4)	13(48.1)	0.33(0.09-1.18)		46(54.8)	1.2(0.89-1.60)				
Age of mother										
• <20	43(21.1)	7(25.9)	1.00		22(26.2)	1.00		3(25.0)	1.00	
• 20-34	129(63.2)	16(59.3)	0.76(0.34-1.73)	0.79	48(57.1)	1.09(0.97-1.22)	0.12	8(66.7)	0.76(0.31 - 1.85)	0.83
• 35+	32 (15.7)	4(14.8)	0.77(0.25-2.40)		14(16.7)	1.05(0.90-1.22)		1(8.3)	0.77(0.22 - 2.62)	
Mother's BMI (kg/m^2)										
• <18.5	**43(21.1)**	11(40.7)	1.00		19(22.6)	1.00		4(33.3)	1.00	
• ≥18.5	161(78.9)	16(59.3)	0.39(0.19-0.76)	0.01	65(77.4)	1.02(0.92-1.13)	0.66	8(66.7)	0.51 (0.15-1.79)	0.28
Mother's parity (number of children)										
• <3	75(36.8)	13(48.1)	1.00		36(42.9)	1.00		5(41.7)	1.00	
• ≥3	129(63.2)	14(51.9)	0.62(0.31-1.26)	0.19	48(57.1)	1.07(0.98-1.17)	0.13	7(58.3)	0.80 (0.25-2.64)	0.47
Marital status of mother										
• Living with partner	154(75.5)	4(14.8)	1.00	0.21	21(25.0)	1.00		2(16.7)	1.00	
• Not living with partner	50 (24.5)	23(85.2)	1.87(0.68-5.35)		63(75.0)	1.01(0.91-1.11)	0.89	10(83.3)	1.68 (0.35-7.92)	0.40
Household family size										
• <3	61(29.9)	10(37)	1.00		23(27.4)	1.00		3(25.0)	1.00	
• ≥3	143(70.1)	17(63)	0.73(0.35-1.49)	0.38	61(72.6)	0.97(0.88-1.06)	0.51	9(75.0)	1.29 (0.34-4.99)	0.49
Mother's education										
• No formal education	31(15.2)	6(22.2)	1.00	0.53	15(17.9)	1.00		4(33.3)	1.00	
• Primary education	143(70.1)	18(66.7)	0.65(0.28-1.50)		65(77.4)	1.02(0.74-1.39)	0.003	0(0.0)	0.00	-
• Secondary education+	30(14.7)	3(11.1)	0.52(0.14-1.88)		4(4.8)	1.23(1.08-1.41)		8(66.7)	0.40(0.11- 1.44)	0.09
Head of household education										
• No formal education	14(6.9)	2(7.4)	1.00		1(1.2)	1.00		0(0.0)	1.00	
• Primary education	128(62.7)	17(63)	0.93(0.24-3.62)	0.99	54(64.3)	0.82(0.75-0.89)	0.023	6(50.0)	-	0.35
• Secondary education+	62(30.4)	8(29.6)	0.90(0.21-4.)		29(34.5)	0.79(0.71-0.88)		6(50.0)	-	
Household living condition										
• Low	196(96.1)	26(96.3)	1.00	0.71	81(96.4)	1.00		185(96.4)	1.00	
• High	8(3.9)	1(3.7)	0.94(0.15-6.12)		3(3.6)	1.02(0.82-1.27)	0.83	7(3.6)	2.4(0.27-21.48)	0.42
Maternal care (preparing food and purchasing food especially for IYC)	87(42.6)	14(51.9)	1.00		55(66.3)	1.00		77(40.7)	1.00	
	117(57.4)	13(48.1)	0.71(0.35-1.43)	0.41	28(33.7)	1.28(1.18-1.39)	<0.001	112(59.3)	0.14(0.03-0.67)	0.004
• Yes										
• No										

PRR: Prevalence risk ratio; OR: Odds ratio; CI: Confidence interval; MMF: minimum meal frequency; MDD: minimum dietary diversity; MAD: Minimum acceptable diet.

4.4 Discussion

This study documented maternal socio-demographic characteristics, complementary feeding practices, and food groups consumed by IYC diagnosed with MAM in Arua, Uganda. The data was collected during the hunger period, before crop harvest at the baseline of MSBP or CSB+ supplementation of breastfed IYC with MAM.

4.4.1 Household food security

In this study, about two thirds of the households where the IYC diagnosed with MAM resided, were food secure based on the HFIAS (Coates et al., 2007). This finding suggests that the poor nutritional status of IYC was not only due to lack of food at household level. It is therefore possible, that where food was available, the variety, quality, quantity, feeding frequency, IYC preference could have not been taken into consideration or was inappropriate as a result of a lack of maternal knowledge or care. In addition, the presence of acute infections such diarrhoea and respiratory tract infections or conditions such as malaria, could also have affected IYC nutritional status (Requejo & Bhutta, 2015; Menon, 2012).

4.4.2 Maternal level of education and care

The low level of maternal education (combined levels of only primary school and no formal education) documented in this study is higher (85.3%) than that reported by the UDHS (2016), where 67.0% of mothers were reported to have attained a primary school level of education or no formal education (UBOS, 2018). In addition, Arua is a rural district where the majority of inhabitants are of a low socio-economic status (UBOS, 2018). This implies that mothers had access to limited income and that employment opportunities were limited. This finding could possibly be related to the geographic location of the study in that mothers were living in a rural area. It is possible that the low level of maternal education could have impacted on maternal care for IYC diagnosed with MAM (Menon, 2012). In addition, this finding concurs with that of studies conducted in Kenya and Bangladesh, where a lack of maternal education was a good predictor of a poor nutritional status among IYC (Abuya et al., 2012; Senarath et al., 2012). Nevertheless, mothers are important caregivers when it comes to the complementary feeding of their IYC (Khunga, Okop, & Puoane, 2014; Komro et al., 2011).

4.4.4 Consumption of food groups

IYC in this study sample consumed predominantly starchy complementary cereals in addition to legumes as their main source of nutrition. This may be due to food insecurity, inappropriate feeding practices due to a lack of knowledge or a lack of household purchasing power, since foods of animal origin are often more expensive than starchy foods. These results are consistent with earlier studies where it was documented that mothers of a low socio-status rarely feed their children animal foods in appropriate quantities (Golait & Pradhan, 2016; Khunga et al., 2014; Young et al., 2014).

In addition, the predominant consumption of starchy complementary foods meant that IYC consumed a diet that is known to be bulky and have a low nutrient density (Sunguya et al., 2014). This finding was similar to that reported by Ugandan studies who found that carbohydrate based foods are the most common complementary gruels and porridges fed to IYC (UBOS, 2018; Acheng, 2014; Ochola et al., 2014).

4.4.5 Complementary feeding practices

The levels of MDD (13.2%), MMF (41.2%) and MAD (6.9%) among IYC diagnosed with MAM was very low, thus alluding to the fact that mothers were not implementing appropriate complementary feeding practices when compared to international indicators of complementary feeding (WHO, 2008a). However, inappropriate complementary feeding practices may not be solely related to a low level of maternal education and hence a lack of knowledge, but that poverty, household food insecurity and geographic location could have prevented mothers from accessing sufficient, appropriate and affordable complementary foods.

The MAD of 6.9%, was lower than the national average of 14% for breastfed as well as non breastfed IYC aged 6 to 23 months (UBOS, 2018). The findings regarding MDD, MMF and MAD could be related to the fact that IYC included in the study sample were fed less frequently with a diet that lacked diversity due to participants being of a lower socio-economic status as well as living in the rural district of Arua, situated in northern Uganda (UBOS, 2018), as this could have affected access to a variety of affordable complementary foods. These results are similar to that reported by studies conducted in Tanzania and Ethiopia among IYC aged 6 to 23

months where MAD was reported as 15.9% and 10.8% respectively (Aemro et al., 2013; Victor et al., 2014). In addition, the result regarding a MMF of 41.2% in the current study, is comparable to that of a study conducted in India, where a meal frequency of 48.6% among IYC was reported (Khan et al., 2012). However, the MDD of 32.6% documented in India, was higher than the 13.2% recorded in the current study (Khan et al., 2012). However, the findings of the current study compare favourably to that of other developing countries in terms of MDD, MMF and MAD as criteria of inappropriate complementary feeding practices and the presence of MAM among IYC (Irene Olmedo & Valeggia, 2014; Latham, 2014).

4.4.6 Maternal factors associated with complementary feeding practices

Maternal care and level of education

Apart from maternal level of education and maternal care and head of household, none of the other variables used to determine socio-demographic status were associated with the MMF of IYC with MAM. A possible explanation may be that the purchase and preparation of foods especially for the IYC would provide them with something to eat in addition to their usual household diets so as to increase on the meal frequency. This finding is consistent with data reported in studies that investigated the relationship between complementary feeding practices and maternal level of education, as a low level of maternal education was a good predictor of inappropriate complementary feeding practices (Beyene, Worku, & Wassie, 2015b; Senarath et al., 2012). A study conducted in Northwest Ethiopia reported that a higher level of formal maternal education was associated with improved dietary diversity and meal frequency among children (Beyene, Worku, & Wassie, 2015a). The current study findings underscore the fact that a higher level of formal maternal education could contribute to better complementary feeding practices (Lassi et al., 2013), as a higher level of education is related to a greater likelihood of being employed, which in turn is indicative of having more expendable income to spend on food purchases (Latham, 2014).

Furthermore, maternal care in terms of purchasing and preparing food especially for IYC was related to increased meal frequency and dietary diversity, emphasising the fact that mothers are important caregivers when it comes to the provision of complementary foods to their IYC (Komro et al., 2011). In the current study, mothers who did not prepare food such as porridge

especially for their IYC, were more likely to meet the criteria for MMF, but less likely to attain a MAD.

It is therefore possible that a higher level of maternal education would result in IYC being fed regularly and on a verity of foods so as to meet their MMF, MDD and MAD (Imdad et al., 2011; Lassi et al., 2013). That is, inadequate maternal care for IYC and a low level of maternal education could be underlying factors that contribute to the development of MAM (Gillespie et al., 2015; Menon, 2012). In addition, it can be speculated that if a mother prepared food especially meant for her IYC, she would be more likely to feed the IYC herself to ensure that they fed regularly (Komro et al., 2011). Therefore, maternal care complements the receipt of appropriate complementary food and therefore adequate IYC food intake (Latham, 2014).

Maternal body mass index

IYC whose mothers had a normal BMI were more likely to meet the criteria of MDD. It would therefore seem that the study result of a secure level of household food security seems to have favoured the mothers' nutritional status and not that of their children. This suggests that mothers with a normal BMI could have malnourished IYC. A possible explanation could be that adults are able to utilize the available household starchy foods such as maize to attain a normal nutritional status, whereas their IYC whose digestive system is still immature and compromised due to MAM are not able to (Herlache, 2010). This result seems to be consistent with that of a study reporting that a mothers' BMI is an important correlate of a child's dietary diversity (Pei et al., 2014). Therefore, the absence of dietary diversity could be one of the major factors causing MAM among IYC in Arua district.

4.4.7 Overall discussion

The results this study shows that maternal level of education, maternal care as indicated by the preparation and purchase of foods especially for the IYC, maternal body mass index and household head level of education, were strong predictors of appropriate complementary feeding practices. The results of this study also provided evidence that starchy household foods such as cereals and tubers commonly fed to IYC, are indicative of having inappropriate complementary feeding practices. Therefore, the inappropriate complementary feeding practices of mother of

IYC with MAM in terms of MDD, MMF, and MAD could be improved by conducting nutrition education of mothers.

4.4.8 Study Limitation

As the mother's complementary feeding practices were determined by a single 24-hour dietary recall, it is possible that the data gathered was not an accurate reflection of the mothers' usual IYC complementary feeding practices (Salvador Castell, Serra-Majem, & Ribas-Barba, 2015). It is also possible that mothers could have given information which they thought was correct, yet the information was not implemented (Salvador Castell et al., 2015). However, should the latter be applicable to the current study, it was addressed as follows: Mothers were interviewed in their home language, research assistants resided in the district where mother-child pairs were recruited from, and research assistants built rapport with mothers before conducting face-to-face interviews. Therefore, the above enabled probing of mothers to accurately recall what their IYC consumed within the last 24-hour prior to the interview.

4.5 Conclusion and recommendations

4.5.1 Conclusions

Optimal complementary feeding practices assessed in accordance with the WHO indicator definitions of MDD, MMF and MAD, were not practised by the majority of breastfeeding mothers with IYC diagnosed with MAM. The level of education attained by the head of the household, maternal level of education and care were significantly associated with MMF. In addition, maternal care and level of education were strong predictors of MMF. Further, a significant association was found between MAD and maternal care, as indicated by mothers especially preparing and purchasing food for their IYC. Mothers who had normal BMI of $\geq 18.5/kg/m^2$ were less likely to have IYC whose dietary intake meets the criteria for a MDD. Overall, maternal level of education, care as indicated by the special foods prepared and purchased, body mass index of mothers, and level of education attained by the head of the household, were strong predictors of appropriate complementary feeding practices.

4.5.2 Recommendations

The Health Ministry in Uganda can use the results of this study to prioritise targeted nutrition education regarding appropriate complementary feeding practices, especially related to the importance of dietary diversity and meal frequency in order to achieve the MAD for IYC recommended by the WHO. The content of nutrition education strategies should include reference to meal frequency and dietary diversity when implementing complementary feeding of IYC, as it could contribute to a reduction in the prevalence of MAM. Studies investigating the complementary feeding practices and related socio-demographic characteristics of mothers with IYC diagnosed with MAM should be conducted in other districts of Uganda, to determine whether the findings of the current study are applicable at a national or regional level.

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CHAPTER 5: EFFECT OF A MALTED SORGHUM BASED SUPPLEMENTARY PORRIDGE ON THE ANTHROPOMETRIC STATUS AND HAEMOGLOBIN LEVELS OF INFANTS AND YOUNG CHILDREN WITH MODERATE ACUTE MALNUTRITION[6]

Abstract

Background: Children with moderate acute malnutrition (MAM) have a higher risk for mortality compared to their healthy counterparts and require additional nutritional support to manage the condition. Although infants and young children (IYC) with MAM respond to dietary treatment with a supplementary food in addition to their usual diet, there is still a level of uncertainty regarding the efficacy of these supplementary foods. In addition, evidence-based studies of this nature have not yet been conducted in Uganda.

Objective: To determine the effect of a novel malted sorghum based porridge (MSBP) and a fortified corn soy blend (CSB+) in conjunction with nutrition education on the anthropometric status and haemoglobin levels of IYC aged 6 to 18 months with MAM.

Method: A double blind cluster randomised control trial (cRCT) with eight to ten conveniently sampled mothers of IYC with MAM per cluster, were randomly assigned to MSBP (treatment) (n=110) or CSB+ (control) (n=110) for three months. Twenty-four clusters were selected from four randomly selected sub-counties in the Arua District, North Western Uganda. Mothers received a daily ration of 150g of MSBP or CSB+ as a supplementary porridge. Weight, length and mid upper-arm circumference (MUAC) were measured weekly, whereas haemoglobin levels were determined at baseline and at the end of study. At three months, mean values for weight gain, length gain, length-for-age z-scores, weight-for-age z-scores, length-for-weight z-scores, MUAC and mean haemoglobin levels as outcome indicators were determined, followed by a comparison between the treatment and control groups with the independent t-test. The z-test was used to compare proportions of the outcome indictors between both groups.

Results: At three months, the mean weight-for-age z-score difference of IYC in the treatment group was significantly higher than for the control group (p=0.01). However, there were no

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significant differences between length-for-age z-scores (p = 0.104), weight-for-length z-scores (p = 0.064), mean weight (p = 0.133) and length (p = 0.536) between treatment and control groups. The change in mean haemoglobin levels was significantly lower in the treatment versus control group (p=0.01). The proportion of IYC who recovered from MAM between the treatment and control group did not differ significantly (p=0.055).

Conclusion and recommendation: MSBP supplementation of IYC with MAM results in comparable recovery rates in terms of weight-for-length z-scores and improved haemoglobin levels compared to CSB+. Therefore, MSBP could be considered as an alternative to CSB+ in the treatment of IYC with MAM.

5.1 Introduction

In 2015, globally nearly 35 million children younger than five years were reported to suffer from moderate acute malnutrition (MAM) based on weight-for-length z-scores (WHO, 2015b). The UNICEF, WHO and World Bank Group estimates that globally, more than two thirds (69%) of children younger than five years of age with acute malnutrition lived in Asia, while more than a quarter (27%) lived in Africa (UNICEF, 2016). In low- and middle-income countries, MAM affects an estimated 10% (47.5 million) of children younger than five years (Lazzerini et al., 2013). In Sub-Saharan Africa, the diets of infants and young children (IYC) are often deficient in macronutrients, micronutrients or both (WHO, 2015a 2012; Annan et al., 2014; Dewey & Adu-Afarwuah, 2008). Moreover, the prevalence of undernutrition in East Africa has remained very high over the past two decades (WHO, 2015b).

In North Western Uganda, including the Arua district, the prevalence of underweight and MAM among infants aged 6 to 8 months was 19.1% and 13.6% respectively (UBOS, 2018). The prevalence of anaemia in the same region was 56.4%, with 52.8% of IYC aged 6 to 59 months being anaemic (UBOS, 2018). Of the IYC that were anaemic, 78% were aged 9 to 11 months (UBOS, 2018). If undernutrition amongst IYC is not prevented or adequately managed, it results in growth failure, delayed motor, cognitive, and behavioural development, a compromised immune response, as well as an increased risk of morbidity and mortality (Cichon et al., 2016; Rytter et al., 2014). It has also been reported that IYC with MAM seldom achieve their full

potential in terms of physical, intellectual, or cognitive development (UBOS, 2018; Cichon et al., 2016; Rytter et al., 2014).

For the management of MAM, studies conducted in low and middle-income countries recommended the use of nutrient dense commercially manufactured and local supplementary foods (Lazzerini et al., 2013; Lenters et al., 2013; Phuka et al., 2012; Lin et al., 2008). In Sub-Saharan Africa, studies using extruded or malted supplementary foods have been conducted to gain a better understanding of the potential dietary interventions have to improve the nutritional status of IYC with MAM (Ickes, Adair, et al., 2015; Lassi et al., 2013; Lin et al., 2008; Matilsky et al., 2009; Ochola et al., 2014)). However, there is a lack of consensus regarding the most effective strategy for the management of IYC with MAM (Annan et al., 2014).

In the present study, an energy rich, nutrient dense hydrolysed malted sorghum based porridge (MSBP), formulated for the purpose of the study was used for treating IYC aged 6 to 18 months with MAM. This was compared to CSB+ (standard care in Uganda). The rationale for using a portion of the maize in the CSB+ formulation, thereby maintaining a protein: energy ratio of 1:4. In addition, the pre-digested malt, soy and maize extrudates, in addition to the sorghum dry matter, served to increase the nutrient density while attaining an acceptable viscosity.

However, the effectiveness of MSBP compared to CSB+ has not been demonstrated. It was against this background that a clustered randomized controlled trial (cRCT) was conducted to assess the effect of MSBP as a supplementary food, in combination with targeted nutrition education on the nutritional status of Ugandan IYC (6 to 18 months) diagnosed with MAM. Evidence-based studies of this nature have not been conducted in Uganda.

5.2 Methodology

5.2.1 Study design

A double blind cRCT was conducted to determine the effect of MSBP in conjunction with nutrition education on the anthropometric status and haemoglobin levels of breastfed IYC with MAM. The treatment group consisting of 12 clusters, received MSBP, whereas the control group of 12 clusters received CSB+. Each cluster consisted of eight to ten mother-IYC pairs,

recruited after IYC were diagnosed with MAM. To avoid bias towards one treatment cluster or another, trained research assistants were blinded to avoid prognostic divergence for reasons other than the intervention. In addition, the MSBP and CSB+ flours had similar transparent packaging. To minimise contamination due to mothers sharing the supplementary porridge, mothers in the treatment and control clusters received the weekly porridge rations after attending nutrition education sessions. IYC consumption of the supplementary porridge at household level was monitored on a weekly basis by a parish (cluster) chief in collaboration with village health teams. Monitoring was done to ensure that the supplementary porridges were only consumed by the IYC enrolled in the study as opposed to other household members. However, contamination and co-intervention was monitored at household by the researcher on a biweekly basis using a 24-hour recall questionnaire with the help of the parish chief in collaboration with the village health team.

5.2.2 Null hypothesis

It was hypothesised that there will be no significant difference between the anthropometric status namely weight, length and MUAC, and haemoglobin levels of breastfed IYC aged 6 to 18months diagnosed with MAM, irrespective of whether they were fed MSBP or CSB+ supplementary porridge for a period of three months.

5.2.3 Study setting

The study was conducted in 24 of the 35 parishes (servings as clusters) in the rural and semi-urban districts of Pajulu (nine parishes), Oluko (nine parishes), Oli River (ten parishes) and Dadamu (seven parishes) of the Arua district in North Western Uganda. The majority of residents in the district belong to the Lugbara ethnic tribe, and is mostly reliant on subsistence farming and petty business (UBOS, 2018). The area was conveniently selected because sorghum, maize and soy, the key ingredients of MSBP and CSB+, are primary staples in the diet of residents in the district. Staple foods are supplemented with limited amounts of food from animal origin such as small fish from the Nile River. In addition, the use of these cereals as complementary foods for IYC is common practice in this district. An additional consideration was that the selected parishes were within a radius of 50km from Arua Regional Referral Hospital (ARRH), where the health care team have vast expertise and experience in the management of IYC diagnosed with MAM. In addition, the treatment of severe acute

malnutrition (SAM) was available in one government and two not-profit hospitals in the same radius. High food prices coupled with low household incomes contributed to food insecurity in the district (Kasozi, Kasozi, Mayega, & Orach, 2018). In addition, the influx of one million refugees from South Sudan also limits access to food in the North Western region of the country (Kasozi et al, 2018)

5.2.4 Ethical considerations

The study received ethics approval from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, South Africa, the Uganda National Council of Science and Technology, and the Higher Degrees Research and Ethics Committee School of Public Health, Makerere University (Appendix A, p193). The local government leadership in the Arua district, provided permission to conduct the study within its parishes serving as clusters in the cRCT. Prospective mother-IYC pairs meeting the inclusion criteria were individually informed about the purpose of the study in the local language. Enrolment occurred after mothers signed or thumb printed (if illiterate) an informed consent form (Appendix B, p196) in the local language.

5.2.5 Recruitment of mother-IYC pairs

IYC aged 6 to 18 months diagnosed with MAM, based on weight-for-length z-scores of -3 to -2, were identified in the selected parishes. Thereafter their mothers were asked to voluntarily participate in a three months supplementation intervention. The village health teams (VHT) in the parishes that did not participate in this study were encouraged to continue carrying out their routine screening and referral activities at existing nutrition service centres. Participants were followed up on a weekly basis by the VHT who monitored the consumption of the supplementary porridges while encouraging mothers to follow the study protocol. Participant monitoring by VHT at household level was conducted using an observation check list to ensure the consumption of the MSBP and CSB+ supplementary porridges.

<u>Inclusion criteria</u>

Breastfeeding IYC aged 6 to 18 months diagnosed with MAM. Mothers were required to continue breastfeeding their IYC for the duration of the study.

Exclusion criteria

IYC aged 6 to 18 months who were already enrolled in an existing feeding programme, had physical deformities that would influence the accurate measurement of length were not eligible for participation. In addition, mothers planning to relocate from the study site during the intervention were also excluded.

5.2.6 Randomisation of clusters

A sample of 24 parishes was conveniently sampled out of a possible 35 in four sub-counties within the Arua district. They were subsequently randomised into treatment or control in a ratio of 1:1. Randomisation was pre-determined by a statistician other than the researcher. The computer-generated sequentially numbered randomisation of the 24 cluster contained the group allocations and codes for the 220 IYC with MAM recruited for the intervention. The parishes serving as clusters were separated by a buffer zone similar in size to a parish or natural geographical barrier like a swamp, forest or mountain. The trained research assistants, who were involved in assessing IYC for eligibility and follow-up, were not involved in cluster allocation.

5.2.7 Mother-IYC pair follow up

The cRCT was conducted in rural community where the IYC with MAM resided. After enrolment and allocation to treatment or control, mothers were asked to routinely bring their IYC to a specified site in their parish on a weekly basis to collect the MSBP or CSB+ rations. In addition, mothers in all the clusters received weekly nutrition education with a duration of one hour. At the site, three trained research assistants conducted the weekly measurement of MUAC, weight and length of the IYC. The remaining research assistants who were health workers, provided nutrition education to the mothers regarding appropriate complementary feeding and hygiene practices. After the nutrition education and anthropometric measurements were conducted, mothers were given the supplementary porridge rations to take home. The consumption of the supplementary porridges were monitored at household level on a weekly basis by a parish chief in collaboration with the VHT.

5.2.8 Supplementary porridges

The MSBP (treatment) was a mixture of extruded soy and maize blended with sorghum active enzyme malt in a ratio of 1:2:1 with a nutrient density of 1.6g/100 gram as fed (w/v) at a flour

rate of 25%, whereas CSB+ (control), was a combination of fortified extruded maize and soy blend in a ratio of 4:1 with a nutrient density of 1.3g/100 grams as fed (w/v). The energy and nutrient content of MSBP and CSB+ are shown in Table 5.1. The MSBP was formulated by the researcher at laboratory level and produced at Reco Industries Ltd, an officially recognised WHO CSB+ supplier. The supplementary foods met the WHO (2002) specifications for the management of IYC with MAM.

Table 5.1: Ingredient and nutrients of the supplementary foods

Ingreient & nutrients	**MSBP**	**CSB+**
Ingredients (g/100g)		
Maize, extruded	52.5	80.0
Soy bean, extruded	22.5	20.0
Sorghum, malted	25.0	0.0
Nutrient content per 100g on a dry basis		
Moisture, g/100g	6.6	8.9
Ash, g/100g	2.1	4.1
Energy, kcal/100g	487.3	380.0
Crude protein, g/100g	19.1	14.0
Crude fat, g/100g	4.4	6.0
Dietary fibre, g/100g	2.8	5.0
Iron, mg/100g	2.8	6.5

5.2.9 Nutrition education to mothers

The nutrition education of mothers with IYC diagnosed with MAM was conducted in Lugbarati, the local language spoken by two research assistants who were health workers. Educational tools included counselling cards as well as demonstrations of supplementary porridge preparation. The content of the nutrition education sessions included: complementary feeding practices, disease prevention by sleeping under a mosquito net, drinking safe water, washing hands. The nutrition education sessions were developed to enhance adoption of appropriate complementary feeding practises for the management of IYC with MAM, in addition to supplementary porridge provision IYC the appropriate rations of MSBP or CSB+ at regular intervals.

5.2.10 Supplementary food ration

A weekly ration of 1,050kg pre-packaged MSBP or CSB+ supplementary porridges were issued to mothers of IYC diagnosed with MAM depending on the parish they resided in after they attended a nutrition education session. This equated to a daily ration of 150g. MSBP provided 675kcal, and 26g protein per 100g dry matter, while the 150g daily ration of CSB+ provided 600 kcal, 25g protein and 17g of fat.

When consumed three times a day for a period of three months, it was expected that MSBP would yield an average weight gain of 10%, weight-for-length of greater than -2 z-scores, and MUAC of greater than 12.5 cm resulting in recovery from MAM (MoH, 2010). The IYC who did not attain a weight gain of 10% or a weight-for-length of greater than -2 z-scores, for two consecutive visits after supplementation of porridge for three months, was recorded as not having recovered from MAM.

5.2.11 Instruction to mothers

Mothers of IYC receiving MSBP or CSB+ were shown a porridge sample of appropriate consistency and received identical cups and teaspoon. The mothers were instructed how to measure the amount of both MSBP or CSB+ flours and water to reconstitute a single serving of 50g. That is, one part of MSBP flour was added to two parts of water, followed by cooking for 10-15 minutes. The mothers had to demonstrate their understanding of preparing the supplementary porridge through an interactive cooking session conducted in each cluster at the beginning of the supplementation intervention. In addition, mothers were told to feed their IYC with MSBP or CSB+ three times a day for a period of three months without sharing the rations with other household members. They were also requested to continue breastfeeding and feeding their IYC household diets of both animal and plant origin.

5.2.12 Sample size

To calculate sample size, the equation below was used for the cRCT with fixed clusters of 24 and flexible cluster size of eight to ten IYC with MAM. The 24 clusters satisfied the inequality to detect difference at the power (β) of 95% that approximates the sample size for individual randomization at 0.05 cluster correlation (Brestoff & Broeck, 2013; Hemming et al., 2011).

$$Sample\ size\ (n) = \frac{2\left((Z_\alpha + Z_\beta)^2(\delta^2)(1+(m-1)\,\rho\right)}{(\mu_1 - \mu_1)2} \qquad \text{Equation 1}$$

Where: $(1 + (m - 1)\rho)$ = 1.5 - Design effect

$(\mu_1 - \mu_1)^2$ = 0.4 - Expected minimum difference between desired power

$(Z_\alpha + Z_\beta)^2$ = 13 - Constant defined by p-value and desired power

$Z_\alpha = 1.96\ and\ Z_\beta = 1.645$

δ = 0.92 - Expected standard deviation of the mean difference

m = 10 – Average cluster size

On substitution in equation 1, $sample\ size\ (n) = \frac{((1.96+1.645)^2(0.92^2)(1+(10-1)0.05\,))}{0.4^2}$ = 100

In order to cater for a potential loss to follow up of 10%, the calculated sample size (n) equalled to 100+10 resulting in 110 IYC for both the treatment and control arms of the study. Thus, 220 IYC diagnosed with MAM were recruited at baseline for the supplementation intervention. The calculated sample size was large enough to compare the mean difference of the anthropometric and haemoglobin levels between the treatment and control groups after the three month of intervention. Twelve clusters per treatment and control group with mean cluster size of nine IYC with MAM, satisfied the inequality Ʀ > $n_1\rho$ (cv^2+1) to detect difference at the power (β) of 95%. Where n_1 equal to 60 the sample size for individual randomization, and ρ = equal to 0.05 the intra-cluster correlation (Hemming et al., 2011). Thus, Ʀ > 60*0.05 = Ʀ > 3.

5.2.13 Measurements

The questionnaire used in the Uganda Demographic Health Survey (2016) was adapted after gaining expert input for collecting socio-demographic data of the IYC with MAM (UBOS, 2018). The weight, length, and MUAC were measured under standard procedures in accordance with WHO standards (WHO, 2008b). Collection of a blood sample by means of a finger prick to measure haemoglobin levels was conducted using a WHO standard operation procedure (WHO, 2010). The socio-demographic characteristics, weight, length, MUAC, and measurement of haemoglobin levels are discussed in the sub-sections that follow.

Socio demographic characteristics

IYC socio-demographic characteristics regarding their type of residence, age, gender, birth weight and household members were obtained from their mothers at the baseline. The completeness and accuracy of data was checked by research assistants before leaving the field. The age of the IYC was determined to the nearest month from the child health card.

Measurement of length

The IYC length measurements were conducted using a ShorrBoard length measuring board (Shorr Productions, Woonsocket, USA). For each IYC, the mother was asked to remove shoes or sandals. Then IYC was positioned to lie on their back, with feet together and heels, buttocks, shoulders and the back of the head touching the fixed headboard of the ShorrBoard's length measuring board while the IYC's eyes were looking straight upwards. The head was held in position while ensuring that the neck was straight. The sliding footboard of the shorrBoard's length measuring board was positioned to firmly touch the soles of the feet while toes were pointing upwards. Where IYC had thick and curly hair, the hair was gently compressed to ensure that the head touches the head board. To ensure accurate measurement, the IYC was positioned by two trained research assistants of whom one carried out the measurement, while the other assisted by keeping the legs straight. All the length measurements were repeated twice, with the mean value being recorded to the nearest 0.1cm.

Measurement of weight

IYC weight was measured using a TANITA Digital scale model THD-305. The scale was calibrated on a daily basis as well as after each measurement with a standard known weight of 10kg. The mother was asked to remove IYC shoes and they were weighed wearing light indoor clothing. On weighing, the scale was zeroed. The IYC was then asked to step onto the scale, while being weighed, the IYC was asked to stand upright, with arms hanging loosely at the sides. While the weight was measured, the IYC was asked not to move, but look straight ahead and not lean on anything those who were able to stand alone on the scale. For those who could not stand alone on the scale, they were weighed with their mother. The scale display was read to the nearest 0.1kg. The child was then requested to get off the scale and the measurement was

repeated. If the IYC was unable to stand, weight was measured by asking the mother to stand on the scale first. The scale was zeroed and the child was handed to the mother while she remained on the scale to measure the IYC weight. .

Measurement of MUAC

The MUAC tape (TALC, St Albans, United Kingdom), a non-stretch insertion tape was used to measure MUAC on the IYC left arm. The mother was asked to remove IYC clothing to expose the left arm up to the shoulder. The left arm was bent while the mother or research assistant assisted to hold it in position. The acromion process on the shoulder blade and olecranon process of the ulna were identified and marked with a pen. While standing behind the child, the distance between the two marks was measured and the mid-point was marked. The mother or research assistant relaxed the IYC arm so that it hanged straight down the side of the body. The MUAC tape was placed around the upper arm at the marked midpoint, while ensuring that it was not too tight or loose. Subsequently MUAC was measured from the window of the tape. The measurement was repeated twice and the mean value recorded to 0.1cm.

Measurement of haemoglobin level

The Hemocue Hb301 Analyser 121805 was used to measure haemoglobin levels of IYC on site at baseline and at conclusion of the intervention of three months. Blood samples were collected by means of a finger prick from IYC whose mothers provided the necessary written informed consent. A biomedical technologist, under the supervision of the researcher, collected the blood sample and performed the haemoglobin analysis. The figure was disinfected and lightly pressed using the thumb from the top to the knuckle towards its tip. While applying light pressure, the figure was pricked using a stainless steel lancet. The first two drops of blood were wiped off. Subsequent light pressure was re-applied until another large enough drop of blood appeared. The micro cuvette was allowed to fill in one continues process. It was then wiped off excess blood on the outside, and placed in cuvette holder without touching its open end. A haemoglobin concentration of less than 10.5g/dl, after adjustment for altitude from 11g/dl, was recorded as anaemic as per the WHO classification (Coutinho, Goloni-Bertollo, & Pavarino-Bertelli, 2008; WHO, 2015a). IYC diagnosed with haemoglobin levels less than 8g/dl, were referred to the Arua Regional Referral Hospital (ARRH) in close proximity of the study area for follow-up care.

5.2.14 Training research assistants

Research assistants were trained for two days on how to measure weight, length, and MUAC as well as interviewing techniques. In addition, a biomedical technologist was trained for one day regarding the collection of blood samples for measurement of haemoglobin levels. In addition, the research assistants were trained on how to collect morbidity data of IYC during the nutrition education sessions. The research assistants were trained how to obtain informed consent (Appendix B, p196). On the second day, the procedures for determining anthropometric status and haemoglobin levels were piloted in the field by the research assistants supervised by the researcher.

5.2.15 Data collection

Anthropometric data was collected by the same trained research assistants at baseline, on a weekly basis in the course of the intervention, and at the conclusion of the supplementation of three months to avoid interpersonal variability. Capillary blood samples were collected to determine the haemoglobin levels at baseline and after the conclusion of the supplementation intervention of three months by the same biomedical technologist, while morbidity data was collected bi-weekly. The researcher supervised the collection of socio-demographic data, nutritional status and haemoglobin levels.

5.2.16 Data management

Anthropometric data was entered into Epi-info Version 3 and later exported into STATA Version 15 for analysis. Haemoglobin levels and socio-demographic data entry sheets were developed in EpiData. All survey questionnaires were coded with an identifier number before data entry commenced. Survey questionnaires that contained missing data were not considered for data entry. Double data entry was conducted and subsequently checked for accuracy and consistency using STATA command sum. It was then edited before being backed-up and stored as password protected files. The hard copies of the survey questionnaires were securely stored in a locked cupboard in the researcher's office.

5.1.17 Data analysis

The STATA Version 15 statistical software package was used conduct descriptive statistics. Anthropometric outcome indicators regarding weight-for-length, weight-for-age, and length-for-age z-scores were computed based on the WHO 2006 Child Growth Standards, using the 2011 AnthroPlus statistical software version 3.2.2 (WHO, 2011). Anthropometric variables such as weight, length and MUAC, as well as haemoglobin levels were expressed as means and standard deviations (±SD). At three months, the mean anthropometric outcome indicators of weight, length, length-for-age z-scores, weight-for-age z-scores, length-for-weight z-scores, and blood haemoglobin levels in the treatment and control groups were compared using the independent t-test. In addition, comparison of proportions of the anthropometric outcome indictors and haemoglobin levels as well as MAM recovery rates, weight gain and an increase in haemoglobin levels between the treatment and control groups at three months, was performed using a z-test. All results were considered significant at $p < 0.05$.

5.3 Results

Findings generated by the cRCT after a period of three months with MSBP (treatment) and CSB+ (control) on weight, length, MUAC, recovery from MAM, haemoglobin level, weight-for-age, weight-for-length and length-for-age z-scores of IYC with MAM, are presented in the sections that follow. Overall, 204 out of the 220 (92.3%) mother-IYC pairs that enrolled in this study, had complete data set, as 16 were lost to follow-up. Of those who were lost to follow-up, nine had incomplete anthropometric and haemoglobin data sets, while six dropped out for personal reasons and one passed away due to malaria. The study randomisation, recruitment of mother-IYC pairs as well as those who were lost to follow up, is illustrated in Figure 5.1.

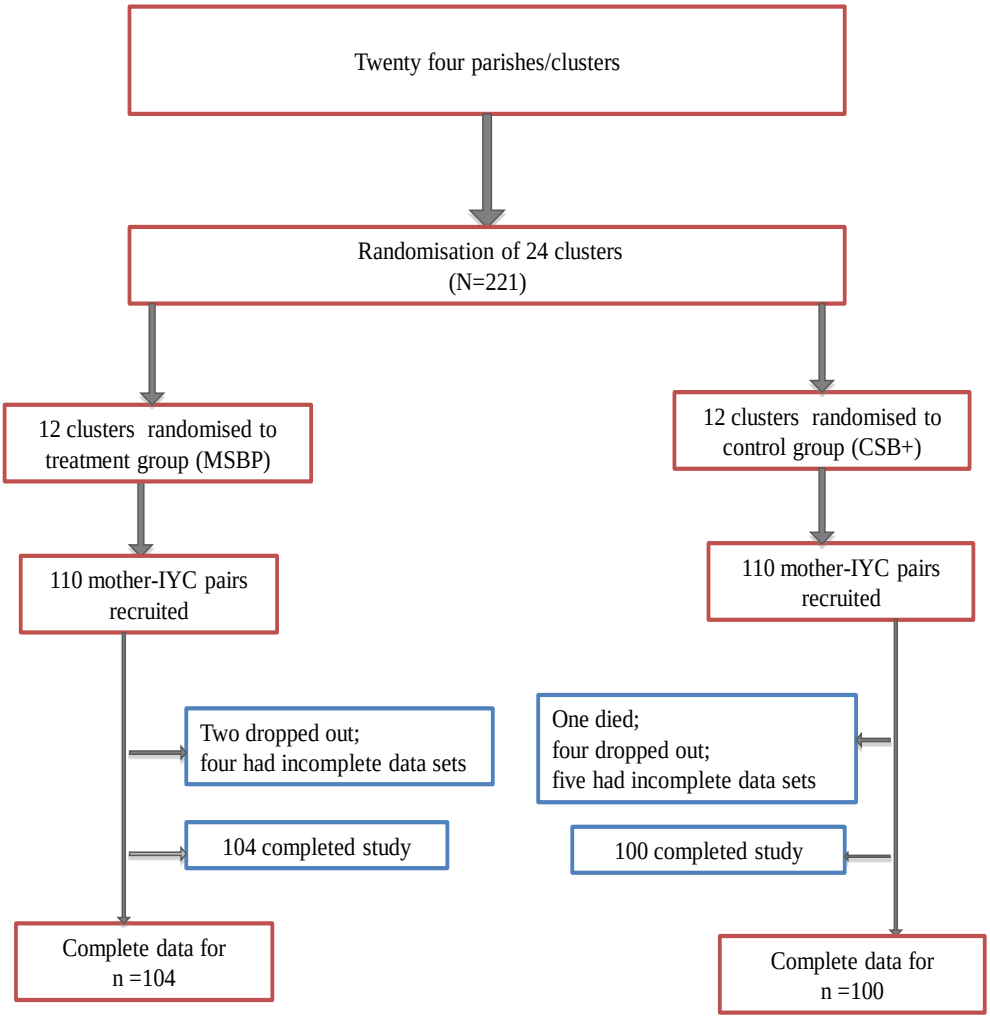

Figure 5.1: Study randomisation, recruitment and mother-IYC pairs lost to follow-up

5.3.1 Baseline characteristics of IYC

The mean age of IYC was 11.9 ± 5.3 months with the majority of households (97.5%) where the IYC resided, comprising of less than three children under the age of 59 months. The ratio of IYC aged 6 to11 months to those aged 12 to 23 months, as well as the gender distribution in both groups was 1:1. There was no significant difference between the IYC socio-demographic characteristics of the control versus treatment groups (Table 5.2).

Table 5.2: Baseline socio-demographic characteristics of IYC per treatment and control group

Socio-demographic characteristics (N=204)	Treatment n (%)	Control n (%)	All combined n (%)	P-value*
Age of IYC (months)				
6-11	57(54.8)	51(51.0)	108(52.9)	
12-24	47(45.2)	49(49.0)	96(47.1)	0.386
IYC gender				
Male	52(50.5)	51(51.0)	103(50.7)	
Female	52(49.5)	49(49.0)	101(49.3)	0.942
IYC birth weight (kg)				
<2.5	16(16.5)	20(20.4)	36(18.5)	
≥2.5	81(83.5)	78(79.6)	159(81.5)	0.481
Number of children younger than 59 months in a household				
≥3 children	3(2.9)	2(2.0)	5(2.5)	
<3 children	101(97.1)	98(98.0)	199(97.5)	0.683
IYC living with their father				
Yes	70(67.3)	72(72.0)	142(69.6)	
No	34(32.7)	28(28.0)	62(30.4)	0.466

*z-test

The anthropometric status and haemoglobin levels of IYC with MAM at baseline, are presented in Table 5.3. The mean weight-for-age z-scores in the treatment group, differed significantly from the control group at baseline (p=0.016). Anthropometric measurements indicative of stunting, wasting, MUAC and haemoglobin levels in the treatment group did not differ significantly from control at baseline before commencement of MSBP and CSB+ supplementation.

Table 5.3: Anthropometric status and haemoglobin levels per treatment and control group baseline

Anthropometric indictors and haemoglobin levels	Groups		P-value*
	Treatment (104) Mean (SD) [a]	Control (100) Mean (SD) [a]	
Weight (kg)	7.12(0.08)	7.01(0.09)	0.345
Length (cm)	69.43(0.42)	69.14(0.45)	0.640
MUAC [b] (cm)	12.82(0.07)	12.75(0.07)	0.476
Weight-for-age z-scores	-2.289(0.621)	-2.506(0.649)	0.016
Length-for-age z-scores	-2.098(0.993)	-2.327(1.053)	0.111
Length-for-weight z-scores	-2.192(0.830)	-2.403(0.756)	0.315
Haemoglobin level (g/dl)	9.71(0.15)	9.62(0.16)	0.890

*independent t-test
[a] SD =standard deviation
[b] MUAC = mid-upper arm circumference.

5.3.2 Anthropometric outcome indicators and haemoglobin levels at end line

After supplementation for three months, mean weight-for-age z-scores in the treatment group, was significantly higher than in the control group (Table 5.4). However, there was no significant difference between length-for-age z-scores and weight-for-length z-scores, as well as the mean weight and length. In addition, the mean haemoglobin levels of the treatment and control groups did not differ significantly and was below the WHO reference cut off value of 11g/dl for healthy IYC (WHO, 2015a).

Table 5.4: Comparison of the mean anthropometric and haemoglobin levels between treatment and control groups at end line

Anthropometric indicators and haemoglobin levels (N=204)	Mean (SD) [a]		P-value*
	Treatment	Control	
Weight (kg)	7.966(0.866)	7.776(0.934)	0.133
Length (cm)	72.093(4.273)	71.728(.135)	0.536
MUAC [b] (cm)	13.411(0.785)	13.298(0.834)	0.318
Weight-for-age z-scores	-1.939(0.690)	-2.214(0.817)	0.010
Length-for-age z-scores	-2.282(1.038)	-2.521(1.057)	0.104
Length-for-weight z-scores	-1.068(0.755)	-1.276(0.846)	0.064
Haemoglobin level (g/dl)	10.145(1.425)	10.463(1.445)	0.115

*Independent t-test, [a] SD =standard deviation, [b] MUAC = mid-upper arm circumference

The result of the mean increase in anthropometric and haemoglobin levels measurements by gender per the treatment and control groups after supplementation for three months are presented in Table 5.5. The mean weight gain, increase in length, MUAC and haemoglobin levels of the males and females in the treatment and control groups when compared after three months of supplementation did not differ significantly.

Table 5.5: Comparison of the mean increase in anthropometric measurements and haemoglobin levels between treatment and control by gender after 90 days

Anthropometric indicators and haemoglobin levels	Treatment (n=104) Mean (SD) [a]	Control (n=100) Mean (SD) [a]	P-value*
Weight gain (kg)			
Male	1.307 (0.731)	1.215 (0.949)	0.581
Female	1.376 (0.735)	1.295 (0.767)	0.587
Length gain (cm)			
Male	4.134 (1.982)	3.889 (2.077)	0.541
Female	4.463 (1.664)	4.548 (1.845)	0.809
MUAC [b] gain (cm)			
Male	4.985 (5.698)	4.977 (5.172)	0.994
Female	5.387 (5.238)	4.647 (6.284)	0.521
Haemoglobin level gain (mg/dl)			
Male	0.419 (1.604)	1.031 (2.034)	0.093
Female	0.849 (1.792)	1.272 (1.488)	0.203

*Independent t-test
[a] SD =standard deviation
[b] MUAC = mid-upper arm circumference

The mean increase in weight, length, MUAC and haemoglobin levels between the treatment and control groups by age at the conclusion of the intervention (Table 5.6). There was no significant difference in the mean increase in weight, length and MUAC between the infants aged 6 to11 months and young children aged 12 to 23 months in the treatment and control groups at three months. However, young children aged 12 to 23 months in the treatment group had a significantly higher mean weight gain and length gain than children in the same age category in the control group.

Table 5.6: Comparison of the mean increase in anthropometric indicators and haemoglobin levels between treatment and control by age after 90 days

Anthropometric and haemoglobin levels	Treatment (n=104) Mean (SD) [a]	Control (n=100) Mean (SD) [a]	P-value*
Weight gain (kg)			
6-11months	1.369 (0.754)	1.545 (0.877)	0.266
12-23 months	1.308 (0.708)	0.951 (0.740)	0.018
Length gain (cm)			
6-11months	4.530 (1.785)	4.754 (1.870)	0.526
12-23 months	4.018 (1.859)	3.647 (1.959)	0.344
MUAC [b] gain (cm)			
6-11months	4.633 (5.409)	5.659 (5.976)	0.351
12-23 months	5.857 (5.482)	3.937 (5.354)	0.085
Haemoglobin level gain (mg/dl)			
6-11months	0.566 (1.715)	1.147 (1.539)	0.068
12-23 months	0.717 (1.709)	1.150 (2.021)	0.261

*independent t-test
[a] SD =standard deviation,
[b] MUAC = mid-upper arm circumference

5.3.3 Mean increase in anthropometric indicators and haemoglobin levels per treatment and control group at end line

The mean increase in haemoglobin levels of IYC after supplementation for three months was significantly lower in the treatment than in the control group as shown in Table 5.7. Further, the mean anthropometric indicators namely weight, length, MUAC, weight-for-age z-scores, weight-for-length z-scores, and length-for-age z-scores of IYC per day were found not to differ significantly between the treatment and control groups after supplementation for three months.

Table 5.7: Comparison of mean increase in anthropometric indicators and haemoglobin levels between treatment and control per day

Anthropometric and haemoglobin levels (N=204)	Mean gain per day gain[a] (SD) [b]		
	Treatment (n=104)	Control (n=100)	P-value*
Weight gain ($g.kg^{-1}.day^{-1}$)	1.342 (0.731)	1.254 (0.862)	0.433
Length gain ($\mu m.cm^{-1}.day^{-1}$)	4.299 (1.828)	4.212 (1.985)	0.744
MUAC [c] gain ($\mu m.cm^{-1}.day^{-1}$)	5.186 (5.449)	4.815 (5.717)	0.636
Weight-for-age z-score gain.day^{-1}	0.148(0.021)	0.115(0.02)	0.310
Length-for-age z-score gain.day^{-1}	0.078(0.102)	-0.152(0.070)	0.556
Length-for-weight z-score gain.day^{-1}	0.350(0.060)	-0.952(1.105)	0.232
Haemoglobin level gain ($g.dl^{-1}$ .day^{-1})	0.634 (1.706)	1.149 (1.783)	0.036

* Independent t-test
[a] Mean gain per day = mean value at three months minus baseline mean value divided by baseline mean value and then divided by 90 days
[b] SD =standard deviation
[c] MUAC = mid-upper arm circumference

There was no significant difference between the treatment and control group in terms of an increase in weight, length, and MUAC at end line. However, the mean increase in haemoglobin levels in the treatment group was significantly lower than in the control group (Table 5.8).

Table 5.8: Comparison of mean increase in weight, length and haemoglobin levels per treatment and control after 90 days

Anthropometric and haemoglobin levels	Mean gain[a] (SD)[b]		P value*
	Treatment	Control	
Weight (kg)	0.988(0.417)	1.086(0.454)	0.433
Length (cm)	2.992(0.107)	2.941(0.111)	0.744
MUAC (cm)	0.697(0.651)	0.793(0.605)	0.636
Haemoglobin level (g/dl)	0.483(0.135)	1.170(0.127)	0.010

*Independent t-test
[a] Mean increase = mean measures at three months – baseline means values
[b] SD =standard deviation

Results of the mean weight, length and MUAC increase over three months, found no significant difference between the treatment and control groups (Figure 5.2). In addition, a significant difference was not found between the weekly increase in weight, length and MUAC between the treatment and control groups.

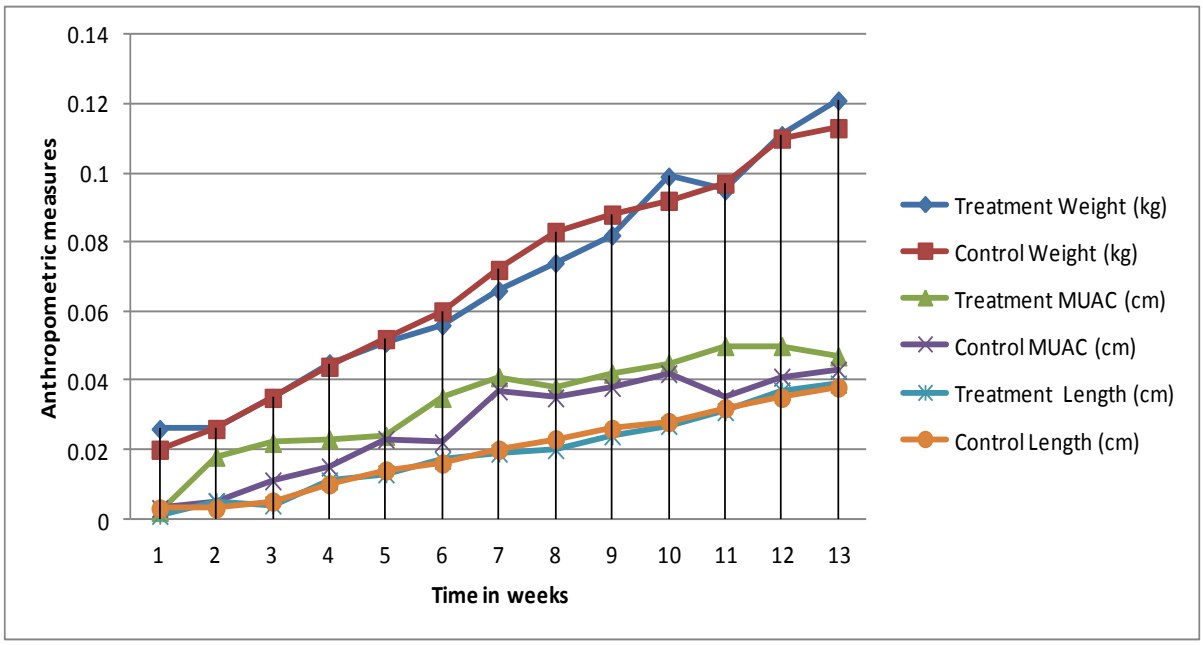

Figure 5.2: Increase in weight, length and MUAC measurements from baseline to end line per treatment and control groups

5.3.3 Proportion of anthropometric measurements and haemoglobin levels per treatment and control at end line

Two thirds of the IYC gained a mean weight of 1.5g/kg per day. However, a significant difference between treatment and control was not observed. The proportion of IYC with MAM who attained a weight-for-age z-score of more than -2 z-scores after three months of supplementation was higher in the treatment than control group, although the difference was not significant (Table 5.9). Similarly, the mean weight gain was higher in the treatment than control group, but lacked significance. The proportion of MAM (weight-for-length z-score between -3 and -2 z-scores) among IYC in the treatment group (9.6%) was below the WHO guideline cut off of 10% for Sub-Saharan African (Greaney et al., 2011), indicative of a public health problem.

More than two thirds of IYC in the treatment and control groups had a length-for-age z-score of less than -2 z-score at end line. The majority of the IYC with a MUAC of more than 12.5 cm was higher in the treatment (93.3%) than the control group, although not significantly so.

Table 5.9: Comparison of the proportion of anthropometric outcome indicators and haemoglobin levels between treatment and control after 90 days

Anthropometric indicators and haemoglobin levels (N=204)	Treatment (n=104) (%)	Control (n=100) (%)	Combined value (%)	P-value*
Mean weight gain				
≥ 1.5g/kg/day	39(37.5)	35(35.0)	74(36.3)	
<1.5g/kg/day	65(62.5)	65(65.0)	130(63.7)	0.710
Mean weight gain				
≥10%	63(60.6)	51(51.0)	114(55.9)	
<10%	41(39.4)	49(49.0)	90(44.1)	0.168
Weight-for-length z-scores				
z-score > -2	94(90.4)	81(81.0)	175(85.8)	
z-score ≤ -2	10(9.6)	19(19.0)	24(14.2)	0.055
Weight-for-age z-scores				
z-score > -2	59(56.7)	44(44.0)	103(50.5)	
z-score ≤ -2	45(43.3)	56(56.0)	101(49.5)	0.069
Length-for-age z-scores				
z-score > -2	36(34.6)	33(33.0)	69(33.8)	
z-score ≤ -2	68(65.4)	67(67.0)	135(66.2)	0.807
Mean MUAC				
> 12.5cm	97(93.3)	87(87.0)	174(85.3)	
≤ 12.5cm	7(6.7)	13(13.0)	30(14.7)	0.364
Mean Haemoglobin level				
> 10.5g/dl	47(45.2)	58(58.0)	105(51.5)	
≤ 10.5g/dl	57(54.8)	42(42.0)	99(48.5)	0.067

*z-test, SD =standard deviation, MUAC = mid-arm upper circumference.

5.3.4 Nutritional status, recovery time and survival estimate of IYC at three months

Nutritional status of IYC

After supplementation for a period of three months, the proportion of IYC that remained wasted was lower (9.6% versus 19%) in the treatment than control group respectively (Figure 5.3). Conversely, more than two thirds of IYC in both the treatment and control groups at end line were stunted, as catch up growth takes longer to manifest (Bisimwa et al., 2012; Lassi et al., 2013).

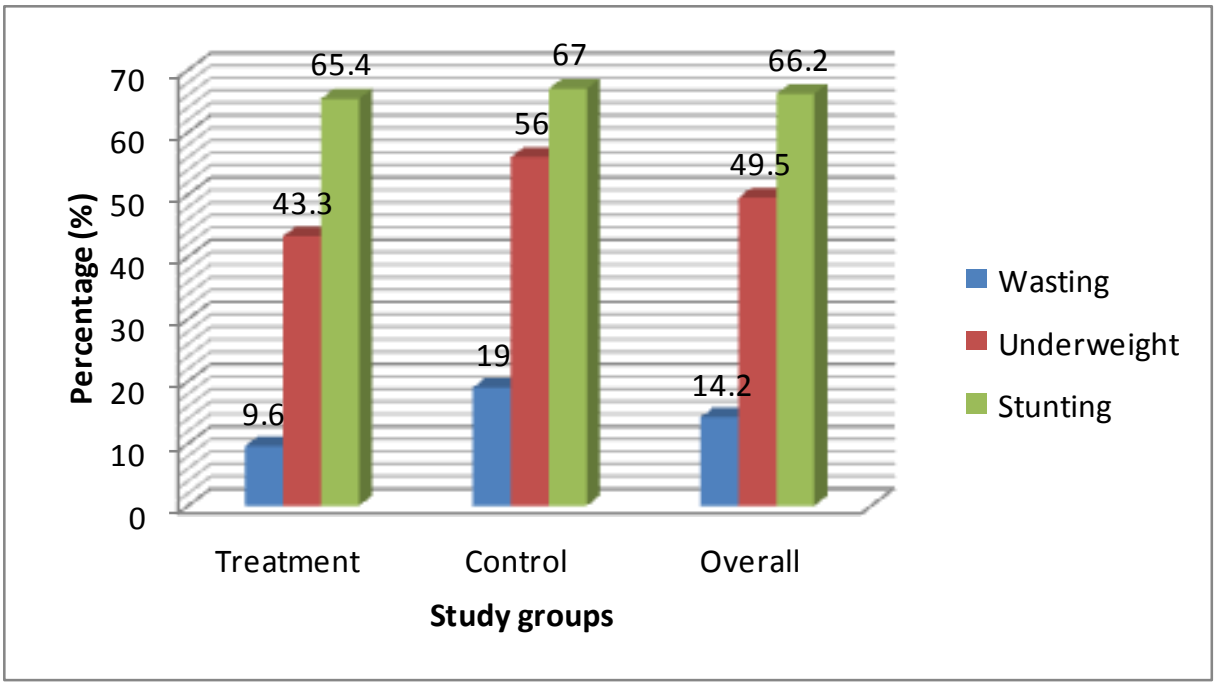

Figure 5.3: Prevalence of nutritional status of IYC among treatment and control groups at end line

5.4 Discussion

This is the first study to evaluate the effectivity of a novel supplementary porridge MSBP on the nutritional status and haemoglobin levels of IYC with MAM. In addition, it provided evidence that MSBP can be used as an alternative to CSB+, standard care for MAM in Uganda, as it resulted in an improvement in weight-for-length z-scores and haemoglobin levels among IYC with MAM following a supplementation period of three months.

5.4.1 Anthropometric outcome measures

IYC in the treatment group gained 131g at end line, while those in the control group gained 122g. A possible explanation for the comparable level of weight gain between treatment and control could be related to the optimal energy and nutrient density of MSBP versus CSB+ in conjunction with appropriate complementary feeding practices of their mothers as a result of targeted nutrition education. The IYC were able to meet their protein and energy requirements, thus enabling growth and tissue repair by consuming MSBP at regular intervals (Dewey & Adu-

Afarwuah, 2008; Lazzerini et al., 2013; WHO, 2012; Lin et al., 2008). The results of the present study compare favourably with that of studies conducted in the Democratic Republic of Congo (Bisimwa et al., 2012) and Malawi (Lin et al., 2008) where no significant difference in weight gain between treatment and control groups with MAM receiving supplementary food was found. The null hypothesis formulated for the purpose of the study stated that the expected weight gain of IYC in the treatment group would not differ from that in the control group would be similar. As the results between the two groups were similar, the null hypothesis is accepted.

In addition, the results of this study indicate that the mean increase in length of IYC after a supplementation period of three months with MSBP (treatment), was higher when compared to IYC who were fed CSB+ (control), although not statistically significant. The increase in length of the IYC with MAM contributed to linear growth which added to overall weight gain. This finding is supported by past studies that reported how the provision of nutrient dense complementary foods to IYC with MAM improves linear growth (Onyango et al., 2014).

Furthermore, the increase in MUAC, representing an increase in lean mass, did not differ between groups. These results are in line with those of previous studies reporting that the provision of nutrient dense supplementary foods in the management of IYC with MAM, contributes to an increase in muscle mass (Matilsky et al., 2009). It is therefore evident that the use of a nutrient dense supplementary porridge such as MSBP, contributes to the formation of lean mass and therefore improvement in nutritional status of malnourished IYC (Lassi et al., 2013).

The above suggest that the contribution of MSBP towards an increase in length, MUAC and overall weight gain of IYC recovering from MAM was modest and did not differ significantly when compared to CSB+. In addition, no significant difference was found at three months between the weight-for-age z-scores and length-for-age z-scores among IYC receiving MSBP when compared to those who were fed on CSB+. Together, the results of this study show that three months of supplementation with MSBP or CSB+ for the treatment of IYC with MAM (MoH, 2010; WHO, 2002), was not sufficient to facilitate recovery from moderate underweight and stunting. Thus, management of these two conditions might require more time to achieve an appropriate improvement in recovery rate when using plant based supplementary foods.

5.4.2 Haemoglobin levels

The mean IYC haemoglobin level in both the treatment and control groups at end line was lower than the WHO cut off values (11g/dl) for IYC (Coutinho et al., 2008; WHO, 2015a), thus being indicative of anaemia in the study sample. The mean increase in haemoglobin level among IYC fed MSBP at end line (three months) was lower than those receiving CSB+. This finding could be attributed to the fact that CSB+ was fortified with micronutrients including iron, whereas MSBP was malted and unfortified. However, the improvement in haemoglobin levels among IYC in the treatment group could be attributed to the active enzymatic sorghum malt effect in MSBP facilitated by the cooking process. Nevertheless, the lower mean haemoglobin level among IYC receiving MSBP, did not compromise weight gain and overall recovery of IYC from MAM. This result is consistent with earlier studies reporting that iron supplementation of IYC at risk of growth faltering does not affect weight gain (Coutinho et al., 2008). Thus, it may be optional to fortify MSBP with micronutrients.

5.4.3 Recovery outcome measure

In this study, supplementation with MSBP (treatment) for a period of three months yielded a recovery rate of 90.4% for IYC with MAM, although it did not differ significantly from the 81.0% recorded for CSB+ (control). However, the recovery rate recorded was higher than that recorded by past studies that reported modest outcomes regarding the effectivity of supplementary foods processed from legume-cereals for the management of IYC with MAM (Lenters et al., 2013; Manary & Sandige, 2008). The expected recovery rate according to the Sphere standard is ≥75% as measured by weight-for-length z-scores (Greaney et al., 2011). A possible explanation for the recovery rate above the recommended sphere standard value could have been partly related to the optimal nutrient density of MSBP, coupled with appropriate IYC complementary feeding practices. The findings of this study are in agreement with past studies reporting that the provision of nutrient dense foods in the management of IYC with MAM increases their recovery rate in terms of improved weight-for-length indicators (Lazzerini et al., 2013; WHO, 2012). The result regarding recovery rate agrees with a study conducted in Uganda that used a sorghum peanut mixture with the addition of ghee and honey as a supplement for the management of MAM among children aged 6 to 59 months, yielding a recovery rate of 82.3%

(Ochola et al., 2014; Greaney et al., 2011). Overall, past studies which have used cereal-legume based supplementary foods in the management of IYC with MAM have reported comparable recovery rates to the findings of the present study (Phuka et al., 2012; Dewey & Adu-Afarwuah, 2008).

5.4.4 Overall discussion

The findings of this study showed that supplementing IYC with MAM with MSBP for a period of three months resulted in improved weight-for-length z-scores and blood haemoglobin levels. That is, MSBP supplementation in addition to nutrition education was able to lower the prevalence of MAM among IYC to 9.6%, a level which was no longer considered to be a public health problem as the cut off value is greater than 10% contrary to the control group which recorded 19%. Importantly, the IYC fed MSBP acquired higher recovery rates than their counterparts who received CSB+. It is therefore possible to rehabilitate IYC with MAM using MSBP, a locally formulated nutrient dense supplementary food using locally grown ingredients which are culturally acceptable. The evidence from this study suggests that the energy and protein content of MSBP was able to meet the nutrient requirements of IYC with MAM. Its value as a supplementary porridge should therefore not be overlooked. Further, this study supports the WHO (2012) technical recommendation for a supplementary feeding protocol of three months to rehabilitate IYC with MAM. As a weight gain of a third a kilogram per month or more is sufficient to yield a satisfactory recovery rate of IYC from MAM, MSBP can be used as an alternative to CSB+ in the management of malnutrition in Uganda. Although, the three month supplementation period seems to be adequate for the management of wasting among the IYC diagnosed with MAM, this period is not adequate for the management of IYC with moderate stunting. Therefore, the potential for scaling up the use of a novel supplementary porridge such as MSBP should be investigated.

Based on the null hypothesis that there will be no significant difference between the anthropometric status namely weight, length and MUAC, and haemoglobin levels of breastfed IYC aged 6 to 18months diagnosed with MAM, irrespective of whether they were fed MSBP or CSB+ supplementary porridge for a period of three months and the study findings, the null hypothesis can be accepted. .

5.4.5 Study strength

One of the strengths of this study was that the consumption of supplementary food by the IYC at household level was monitored by the research team. Observation during home visits confirmed that IYC were fed the supplementary porridge three times a day as per the study protocol, adds to the validity of the study findings. Conversely, loss to follow up was minimal as the supplementary porridges were delivered within the community where the IYC resided.

5.5 Conclusion and recommendations

5.5.1 Conclusion

The supplementation of MSBP to IYC with MAM for a period of three months results in a satisfactorily recovery rate in terms of weight-for-length z-scores. The recovery rate suggests that the management of IYC with MAM requires an energy rich and nutrient dense supplementary food in conjunction with targeted nutrition education to mothers regarding appropriate complementary feeding practices, and personal hygiene. Overall, IYC with MAM fed on MSBP supplementary porridge gained 1kg, grew 3cm, while MUAC increased by 0.7cm. In addition, haemoglobin levels increased by 0.5 $g.dl^{-1}$, which resulting in a 90.4% recovery rate. This finding provides evidence that MSBP has the potential to be used as an alternative to CSB+ in the management of IYC with MAM in Uganda. Therefore, IYC with MAM fed MSBP are able to achieve a nutritional status that compared favourably to that of their counterparts being fed CSB+, the current standard care. Therefore, the potential of scaling up the use of a novel supplementary porridge such as MSBP should be investigated.

5.5.2 Recommendations

The provision of a supplementary food with an optimal energy density and protein content that improved nutritional status and haemoglobin levels should be promoted to facilitate the recovery of IYC from MAM. Appropriate complementary feeding practices in terms of dietary diversity, meal frequency, and optimal personal hygiene practices should be promoted. The potential of MSBP in improving the nutritional status of IYC with MAM should be investigated and scaled up.

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CHAPTER 6: EFFECT OF NUTRITION EDUCATION ON KNOWLEDGE, COMPLEMENTARY FEEDING AND HYGIENE PRACTICES OF MOTHERS WITH MODERATE ACUTELY MALNOURISHED CHILDREN, UGANDA[7]

Abstract

Background: Inappropriate infant and young child complementary feeding practices as a result of a lack of maternal knowledge, contributes to an increased risk of malnutrition, morbidity and mortality. There is a lack of data regarding the effect of nutrition education on maternal knowledge, complementary feeding and hygiene practices as part of a supplementary feeding intervention targeting infants and young children (IYC) with moderate acute malnutrition (MAM) in low income countries, like Uganda. This study determined whether nutrition education improves knowledge, complementary feeding and hygiene practices of mothers with IYC diagnosed with MAM.

Methods: A cross-sequential study using a pre-test-post-test design included 204 mother-IYC pairs enrolled across 24 conveniently sampled clusters. Weekly nutrition education sessions were embedded in a supplementary porridge intervention for three months. Mean scores and proportions for knowledge, feeding and hygiene practices were determined at baseline and end line. The difference between mean scores at the two time points were calculated with a paired t-test, while the proportions between baseline and end line were calculated using a z-test.

Results: Mean scores for knowledge, dietary diversity, and meal frequency were higher at end line compared to baseline ($p < 0.001$). Handwashing, did not improve significantly ($p = 0.183$), while boiling water to enhance water quality improved ($p < 0.001$). The prevalence of illness of IYC decreased significantly at end line ($p<0.001$).

Conclusion: Maternal nutrition education in conjunction with a supplementary feeding intervention targeting IYC with MAM improved meal frequency, dietary diversity, and water quality as well as decreased morbidity.

[7] This chapter has been published in the Food and Nutrition Bulletin as; Kajjura RB, Veldman FJ, & Kassier SM. Maternal perceptions and barriers during managing moderately malnourished children with malted sorghum-based porridge versus fortified soy corn blend, Uganda.

6.1 Introduction

Globally, undernutrition contributes to an estimated 60% of under-five mortality (Patel et al., 2015). In developing countries, approximately one third of infant and young child (IYC) deaths are associated with underlying causes of undernutrition (Lassi et al., 2013), with an estimated two-thirds being due to inappropriate complementary feeding practices (Lenters et al., 2013; WHO, 2012). In Sub-Saharan Africa, IYC between 6 to 23 months with moderate acute malnutrition (MAM) are more vulnerable to inadequate food intake due to inappropriate feeding and hygiene practices, as it can result in high morbidity and mortality rates (Negash et al., 2014). Childhood infections such as diarrhoea and poor feeding practices including low meal frequency and a lack of dietary diversity, contribute to delayed recovery from MAM (Annan et al., 2014; Imdad et al., 2011). However, good hygiene practices, especially hand washing with soap, reduce the risk of diarrhoea by 23% (Freeman et al., 2014). Nutrition education on appropriate feeding and hygiene practices that target mothers of IYC have been reported to significantly improve knowledge, nutritional status, and minimise disease when combined with the provision of supplementary foods in the management of MAM (Lassi et al., 2013; Imdad et al., 2011).

Optimal feeding and hygiene practices therefore have the potential to prevent growth faltering among breastfed IYC with MAM (Annan et al., 2014; Jones et al., 2014). However, it has been reported that supplementary feeding interventions either lack, or provide inadequate nutrition education (Negash et al., 2014). Further, where nutrition education was conducted in low income countries, there is a paucity of data documenting the impact thereof on mothers' knowledge regarding IYC complementary feeding and hygiene practices (Negash et al., 2014; Lassi et al., 2013; Imdad et al., 2011). It is possible, that the nutrition education given to mothers could be inadequate to facilitate an improvement in their knowledge (Lassi et al., 2013; Lenters et al., 2013; WHO, 2012; Imdad et al., 2011). It would therefore seem that changes implemented by mothers as a result of nutrition education have not been adequately documented in low income settings. Therefore, the aim of this study was to determine the effect of nutrition education on nutrition knowledge, complementary feeding and hygiene practices as part of the management strategy of IYC aged 6 to 18 months diagnosed with MAM.

This study was embedded in a cRCT (see Chapter 5) that determined the effect of MSBP supplementation in conjunction with nutrition education of mothers on the nutritional status of

their IYC diagnosed with MAM. The targeted nutrition education focused on improving the complementary feeding practices and prevention of infection among IYC receiving supplementary porridges. The nutrition education messages were based on data collected at baseline (Chapter 4) from the same mothers that participated in the cRCT (Chapter 5). Hence, data collected at baseline, served as background information for the nutrition education intervention, thereby contributing to its relevance for mothers of IYC with MAM who received a supplementary porridge in addition to a home-based diet.

6.2 Methods

6.2.1 Study design

A cross-sequential approach employing a pre-test-post-test design was used to determine nutrition knowledge, complementary feeding and hygiene practices of breastfeeding mothers with IYC diagnosed with MAM. Seven to nine mothers of IYC diagnosed with MAM were conveniently enrolled from each of the 24 conveniently sampled clusters for participation in the nutrition education intervention with a duration of three months. In 12 of the clusters, mothers were randomised to feeding their IYC a MSBP serving as treatment, whereas mothers in the remaining 12 clusters were randomised to feeding their IYC a CSB+ that served as control.

6.2.2 Study setting

This study was embedded in a community-based cRCT that determined the effect of MSBP versus CSB+ supplementary porridges, in conjunction with nutrition education of breastfeeding mothers, on the nutritional status of IYC with MAM. The mothers who participated in this study resided in four sub counties of a rural district of Arua in West Nile, North Western Uganda. The region is characterised by a high prevalence of wasting (13.6%) among IYC (UBOS, 2018).

6.2.2 Null hypothesis

It was hypothesised that there will be no statistically significant difference between the hygiene and complementary feeding practices (dietary diversity and meal frequency) of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM before and after they received targeted nutrition education in conjunction with their IYC receiving MSBP or CSB+ supplementary porridge for a period of three months.

6.2.4 Study participants

Two hundred and four mothers of IYC with MAM, who were participating in the cRCT supplementation phase of this study (Chapter 5) were followed up after one week and recruited to participate in the nutrition education intervention.

6.2.5 Ethical considerations

Ethics approval was obtained from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, the Uganda National Council of Science and Technology, and the Higher Degrees, Research and Ethics Committee of the School of Public Health, Makerere University (Appendix A, p193). Informed consent forms (Appendix B, p196) were signed by participants who were literate, while illiterate participants made a thumb-print on the informed consent form prior to participation in the study. All participants were guaranteed confidentiality and anonymity as they were assigned a coded number for identification purposes.

Inclusion criteria

Breastfeeding mothers of IYC with MAM participating in the cRCT supplementation study phase and willing to attend weekly nutrition education sessions were included in this study upon signing an informed consent form.

Exclusion criteria

Breastfeeding mothers of IYC with MAM with hearing disorders and speech difficulties, all well as mothers who did not reside in the selected parishes that served as clusters, were not eligible for participation.

6.2.6 Participant recruitment

Two hundred and four (N=204) mothers of IYC aged between 6 and 18 months who were enrolled in either the MBSP or CSB+ supplementation arm of the cRCT were recruited for participation. Each supplementation arm consisted of 12 clusters after randomisation into either treatment or control in a ratio of 1:1. A cluster consisted of eight to ten mother-IYC pairs (Chapter 5). A week after of enrolment in the cRCT, participants were approached and recruited to participate in the nutrition education intervention.

6.2.7 Nutrition education

The nutrition education intervention was implemented based on the constructs of the HBM (Bandura, 1977), in order to improve maternal complementary feeding and hygiene practices. As per the HBM, it was believed that when mothers acquire knowledge through the nutrition education intervention, it will be internalised to result in behavioural change (French et al., 2012; Glanz et al., 2015). The nutrition education was conducted on a weekly basis for a period of three months. The contents of the education sessions with a duration of up to 60 minutes, included information on appropriate complementary feeding and optimal hygiene practices (Table 6.1), using nutrition counselling cards adopted from the Ministry of Health in Uganda, after expert input (MoH, 2010).

Table 6.1: Nutrition education given to mothers

Optimal complementary feeding practices

- Continue breastfeeding and give breast milk first before giving other foods
- Actively feed the IYC three times a day on appropriate amounts of a thick MSBP or CSB+ porridges and household foods.

Safe water and proper hygiene

- Always wash your hands with water and soap; after using the latrine, before preparing food and eating it, and after cleaning IYC faeces to prevent diseases
- Always wash the IYC hands and face before feeding
- Use clean boiled water for drinking and cook food thoroughly before feeding it to IYC

Environmental health

- Immunizations for all IYC; It is safe and free and they keep your IYC from getting disease
- IYC must sleep under an insecticide treated mosquito net every night to prevent malaria.
- Wash eating and cooking utensils thoroughly with soap and dry on a rack

Face-to-face group education and discussion sessions in addition to practical demonstrations regarding the preparation of the supplementary porridges were used throughout the nutrition education intervention. Key messages conveyed included breastfeeding before giving the IYC the supplementary porridge or other household foods. For the purpose of this study, active feeding practices such as feeding the IYC three times a day was encouraged, as well as feeding an appropriate recommended amount of supplementary porridge of an appropriate consistency to ensure an optimal energy and nutrient intake. Regular hand washing to prevent IYC diarrhoea was also promoted, as was the use of previously boiled water for drinking. The promotions of other appropriate IYC food preparation techniques that are known to prevent disease were also

included. Before introducing a new topic, a review of the content previously covered and an overview of previous group discussions were held to obtain feedback from mothers and discuss what was learnt during the previous session, as well as how this information was being implemented at the mother's home.

6.2.6 Measurement of study variables

The dependent variables included complementary feeding practices such as dietary diversity and meal frequency; hygiene practices regarding food and water safety in terms of boiling drinking water, as well as hand washing with soap and water, and a reduction in IYC illness. The independent variables included maternal age, marital status, parity, and level of education.

Assessment of socio-demographic characteristics

The mothers' socio-demographic data was collected using the Uganda Demographic Health Survey (2016) questions which was adapted after expert input for the purpose of this study (UBOS, 2018). Maternal socio-demographic characteristics collected at baseline included age, marital status, and level of education (Appendix D, p204).

Determining knowledge regarding complementary feeding and hygiene practices

The questions in the Food and Agriculture Organization (FAO) guidelines for assessing nutrition knowledge were adapted and modified after expert input to facilitate data collection regarding mother's complementary feeding and hygiene practices (Marías & Glasauer, 2014). To determine knowledge regarding complementary feeding and hygiene practices, mothers were asked eight questions (Appendix D, p204). Each correct response was given a score of one. Knowledge scores for either feeding or hygiene practices were the sum of the correct responses out of a total score of eight. A score of one to three was classified as poor knowledge; while a score of four to eight was classified as a good knowledge for either complementary feeding practices (dietary diversity and meal frequency) or hygiene practices (water quality and food safety).

Determination of morbidity

The validated questions used in the Uganda Demographic Health Survey (2016), were adapted after expert input to collect data on malaria, diarrhoea, and acute respiratory infections of IYC (UBOS, 2018) at baseline and three months (Appendix D, 204; Appendix G, p232). IYC were diagnosed with malaria based on a plasmodium test, while the prevalence of diarrhoea was based on episodes of a loose stool, and acute respiratory infections based on coughing. Mothers were asked if their IYC suffered from; diarrhoea, acute respiratory infection (ARI), or malaria two weeks prior the interview. A yes response was recorded for IYC whose mothers reported an infection two weeks prior to the interview.

Determining dietary diversity

A 24-hour recall was used to determine the dietary diversity score of IYC (Marías & Glasauer, 2014). Mothers were asked to recall any solid, semi-solid foods or drinks other than breast milk given to the IYC during the previous 24 hours. The minimum dietary diversity score was determined with reference to the WHO seven recommended food groups (WHO, 2008a). Each food group was allocated a score of one. However, breast milk was scored (WHO, 2008a). The dietary diversity scores were recorded as adequate for IYC who consumed four or more food groups (FAO, 2011; WHO, 2008a).

Determining meal frequency

The validated questions (Appendix B, p204) used in determining meal frequency in the FAO guidelines for assessing nutrition-related knowledge and practices, were adapted after expert input (Marías & Glasauer, 2014). Mothers were asked to recall the number of times the IYC consumed solid, semi-solid, or soft foods (other than liquids) within the previous 24 hours**.** The number of times the IYC consumed solid, semi-solid, or soft foods (other than liquids), was determined using food frequency questions (WHO, 2008a).

6.2.7 Data collection

Face-to-face interviews were conducted in the local language (Lugbarati) at their nutrition education sites by research assistants. Pre-test and post-test data was collected using a semi-

structured questionnaire that was administered by the same trained research assistants to avoid personal inter-variability (Costa et al., 2016) and ensure validity.

6.2.8 Data quality

The survey questionnaire was translated into the local language (Lugbarati) and back-translated into English in order to ensure content validity. Research assistants used for data collection, were trained in appropriate questionnaire administration techniques prior to data collection. The research assistants were also trained in conducting nutrition education, were trained on appropriate IYC complementary feeding practices, water quality, food preparation and food hygiene messages. A pilot study was conducted among 24 breastfeeding mothers in an area with characteristics similar to that of the study area prior to commencement of data collection to determine whether questions posed were clear and unambiguous. Following piloting, it was confirmed that the research questionnaire, informed consent (Appendix B, p196) form and information sheet (Appendix C, p198) did not require adjustments, as mothers did not find any questions or content form statements unclear or ambiguous. Piloting also enabled research assistants to understand the questions and the variables it measured and familiarise themselves with completion of the questionnaire in the field as well as interact with study participants.

Face-to-face interviews were conducted in Lugbarati, the local language spoken by mothers and the trained research assistants. The response to each questionnaire was reviewed for completeness and consistency before leaving the field. After data collection, all questions were coded and cleaned before double data entry was performed to ensure accuracy. Mothers' knowledge and complementary feeding practices regarding meal frequency and dietary diversity, as well as hygiene practices were analysed as mean scores and proportions at baseline and end line (three months).

6.2.10 Data analysis

The STATA /SE version 15.0 statistical software was used to generate descriptive statistics. Baseline and end line data were analysed and presented as proportions and mean scores. The z-test was used to compare mothers' knowledge proportions regarding water quality, IYC feeding and hygiene practices between the MSBP and CSB+ groups. The paired t-test was used to

compare complementary feeding and hygiene practice mean scores between baseline and end line data. A p-value of ≤ 0.05 was considered statistically significant.

6.3 Results

6.3.1 Socio-demographic and baseline characteristics

Result of the univariate analysis (Table 6.2) illustrate that the majority of mothers (84.3%) were younger than 35 years, while (70.1%) had a primary school education and 15.1% had no formal education. In addition, 81.9% of the mothers reported willingness to breast feed their IYC for 24 months or more. More than three quarters (77.5%) of the mothers reported to be feeding their IYC breast milk and complementary foods.

In addition, 58.6% of mothers reported to have introduced complementary foods to their IYC between the age of six and eight months as recommended by World Health Organisation (WHO, 2012). While 41.7% of the mothers reported to have practiced exclusive breast feeding, it was lower than the national average of 66% (UBOS, 2018).

Table 6.2 Maternal socio-demographic and baseline characteristics

Characteristics (N=204)	Frequency (n)	Percentage (%)
Socio demographic characteristics		
Mother younger than 35 years	172	84.3
Mother with ≥ 3 live children	129	63.8
Mother living with father of the IYC	154	75.5
Mother with primary school level of education	143	70.1
Mother with no formal education	31	15.1
Baseline feeding characteristics		
Introduced complementary foods (6-8 months)	119	58.6
Exclusively breast fed up to 6 months	85	41.7
Willingness to breastfeed up to 24 months and more	167	81.9
Breast feeding and complementary foods	158	77.5

Proportions of mothers' knowledge at baseline

The knowledge proportions of mothers' complementary feeding and hygiene practises in the MSBP group did not differ significantly from their counterpart in the CSB+ group at baseline (Table 6.3). Further, the results show that a fifth (19.1%) of the mothers reported to have practiced appropriate complementary feeding at baseline.

Table 6.3: Proportion of mothers' knowledge regarding feeding and hygiene practices by supplementary groups at baseline

Parameter (N=204)	MSBP group n (%)	CSB+ group n (%)	p value*
Feeding practices	20 (19.2)	19 (19.0)	0.967
Hygiene practices	15 (14.4)	18 (18.0)	0.488

*z-test analysis

6.3.2 Mean knowledge scores regarding complementary feeding and hygiene practices

There was a significant difference between mothers' mean knowledge score regarding IYC feeding and hygiene practices at three months compared to baseline, irrespective of the supplementary porridge received, with a significant difference ($p < 0.001$) between mothers' mean knowledge score regarding complementary feeding and hygiene practices at three months when compared to baseline and end line (Table 6.4).

Table 6.4: Mean knowledge scores regarding appropriate IYC feeding and hygiene practices at baseline versus three months

Knowledge parameter (N=204)	MSBP group (n=104) Mean score (SD)[a]		p value*	CSB+ group (n=100) Mean score (SD)		p value*
	Baseline	End line		Baseline	End line	
Feeding practices						
Meal frequency	2.21(0.84)	2.82 (0.90)	<0.001	2.10 (0.94)	2.83 (0.82)	<0.001
Dietary diversity	3.76 (2.35)	5.63 (2.13)	<0.001	3.76 (2.19)	6.14 (2.08)	<0.001
Hygiene practices						
Food safety and water quality [b]	2.13 (0.66)	3.31 (1.29)	<0.001	2.08 (0.73)	3.52 (1.20)	<0.001

*Paired t-test analysis; [a] Maximum mean score = 8

[b] Food safety and water quality scores = Safe food preparation and feeding approaches including boiling water for drinking and food preparation to render it safe for IYC consumption.

6.3.3 Proportions of mothers' complementary feeding and hygiene practice at end line

Appropriate IYC complementary feeding and hygiene practice proportions differed significantly ($p < 0.001$) at three months when compared to baseline for all variables, except for handwashing (Table 6.5). The IYC dietary diversity score at three months improved six fold when compared to baseline. In addition, there was a significant difference ($p < 0.001$) between baseline and three month dietary diversity scores (fed ≥ four food groups a day). Hygiene practices regarding water

quality improved from 36.7% at baseline to 90.2% at three months. In contrast, hand washing with soap and water increased by 4.0% from 7.8% to 11.8% at three months.

Table 6.5: Comparison of proportion of mothers practicing appropriate complementary feeding and hygiene practices by baseline and end line

Parameter	Baseline n (%)	End line n (%)	Change (%)	p value*
Feeding practices				
Fed ≥ three meal per day	83 (40.7)	180 (88.2)	47.6	<0.001
Fed ≥ four food groups per day	27 (13.2)	169 (82.8)	69.6	<0.001
Met minimum acceptable diet	12 (5.9)	151 (74.2)	68.1	<0.001
Hygiene practices				
Food safety and/or water quality	36 (36.7)	184 (90.2)	72.6	<0.001
Hand washing with soap and water	16 (7.8)	24 (11.8)	4.0	<0.183

*paired t-test

The z-test results reported in Table 6.6 indicated that the IYC feeding practice of feeding three or more meals per day differed significantly between mothers in the CSB+ group, when compared to those in the MSBP group at three months. However, the practice of making water and food safe for consumption differed significantly between mothers in the MSBP group compared to their CSB+ counterparts at baseline. The remaining IYC feeding and hygiene practices did not differ significantly between groups at end line.

Table 6.6: Comparison of the proportion of mothers regarding complementary feeding and hygiene practices by supplementary group at baseline and end line

Parameters	Baseline			End line (three months)		
Feeding Practices	**MSBP**	**CSB+**	**p value***	**MSBP**	**CSB+**	**p value***
IYC fed ≥ three meals per day	43(41.4)	40(40.0)	0.845	87(83.7)	93(93.0)	0.038
IYC fed ≥ four food groups per day	9(8.7)	18(18.0)	0.049	81(77.9)	88(88.0)	0.055
Hygiene practices						
Washing hands with water and soap	9(8.7)	7(7.0)	0.660	9(8.7)	15(15.0)	0.160
Food safety and/or water quality	24(23.1)	12(12.0)	0.038	86(82.7)	87(87.0)	0.294

*z-test

The consumption of food from the seven food groups at three months was significantly higher ($p<0.001$) compared to baseline proportions with eggs and dairy being consumed the least (Table

6.7). Overall, at end line, the consumption of cereal (99.5%) was the highest, followed by legumes (88.7%).

Table 6.7: Proportions of food groups consumed by IYC at baseline and end line

Food group (N= 204)	Baseline n (%)	End line n (%)
Grains, roots, plantain & tubers**	129 (63.2)	203 (99.5)
Legumes and nuts**	118 (57.8)	181 (88.7)
Dairy products**	7 (3.4)	23 (11.3)
Flesh foods (meat, fish , poultry, liver/organ meats)**	52 (25.5)	150 (73.5)
Eggs**	10 (4.9)	34 (16.7)
Vitamin A fruits and vegetables**	104 (51.0)	164 (80.4)
Other fruits & vegetables**	29 (14.2)	138 (67.6)

**Values at end line (three months) were significantly higher than at baseline ($p<0.001$)

6.4.4 Change in the prevalence of morbidity among IYC

Table 6.8 show that there was a significant ($p<0.001$) decrease in the prevalence of illness in terms of malaria, diarrhoea, and acute respiratory infection at end line (three months). The prevalence of diarrhoea among IYC was reported by mothers to have reduced by more than a half (57.3%) at end line, whereas that of malaria reduced by a third (34.3%). The reduction in acute respiratory infection of 17.8% was minimal and was not significantly different at end line.

Table 6.8: Comparison of the proportions of IYC's illness between baseline and end line

IYC illness (N=204)	Baseline n (%)	End line n (%)	Change [a] (%)	P value*
Acute respiratory infection (ARI)	84 (41.2)	69 (33.8)	7.6	<0.116
Diarrhoea	82 (40.2)	35 (17.2)	23.0	<0.001
Malaria	107 (52.5)	70 (34.3)	18.1	<0.011

*Paired t-test

[a] Change = (end line value-baseline value) divided by baseline value*100

6.4 Discussion

This is the first known study that investigated complementary feeding practices and measures of hygiene following nutrition education in the management of IYC with MAM in Uganda. It included a targeted nutrition education intervention for a period of three months**,** during which an improvement in IYC complementary feeding and hygiene practices that differed significant from baseline values was documented. However, hand washing in both the MSBP and CSB+ supplementation groups, did not improve significantly after the three month intervention period. The changes in mothers' knowledge, feeding and hygiene practices, as well as IYC diseases prevalence between baseline and at three months, are discussed in the subsequent sections.

6.4.1 Socio-demographic and baseline characteristics

The majority of participating mothers were younger than 35 years, similar to the findings of 2016 Ugandan Demographic and Health Survey (UBOS, 2018). Mothers' level of education was also comparable to that of national statistics (UBOS, 2018). As a lack of knowledge among mothers of IYC with MAM hinders appropriate complementary feeding practices, this finding provides evidence that the provision of nutrition education to mothers of IYC with MAM could improve their complementary feeding practices (Lassi et al., 2013). In addition, IYC who were being fed a MAD at baseline, was 5.9% compared to the national average of 14.0% (UBOS, 2018). This finding could be related to the fact that IYC with MAM seldom receive a diverse diet and are often fed less frequently than their healthy counterparts. However, results of the current study compares favourably with that of a study conducted in Ethiopia among healthy IYC aged 6 to 23 months with a reported MAD of 10.8% (Aemro et al., 2013).

6.4.2 Change in mother's knowledge

The majority of mothers had a primary school education or no formal education, suggesting that they could have experienced difficulty in comprehending available nutrition education messages. Results from this study indicated that at the conclusion of the intervention period, mothers' knowledge regarding IYC complementary feeding practices differed significantly from baseline. The latter is consistent with results documented in Kenya and India, where it was reported that nutrition education regarding appropriate IYC feeding practices, contributed to an improvement in mothers' knowledge (Abuya et al., 2012). It is possible that the significant change in mother's

knowledge at three months could have been ascribed to the targeted nutrition education messages provided in their mother tongue.

In addition, nutrition education improved mothers' knowledge regarding meal frequency and dietary variety appropriate for IYC. This suggests that an improvement in mother's knowledge about appropriate IYC complementary feeding practices could contribute to improved food intake among their offspring (Negash et al., 2014), with a concomitant improvement in IYC nutritional status (Saha et al., 2008b; Penny et al., 2005). However, despite targeted nutrition education messages, not all mothers showed an improvement in knowledge after the three month intervention period. It is possible that the implementation of newly acquired knowledge regarding appropriate IYC feeding practices could have been compromised by household socio-economic factors, including mother's level of education (Nankumbi & Muliira, 2015).

6.4.3 Change in mothers' feeding practices

Maternal complementary feeding practices, especially in terms of dietary diversity and meal frequency, significantly improved at follow-up compared to baseline ($p<0.001$). This illustrates that a nutrition education intervention with a duration of three months is able to improve complementary feeding practices of mothers with IYC diagnosed with MAM (Ashworth & Ferguson, 2009). Findings from this study concur with those of a meta-analysis (Lassi et al., 2013) illustrating that nutrition education could be beneficial to IYC complementary feeding practices (Lassi et al., 2013). It also compares favourably with those documented in Peru where it was shown that a nutrition education intervention promoting appropriate complementary feeding practices, could improve IYC feeding practices for the management of MAM (Abuya et al., 2012; Lassi et al., 2013; Bhandari et al., 2004). This view is supported by an investigation of the factors associated with complementary feeding practices in Uganda where it was reported that maternal nutrition education has the ability to improve their IYC feeding practices (Mokori et al., 2017).

Study findings also compare favourably with that of a study conducted in Ethiopia where it was reported that bimonthly nutrition education for a period of 6 months, improves IYC dietary diversity (Negash et al., 2014). A Peruvian study demonstrated an improvement in IYC dietary diversity as a result of an 18 month nutrition education intervention (Penny et al., 2005).

6.4.4 Change in mothers' hygiene practices

In this study, no significant difference was found between mothers' hygiene practices in terms of hand washing with soap and water after contact with excreta, and before feeding IYC after nutrition education for a period of three months when compared to baseline ($p=0.183$). The prevalence of hand washing at three month follow-up (11.8%), was lower than the mean of 14% for the African continent, despite being within the estimated prevalence of 9 to 24% for Uganda (Freeman et al., 2014).

These results show that the targeted nutrition education intervention with a duration of three months was not adequate to bring about a significant behavioural change in hand washing practices among mothers of IYC with MAM. Thus this finding suggests that nutrition education alone may not be sufficient to change personal hygiene habits in rural low-income settings such as the setting of this study. It is possible that mothers existing hand washing practices were so entrenched or that water was not freely available (Freeman et al., 2014). Alternatively, mothers could have been reluctant to change handwashing behaviour as it would have not been sustainable considering their home and immediate environment, in addition to washing not being a social norm (Rabbi & Dey, 2013).

The results of this study compare favourably with that of a study conducted in Bangladesh, where a disparity between knowledge and practices prevailed when it came to hand washing practices (Rabbi & Dey, 2013). Hence, continuous motivation and education is required to improve hand washing with soap (Rabbi & Dey, 2013). Despite the health benefits of reducing the prevalence of diarrhoea, a systematic review providing a global overview regarding hand washing practices (Freeman et al., 2014), concluded that hand washing with soap after contact with excreta is not practices regularly. Due to a lack of awareness regarding the importance of this practice (Freeman et al., 2014), it is possible that a three month intervention is insufficient in bringing about significant behavioural change regarding hand washing practices among mothers of IYC diagnosed with MAM.

In contrast, the practice of washing hands with soap and water before preparing IYC's food, and boiling water to make it safe for consumption, differed significantly between baseline and three month follow-up ($p<0.001$). It is therefore possible that the nutrition education intervention

could have improved mothers' attitude towards appropriate food preparation techniques and boiling water (Flax et al., 2009).

6.4.5 Change in water quality

The practice of boiling water to make it safe for IYC drinking was significantly higher at end line compared to baseline ($p<0.001$). Hence, it can be assumed that nutrition education messages promoting the habit of boiling water were sufficient. Maternal knowledge regarding the importance of safe drinking water could have contributed to the observed reduction in the prevalence of diarrhoea discussed in section 6.4.6. In addition, nutrition education could have improved maternal attitude (Flax et al., 2009) regarding boiling water to make it safe for consumption as part of the management of IYC with MAM. This study finding agrees favourably with those reported in a study conducted in Peru where it was reported that practicing water safety in the home requires interventions such as education and water treatment practices (Heitzinger et al., 2015).

6.4.6 Change in prevalence of morbidity among IYC

In this study, the prevalence of malaria and diarrhoea was significantly lower at end line when compared to the baseline ($p<0.001$). A reduction of 12% in the prevalence of morbidity of the IYC with MAM after intervention of three months was low compared to a 50% reduction reported in India among moderately malnourished preschool children supplemented with on a malted mixes (ragi/wheat) for a similar period (Khader & Maheswari, 2012). Further, the prevalence of diarrhoea reduced significantly by 23% from 40.2% at baseline to 17.2% at end line ($p<0.001$).

It is possible that a lack of time for hand washing due to IYC care and household responsibilities could have impacted the hand washing actions of the mothers to prevent diarrhoeal infections (Parveen et al., 2018). Seeming, malaria, diarrhoea, and acute respiratory infections (ARI) often co-exist with MAM (Sood & Sood, 2015). The maternal household responsibilities (Jones et al., 2012) have been alluded to in chapter 7 of this study as a perceived barrier to IYC care due to a limited time.

6.4.7 Overall discussion

The changes in mean knowledge scores regarding complementary feeding practices (meal frequency and dietary diversity) were significantly higher after three months of nutrition education when compared to baseline values. Improvement in the complementary feeding and hygiene practices could have partially contributed to the reduction in morbidity documented in the study sample. For example, the prevalence of diarrhoea decreased by half, following improved personal hygiene practices such as hand washing and boiling drinking water. The finding of this study shows that targeted nutrition education given to mothers during the management of IYC with MAM is effective and should form a pivotal part of such intervention strategies. Overall, the study results show that targeted nutrition education results in improved complementary feeding practices and appropriate hygiene practices. This nutrition education intervention based on the constructs of the HBM could be adopted to improve the outcome of supplementary food interventions in the management of IYC with MAM.

Based on the study results, the null hypothesis namely that there will be no statistically significant difference between the hygiene and complementary feeding practices (dietary diversity and meal frequency) of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM before and after they received targeted nutrition education in conjunction with their IYC receiving MSBP or CSB+ supplementary porridge for a period of three months, will be rejected.

As there was a statistically significant difference between the hygiene and complementary feeding practices (dietary diversity and meal frequency) of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM before and after they received targeted nutrition education in conjunction with their IYC receiving MSBP or CSB+ supplementary porridge for a period of three months, the alternative hypothesis will be accepted.

6.4.8 Limitations

It is possible that there could have been some form of social desirability bias when it came to the evaluation of dietary diversity, as it is possible that mothers could have provided information which they thought was appropriate, yet they did not implement this knowledge and/or beliefs

(FAO, 2011). However, this phenomenon was addressed by building rapport with mothers in their mother tongue and probing them to remember food items such as snacks given to IYC between main meals and mixed dishes consumed 24 hours prior to data collection.

6.5 Conclusion and recommendations

6.5.1 Conclusion

The IYC feeding practices in terms of dietary diversity, meal frequency, and hygiene practices through hand washing with soap and water, using boiled water for drinking and cook foods thoroughly before feeding it to IYC, significantly improved at three month follow-up (post intervention) when compared to baseline. Thus, targeted nutrition education interventions with a duration of three months has the ability to change knowledge and practices of mothers with IYC diagnosed with MAM when combined with a supplementary feeding programme.

6.5.2 Recommendation

Health workers should continue the promotion of dietary diversity, increased meal frequency, food safety, and improved water quality among mothers to enhance the effectivity of supplementary foods given to IYC as part of the management of MAM. However, an approach other than the constructs on which the HBM is based, should be considered to significantly improve hand washing practice among mothers. Thus, mother's opinion regarding the content and worth of targeted nutrition education in the management of malnourished IYC should be sought. This is important because a limitation of the Health Belief Model is related to a lack of perceived benefit by the mothers (O'connor, Martin, Weeks, & Ong, 2014).

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CHAPTER 7: MATERNAL PERCEPTIONS AND BARRIERS WHILE USING SUPPLEMENTARY PORRIDGES FOR MANAGING INFANTS AND YOUNG CHILDREN WITH MODERATE ACUTE MALNUTRITION IN UGANDA[8]

Abstract

Introduction: Little is known about how the use of supplementary foods in the management of IYC with MAM is perceived by mothers, as well as the barriers they encounter/experience while

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using it in Uganda. This study determined maternal perceptions and barriers experienced during the management moderately malnourished IYC using supplementary porridges.

Method: In cross-sectional study design, using 12 focus groups and 48 in-depth interviews were conducted among purposively sampled mothers a week after completing a three month intervention with a supplementary porridge for the management of their IYC with MAM. Qualitative data was analysed using a deductive approach.

Findings: Mothers perceived the supplementary porridge as a contributor to weight gain, reducing the prevalence of illness, improving appetite, a healthy glowing skin, and improving active play. Barriers to using the supplementary porridges were limited time to feed the IYC due to household responsibilities such as preparation of the porridge, household meals, and maternal hunger due to household food insecurity.

Conclusion: Mothers were satisfied with the use of the supplementary foods for the management of their IYC with MAM, as it resulted in weight gain, improved appetite, active play, a glowing skin, and reduced the prevalence of illness. The perceived barriers by mothers while managing their IYC with MAM were limited time related to routine household chores, and a lack of social support, household food insecurity. Therefore, maternal stress should be addressed through improving household food security status and an even distribution of workload among household members so that IYC with MAM can reap maximum benefits of supplementary food interventions.

7.1 Introduction

Globally, an estimated 35 million IYC under the age of five years suffer from MAM, with more than a quarter (27%) of all wasted children living in Africa (UNICEF, 2016). It is suggested that children younger than two years of age with MAM residing in Africa, seldom achieve their full physical, intellectual, or cognitive potential (Cichon et al., 2016; Rytter et al., 2014). More than two thirds of IYC deaths in low income countries are due to inappropriate complementary feeding practices (Lenters et al., 2013). In addition, in a low income country like Uganda, only 14% of those aged 6 to 23 months consume a MAD (UBOS, 2018).

Systematic reviews indicated that supplementary foods are increasingly used in the management of IYC aged 6 to 23 months diagnosed with MAM (Annan et al., 2014; Lazzerini et al., 2013). Moreover, the use of supplementary foods for the management of MAM in low and middle income counties has not adequately focused on maternal perceptions and barriers regarding the use of supplementary foods (Lazzerini et al., 2013). An Ethiopian study investigating caregivers' perception regarding supplementary food used to treat malnourished IYC, found that the food was used to meet household needs as a result of household food insecurity (Tadesse, Berhane, Hjern, Olsson, & Ekström, 2015b). Under certain circumstances including the poor management of MAM, IYC did not recover and progressed to severe acute malnutrition, while others defaulted, and some died (Lazzerini et al., 2013). The most commonly reported barriers to appropriate IYC feeding practices are a lack of time, household food insecurity, and a lack of social support from household members (Nankumbi & Muliira, 2015; Jones et al., 2012; Nor et al., 2012).

It is therefore evident that many IYC could be receiving inadequate supplementary food (Lazzerini et al., 2013), compounded by social and care issues as a result of socio-economic status (Nankumbi & Muliira, 2015; Nor et al., 2012)). In addition, some mothers may be seeking complementary treatment options such as traditional and spiritual healers as an adjunct to mainstream treatment options including supplementary foods (Nor et al., 2012). It is also evident that the decision of mothers to feed their IYC the supplementary foods they are issued with, is based on whether they believe in the ability of these foods to treat MAM (Diddana et al., 2018) However, little is known about maternal perceptions regarding the dietary management of their IYC diagnosed with MAM (Lenters et al., 2013). Furthermore, the barriers experienced by mothers of IYC with MAM using the prescribed supplementary foods are unknown, as research by others (Langlois et al., 2017; Nakumbi and Muliira, 2015) have not investigated this phenomenon in relation to malnourished children as health workers often assume that mothers will feed their malnourished children the supplementary foods they are being issued with.

7.2 Methods

Focus group discussions (FGD) and in-depth interviews (IDI) were used to collect qualitative data on the perceptions and barriers of breastfeeding mothers that participated in a

supplementary porridge intervention for the management of their IYC with MAM. Members of FGD were kept homogeneous with respect to the whether their IYC were receiving MSBP (treatment) or CSB+ (control).

7.2.1 Study design

A cross-sectional study design was conducted among breastfeeding mothers a week after completion of the cRCT that involved MSBP and CSB+ supplementation of IYC diagnosed with MAM, in addition to the nutrition education of their mothers (Chapter 5 and 6. This study employed qualitative research techniques for gathering data, namely focus group discussions (FGDs) and in depth interviews (IDIs) (Marshall & Rossman, 2014; Maxwell, 2012) to explore maternal perceptions and barriers to feeding their IYC the respective supplementary porridges. Participating mothers regularly interacted with each other in the course of the three month cRCT. As a result, they had already developed good rapport with one another. This relationship contributed to their ability to freely express their views, ideas, thoughts and feelings in the course of the FGD (Stewart & Shamdasani, 2014).

7.2.2 Research question

What are the perceptions and barriers of breastfeeding mothers during the management of their IYC with MAM receiving MSBP or CSB+ as a supplementary porridge in Aura, Uganda?

7.2.3 Study participants

Study participants were breastfeeding mothers of IYC diagnosed with MAM who participated in a three month cRCT up to completion.

Inclusion criteria

Breastfeeding mothers of IYC diagnosed with MAM who completed the cRCT supplementary porridge were included in this study.

Exclusion criteria

Breastfeeding mothers of IYC diagnosed with MAM who completed the cRCT supplementary porridge suffering from a hearing and/or speech disorder.

7.2.4 Enrolment of mothers

Mothers, who participated in the cRCT supplementary porridge intervention, were eligible for participation. Purposive sampling was used to recruit mothers for this qualitative study. Twelve focus groups with eight to nine mothers per group were enrolled. One hundred and eight mother-IYC pairs, including 59 mother-IYC pairs who participated in the MSBP arm of the cRCT treatment, participated in seven FGDs, while 49 mothers who participated in the CSB+ arm of the control participated in five FGDs respectively (Figure 7.1).

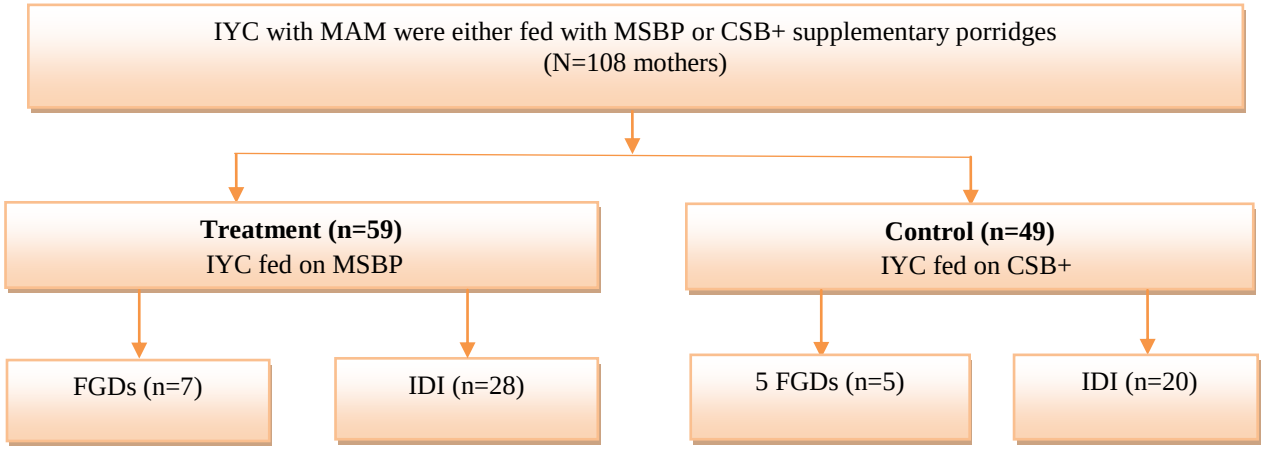

Figure 7.1: Enrolment of mothers and sample size

After completion of the FGDs, on the same day 48 mothers who participated in the FGDs were purposely sampled to participate in the IDIs, with 28 being interviewed from the MSBP (treatment) group and 20 representing the CSB+ (control) groups respectively. The FGDs and IDIs were conducted until no additional concepts or themes emerged, indicative of data saturation (Saunders et al., 2018).

Ethical considerations

Ethics approval was obtained from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal, South Africa, the Uganda National Council of Science and Technology, and the Higher Degrees, Research and Ethics Committee of the School of Public Health, Makerere

University (Appendix A, p193). All study participants signed an informed consent form in Lugbarati prior to participation (Appendix G, p252). Where participants were illiterate, they made a thumb print on the consent form. All participants were guaranteed confidentiality and anonymity as they were assigned a coded number for identification purposes.

7.2.5 Recruitment and training of research assistants

One social scientist and a psychologist were recruited as research assistants, as they had experience in qualitative data collection techniques. In addition, the two research assistants (serving as facilitator and scribe) were fluent in Lugbarati, the local language spoken by the participants. The research assistants underwent a two day training session so that they could gain an understanding of the questions on the interview guide and objectives of this qualitative study. Further, the research assistants were coached on appropriate probing techniques for use during FGDs and IDIs. In addition, research assistants were asked to remain neutral during both types of qualitative assessment. They were also guided on how to obtain informed consent from participants. Confidentiality of participant responses and privacy regarding the protection of their identity was emphasised as part of the training.

7.2.6 Research instruments

Semi-structured open-ended FGD (Appendix H, p233) and IDI guides (Appendix I, p237), together with audio digital recorders were used for data collection. Construct validity of the research instruments were ensured by developing the FGD and structured IDI guides with reference to relevant literature. Content validity was ensured by expert review of the FGD and IDI guides. In addition, input from an anthropologist was sought to review both guides. The two research instruments were developed in English and translated into the local language, Lugbarati. This was followed by back translation into English to ensure internal validity.

The FGD and IDI guides contained open ended questions, to determine mothers' perceptions and barriers regarding the use of supplementary porridges to treat IYC with MAM for a period of three months. The respective guides contained questions that allowed the researcher to obtain information regarding household IYC care, intervention-related aspects such as mothers' motivation for completion, opinions from community members, IYC health-related responses

and IYC health status. The guides remained flexible to enable discussions of emerging concepts in the course of the interviews.

Piloting research instruments

The FGD and IDI guides were piloted on 24 breastfeeding mothers who participated in the cRCT supplementary intervention but were not purposively sampled for this study. The purpose of piloting was to determine whether the respective FGD and IDI guides were clear and unambiguous, thereby ensuring reliability of the data. In addition, informed consent forms (Appendix B, p196) and information sheets (Appendix C, p198) were corrected for any inaccuracies encountered during piloting. The pilot study enabled the research assistants to understand the questions in the interview guide, thus ensuring applicability before being used.

7.2.7 Socio-demographic characteristics and perceptions

Assessment of socio-demographic characteristics

The questions in the Uganda Demographic and Health Survey (2016) were adapted to collect socio-demographic data of the mothers of IYC with MAM (UBOS, 2018). The socio-demographic characteristics that were assessed included maternal age, marital status, and level of education, as well as parity (Chapter 4).

Assessment of perceptions and barriers

The discussion topics included asking mothers to reflect on the period during which their IYC had been enrolled in the cRCT in order to gauge perceptions and barriers related to the IYC's weight gain, growth, feeding frequency, dietary diversity and satisfaction with the supplementary porridges that were provided. Mothers were also asked to reflect on the reason/s why they were willing to feed their IYC with the respective supplementary porridges, as well as comment on interactions with family members and members of the community during the intervention period.

7.2.8 Intervention

IYC diagnosed with MAM residing in a rural community in Arua district, Uganda, were supplemented with a malted sorghum based porridge (MSBP) as the treatment group, and a fortified soy corn blend (SCB+) as the control. The control supplementary porridge was used as the standard care for managing MAM in Uganda, while the treatment was developed as an alternative. Mother-IYC pairs were given a weekly ration of either one kg of MSBP or one kg of CSB+ as dry rations, based on the cRCT arm they were enrolled in. Apart from a supplementary porridge, mothers also received weekly nutrition education guided by the Health Belief Model (Bandura, 1977), to improve their complementary feeding and hygiene practices for a period of three months. This model highlighted the mothers' perception of the threat posed by MAM in terms of its severity and possible cues to action such as perception and barriers that could influence their decision to implement the intervention (Glanz et al., 2015; French et al., 2012).

7.2.9 Data collection

FGDs and IDIs were used to collect qualitative data regarding maternal perceptions and barriers to feeding their IYC the respective supplementary porridges that form part of the management of MAM (Marshall & Rossman, 2014; Maxwell, 2012). FGDs were conducted by two trained research assistants in Lugbarati, the local language spoken by mothers. One research assistant served as facilitator while the other served as scribe. Each FGD had an approximate duration of one hour. The scribe took notes on verbal and non-verbal cues displayed by mothers in the course of discussions. IDIs were also conducted in Lugbarati. All discussions and interviews were tape recorded to facilitate verbatim transcription. Individual FGDs were terminated once data saturation was reached (Saunders et al., 2018).

7.2.10 Reliability and validity

A FGD guide developed using relevant literature ensured internal validity, while expert input contributed to content validity. The training of the FGD facilitator who was fluent in Lugbarati also ensured validity of the data. Face validity was ensured by observations and field notes made by the primary researcher, based on interactions with the research team and intervention participants. Pilot testing of the FGD guide prior to implementation contributed to reliability. Face validity of semi-structured IDIs were addressed by developing an interview guide in

conjunction with seeking expert input review and piloting the structured IDI guide, while reliability was ensured by using a trained interviewer and scribe who were fluent in Lugbarati. Follow-up questions and probes were used to validate mother's responses during the FDGs and IDIs. At the conclusion of the FGDs and IDIs, the focus group facilitator and interviewer respectively, checked the scribed content by moderating notes taken by the scribe to determine assertion and meaning with the mothers.

Verbatim transcriptions were done in Lugbarati and then translated into English. This was followed by the identification of codes to generate core themes, using an inductive approach. The primary researcher, focus group facilitator, interviewer, and scribe were involved in manually coding transcripts twice to assess the quality of the categorisation matrix and minimise inter-coding variability, thus ensuring confirmability and reliability (Schreier, 2012). Hence the approach was data driven and did not rely on a predetermined coding framework.

The peer reviews of the coding frameworks by members of the research team and expert input, contributed to reliability. Construct validity was enhanced by content analysis of saturated data sets in relation to relevant literature. Respondent validation was ensured by concurring with focus group participants and those participating in IDI at the conclusion of discussions and interviews respectively.

7.2.11 Data analysis

FGD and IDI transcripts were transcribed verbatim from recordings made on an audio digital recorder in Lugbarati; these were transcribed into Lugbarati and then translated into English. Data was subsequently entered into Atlas.ti software Version 5.2, followed by content analysis using an inductive approach (Elo et al., 2014; Graneheim & Lundman, 2004) to generate codes and subsequent core themes that were used to explore maternal perceptions and barriers to feeding their IYC the respective supplementary porridges during the management of MAM. In addition, relevant quotes were identified to support a theme that emerged during the process of content analysis.

7.3. Results

7.3.1 Socio-demographic characteristics

Participants' age ranged between 18 and 50 years. Of the 108 mothers, 84.3% (n=91) were younger than 35 years, 75.9% (n=82) were traditionally married, while the remaining 24.1% (n=26) had a religious ceremony. The majority of participants (85.2%; n=92) had a primary school education or no formal education, while 63.0% (n=68) had three or more children.

7.3.2 Maternal perceptions regarding supplementary porridge use by FGD

Focus group participants reported that they were satisfied with the use of MSBP or CSB+ to feed their IYC. Enhanced IYC appetite in the course of the intervention period was mentioned as an advantage gained from feeding their IYC with the respective supplementary porridges. Quotes illustrating these findings are the following:

"This child was without strength,... the appetite for food was not there, but now because of taking this porridge, it has brought him appetite for food. He now eats all foods well than before, makes his weight to increase and now my child is well" (FGD mother, CSB+).

"My child before the porridge, appetite for household foods in addition to breast milk was low.... after taking the porridge, he has a lot of appetite for breast milk and he feeds happily with good appetite till he is satisfied…..and his weight has increased" (FGD mother, MSBP).

An improvement in IYC participation in active play, satisfying hunger and increased feeding frequency as a result of nutrition education, as well as contribution to dietary diversity also emerged as an advantage of receiving supplementary porridges. Mothers also reported that supplementary porridges were a source of energy for IYC, and that it contributed to a healthy skin and growth.

"The health of my child was not good, he was in and out of hospital, his general appearance was not good, his body was pale, he had brown hair but now he is healthy with good appetite and less sickly after taking the porridge" (IDI mother, CSB+).

"My child was weak, with rough skin, and brown hair, but now she stand on her own, and her hair is dark with a smooth face". She used to be sickly but he does not fall ill often" (IDI mother, MSBP).

7.3.3 Maternal perceptions regarding supplementary porridge use by IDI

Mothers reported that feeding infants the supplementary porridge resulted in healthy growth, as was evidenced by weight gain. In addition, an improvement in IYC appetite also emerged as a common theme. Participant motivation to feed their IYC the supplementary porridge was mainly attributed to the fact that where they were weak and underweight. However, once the intervention commenced, they became healthy and gained weight in due course. This is illustrated by the following quotes:

"I did not expect my child to improve like this; He is now healthy, gained weight and more active" (IDI mother, MSBP).

It was perceived that underweight prior to participating in the intervention, was related to a lack of energy, resulting in a lack of strength for active play. The health indicators perceived by mothers are summarised in Table 7.1.

Table 7.1: Commonly mentioned perceptions among IDI mothers

Health indicators (N=48)	Mothers of MSBP group (n=28)	Mothers of CSB+ group (n=20)
IYC gained weight	27	18
IYC appetite improved	22	16
IYC engaged in active play	25	17
IYC rarely ill	18	13
IYC skin looked healthy	16	11
IYC became healthy	26	17

Mothers reported that the supplementary porridge resulted in weight gain, improved appetite, engagement in active play, reduced illness, improved skin health, and contributed to IYC overall health. Two of the IDI mothers mentioned that:

"Frequent illness is suggestive that the child does not have enough food intakes in the body" (IDI mother, CSB+).

"Child health was not good before the porridge... the child that was once weak is now healthy" (IDI mother, MSBP).

Throughout the IDIs, mothers mentioned a decrease in the frequency of infectious disease such as diarrhoea among IYC by the time the intervention had concluded.

7.3.4 Maternal barriers and experiences regarding supplementary porridge use by FGD and IDI

Mothers participating in FGDs from both the treatment and control groups explained that barriers to the implementation of the supplementary intervention included household chores such as subsistence farming, gathering food, as well as food preparation for which they received minimal social support from household members. During IDIs, mothers that received both supplementary porridges also reported that they received minimal household support in the management of their IYC with MAM during the intervention period. Maternal stress emerged as a barrier to IYC care, stemming from; having to do household chores, limited time, a lack of money, food insecurity, and a lack of adequate knowledge regarding appropriate IYC feeding practices due to low level of formal education. These themes (Table 7.2) were also indicative of barriers to intervention implementation. In addition, a lack of time for feeding IYC due to household responsibilities was commonly mentioned as a reason for partially implementing the intervention protocol such as feeding the IYC twice instead of three times a day. The barrier themes are illustrated by the following quote:

"My family is large, with a lot of house work that needs me, such as gardening and preparing food, which takes a lot of my time before I feed my child the porridge" (FGD mother, MSBP).

"As a mother you start working in the morning with gardening, gathering food, washing clothes, bathing children, going to the market, and cooking food, which takes a lot my time before feed my child" (IDI mother, MSBP).

"Before this intervention, buying food was so difficult for me to feed my children adequately. Because I don't work to get money, but after learning of cheaper foods like silver fish, oranges, fruits it became easy for me to feed my children on a variety of foods" (FGD mother, CSB+).

Nevertheless, mothers who participated in IDIs of both supplementary groups reported an improvement in the feeding regime of their IYC compared to what it was prior to the intervention. Due to the supplementation, feeding of IYC in conjunction with breastfeeding

became more structured as IYC were seemingly hungry less often, and therefore demanded breastfeeding less frequently. The IDIs mothers seemed satisfied with the IYC breastfeeding and supplementary feeding regimes as a result of the intervention. Some of the themes are illustrated by the following quote:

"The porridge has made my child look good, I'm so happy for his weight to increase and also he does not breastfeed so often like he used to before the porridge intervention. Often, when I don't give her the porridge, she over breastfeeds me, and I don't get any break to rest" (IDI mother, MSBP).

Table 7.2: Perceived barriers and experiences regarding supplementary intervention by IDI and FGD mothers

Perceived barriers regarding intervention implementation
Lack of social support resulted in demanding household chores
Shortage of household food resulted in maternal hunger
Inadequate of knowledge regarding appropriate IYC feeding due low level of education
Inadequate household income influenced quality of IYC feeding care
Limited livelihoods and unemployment
Perceived experiences during the intervention
Supplementary porridge improved engagement in active play
Supplementary feeding complemented breastfeeding
Weight gain of IYC motivated intervention completion
Supplementary porridge satisfied IYC hunger
Illness occurrence among IYC reduced
Maternal stress related to inadequate food for IYC reduced
Mothers' household chores increased by the preparation of supplementary porridge

Mothers of FGDs reported that members of the community had mixed feelings regarding the intervention among IYC with MAM. Some members of the community commented that supplementary foods are intended for households that failed to take care of the nutritional needs of their IYC. However, this comment did not stigmatise the mother or deter them from continuing with the intervention. For example, one month after the intervention was implemented, the same members of the community with healthy children enquired from participating mothers about how to go about joining the intervention. The latter phenomenon encouraged mothers to continue with the intervention, as well as tangible evidence such as

improved appetite, weight gain and participation in active play of their IYC. This is reflected by the following verbatim quotes:

"My neighbour was happy because my child's body was wrinkled before but now it is smooth...his hair has changed from brown to black….the father and my mother are both happy and do not want me to stop giving porridge because my child's health is good" (FGD mother, MSBP).

"When the porridge ration began, people in my community despised me saying that porridge was for those with no food at home but later, the same people saw positive changes such as weight gain in my child, and wanted to pick the porridge though it was too late" (FGD mother, CBS+).

Mothers who participated in FGD and IDI reported that the intervention resulted in healthy growth as evidenced by IYC weight gain and improved appetite. In addition, participants reported that their motivation to use the supplementary porridge was mainly based on the fact that IYC were weak and underweight before intervention participation, but became healthy and gained weight once enrolled.

7.4. Discussion

The aim of this qualitative study that included purposively sampled mothers of IYC diagnosed with MAM, was to determine their perceptions and barriers to feeding their IYC the respective supplementary porridges that formed part of a three month intervention period (Chapters 5 and 6). Data that was collected by means of FGD and IDI a week after the MSBP and CSB+ porridge supplementation concluded. Overall, a discussion of the mother's perceptions and barriers regarding the use of a supplementary porridge in the management of IYC with MAM by means of FGD, IDI and the relevant literature was triangulated. The discriminate purposive sampling of mothers who fed their IYC with MAM a supplementary porridge used in the intervention, helped to determine whether mothers in the treatment or control, had similar perceptions and barriers.

7.4.1 Maternal perceptions regarding the use of supplementary porridges

Mothers' perception that the supplementary porridges contributed to IYC weight gain was similar for both the treatment and control groups. This finding is consistent with that of a study conducted in Malawi that reported a positive perception towards using supplementary food

among rural mothers (Flax et al., 2009) as well as other studies findings (Iuel-Brockdorf et al., 2015; Langlois et al., 2017) that malted and fortified cereal-legume based supplementary foods fed to IYC with MAM met their nutritional needs for healthy growth (Briend et al., 2015; Dewey & Adu-Afarwuah, 2008). It therefore suggests that mothers who participated in the present study were confident that the supplementary porridges would contribute to IYC growth in terms of weight gain. This confidence in the properties such as nutrient density of supplementary foods is supported by Briend et al. (2015) who concluded that nutrient dense foods are required by IYC with MAM for active play and growth.

The improvement in appetite experienced by IYC during the intervention period was perceived by many mothers. In addition, it was also perceived to be an indicator of improved health which mothers valued, as they expressed their satisfaction with the intervention. The outcome related to an improvement in IYC appetite compares favourably with that reported by a study conducted in Burkina Faso, where mothers experienced an improvement in IYC appetite as a result of appropriate supplementary feeing practices with corn soy blends (Nousiainen, 2014).

An improvement in participation in active play was commonly mentioned by FGD participants, irrespective of whether their IYC were supplemented with MSBP or CSB+. The observed improvement in health of the IYC could have resulted in alleviation of apathy in malnourished IYC which contributed to an increase in active play. In addition, mothers reported that their IYC had an improvement in skin health. This perception was held by mothers, irrespective of which supplementary porridge their IYC received. This compares favourably with the finding that skin health among IYC are related to an increase in food intake (Aguilar, Wengreen, Lefevre, Madden, & Gast, 2014). Thus, an improvement in IYC health could have been responsible for the alleviation of skin lesions.

Furthermore, a reduction in IYC illness after completion of the three month intervention period, irrespective of the supplementary porridge received was reported by the mothers, implying that adequate consumption of these supplementary porridges enhanced IYC immunity. This opinion is similar to that reported by a study conducted in India, where it was shown that an improvement in nutritional status was associated with infrequent infections among IYC (Sood & Sood, 2015).

The health indicators of weight gain, improved appetite, participation in active play, reduced frequency of illness, and improvement in skin health reported by mothers, for the IYC who participated in the supplementary intervention were similar to those in the community who were not diagnosed with MAM. Overall, it would seem that provision of supplementary foods in conjunction with nutrition education improves the health indicators of their IYC with MAM.

7.4.2 Maternal barriers and experiences during the supplementation intervention

The opinion of community members regarding the use of supplementary foods, were that they are meant for households that failed to take care of their IYC. It is therefore evident that certain members of the community stigmatized mothers of IYC with MAM due to their participation in the intervention. In addition, this opinion by members of the community points towards a lack of knowledge and insight regarding the importance of supplementary foods in the management of IYC with MAM. This opinion is supported by the fact that a lack of knowledge affects IYC feeding practices (Nankumbi & Muliira, 2015; Jones et al., 2012).

Mothers mentioned that household chores competed with responsibilities related to compliance with the intervention protocol, especially in terms of the frequency with which IYC were supposed to be fed the supplementary porridge. In addition, mothers reported that they lacked the necessary time to take care of their IYC in terms of feeding frequency due to limited livelihoods.

Another barrier experienced by mothers, was related to a lack of social support from household members. Barriers related to a lack of time to feed IYC that prevented them from meeting their nutritional requirement, have also been reported in Uganda (Nankumbi & Muliira, 2015), Bolivia (Jones et al., 2012) and South African (Nor et al., 2012). It is therefore important to take cognisance of factors such as inadequate household income, as it has an impact on household food security, available time for IYC care, as well as lack of social support from family members as well as the community. These potential barriers can significantly impair the ability of mothers with malnourished IYC from complying with supplementation protocols.

7.4.3 Overall discussion

This study examined mother's perceptions and barriers during the use of supplementary porridges such as MSBP or CSB+ in the management of IYC with MAM. The study found that the use of MSBP or CSB+ for managing IYC with MAM resulted in weight gain, reduction in the prevalence of illness, a positive attitude towards adhering to the supplementary porridge intervention, good appetite, improved active play, and healthy glowing skin. Although mothers were adherent to the management protocol during the intervention, their perception that the supplementary porridges would result in IYC weight gain, could have increased their motivation to complete the intervention. Collectively, the perceived barriers held by mothers regarding the use of MSBP or CBS+ to manage breastfed IYC with MAM were routine household chores, a lack of money, minimal social support, negative community opinions, limited time, and negative attitude of the community to supplementary feeding interventions. Largely, the mothers understood the importance of feeding malnourished IYC supplementary porridge. Taken as a whole, the perceived benefit regarding the use of MSBP as a supplementary porridge did not differ from that of CSB+ in the management of IYC with MAM.

Furthermore, the preparation of supplementary porridges used for the management of IYC with MAM could be viewed as being challenging for the mother. Collectively, the ration of supplementary porridge issued to mothers, may not have been consumed entirely by the IYC it was intended for, due to household food insecurity. This study presents qualitative evidence that the provision of supplementary foods for the management of IYC with MAM should be accompanied by sensitizing mothers regarding the potential benefits for IYC to counteract maternal barriers that could affect implementation. In addition, health care workers should take cognisance of barriers that could compromise the effectivity of using supplementary foods in the management of malnourished children.

7.4.4 Limitation

The sample size may not have been large enough to be representative of mothers in other district in Uganda. Therefore, it is not possible to generalise the findings of this study.

7.5 Conclusions and recommendations

7.5.1 Conclusion

Study participants believed that MSBP and CSB+ supplementation of IYC with MAM resulted in weight gain as an indicator of growth, an improved appetite, participation in active play, improvement in skin health and a reduced prevalence of illness. Perceived barriers that impaired mothers' ability to comply with the supplementation protocol included household chores, limited time to feed IYC regularly, limited household income and household food insecurity. Other barriers included a lack of social support by household members and stigmatization by members of the community. Hence, results generated by this qualitative study provides insight into mothers' perceived benefits regarding the implementation of an intervention that includes the supplementation of breastfed IYC with MAM with a supplementary porridge, as well as the barriers to implementation. Therefore, an intervention that provides supplementary foods to IYC in conjunction with nutrition knowledge to mothers based on constructs of the Health Belief Model could prove to be effective in the management of IYC with MAM in low income settings similar to that of this study.

7.5.2 Recommendations

Efforts to reduce perceived barriers of mothers regarding the use supplementary foods in the management of IYC with MAM need to be addressed through individual, household, and community sensitisation strategies. In addition, the providers of supplementary foods in the management of IYC with MAM should aim to sensitise mothers regarding the potential household IYC care barriers faced by the mothers in different settings in addition to emphasising the health benefits of supplementary foods. Overall, the head of the household should encourage its members to provide support of mothers' care regarding environmental barriers such as household workload resulting in limited time for IYC feeding practices. Therefore, these factors should be considered by health care professionals before implementing supplementary interventions that address MAM among IYC to enhance its efficacy.

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CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

MAM compromises the immature digestive system of IYC (Herlache, 2010) and requires an energy rich, nutrient dense supplementary food to reverse the condition and promote catch up growth and development (Lazzerini et al., 2013; Lenters et al., 2013; WHO, 2012). In this study, the formulation of MSBP and its subsequent use as a supplementary porridge for the management of breastfed IYC with MAM was investigated to determine whether it is suitable as an alternative supplementary porridge to CSB+, the standard care of MAM in Uganda. The UNICEF conceptual framework and HBM provided the necessary concepts and constructs for the implementation and evaluation of this study. Overall, the effect of MSBP as a supplementary porridge in conjunction with nutrition education on the nutritional status of IYC with MAM was determined. As part of this study, maternal knowledge, complementary feeding and hygiene practices, and the effect of nutrition education on the feeding and hygiene practices of mothers of IYC with MAM was determined. Ultimately, maternal perceptions and barriers to the implementation of the supplementary feeding intervention were explored.

This chapter presents a synopsis of the study, its main findings in relation to the study objectives, and discusses the contribution this study has made towards the management of IYC with MAM. Recommendations regarding the potential future use of MSBP as a supplementary porridge for the management of MAM are also presented. In addition, study limitations are acknowledged and methodological considerations for future studies of a similar nature are discussed, as well as future areas of investigation.

8.2 Synopsis of the study

The study objectives, outcome variables, and indicators are presented in Table 8.1. Initially, an energy rich, nutrient dense supplementary porridge MSBP was formulated based on WHO recommended specification guidelines (WHO, 2002) for the management of IYC with MAM. The MSBP formulation had an optimal nutrient outcome in terms of its energy content and nutrient composition, coupled with acceptable sensory attributes, and viscosity level. These results showed that MSBP had an optimal nutrient density with the potential of enabling IYC

with MAM to gain weight in order to achieve a normal nutritional status in terms of anthropometric indicators and haemoglobin levels.

Table 8.1: Study objectives and dependent variables

Study objectives	Outcome variables	Indicator
To determine the ideal MSBP ingredient proportion to yield an energy rich, nutrient dense supplementary porridge with acceptable sensory attributes and viscosity levels.	Energy content, nutrient composition, viscosity levels, and sensory attributes of MSBP.	Optimal nutrient density of MSBP
To determine the socio-demographic characteristics and complementary feeding practices of breastfeeding mothers with IYC aged 6 to 18 months diagnosed with MAM.	Level of education, feeding practices regarding meal frequency and dietary diversity	Feeding practice in terms of MDD, MMF, and MAD.
To determine the anthropometric measurements and haemoglobin level of breast fed IYC aged 6 to 18 months supplemented with MSBP or CSB+ porridges for a period of three months.	Weight, length, MUAC, haemoglobin level, length-for-age z-score, weight-for-age z-score and weight-for-length z-score.	Weight gain, increase in haemoglobin level, and anthropometric measures
To determine knowledge, complementary feeding and hygiene practices of breastfeeding mothers before and after receiving nutrition education in conjunction with MSBP or CSB+ supplementary porridge for a period of three months.	Knowledge, meal frequency, dietary diversity, hand washing and boiling water for drinking and food preparation	Improved knowledge, meal frequency, dietary diversity, water quality, food safety
To determine breastfeeding mothers' perceptions and barriers to IYC feeding during the management of their IYC with MAM with MSBP or CSB+ supplementary porridge for a period of three months.	Maternal perceptions and barriers during the management of MAM.	Beliefs and perceived barriers while using supplementary porridges in the management of IYC with MAM

The existing complementary feeding practices of mothers of IYC diagnosed with MAM was determined, as it served as a guide for using MSBP in conjunction with nutrition education. Results of the study documented inadequate complementary feeding practices as was determined against WHO guidelines regarding MDD, MMF and MAD among IYC diagnosed with MAM that needed improvement through the frequent consumption of appropriate energy rich, nutrient dense supplementary foods.

Understanding the association between maternal level of education and maternal care in terms of preparing or purchasing food especially for their IYC, was used to make informed decisions regarding the content of the nutrition education mothers received. In addition, the knowledge regarding IYC complementary feeding and hygiene practices was used in the development of appropriate teaching aides such as counselling cards which contained key messages in the local language spoken by mothers.

MSBP supplementation in conjunction with targeted nutrition education resulted in a reduced prevalence of MAM among IYC at three months, to a level which was below a public health concern (Greaney, Pfiffner, & Wilson, 2011). Although the prevalence among IYC that received MSBP (9.6%) was lower than their counterparts that received CSB+ (19%), the difference was not statistically significant. However, it generated evidence to suggest that it is possible to manage IYC with MAM using malted based porridges such as MSBP. As a result, MSBP can be used as an alternative to CSB+, the standard care for MAM in Uganda, and in a setting similar to that of the study.

The effect of nutrition education, provided as part of the management of IYC with MAM, on maternal complementary feeding and hygiene practices, resulted in an improvement of knowledge regarding dietary diversity, meal frequency, food safety and water quality. The targeted nutrition education of mothers based on the constructs of the HBM, did contribute to a reduction in the prevalence of malaria and that of diarrhoea to a half among the study sample. However, although morbidity was not a core objective variable for the current study, it was important to understand its prevalence so as to mitigate it influence to the variable of weight gain. Overall, there was a significant improvement in meal frequency and dietary diversity at three months when compared to that measured at baseline.

Maternal perceptions and barriers experienced during the management of moderately malnourished IYC with MSBP or CSB+ supplementary porridges were similar. Both supplementary porridges resulted in weight gain, a reduced prevalence of illness, a positive attitude towards the supplementary porridge intervention, improved appetite, engagement in active play and healthy looking skin. The perceived barriers regarding the use of supplementary porridges to manage breastfed IYC diagnosed with MAM included a lack of social support from household members, household food insecurity, limited household income, limited livelihood and unemployment, which negatively affected mothers' ability to comply with the supplementation protocol as a result of household chores, and limited time to feed IYC regularly. The qualitative evidence presented, showed that an intervention that provides supplementary foods to IYC in conjunctions with nutrition knowledge to mothers based on constructs of the Health Belief Model, could prove to be effective in the management of IYC with MAM in low income settings similar to that of this study.

8.3 Methodological considerations

The logistical and financial implication of the daily supplementation of IYC with MAM in different clusters (parishes) of the rural Arua district, coupled with the assessment of nutritional status and measurement of haemoglobin levels, as well as the weekly provision of maternal nutrition education, resulted in the implantation of this study within a 50 km radius. In this study, proper personal hygiene practices were adhered to during the production of the malt. The quality of the MSBP, especially in terms of aflatoxin levels, was monitored before mixing with the extruded soy-maize flour for IYC feeding. It is however important to note that the process of producing a quality malt requires technical skills and is labour intensive, although it may be cost effective on an industrial scale.

8.4 Limitations

The cross sectional study design employed at baseline, had the limitation of not being able to determine cause and effect. For example, the study only established that maternal care regarding the preparation or purchase of food, especially for IYC with MAM, was associated with complementary feeding practices assessed in terms of MMF and MAD. Therefore, the study cannot claim whether the IYC lacked nutrient dense foods before developing MAM or whether it

was merely the feeding frequency of a diet based on complementary foods with a low energy content and nutrient density that could have contributed to the development of MAM.

8.5 Main findings

The study established that sorghum malt combined with extruded maize-soy flour is suitable for the development of an acceptable energy rich and nutrient dense supplementary porridge that can be adopted for the management of IYC with MAM. That is, a quarter sorghum malt flour mixed with three quarters of extruded soy-maize flour resulted in a malty sweet supplementary porridge with acceptable viscosity levels for potential use as an IYC food. The sweetness of the MSBP after cooking, served as an indicator of malt enzyme activity as it pre-digested the carbohydrate, protein, and fat to improve the taste of the porridge. Maternal level of education and care for IYC were documented as strong predictors of MMF among IYC diagnosed with MAM. Moreover, the prevalence of appropriate complementary feeding practices assessed according to MDD, MDD, and MAD were found to be inadequate among IYC with MAM.

In addition, the supplementary porridge intervention with a duration of three months lead to an improvement of anthropometric status and haemoglobin levels, resulting in a satisfactory recovery rate in terms of no longer suffering from MAM. The documented recovery rate provided evidence that the management of IYC with MAM requires an energy rich, nutrient dense supplementary food in conjunction with targeted nutrition education of mothers in terms of appropriate complementary feeding and hygiene practices. Therefore, MSBP has the potential for being scaled up as an alternative to CSB+ as a supplementary porridge used for the management of IYC with MAM in Uganda.

Furthermore, targeted nutrition education of mothers embedded in the supplementary feeding intervention, improved their complementary feeding and hygiene practices. Complementary feeding practices improved in terms of meal frequency and dietary diversity, while hygiene practices improved in terms of food safety practices and water quality. Therefore, health workers should promote dietary diversity, increased meal frequency, food safety, and improved water quality among mothers of IYC with MAM to enhance the effectivity of supplementary feeding. An improvement in maternal complementary feeding and hygiene practices are possible, and could have made a positive contribution to the appropriate intake of the supplementary porridge

and a reduction in IYC illness. However, an approach other than the constructs of the HBM, should be considered to significantly improve hand washing practices among mothers.

Mothers expressed their satisfaction regarding the perceived benefits gained from feeding their moderately malnourished IYC with the respective supplementary porridges. Collectively, the mothers' perceptions included health benefits such as weight gain, improved appetite, participation in active play, a healthy glowing skin, and a reduction in the prevalence of IYC illness. The perceived barriers to the implementation of the supplementary feeding intervention included limited time for preparing the supplementary porridges, a lack of social support from household members, routine household chores, household food insecurity and a negative attitude of the community towards the supplementary feeding intervention. Therefore, maternal stress should be addressed through an improvement in family economics, in addition to improving social support with the aim of reducing mothers' workload to maximise the effect of supplementary foods on IYC with MAM.

The evidence regarding the efficacy of MSBP in the management of IYC with MAM, in conjunction with nutrition education, was satisfactory as confirmed by the improvement in nutritional status in terms of weight-for-length z-scores of IYC following the supplementation intervention.

8.6 Thesis hypothesis statement

This study failed to reject the null hypothesis that supplementation with MSBP in conjunction with nutrition education of breastfeeding mothers will not result in a significant improvement in maternal feeding and hygiene practices, weight gain, weight-for-length z-scores and haemoglobin levels compared to that of CSB+ in the management of IYC with MAM. This was underscored by the fact that the effect of MSBP on the nutritional status of IYC with MAM was not significantly different to that CSB+ at 5% confidence interval.

8.7 Contribution of the study

This study developed a supplementary porridge, MSBP, that is nutrient dense and energy rich. Its formulation from malt active sorghum flour combined with extruded soy and maize flour produced a composite blend with sensory attributes that were acceptable for mothers of IYC with

MAM. From a consumer perspective, the hydrolysis resulted in a reduction in cooking time and fuel usage. The gradual cooking of MSBP resulted in a pre-digested porridge by the enzyme active malt, making it suitable for use in the management of IYC with MAM. Is important to note that CSB+ and MSBP had the same protein and energy source in the same ratio, expect CSB+ was fortified with micronutrients while the MSBP was enriched with a biological enzyme active malt made from sorghum. This in turn, could have enhanced the nutrient absorption of the already malnourished child's digestive system comparable to CSB+ porridge, the current standard care for IYC with MAM in Uganda. The MSBP supplementary porridge is the first known of its kind to be formulated in Uganda, while making use of locally produced indigenous ingredients. Therefore this study generated an alternative supplementary porridge to CSB+. In addition, the evidence generated by the cRCT regarding the effectivity of MSBP in managing MAM, is scarce in low income countries.

Furthermore, the study identified the knowledge gap regarding IYC complementary feeding practices that exists among mothers of IYC with MAM, thereby highlighting the importance of targeted nutrition education in conjunction with supplementary feeding for the management of MAM in low income settings such as Uganda.

The novel supplementary porridge used to manage MAM among IYC, was accompanied by targeted nutrition education messages based on data gathered at baseline from mothers forming part of the study sample prior to MSBP supplementation. It was therefore evident that mothers required education on IYC care practices as per the UNICEF conceptual framework regarding the immediate causes of MAM, by addressing inappropriate complementary feeding practices, the promotion of a sufficient intake of the supplementary porridges, as well as prevention of diarrhoea through education regarding personal hygiene such as hand washing and the use of safe drinking water. In addition, mothers were counselled to sleep with their IYC under an insecticide treated mosquito net every night to prevent malaria.

In this study, the qualitative data obtained through FGDs and IDI enabled the researcher to gain an understanding of the perceived barriers mothers of IYC with MAM face in low income settings in Uganda while participating in supplementary feeding interventions. On the other hand, despite relevant education, hand washing was not practiced regularly among breastfeeding

mothers in the study sample. Hence, the apparent norm of infrequent handwashing should be considered while promoting personal hygiene among mothers in a low income setting.

8.8 Conclusions

Results of this study provided additional evidence regarding the effectivity of a locally formulated energy rich, nutrient dense malted supplementary porridge with suitable consumer and nutrient qualities in the management of IYC with MAM in low a socio-economic setting. The nutrient composition of MSBP met the WHO specifications for supplementary foods suitable for the management of IYC with MAM. Its optimal nutrient density coupled with acceptable sensory attributes and viscosity level, rendered MSBP a suitable supplementary food for the management of IYC with MAM.

Supplementation with MSBP coupled with nutrition education of mothers on appropriate complementary feeding and hygiene practices, resulted in IYC weight gain, as well as an improvement in weight-for-length z-scores and haemoglobin levels. Thus, maternal knowledge regarding appropriate complementary feeding and hygiene practices in conjunction with the use of dietary supplementation with MSBP, proved important for IYC to significantly recover from MAM. Thus, MSBP has the potential to be used as an alternative supplementary porridge to CSB+, the standard care in the management of IYC with MAM in Uganda.

8.9 Recommendations for future further research

Recommendations for follow-up research include the following:

- The use of a nationally representative sample size, including all regions of Uganda in urban and rural areas.
- The effect of MSBP on IYC with MAM, irrespective of whether they are breastfed, living with HIV/AIDs, or receiving infant formula should be investigated.
- The cost-effectiveness of using a locally produced malt-based supplementary porridge such as MSBP in the management of IYC with MAM compared to CSB+, should be investigated.

- Appropriate strategies to reduce perceived maternal barriers experienced while using supplementary foods in the management of IYC with MAM should be investigated.
- The behaviour of washing hands by breastfeeding mothers before preparing food and feeding their IYC should be investigated. Perhaps reluctance towards regular hand washing could have contributed to the portion of IYC that did not attain a normal nutritional status as a result of the intervention, as it could have negative implications towards the prevention of diarrhoea as well as respiratory infections.
- It would be useful for policy purposes to document maternal perceptions and barriers experienced while using supplementary foods in the management of IYC diagnosed with MAM on a national level in urban, as well as rural settings in Uganda

A new research question generated by the current study worthy of future investigation is whether supplementation of IYC with MAM with MSBP or CSB+ prevents relapse. Hence, a longitudinal follow up study on IYC with MAM enrolled in a supplementary feeding intervention should be conducted once their nutritional status normalises. The relevance of the current study to other areas or disciplines relates to whether MSBP could be used as a supplementary food for adults as well as children that became malnourished as a result of chronic diseases such as cancer or among those living with AIDS. Scaling up the use of locally manufactured supplementary foods made from locally available ingredients, could serve as a source of income for local farmers and create jobs for those employed by local manufacturers of such supplementary foods.

8.10 Policy implications

The Ministry of Health in Uganda should prioritise the nutrition education of all mothers with IYC regarding appropriate complementary feeding and hygiene practices through standard messages that are acceptable and delivered at health facilities at community level. In addition, social marketing techniques should be used to create public awareness regarding the importance of appropriate complementary feeding and hygiene practices to combat MAM among IYC in Uganda. Similar strategies should be used to promote hand washing for the prevention of infectious disease such as diarrhoea as well as MAM and SAM.

Where IYC are diagnosed with MAM and their mothers or caregivers are issued with supplementary foods as part of the management strategy, nutrition education should form an integral part of their nutrition rehabilitation.

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APPENDICES

Appendix A: Ethical approval

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SCHOOL OF PUBLIC HEALTH
HIGHER DEGREES, RESEARCH AND ETHICS COMMITTEE

April 14th, 2016

Bazibu Kajjura Richard Stanley
Principal Investigator, Protocol (394)
PhD Student – University of Kwazulu Natal

Re: Approval of Proposal titled: Effect of malted Sorghum-based porridge on nutritional status of moderately malnourished breastfed infants and young children aged 6 to 18 months in Arua, Uganda

This is to inform you that, the Higher Degrees, Research and Ethics Committee (HDREC) has granted approval to the above referenced study during the 137th HDREC meeting held on 11th/03/2016 reviewed the proposal using the expedited review criteria and made some suggestions and comments which you have adequately incorporated:

Please note that your study protocol number with HDREC is **394**. Please be sure to reference this number in any correspondence with HDREC. Note that the initial approval date for your proposal by HDREC is 14th/04/2016, and therefore approval expires at every annual anniversary of this approval date. The current approval is therefore valid until: **13th/04/2017**.

Continued approval is conditional upon your compliance with the following requirements:

1) No other consent form(s), questionnaire and/or advertisement documents should be used. The consent form(s) must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject must be given a copy of the signed consent form.

2) All protocol amendments and changes to other approved documents must be submitted to HDREC and not be implemented until approved by HDREC except where necessary to eliminate apparent immediate hazards to the study subjects.
3) Significant changes to the study site and significant deviations from the research protocol and all unanticipated problems that may involve risks or affect the safety or welfare of subjects or others, or that may affect the integrity of the research must be promptly reported to HDREC.
4) All deaths, life threatening problems or serious or unexpected adverse events, *whether related to the study or not*, must be reported to HDREC in a timely manner as specified in the National Guidelines for Research Involving Humans as Research Participants.

Makerere University School of Public Health
Valid Thru:
13 APR 2017
Higher Degrees, Research and Ethics Committee

- Please complete and submit reports to HDREC as follows:

a) For renewal of the study approval – complete and return the continuing Review Report – Renewal Request (Form 404A) at least 60 days prior to the expiration of the approval period. The study cannot continue until re-approved by HDREC.

b) Completion, termination, or if not renewing the project – send a final report within 90 days upon completion of the study.

- Finally, the legal requirement in Uganda is that all research activities must be registered with the National Council of Science and Technology. The forms for this registration can be obtained from their website www.uncst.go.ug. Please contact the Administrative Assistant of the Higher Degrees, Research and Ethics Committee at wtusiime@musph.ac.ug or telephone number (256)-393 291 397 if you encounter any problems.

Yours sincerely

Makerere University School of Public Health • Valid Thru: 13 APR 2017 • Higher Degrees, Research and Ethics Committee

Assoc. Prof. Lynn Atuyambe

Vice Chairperson: Higher Degrees, Research and Ethics Committee

Enclosures:

a) A stamped, approved study documents (informed consent documents):

Study research tools

Appendix B: Informed consent form

English version

Biomedical Research Ethics Administration
Research Office, Westville Campus
Govan Mbeki Building
University of KwaZulu-Natal
Private Bag X 54001, Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2602486 - Fax: 27 31 2604609
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Research Project Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

By giving consent, I agree that

I. The implication of my voluntary participation, the nature, duration and purpose of the study, the methods and means by which it is to be conducted and the inconveniences or hazards that may reasonably be expected have been explained in a language with which I am fluent and comfortable.

II. I have been given the opportunity to ask questions concerning this study and was answered to my full and complete satisfaction.

III. I am free now and in the future to ask questions about the study

IV. I understand that I may at any time during the course of the study revoke my consent and withdraw from the study without any penalty.

V. If you have any question concerning your rights as a research participant that have not been answered by the investigator or if you wish to report any concerns about the study,

you may contact the Chairperson, Biomedical Research Ethics Committee, University of Kwazulu Natal Research Office, at Westville Campus Govan Mbeki Building, Private bag X 54001, Durban, 4000, Kwazulu Natal South Africa

Participant's signature (or thumbprint)	**Date**

► I have accurately explained the information regarding the study to the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given informed consent freely.

Researchers' signature	**Print name**	**Date**

Kokobi E'yo 'Diri Atizu Ri

Lugubrati version

Research Project Title: E'yo i bipi e'di edele ondu e'dopi engapi were rakaka risi rini ejile nyaka ma ogmbo azini esele anzinyiri azini anzi elibe werea e'dozu mba 6 cazu 18 rua alupi tuku ba ndrupi i 'diyi ma rua engazu Arua, Ugandaa

'Yozu ma ati e'yo diri ra, ma ai kini

I. E'yo i ecipi mani ovuzu onitaa 'dima alea indi ma asisile risi pi esele, sawa/ewu azini asisile onitaa 'diniri pie, geriko onitaa 'di 'yezuri pi azini e'yo mani muke ku kaniku onzi 'bani egale ecopi ecapi 'diyi 'ba ece yi mani ti mani nzele kilili ra nisi azini yi mani muke.
II. 'Ba fe mani drileba zitaa ozizu onitaa 'dima dria ra azini omvi yi ra ma api vini ani kilili ra.
III. Ma drile di sawa 'disi wala azini ewu drile ria zitaa ozizu onitaa dima dria.

IV. Ma nira kini ma eco sawa cirisi onitaa ‘dini pari ‘duria ria e’yo aiza maniri ojara azini onitaa ‘di kuzu jara panga azini kokoru.

V. Mivu zitaa azini ka adri ci i bipi mi driwala ovuzu onitaa ‘dima alea indiri pie ‘ba e’yo eti ndaapiri ni omvile kuni kaniku mi ka lee e’yo azi onitaa ‘dibe ni olu, mi eco ‘Bile eii, Biomedical Research Ethics Committee, University of Kwazulu Natal Research Office, at Westville Campus Govan Mbeki Building, Private bag X 54001, Durban, 4000, Kwazulu Natal South Africa.

Dri tiza ‘ba e’yo omvipirini (kaniku driago duza pamvu)	**Mba o’du:**

Ma ece e’yo onitaa ‘dima driari ma efi kilili ‘ba ecopi e’yo omvipirini azini mafe vini drileba ‘ba nderi dri zitaa ozizu ra. Ma ‘yokini ‘ba ‘diri ai e’yo nderi drile walabe.

Dri tiza‘ba eyo onipiri:	**Ru sizari:**	**Mba o’du:**

Appendix C: Consent information sheet

English version

Research Project Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

I am ....., a PhD research student at the University of Kwazulu Natal, Pietermaritzburg Campus in South Africa. I am doing research on “**Effect of malted sorghum-based porridge on nutritional status of moderately malnourished breastfed infants and young children aged 6 to 18 months in Arua, Uganda”.** I am going to give you information and invite you to be part of this research. If there are some words you do not understand, please ask me to stop as

we go through the information and I will take time to explain. Ask me if you would like more information about the research.

What is the reason for doing this study?

It is hoped that the results of this study would provide an alternative supplementation protocol for managing Moderate acute malnutrition (MAM) in Uganda by using locally grown processed staple foods and targeted appropriate nutrition education massages to mothers of infants and young children (IYC) with MAM. It is also hypothesised that the study findings will be useful in identifying optimal culturally acceptable feeding practice to be incorporated into nutrition education messages that will enhance the management of MAM among IYC by their breastfeeding mothers. Therefore, identifying the knowledge gap between appropriate feeding practices and perception regarding infant feeding held by breastfeeding mothers regarding the management of IYC with MAM will provide the Ministry of Health with evidence-based information on how to optimally manage IYC with MAM in Uganda. Therefore, this study will assess effect of using nutrient dense malted sorghum based porridge (MSBP) on the nutritional status of breast fed IYC aged 6 to 18 months diagnosed with MAM in Arua district.

What exactly will happen if you take part?

You (breast feeding mothers) and your child aged 6-18 months diagnosed with moderate acute malnutrition will have to accept to take part in the study by signing or putting a thumbprint on the informed consent form. We will ask you some questions regarding your socio-demographic information, feeding practices, environmental health factors. We shall assess the changes in nutrition knowledge, attitudes towards the treatment/management of MAM using malted sorghum based porridge (MSBP), and practices regarding; sanitation, hygiene, IYC complementary feeding practices, of breastfeeding mothers with IYC aged 6 to 18 months of age participating in the porridge supplementation intervention. We shall take the weight, height and mid arm circumference of the IYC at baseline and post intervention. All the data will be collected using a handheld device or machine and recorded on a questionnaire. After that we will ask mothers to allow us collect two to three drops of blood by pricking one of IYC finger tip. This blood will be tested for haemoglobin level. In case child has a haemoglobin level of less than 8g/dl, the child will be referred to a health centre for appropriate management.

Will I experience any possible risks and/or discomforts?

You may feel some discomfort; get redness, pain, bruising or infection on the finger after pricking. However, I would like to reassure you that the research assistants of our team are well trained and will collect the blood specimens with great care, trying to make you feel as comfortable as possible. Recommended universal infection control precautions will be followed to minimise the risk of infections.

You may feel shy, or feel worried when you are talking about child feeding practices and household standard of living. A trained research assistant will help you to discuss any feelings you may have and to answer your questions.

How long does this study/interview take?

The study will last for three consective months. Interviews will last for not more than one hour. But if some participants are not cooperative especially during baseline, interview may last longer than one hours. Giving you nutrition education and food rations will always last for about one hour.

How will I benefit from joining this research?

During the study infants and young children aged 6-18 months diagnosed with moderate malnutrition will be tested for aneamia and malaria. If found with malaria or inadeqaute blood the child will be referred to nearby health centres for management.

During the study your height and weight will be measured and if found outside the normal range you will be given advise on feeding practices.

You will be provided with nutrition messages, advised and encouraged to feed a variety of usual home foods to their IYC. The mothers will be educated to keep the flask clean to avoid bacterial contamination.

Will we pay you for joining this research?

On participation in this study you will receive a piece of washing soap weekly as an incentive worthy R5 for a period of thirteen weeks to compensate for your time and effort. No hard cash will be paid to you for participating in this research.

Can you withdraw from the study at any time?

Joining this research is voluntary and you can stop responding to questions or participaing in th porridge supplementation intrvention at any time of the study. You are free not to answer some questions which you feel are very senstive. We request for your cooperation with the research team as much as possible.

Confidentialility

We shall respect the privacy of the participant as we identify you with a code number only. The information produced in this study will be kept confidential and will only be reviewed by researchers. All shared information will be kept under lock and key. Findings will be shared with Rotary Foundation and the public through publications in scientific peer review journal and conference presentations.

Who should you contact for more information in case need arises?

If you wish to ask questions later, you may contact the principal investigator Mr. Bazibu Kajjura Richard Stanley on telephone: +256 (0) 773 001 154, email: rbkajura@yahoo.co.uk or rkajura@musph.ac.ug

This proposal has been reviewed and approved by the IRBs University of Kwazulu Natal and school of public health, Makerere University which are committees whose task is to make sure that you research participants are protected from harm. If you wish to find out more about the Ethical Committees, contact the chairpersons on either email: BREC@ukzn.ac.za or email: wtusiime@musph.ac.ug

Kokobi E'yo eceza ni

Lugubrati version

Research Project Title:

E'yo i bipi e'di edele ondu e'dopi engapi were rakaka risi rini ejile nyaka nyaza anzinyiri azini anzi nyiria elibe e'dozu mba 6 cazu 18 rua alupi tuku ba ndrupi indi 'diyi ma rua engazu Arua, Ugandaa.

Ma ru……..i, ma azinga PhD, University of Kwazulu Natal, Pietermaritzburg, South Africa. Ama e'yo eti ova "**E'yo i bipi e'di edele ondu e'dopi engapi were rakaka risi rini ejile**

nyaka nyaza ma ogmbo azini esele anzinyiri azini anzi nyiria elibe e'dozu mba 6 cazu 18 rua alupi tuku ba ndrupi indi 'diyi ma rua engazu Arua, Ugandaa". Ma 'ye mu mini e'yo eceza ece azini mi ai ovuzu e'yo oniza 'dima alia indi. E'yo azini mini vale kuni ka ovu ci yaani, kaecorasi mizima pa sozu 'daa ci amani muria e'yo eceza nderi ma driasi azini ma nga sawa 'du efileni ecezu. Mizi ama mika e'yo eceza le angiri e'yo oniza 'dima dria ria.

Asisile onitaa 'diniri eri ngoni ya?

'Ba ovu asi'baza kini e'yo nga isule onitaa 'dima aleari ni nga geriko azini ndu 'dileni o'baa e'yo anzi ma ruani aluzu tuku nyaka ma e'yosiri (MAM) ma azakozu Ugandaa 'bani nyaka o'bivile ezole caloa ayuzu edezaru azini 'yozu kini eri e'yo eceza onyiru onitaani nyaka ma dria ayia anzinyiri azini anzi elibe werea rua alupi tuku 'diyini. 'Ba ega vini kini e'yo nga isule onitaa 'dima aleari ni nga ovu orodriru 'yetaa nyaka fezasi e'yo a'bini ni aile ra 'diyi e'dazu/oluzu vini ofizu e'yo osiza onitaaru kala nyaka vusi ria ecozu rua alutaa ako ecapi kala nyaka vusiri ma aza kozu cika anzinyiri azini anzi eli be werea 'diyi ma eselea yima ayia anzi endrupi basi 'diyi pie. Ka 'dinile, e'yo ewaru onitaa niri edazura 'yetaa nyaka feza onyiruri piyi ma eselea egataa i ecipi nyaka feza anzinyiri dri ayia anzi dri ba fepi indi 'diyi pie e'yo i bipi anzinyiri (IYC) vini rua alutaa tuku (MAM) ma azakozuri pie 'diyi nga Minisitry Alataa vileri dri e'yo eceza 'bani isulera adaada ri fee nizu kini 'ba ecote anzinyiri (IYC) vini rua alutaa ako (MAM) ma azako kilili Ugandaa ngoni ngoni ru yaari. Ka 'dinile, onitaa 'dini nga e'yo 'bani e'di edele ondu ti soopi engapi were rakaka nyaka alenia rini adrizu 'bualeruri (MSBP) ma ndule ondaa e'yo i bipi nyaka ma ogmbo azini esele anzinyiri ba 'ndrupi elibe e'dozu mba 6 cazu 18 rua alupi tuku (MAM) 'diyi ma rua engazu Arua disitrikitia.

A'di e'yo ninga 'yeruni mika ovu onitaa 'dima alea indi ria?

Mi i(ayia anzi endrupi basi 'diyi) azini mivile mva elibe mba 6 – 18 'bani isule ruani aluku ri (MAM) ni nga aii ovuzu onitaa 'dima alea indi erini ima dri tizu kaniku driago pamvu 'bazu kokobi ecepi kini ma ati/ai rari ma dria. Ama nga mitia zitaa azini yi ozii mi oata vini eli piyi ma dria, 'yetaa nyaka fezu 'diyi ma dria, e'yo i bipi angu mini oazuri pie 'diyi ma dria. Amanga afa 'diyi o'bii; ojataa i ecipi onitaa kala nyaka vusiri, egataa aro isuza/azakoza fele rua alutaa ako (MAM) ni e'di edele ondu egapi were rakaka ri (MSBP) ayuzuri ma dria, azini yetaa i bipi coroni, alataa, anzinyiri (IYC) dri nyaka esele ndundu fezuri, ayia anzi elibe mba 6 cazu 18 'diyi endrupi basi vini ovupi e'di o'bale e'yo 'diniri ma alea indi 'diyi. Ama nga anzinyiri (IYC) 'diyi

ma nziza/kilo, zotaa azini wu ma agadu kurukururi o'bii e'doria azini e'di 'dima vutia. 'Ba nga e'yo 'diyi 'ye/isu woro afa 'bani bile dria nisi kaniku masini si azini osizaru kokobi ozitaa 'dini rima dria. 'Dama vutia, ama nga ayia yi zi yini fezu amani ari 'duzu werea otizaru iri cazu na 'dipi anzinyiri ma driamva aluni ma drile sozu risi. 'Ba nga ari 'diri epimaa afa ari 'bapi ekari ma ogmbo isuzu azini malaria be. Mala ka adri ci yaani 'ba nga midri aro Koatemu ruri fee azini mva mivileri ma ari ka ovu were (Hb< 8g/dl), 'ba nga miti pee arojo ambuu Arua ria ecozu mi aza kozu kililiru beni.

Ma eco e'yo ewaru azini kaniku 'yezu ciriciri 'dileni isura ya?

Mi eco azinisi 'ye ciriciri ra, mile kaza, sutaa, nyabiliko kaniku azo isuzu ra mi driamvaa sozu 'bori ma vutia. Te, male 'yo mini kini 'ba onitaa 'dima alea 'diyi yi 'ba embale kilili 'diyi azini yi nga ari 'bani leleri okunaa geriko onyiru si, yini nga fezu mini mi amazu muke tu. Geriko azo isuza atrizu pari woro ma alea ri 'ba nga vutini obii i ecozu azo isuza omvizu teketeke. Mi eco 'ye drinzasi ra kaniku mini 'yezu orisi mini e'yo nzezu sende isuza ma dria ra. 'Ba onitaa 'dima alea 'diyi nga mi aza ko e'yo nzezu e'yo mini mi amazu ri ma driara azini mi zitaa yi omvizura.

Onitaa/ozitaa 'dini nga sawa 'du ngopi ya?

Onitaa 'dini nga ovu mba na. Ozitaa ngani ovu sawa alu ma drilea ku. Te 'ba onitaa dima alea 'diyi ma azi ka ovu tiecitaa kokoru tutuni e'doria leru, ozitaa 'di eco nga ovu sawa alu ma drilea ra. Mini onitaa fezu kala nyaka vileri ma dria azini nyaka ma ogmbo ma dria rini nga ovu ogogo sawa alu 'dipi.

Ma nga orodri ngoleri isu onitaa 'dima alea i ya?

Onitaa 'dima alia anzinyiri mbabe 6-18isule kini ruani aluni tuku 'diyi 'ba nga yima rua anemia azini malaria o'bii. 'Ba isuu kini malaria onzi tukuri ruania ci, 'ba nga erini aro Koatemu ruri fee mbeleru i engazu akua azini mi ari ka vini caku yaani, 'ba nga miti pee arojo ambuu Arua ria ecozu mi aza kozu beni.

Onitaa 'dima alia, mima zotaa azini nzitaa ninga ovu o'bizaru azini 'ba ka nga isuu kini eri nde amveleru pari kilili ma aleasi, 'ba nga mini egataa onyiruri fee mini ecozu mi rua ma nziza ma azakozu beni.

Emi alualu dri ‘banga fulasika fee e’di o’bale omvele MSBP ruri ma ta mbazu, neti yiyia vile ri mi I azini mivile mvari ma tambazu malaria si. ‘Ba vini nga mini e’yo osile embataaru kala nyak vile risiri fee, egataa onyiruri feza azini ‘ba nga mi eka nyaka esele ndundu oku akua ‘diyi fezu yima anzinyiri (IYC) ‘diyi dri i. ‘Ba nga ayia ‘diyi embaa fulasika ‘diyi ma ta mbazu alaru ecozu o’bu nyiria ru ‘diyi atizu..

Ama nga mi ofee raya mika fi onitaa ‘dima alea indiria?

Mika ovu onitaa ‘dima alea indi mi nga sabuni isu baa alu te ecopi aje nyapi silingi R5 ru ‘dileni mi sawa azini okpo mivileri ofezu. Sende olungu ru ‘dileni ‘ba ngani fee mini ovuzu onitaa ‘dima alea indirisi ku.

Mi eco onitaa ‘diri ku sawa cirisi raya?

Mini fizu onitaa ‘dima alea indiri mi asini lele rile azini mi eco vini ku zitaa omvizu ja kaniku ovuzu yo e’di o’bale e’yo ‘dini siri ma aleara sawa ci onitaa ‘dinirisi. Mi drile wala zitaa azini ‘diyi omvizu kura mika amaa kini yi fee mini ‘yezu ciriciri ria. Ama mizi tiecizu ‘ba onitaa ‘dini ‘diyi pie asi driasi.

Appendix D: Soio-demographic, knowledge, complementary feeding and hygiene questionnairre English version

Project Research Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

Principal Investigator:

Bazibu Kajjura Richard Stanley, PhD Research Student, Dietetics and Human Nutrition, School of Agricultural, Earth and Environmental Sciences, College of Agriculture, Engineering and Science, University of KwaZulu-Natal, Pietermaritzburg, South Africa

SOCIO-DEMOGRAPHIC INFORMATION, ENVIRONMENTAL HEALTH, KNOWLEDGE, ATTITUDE & PRACTICES REGARDING COMPLEMENTARY FEEDING OF IYC AGED 6 - 18 MONTHS WITH MAM		
Only one interview should be conducted per mother of IYC diagnosed with MAM who have consented participate in the supplementation intervention. Circle the appropriate answer where applicable. ***Time:*** *Start _____End_____*		
Date of assessment: _____/_____/_____ *(DD/MM/YYYY)*	**Interviewer Code**	**Sub-County:**
Parish:	**Village:**	**Questionnaire Number:**
Respondent/Child code:	**Level of Nearby Health Facility:**	**Name of nearby Health Facility:**
SECTION 1: HOUSEHOLD, CHILD & MOTHER DEMOGRAPHIC, SOCIO-ECONOMIC INFORMATION		
1. Household (HH) head's full name _____ **2.** Age of HH head _____years **3.** Highest level of education the **HH head** has completed: 1= No formal education 2= Primary education –P1-P7 3=Secondary education-S1-S6 4= Tertiary education	**4.** Mother's full name: _____ **5.** Age of mother _____years **6.** Highest level of education **mother** has completed. 1= No formal education? 2= Primary education -P1-P7 3= Secondary education -S1-S6 4= Tertiary education	**7.** Index child's full name _____ **8.** Gender of the child 1=Male 2=Female **9a.** Age of the child (in complete months) _____months **9b**. Child birth date: _____
10. Mother's contact telephone number _____	**11.** If the telephone number given in **Qn.10** is not for the mother indicate who owns it _____	**12.** Child's birth weight (check on child health card) |__|.|__|kg
13. Relationship of mother of index child to HH Head: 1= Mother is HH Head 2= Wife 3= Daughter 4=Other please specify_____		**14**. Number of children by the mother (parity) |__|__|
15. Number of children in HH **15a**: Below 24 months: _____ **15b:** Below 59 months _____	**16.** Do you live with the father of the Index child (name)? 1= Yes 2= No	**17.** What is your routine feeding practice to the index child? 1= Breast feeding alone 2= Breast feeding & other foods 3= More of breast feeding & less food

18. How many people (besides the index child) sleep in the household for at least four nights a week? 1= One to two 2= Three 3= Four 4= Five 5= Six 6= Seven or more	**19.** Mother's marital status 1=married, monogamous; 2=married, polygamous 3=cohabiting 4=single 5=widowed 6=divorced 7=separated	**20.** What is the main type of walls where the index child lives? 1=Wood and mud 2= Mud bricks or burnt bricks 3= Concrete blocks 4= Wood 5= Grass/bamboo 6= Other specify _____
21. What is the main type of roof where the index child lives? 1= Grass or leaf thatched 2= Corrugated iron sheets 3= Tiles 4= Other specify _____	**22.** What is the main type of floor where the index child lives? 1= Mud or dirt 2= Brick/stones/cement 3= Tiles 4= Other *specify*_____	**23.** How many rooms are there in the house where the index child lives? 1= One 2= Two 3= Three 4= Four or more
24. What is the most common cooking fuel used in your household? 1= Wood 2= Charcoal 3= Gas or biogas 4= Electricity 5= Kerosene/paraffin 6. Other specify_____	**25.** What is your household's main source of fuel or energy for lighting? 1= Electricity 2= Solar 3= Gas 4= Paraffin (lantern) 5= Paraffin (tandooba) 6= Open firewood place	**26.** Does your household have running water? 1=Yes 2=No **27.** Does your household have grid electricity? 1=Yes 2=No
28. Type of toilet used by the household most of the time: 1= None/bush/garden 2=Unimproved pit latrine 3= Improved pit latrine 4= Flush toilet 5= Community owned latrine	**29.** Does your household toilet have a hand washing facility within the vicinity?	1= No water, no soap 2= Water but no soap 3= Soap but no water 4= Water and soap 5= No toilet in the household

SECTION 2: ENVOROMETAL HEALTH INFORMATION OF IYC DIAGNOSED WITH MAM	
30a. Mention the diseases your child has suffered from in the last 2 weeks (Interviewer: Circle all that apply)	1 = Fever (as increase in temperature) 2 = Malaria (as confirmed by diagnosis) 3 = Measles 4 = Diarrhea 5 = Fast breathing /cough/chest infection 6 = Skin diseases & /rash (e.g. excluding nappy rash) 7 = Eye disease 8 = Nose infection 9 = Malnutrition

	10 = No Illness 11 = other (specify)
30b. If the index child in the **30a** was sick, did it affected the way you feed him or her?	1= Yes 2= No
30c. If the answer to **30b** is **YES**, what did you do?	1= Breast feed more often 2= Amount food increased 3= Breast feed less often 4= Amount of food decreased 5= Gave only liquids (e.g. juice, porridge etc)
31. When a child in the household is sick where do you first go for treatment?	1= VHT 2= Drug shop or clinic 3= Traditional healer 4= Neighbour 5= Relatives 6= Health center/Facility 7= Others specify_____
32. Who mainly influences the food choices that you make and prepare for your index child?	1 = Husband / father of the index child 2 = Mother-in-law /grand mother 3 = Mother, myself 4= Relatives, e.g. Aunt, sister-in-law 5 = Other specify_____
33a. Is the index child enrolled in any of the feeding programs?	1= Outpatient Therapeutic (i.e. OTP- e.g. Plumpy'nut) 2= Inpatient Therapeutic (i.e. ITP- e.g. F100) 3= Corn Soy Blend (CSB) 4=None 5= Others specify
33b. Did the index child sleep under a Long Last Insecticide Net (LLIN) / mosquito net yesterday?	1= Yes 2= No
Interviewer: For questions **34-38** ask the mother for the child health card and check	
34. Has the index child been taken for BCG immunization? (Given at birth to protect against tuberculosis on the **right upper arm**)	1=Yes 2=No
35. Has the index child been taken for DPT-HepB+HiB 3 immunization? (Given 10 weeks after birth to protect against Diphtheria/ tetanus/whooping cough/ hepatitis B/ Haemophilus influenza on **the left upper thigh**)	1=Yes 2=No
36. Has the index child been taken for Measles immunization? *(Indicate only for children above 9 months of age) (Given 9 months after birth to protect against Measles on the **left upper arm**)*	1=Yes 2=No
37. In the last 6 months, did the index child receive Vitamin A supplementation?	1=Yes 2=No

38. In the last 6 months, did the index child receive de-worming tablet/syrup? (Interviewer: ask for children from 12 months of age and older)	1=Yes 2=No
Anthropometry and Biochemical measurements	
39. Weight of the index child: 1) |__|__|.|__|kg 2) |__|__|.|__|kg |__|__|.|__|kg (Av)	**40.** MUAC of the index child: 1) |__|__|.|__|cm 2) |__|__|.|__|cm |__|__|.|__|cm (Av)
41. Length of the index child: 1) |__|__|.|__|cm 2) |__|__|.|__|cm |__|__|.|__|cm (Av)	**41a. z-scores:** WFA_____WFH_____ ___
42. Does the index child have Oedema?	1= Yes 2= No
43. Hemoglobin level of the index child	|__|__|.|__|g/dl

SECTION 3: KNOWLEDGE, ATTITUDES & PRACTICESS REGARDING IYC COMPLEMENTARY FEEDING

Ask mothers with children between 6 to 18 months of age. [in case of two children, randomly select the index child]

44. Is the index child (name) currently breastfeeding?	1=Yes 2=No
45. Do you feel the baby is always satisfied after a breast feed (pass pale yellow urine frequently, pass one stool a day, gain weight)?	1=Yes 2=No
46. Was the index child (name) breastfed or did he or she consume breast milk yesterday during the day or at night	1=Yes 2=No
47. How many times did you breast feed the index child (name) yesterday (during the day and during last night)?	_____times
48. Since yesterday (during the day and during last night), did you give index child (name) anything else to eat or drink other than breast milk?	1=Yes 2=No

49. If the answer to **Qn. 48** is YES, which other liquids (e.g. water, liquid, herb or syrup feed) did the index child (name) receive yesterday (during the day and during last night), and how often?

a. Water	1=Yes 2=No If yes _____times
b. Gripe water (any therapy/medicine)	1=Yes 2=No If yes _____times
c. Herb	1=Yes 2=No If yes _____times
d. Glucose	1=Yes 2=No If yes _____times
e. Cow's milk	1=Yes 2=No If yes _____times

f. Other fresh milk	1=Yes 2=No If yes _____times
g. Milk prepared from powder or formula	1=Yes 2=No If yes _____times
h. Fruit juice	1=Yes 2=No If yes _____times
i. Tea/Coffee	1=Yes 0=No If yes _____times
j. Other (specify) _____	1=Yes 0=No If yes _____times
50. How many times (meal frequency) did the **index child** eat solid, semi-solid, or soft foods **(other than liquids)** yesterday during the day and during last night? This includes porridges.	_____times (meals and snacks)
51. If the child had/fed 2 or less meals in Qn. **50,** what was the reason?	1= No food to give the child 2= Child had enough breast milk 3= Mother too busy to feed the child 4= meal is adequate/enough for child 5= Others specify
52. Do you prepare or buy special foods for the index child?	1= Yes 2= No
53. Was the food given to the index child (name) yesterday (during the day and during last night) the usual diet?	1=Yes 2=No 3=Don't know
54. If the answer to Qn. **53** is **NO**, why was the food fed to the index child (name) yesterday (during the day and during last night) different to the usual diet?	1=Child was sick 2=Mother was away 3= Child attended ceremony 4= Other (specify)

55. Which foods did you give to index child (name) since yesterday (during the day and during last night)? *(respond to all below: Interviewer read to the respondent)*

Groups	Food Items	**Responses**		**How many times**
Group 1: Grains, roots, plantain & tubers	Porridge, bread, rice, millet, maize, noodles, or other foods made from grains	1=Yes	2=No	_____*times*
	Matooke (cooking banana), plantains (Gonja, Bogoya, Ndizi)	1=Yes	2=No	_____*times*
	Irish potatoes, white sweet potatoes, white yams, cassava, or any roots tubers	1=Yes	2=No	_____*times*
Group 2: Legumes and nuts	Any foods made from beans, peas, French bean, nuts, or seeds	1=Yes	2=No	_____*times*
Group 3: Dairy products	Infant formula, such as NANI,	1=Yes	2=No	**_____times**
	Milk such as tinned, powered or fresh animal milk	1=Yes	2=No	**_____times**
	Yogurt and drinking yogurt	1=Yes	2=No	**_____times**

	Cheese, yogurt, or other milk products	1=Yes	2=No	_____*times*
Group 4: Fresh foods	Any meat, such as beef, pork, lamb, goat, chicken, or duck	1=Yes	2=No	_____*times*
	Liver, kidney, heart, or other organ meats	1=Yes	2=No	_____*times*
	Fresh, powder or dried fish	1=Yes	2=No	_____*times*
	Grasshoppers, ants, termites, or other insects	1=Yes	2=No	_____*times*
Group 5: Eggs	Eggs	1=Yes	2=No	_____*times*
Group 6: Vitamin A fruits and vegetables	Pumpkin, carrots, squash, or orange fresh sweet potatoes	1=Yes	2=No	_____*times*
	Any dark green leafy vegetables (Nakati, Gobbe, Dodo, Gyobyo, Osubi, Nyirikia)	1=Yes	2=No	_____*times*
	Ripe mangoes fresh or dried **not green**, ripe papayas, water lemon or any other fruits vitamin A-rich fruits	1=Yes	2=No	_____*times*
	Foods made with red palm oil, red palm nut, or red palm nut pulp sauce	1=Yes	2=No	_____*times*
Group 7: Other fruits & vegetables	Any other fruits or vegetables e.g. cabbage	1=Yes	2=No	_____*times*
Others (not counted in the dietary diversity score)	Any oil, fats, or butter, margarine (blue band) or foods made with any of these	1=Yes	2=No	_____*times*
	Any sugary foods such as chocolates, sweets, candies, pastries, cakes, biscuits or sugar in tea/coffee	1=Yes	2=No	_____*times*
	Condiments for flavor, such as chilies, spices or herbs or fish powder	1=Yes	2=No	_____*times*
56. How long is it recommended that a woman breast feeds her child?		1=Six months or less 2=6-11 months 3=12-23 months 4=24 months and more 5=Others 6=Don't know		
57. How old was the index child (name) in months when you first started giving him or her other liquid or semi-solid or solid food in addition to breast milk? |__|__|months		**57b.** What liquid or semi-solid or solid food did you give? _____	
58. What made you decide to start giving liquid, semi solid or solid		1= Not yet started giving foods		

foods to the index child (name)? *(Do not read the responses. Allow the mother to answer, and then fill each item.)*	2= Not enough breast milk/weak milk 3= Baby always crying/ baby hungry 4= Baby active/ Baby reaching for food 5= Not enough time to breastfeed 6= Advised/told to do so 7= Tradition/culture e.g. mother pregnant 8= Baby older than 6 months 9= Breast sore nipples/ Mother was sick
59. Why is it important to give foods in addition to breast milk to babies from the age of six months?	1= Breast milk alone is not sufficient/enough from six months 2= Baby needs more food in addition to breast from six months 3= Others specify 4= Don't know
60. Regarding thick or watery porridge consistencies, which one do you think should be given to IYC?	1 = Thick (semi-solid) porridge 2 = Light (watery) porridge 3 = Don't know
61. If the index child (name) receives liquids or semi-solids other than breast milk, how are liquids or semi-solids given to the index child?	1= Feeding bottle 2= Cup 3= Spoon 4= Hands 5= Other specify_____
62. Which foods or types of food can be added to baby's porridge to make it more nutritious? 1= Animal source food 2= Legumes and nuts (e.g. ground nuts, peas, beans, soybean, peanuts, sunflower seeds 3= Vitamin-A-rich fruits and vegetables (carrots, oranges-fresh sweated potato, yellow pumpkin, mongo, papaya…) 4= Green leafy vegetables (e.g. Nakati, Gobbe, Dodo, Gyobyo, Osubi, Nyirikia) 5= Energy rich food (e.g. oil, butter/ghee) 5= Others 6= Don't know	
63. Do you know any ways to encourage young children to eat? 1= Giving them attention during meals, talk to them, make meal times happy times 2= Clap hands 3= Make funny faces/play/laugh 4= Demonstrate opening your own mouth very wide/modelling how to eat 5= Say encouraging words 6= Draw the child's attention 7= Other 8= Don't know	

IRON DEFICIENCY ANAEMIA AMONG IYC 6 to 18 MONTHS of AGE	
Knowledge	
64. Have you ever heard about iron-deficiency anaemia? 1=Yes 2= No 3=Don't know/no answer	**64a. If Yes:** Can you tell me how you can recognize someone who has anaemia? 1= Less energy/weakness 2= Paleness/pallor 3= Spoon nails/bent nails (koilonychia) 4= More likely to become sick (less immunity to infections) 5= Other 6= Don't know
65. What are the health risks for IYC with a lack of iron in the diet? 1= Delay of mental and physical development 2= Other_____ 3= Don't know	**66.** What causes anaemia? 1= Lack of iron in the diet/eat too little, not much 2= Sickness/infection (malaria, hookworm infection, HIV/AIDS) 3= Heavy bleeding during menstruation 4= Other_____ 5= Don't know
67. Can you list examples of foods rich in iron? 1= Organ meat (Liver, kidney, heart) 2= Flesh meat (Beef, pork, lamb, goat, rabbit, dog, chicken, and duck) 3= Insects (Insect larvae, red ants, grasshoppers, crickets) 4= Fish(Fresh fish, dried fish, canned fish) 5= Other_____	**68.** How can anaemia be prevented? 1= Eat/feed iron-rich foods/having a diet rich in iron 2= Eat/give vitamin-C-rich foods during or right after meals 3= Take/give iron supplements if prescribed 4= Treat other causes of anaemia (diseases & infections) – seek health-care 5= Continue breastfeeding (for infants 6–23 months old) 6= Other specify _____ 7= Don't know
69. When taken during meals, certain foods help the body absorb and use iron. What are those foods? 1= Vitamin-C-rich foods, e.g. fresh citrus fruits (orange, lemons, etc.) 2=Others specify_____ 3= Don't know	**70.** Some beverages decrease iron absorption when taken with meals. Which ones? 1= Coffee 2= Tea 3= Other 4= Don't know Number of correct responses _____

Food-intake practices		
71. Yesterday, during the day and night, did your baby eat any of the following? (*Read the list of iron-rich foods and tick either yes or no for each food item*)	**1=Yes**	**2=No**
a. Organ meat (e.g. liver, kidney& heart)		
b. Flesh meat (e.g. beef, pork, lamb, goat, rabbit, dog, chicken, duck)		
c. Insects (e.g. Insect larvae, red ants, grasshoppers, crickets		

d. Fish (Fresh fish, dried fish, canned fish)		

72. Do you usually give your baby to eat some fresh citrus fruits, such as mango, papaya, water melon or drink juice made from them? 1= Yes 2= No 3=Don't know	***72a. If Yes:*** Every day? 1= Yes 2= No 3- Don't know/no answer

73. When do you usually serve your baby to eat fresh citrus fruits? (*Read the following options to the respondent*)
1= Before a meal
2= During the meal
3= After a meal
4= Other (*specify*) _____
5= Don't know/no answer

74. Do you usually serve your baby a drink of coffee or tea? 1=Yes 2= No 3= Don't know	***74a. If Yes:*** Every day? 1= Yes 2= No 3= Don't know

75. When do you usually give coffee or tea to your child to drink? (*Read the following options to the respondent*)
1= Two hours or more before a meal
2= Right before a meal
3= During the meal
4= Right after a meal 5= Two hours or more after a meal 6= Other(*specify*)
_____ 7= Don't know/no answer

Personal hygiene

Practice

76. Could you please describe **step by step** how you usually wash your hands?
1= Washes hands in a bowl of water (sharing with other people)
2= With someone pouring a little clean water from a jug onto one's hands
3= Under running water
4= Washes hands with soap or ashes
5= Other_____
6= Don't know/no answer

Knowledge

77. Food poisoning often results from contact with germs from faeces. What can you do to avoid sickness from germs from human or animal faeces?
1= Wash hands (after going to the toilet and cleaning the baby's bottom)
2= Remove faeces from the home and surroundings
3= Other_____

4= Don't know

78. There are key moments when you need to wash your hands to prevent germs from reaching food. What are these key moments?
1= After going to the toilet/latrine
2= After cleaning the baby's bottom/changing a baby's nappy
3= Before preparing/handling food
4= Before feeding a child/eating
5= After handling raw food
6= After handling garbage
7= Other_____
8= Don't know

Water and sanitation

Practice

79. What is the main source of water used by your household for drinking, cooking and hand washing? 1= Piped water 2= Piped into dwelling 3= Piped into yard or plot 4= Public tap/standpipe 5= Borehole/tube well 6= Dug well 7= Protected well 8= Unprotected well 9= Water from spring 10= Protected spring 11= Unprotected spring 12= Rainwater collection 13= Tanker-truck 14= Cart with small tank/drum 15= Surface water (river, stream, dam, lake, pond, canal, channel) 16= Bottled water 17= Other (specify) _____ 18= Don't know	**80a**. Do you collect water for domestic use? 1= Yes.....Go to *question 96b*. 2= No..... Go to *question 97* **80b.** What item/container do you use to collect water? 1= Clay pot 2= Saucepan 3= Jerry can 4= Metallic pot/can 5= Others specify ***80c***. Did you treat the item/container in any way to make it clean? 1= Yes 2= No 3= don't know ***80d. If Yes:*** How? 1= Use of water and soap (clean container) 2= Other 3= Don't know/no answer
82. Could you describe how you store water? 1= Clean container or jar 2= Covered container or jar 3= Clean and covered container or jar 4= Other_____ 5= Don't know/no answer	**82.** Do you treat your water in any way to make it safe to drink? 1= Yes 2= No 3= Don't know/no answer

82a. If Yes: What do you usually do to the water to make it safer to drink?
1= Boil it
2= Add bleach/chlorine
3= Strain it through a cloth
4= Use a water filter (ceramic, sand, composite)
5= Use solar disinfection
6= Let it stand and settle
7= Other specify_____
8= Don't know/no answer

Knowledge

83. If you know that the water you are going to use for cooking or drinking is not safe or does not come from a safe source, what should you do?
1= Boil it
2= Add bleach/chlorine
3= Strain it through a cloth
4= Use a water filter (ceramic, sand, composite, etc.)
5= Use solar disinfection
6= Let it stand and settle
7= Discard it and get water from a safe source
8= Other
9= Don't know

THANK YOU FOR YOUR RESPONSES

Lugubrati questionnaire version

Research Project Title:
Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

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OATAA-ELI PIE, E'YO AKUA 'DIYI PIE, E'YO I BIPI ANGU MINI OAZU RI PIE 'DIYI, MI E'YO ONIZA/VAZA, EGATAA AZINI 'YETAA NYAKA FEZANI ANZI NYIRI AZINI ANZI NYIRIA (IYC) MBABE 6 CAZU 18 RUA ALUPI TUKU (MAM) 'DIYI MA ESELEA

Ozitaa 'dima ovu lu aku alu ma alia alu adule. Ayia kaovu aku aluma alea alu ma drilea, mipe lu ayia azini alu kalulusi zitaa omvizu i vile aku azini mva 'dari ma dria. Mi tra ogbo omvitaa erini fele 'diyi ma ageyia ekile ecopi rarile. ***Sawa:*** *E'dozu ri _____Dezu ri_____*

Mba o'du ozitaa 'diniri: _____/_____/_____ *(O'du/Mba/Eli)*	**Agu ozitaa ozi piri maru:**	**Jo-ago:**

	Enyati:	**Namba zitaa ni:**
Agu zitaa omvi piri/Mva maru:	**Aro jo ma esele:**	**Arojo ma ru:**
ESELE 1: E'YO ONIZA AKU ALU ALU MA ALIA MVA AZINI AYIA MA DRIA RI.		
1. Aku drile ma ruworori _____ **2.** Aku drile ma eli _____ **3.** Aku drile asi onitaa be ngopi: 1= La sukulu ku 2= La sukulu–P1-P7 3= La sukulu-S1-S6 4= La sukulu sinia ma drilea **4.** Ayia ma ru worori: _____	**5.** Ayia ma eli _____ **6.** Ayia asi onita be ngopi: 1= La sukulu ku 2= La sukulu–P1-P7 3= La sukulu-S1-S6 4= La sukulu sinia ma drilea **7**. Mva nderi ma ru worori _____ **8.** Mva 'di agupiamvani kani zamva ni? 1=Agupi 2=Oku _____	**9**a. Mva ma eli (mba siri i) Mba_____ 9b. Mva ma o'du osizu ri: 10. Ayia ma simu namba **11.** Simu namba (**10)** 'dika ovu ayia niku mife e'yii ma ru: **12a.** Mva ma kilo osizuri ciya? (I ne kaadi ma dria) |__|.|__|kg
13. Mva nderi ma ayia ni aku drile ma a'dini?: 1= Eri aku drileru ni 2= Aku drile ma okuni i 3= Aku drile ma zamva 4=Azini, ka ecorasi mi ece gba_____		**14**. Ayia nderi ma anzi si ya? |__|__|
15. Anzi nyiri ma kalafe jo 'dima alea ri 15a. Mba 24 ma vutia: _____ 15b. Mba 59 ma vutia _____	**16.** Mi oa mva nderi (runiri) ma atii beya? 1= Ee 2=Yo	**17.** Mva 'dima nyaka o'du driari adini? 1=Ba ndruza a'dule 2= Ba ndruza azini nyaka azi 'diyi pie 3= Ba ndruza ndeni aga nyaka azi 'diyi ra
18. 'Ba si yi (mva nderi ma kalasi) la aku 'dia edozu ini susi muzu drile sabiti alu ma alia niya? 1= Alu cazu iri 2=Na 3= Su 4= Towi 5= Azia 6= Aziri kaniku drilenia	19. Ayia ni agupia ya 1=Agupia, okuru aluni; 2=Agupia, oku tree pie 3=Yilu oa agupi be tualu 4=a'dule 5=awuzi ni 6=Ere yi agupi bera 7=Yi oa ndundu	20. Jo mva nderi ni oazuri ma abi a'disi ya? 1= Pati azini odri 2= Biriki eveza kaniku evele kuri 3= Buloki concrete 4= Pati 5= Ase/odra 6= Azini mi ece mgba----------

21. Jo mva nderi ni oazuri ma dri ‘baa a’disi ya? 1= Ase kaniku ebikobi tile tiri 2= Bati 3= Tegula 4= Pati 6= Azini mi ece----------	22. Jo mva nderi ni oazuri ma ale ‘baa ’disi ya? 1= Pati azini odri 2= Biriki eveza kaniku evele kuri 3= Buloki concrete 4= Pati 5= Ase/odra 6= Azini mi ece ----------	23. Jo mva nderi ni oazu ‘dima rumu siya? 1= Alu 2= Iri 3= Na 4= Su kaniku su ma drilea
24. Aku mivile ria ‘ba enya a’di tutuni adisiya? 1= Ejasi 2= Makaa si 3= Gaasi kaniku biogas 4= Elekitriziti si 5= Tala odusi 6. Azini mi ece Mi opko sende ‘dima ayutaa ma dria ciya? **1= Ee 2= Yo**	25. Aku mivile ria ‘ba tutuni a’di ayu angu ‘yizu i ya? 1= Elekitriziti 2= Sola 3= Gaasi 4= Tala odu (tala) 5= Tala odu (talaa) 6. Eja drole tualu ri	26. Aku mivile ria yi epiza ri ciya 1= Ee 2= Yo **27**. Aku mivile ria aci elekitriziti ruri ciya? 1= Ee Yo

28. Coroni ayule aku ‘dima alea sawa woro siri ngoleri i ya? 1= Coroni yo/jere/amvu 2=Coroni gale gari i 3= Coroni gale pepu oli vileri suzu cirri i 4= Coroni yi esezu ese ri i 5= Coroni o’bini ayule indiri i	**29.** Coroni mivile akua ria pari/afa dri ojizuri ogogoa ciya?	1= Yi yo, sabuni yo 2= Yi ci te sabuni yo 3= Sabuni ci te yi yo 4= Yi azini sabuni ci 5= Coroni akua yo

SECTION 2: ENVOROMETAL HEALTH INFORMATION OF IYC DIAGNOSED WITH MAM	
30a. Mi olu azo mivile mva bipi sabiti asizu 2 ‘dima alea diyi (Interviewer: Circle all that apply)	1 = Rua driza (rua driza) 2 = Malaria (Dakitari ma sini) 3 = Ngulua 4 = Sutaa/aditaa 5 = Ava ‘yaza mbelembeleri/ekele /agati azo 6 = Enyiriko azo azini /rua droza (e.g. mike rua droza napi siri amve) 7 = Mile azo 8 = Omvu azoru 9 = Nyaka ni cazu kuri ma azo 10 = Azo yo 11 = Azini (mi ece)
30b. Mva nderi **30a** ka ndra ovu azoru, oja ndra geriko mini eridri nyaka fezuri raya?	1= Ee 2= Yo
30c. Omvitaa **30b** vileri ka adri **EE**, mi ’ye	1= Mafe ba ndruza enyia enyia

ndra a'dini/ngoni?	2= Nyaka ma ogmbo edri i ra 3= Mafe ba ndruza enyia enyia ku 4= Nyaka ma ogmbo omvi i ra 5= Mafe afa mvuza lu i adule (e.g. pati efi su, e'di etc)
31. Mva aku 'diani ka ovu azoru mi eri ji okoni aro isu ngua ya?	1= VHT 2= Dukani aro ozizu ria kaniku kilinikia 3= Ojoo nyakuni rivu 4= Jo ejele vu 5= Ori'ba vu 6= Aro joa 7= Pari azini Mi si vaa _____
32. A'dini tutuni nyaka ope azini edee mva nderi dri niya?	1= Ma agupini/Mva atii I 2= Ma edrii i/Dii i 3= Ayia, ma i 4= Ori'ba ni ecetaa si ma a'wuu i 5= Azini mi ece _____
33a. Mva nderi 'ba si eri otitaa nyaka nyaza awazu cini ma alea raya?	1= Nyaka 'duzu arojoa engazu akuasi (OTP e.g. Plumpy'nut) 2= Ovuzu pi arojoa ka nyaka isuzu ndo (ITPe.g. F100) 3= Kaka osazaru soya be 4=Aluni yo 5= Azini mi ece
33b. Mva nderi ko aje o'du neti aro osasaa o'dipi oapi rua nia ewu ezuu (LLIN) / rima alea ya?	1= Ee 2= Yo

34. Mva nderi 'ba ji eri BCG immunization-ia raya? ('Ba eri fee osiria ta mbaza TB nisi **wu dri adaaria oruleru**)	
35. Mva nderi 'ba ji eri DPT-HepB+HiB 3 imunayizesonia raya? ('Ba eri fee sabiti 10 zurisi mvani osizu 'bori ma vutia tambaza azo Dipiteria/ tetenasi/ekele 'ba osepiose risi/ hepatitis B/ Haemophilus influenza nisi **od'u pa ejiria oruleru**)	1=Ee 2=Yo
36. Mva nderi 'ba ji eri sozu ngulua si raya? *(Mi ece kini eri lu anzi elibe mba 9 ma drilea 'diyini a'dule) ('Ba eri fee mba 9 zurisi mvani osizu 'bori ma vutia tambaza ngulua nisi **wu dri ejiaria oruleru**)*	1=Ee 2=Yo
37. Mba asizu 6 'diyi ma alea, mva nderi isu Vitamin A o'bazaru driniari raya?	1=Ee 2=Yo
38. Mba asizu 6 'diyi ma alea, mva nderi isu **aro o'bu vileri efifi/susu ruri raya?** ('Ba e'yo ozipiri: Mizi anzi e'dozu mba 12 si azini 'dima drilea 'diyini)	1=Ee 2=Yo

39. Mva nderi ma nziza kilosi: |__||__|.|__|kg |__||__|.|__|kg |__||__|.|__|kg (AV)	**40**. Mva nderi ma MUAC: |__||__|.|__|cm |__||__|.|__|cm |__||__|.|__|cm (AV)
41. M va nderi ma zotaa**:** |__||__|.|__|cm |__||__|.|__|cm |__||__|.|__|cm (Av)	41a. z-scores WFA_____ WFH_____
42. Mva nderi vu Oedema ciya?	1= Ee 2= Yo
43. Mva nderi ma arima ogmbo/ haemoglobin	|__||__|.|__|g/dl

SECTION 3: KNOWLEDGE, ATTITUDES & PRACTICESS REGARDING IYC COMPLEMENTARY FEEDING

Ask mothers with children between 6 to 18 months of age. [in case of two children, randomly select the index child]

44. Mva (ru) nderi ni curu'do kiri ba ndru indi ya?	1= Eee 2= Yo
45. Mini nilerisi mva nderi sawa worosi apira ba ndruza ma vutia ria ya?	1= Eee 2= Yo
46. Mva (ru) nderi ndru ba kaniku fee eridri basu aje etusi kaniku inisi raya?	1= Eee 2= Yo
47. Mi fe aje mva (ru) nderini ba paleko siya (etusi azini in asizu risi)?	**P**aleko _____
48. E'dozu aje (etu ma alea kaniku ini ma alea) mife mva (ru) nderi ni afa azini ndu nyazaru kaniku mvuzaru ba ma paria i raya?	1= Eee 2= Yo

49. Omvita **48** ka ovu EE, afa mvuza (ekile yi le, pati ola ma su, kaniku nyaka sirapu ru) ngo ma eselea 'ba ebi fe mva (ru) nderi ni aje i(etusi kani ku inisi) azini paleko siya?

a. Yi	1=Ee 2=Yo	Ka adri ee pale si? _____
b. Yi 'bani omvele guripi wota ruri	1=Ee 2=Yo	Ka adri ee pale si? _____

c. Pati ola ma su	1=Ee 2=Yo Ka adri ee pale si? _____
d. Sukari osale yi ma alea ri	1=Ee 2=Yo Ka adri ee pale si? _____
e. Ti lesu	1=Ee 2=Yo Ka adri ee pale si? _____
f. Lesu azini 'bani zozo ndundu ri	1=Ee 2=Yo Ka adri ee pale si? _____
g. Lesu fura bani osale osa ri	1=Ee 2=Yo Ka adri ee pale si? _____
h. Pati efi ma su	1=Ee 2=Yo Ka adri ee pale si? _____
i. Majani cai/kawa	1=Ee 2=Yo Ka adri ee pale si? _____
j. Azini nduni (mi ece)_____	1=Ee 2=Yo Ka adri ee pale si? _____
50. Mva nderi nya aje etusi azini ini asizuri ma alea (nyaka) enya olungu, enya ore, kaniku nyaka menemene (ovupi yi ru kuni) paleko siya? E'di eri alenia indi.	_____paleko (nyaka azini afa nyaza)
51. Mva ka nyaka nya paleko iri (2) kaniku iri ma vutia zitaa **50** ma alea**,** a'di e'yo siya?	1= Nyaka mvani fezaru yo 2= Mva ndru ba angiri 3= Ayia ma dria azi amba mba 4= Nyaka nderi ca mvani ra 5= E'yo azini (mi ece)
52. Mva nderi dri mi nyaka ndu i sini ede kaniku je raya?	1= Ee 2= Yo
53. Nyaka 'bani fele mva nderi (ru) dri aje (etusi kaniku ini asizu risi) ri nyaka erini nyale o'du driari i ya?	1=Ee 2=Yo 3= Aniku
54. Omvitaa zitaa 53 vileri ka andri YO, 'ba fe nyaka nde ndu 'dari mva nderi dri (ru) aje (etusi kaniku ini asizu risi) i a'di e'yo siya?	1=Mva nderi aje azoru 2=Ayia ni aje yo 3= Mva nderi aje omua 4= Azini (mi ece)

55. Nyaka ngole ‘diyi mi fe mva (ru) nderi ni i e’dozu aje (etu ma alea azini ini asizu rima alea) ya? *(mi omvi e’yo andraleru ‘diyi dria: Interviewer read to the respondent)*

Groups	Food Items	Responses	
Group 1: Grains, roots, plantain & tubers	E’di, mukati, mucele, anya, kaka, nyaka azini ‘bani edele nyaka efi si	1=Yes	2=No
	Abua (‘bani a’di a’diri), a’bua mbeza (Gonja, Bogoya, memvua)	1=Yes	2=No
	Mundu maku, maku ale be emve ri, mayuni, olaa, kaniku nyaka azi pati olaruni	1=Yes	2=No
Group 2: Legumes and nuts	Nyaka ci ‘bani edele engazu kayiko, osu, funyo kaniku ori siri	1=Yes	2=No
Group 3: Dairy products	Lesu anz nyirini ekile NANI le	1=Yes	2=No
	Lesu ekile fufura kaniku ezole anyapa ma baa o’diruni	1=Yes	2=No
	Yogati azini lesu kuza mvule mvuri	1=Yes	2=No
	Ciizi, yogati, kaniku nyaka ci engapi lesu vuri	1=Yes	2=No
Group 4: Fresh Foods	Za, kile ti za, ngurube za, kabilo za, ndri za, au, kaniku mbata	1=Yes	2=No
	Ogu, orofi, furufuru, culu, kaniku fi	1=Yes	2=No
	E’bi ebi, e’bi funyiru kaniku ebi	1=Yes	2=No
	Ese, onya, ejiriko, ozi, kaniku osasaa ndundu azini	1=Yes	2=No
Group 5: Eggs	Gbe	1=Yes	2=No
Group 6: Vitamin A fruits and vegetables	Ago, karoti, maku alebe orenzi agoleri i	1=Yes	2=No
	Tibi ini iribi ruri (Nakati, Jiribi, Dodo, jobio, Osubi, Nyirikia)	1=Yes	2=No
	Meengu kaza, paipai kaza, wota meloni, kaniku pati efi ci vitamini A be angiri ni	1=Yes	2=No
	Nyaka edele mbela odusi, mbela efi si kaniku tibi	1=Yes	2=No
Group 7: Other fruits & vegetables	Pati efi azi nduni kaniku ebikobi ru ecetaa si kabeji le	1=Yes	2=No
Others (not counted in the dietary diversity score)	Odu azi ciri, oso, kaniku bata, magarini (blue band) kaniku nyaka edele odu ‘diyi siri	1=Yes	2=No
	Nyaka ci sukari be alea ekile pipi, keki, bisikoti, kaniku sukari cai/kawa ma alea ri	1=Yes	2=No
	Afa nyaka ma azanga bapi arikari, piripri, mbasala, binzari	1=Yes	2=No

56. ‘Bani ‘yolerisi lete adani oku ma fe ba i ma mva dri sawa ngopi ya?	1= Mba azia kaniku vuti nia 2= mba 6 – 11 3= Mba 12 – 23 4= Mba 24 kaniku drile nia 5= Azini 6= Aniku
57. Mva nderi (ru) ma eli mbasiri ca dere siya mini e’dozu eridri nyaka azi yi ru kaniku ore ru kaniku olungu runi fezu okorisi ba ndruza ma dria ria? |__|__|months	**57b.** Nyaka yi ru kaniku ore ru kaniku olungu ru mini feleri ngo i ya?
58. A’di e’yo fe mini e’dozu mva nderi (ru) dri nyaka azi yi ru kaniku ore ru kaniku olungu runi fezu ni ya? *(Do not read the responses. Allow the mother to answer, and then fill each item.)*	1= E’do ninga nyaka fezu ku 2= Basu cani ku/lesu okpo yo 3= Mvani owu sawa worosi 4= Mvani avii tu/ eri dri ejuu nyaka vu 5= Sawa cani ba fezu mva dri /ayia azia ‘diyi ku 6= ‘Ba ‘yo ma ma ‘ye ‘dile 7= E’yo a’biari/a’bi e.g ayia ni okporovuru 8= Mva ma mba aga 6 ni’bo 9= Ba ti azoazo/ayia ni ndra azoru
59. Eri okporu ‘bani nyaka fezu ba ndruza ma dria anzi e’dozu mba aziasi ‘diyi dri ci a’di e’yo siya?	1= Breast milk alone is not sufficient/enough from six months 2= Baby needs more food in addition to breast from six months 3= Others specify 4= Don’t know
60. E’di kuza piyi yiru ribe ria, mini egalerisi lete ‘bama fe anzi nyiri dri ngoleri i ya?	1 = Thick (semi-solid) porridge 2 = Light (watery) porridge 3 = Don’t know
61. Mva nderi ka afa yi ru kaniku kuza ru ovupi basu niku ‘dileri isu i, ‘ba afa yi ru kaniku kuza ru fee mva nderi dri ngoni ngoniru ya?	1= Cupa afa nyaza fezurisi 2= Kopo 3= Malaga/Kijiko 4= Drisi 5= Azini mi ece runi_____
62. ‘Ba eco nyaka kaniku nyaka esele ngoleri ‘baa mva vile e’di ma alia I ya erini ecazu ani nyaka kilili rutu? 1= Animal source food 2= Legumes and nuts (e.g. ground nuts, peas, beans, soybean, peanuts, sunflower seeds 3= Vitamin-A-rich fruits and vegetables (carrots, oranges-fresh sweated potato, yellow pumpkin, mongo, papaya…) 4= Green leafy vegetables (e.g. Nakati, Gobbe, Dodo, Gyobyo, Osubi, Nyirikia) 5= Energy rich food (e.g. oil, butter/ghee)	

5= Others 6= Don't know	
63. Mi ni e'yo geriko ci anzi nyiri dri ava fezu nyaka nyazu ri ma dria raya? 1= Mini oazu yibe sawa nyaka vilerisi, o'yozu yi pie, sawa afa nyaza vileri 'bazu sawa ayikoni 2= Dri saza 3= Andrati 'bazu ndu/avizu/oguzu 4= E'dazu yini mini mi tile zizu amboru risi/ ecezu yini 'ba afa nya ngoni yaari 5= E'yo ava fepi 'dileri o'yozu 6= mi ese anzi ma endri mivu 7= Azini 8= Aniku	
IRON DEFICIENCY ANAEMIA AMONG IYC 6 to 18 MONTHS of AGE	
Knowledge	
64. Mi eri oku e'yo aya ni cazu ruaku anemia ma dria raya? 1=Yes 2= No 3=Don't know/no answer	**64a. Ka adri Ee**: Mi eco ece mani 'ba anemia beri ni e'daa ngole yaari raya? 1= Less energy/weakness 2= Paleness/pallor 3= Spoon nails/bent nails (koilonychia) 4= More likely to become sick (less immunity to infections) 5= Other 6= Don't know
65. E'yo ayani ovuzu nyaka ma alia yori anzi nyiri ma rua a'di e'yo ejiya kala alataa ruarisi ya? 1= Delay of mental and physical development 2= Other_____ 3= Don't know	**65a.** A'di ni fee 'ba azini ovuzu anemia niya? 1= Lack of iron in the diet/eat too little, not much 2= Sickness/infection (malaria, hookworm infection, HIV/AIDS) 3= Heavy bleeding during menstruation 4= Other_____ 5= Don't know
66. Mi eco nyaka ayani ovuzu alenia angiri 'diyi ma ecetaa olaa raya? 1= Organ meat (Liver, kidney, heart) 2= Flesh meat (Beef, pork, lamb, goat, rabbit, dog, chicken, and duck) 3= Insects (Insect larvae, red ants, grasshoppers, crickets) 4= Fish(Fresh fish, dried fish, canned fish) 5= Other_____	**67**. 'Ba eco anemia atrii ngoni ngoni ya? 1= Eat/feed iron-rich foods/having a diet rich in iron 2= Eat/give vitamin-C-rich foods during or right after meals 3= Take/give iron supplements if prescribed 4= Treat other causes of anaemia (diseases & infections) – seek health-care 5= Continue breastfeeding (for infants 6–23 months old) 6= Other specify _____ 7= Don't know
68. 'Ba ka nya sawa enya nyazuria, nyaka else azini yi rua ma azako aya enzuzu azini aya ayuzu. Nyaka nde 'dayi ngoyi yaa? 1= Vitamin-C-rich foods, e.g. fresh citrus	**69.** Afa mvuza azi 'diyi aya ma nzuza omvi ele 'ba ka yi mvu sawa enya nyazu ria. Afa mvuza 'diyi ngoyi yaa? 1= Coffee 2= Tea

fruits (orange, lemons, etc.) 2=Others specify_____ 3= Don't know	3= Other 4= Don't know
Food-intake practices	
70. Aje etusi azini inisi, mva mivileri nya nyaka andraleru 'diyi raya? (*Read the list of iron-rich foods and tick either yes or no for each food item*)	1= Yes 2= No
a. Za trunya (ecetaa si ogu, orofi & culu)	1= Yes 2= No
b. Za kalanya (ecetaa si tiza, ngurugbe za, kabilo za, ndri, etoo, ocoo, au, mbata)	1= Yes 2= No
c. Osasaa (ecetaa si osasaa ma mundra, yakiya, ese, kulu, etirili)	1= Yes 2= No
d. E'bi (e'bi ebi, e'bi a'wi, e'bi kopoari)	1= Yes 2= No
71. Mi oku mivile mvadri fe pati efi ekile meengu, payipayi, wota meloni, kaniku fee pati efi su edele afa nde 'diyivuri mvura yaa? 1= Yes 2= No 3=Don't know	**71a**. Ka adri Ee: O'du dria ya? 1= Yes 2= No 3=Don't know
72. Mi oku mivile mvadri fee pati efi payipayi pile 'diyi nya sawa ngole rima alia ya? (*Read the following options to the respondent*) 1= Denga nyani enya ku 2= Sawa enya nyazu risi 3= Enya vutia 4= Azini (mi ece)_____ 5= Niku/omvitaa yo	
73. Mi oku mva mivileri dri afa mvuza ekile kawa kaniku majani cai fee raya? 1=Yes 2= No 3= Don't know	**73a. Ka adri Ee: O**'du dria ya? 1= Yes 2= No 3= Don't know
74. Mi oku mivile mvadri fee kawa kaniku cai mvu sawa ngoleri ma alia ya? (*Read the following options to the respondent*) 1= Sawa iri kaniku iri ma drilia denga nyani enya ku 2= Indikindi denga nyani enya ku 3= Enya nyaria 4= Indikindi enya vutia 5= Sawa iri kaniku iri ma drilia enya vutia 6= Azini (mi ece) _____ 7= Niku/omvitaa yo	
Personal hygiene	

Practice

75. Ka ecorasi mi ece mani mi oku mi dri oji ngoni yaari **'yeza alu alu si**
1= Washes hands in a bowl of water (sharing with other people)
2= With someone pouring a little clean water from a jug onto one's hands
3= Under running water
4= Washes hands with soap or ashes
5= Other_____
6= Don't know/no answer

Knowledge

76. Nyaka enyataaru ri ni ecaa isude o'bu zema alia 'diyi eci yi nyaka bera**.** Mi eco a'di 'ye i ka mini ecozu azo engapi o'bu 'ba ada kaniku anyapa ma ze vusiri atrizu yaa?
1= Wash hands (after going to the toilet and cleaning the baby's bottom)
2= Remove faeces from the home and surroundings
3= Other_____
4= Don't know

77. Sawa azini yici eri lee mima oji midri kilili ecozu o'bu yi atrizu cazu nyaka vu. Sawa 'diyi sawa ngole 'diyi yaa?
1= After going to the toilet/latrine
2= After cleaning the baby's bottom/changing a baby's nappy
3= Before preparing/handling food
4= Before feeding a child/eating
5= After handling raw food
6= After handling garbage
7= Other_____
8= Don't know

Water quality

Practice

78. Yi 'bani ayule mivile akua mvuzaru, enya 'yizu azini dri ojizuri tutuni yi ngoleri/engazu ngoari i ya?
1= Piped water
2= Piped into dwelling
3= Piped into yard or plot
4= Public tap/standpipe
5= Borehole/tube well
6= Dug well
7= Protected well
8= Unprotected well
9= Water from spring

79a. Mi yi oko/ebee ayuzaru akua raya?
1= Yes.....Go to *question 96b.*
2= No..... Go to *question 97*

79b. Mi afaju ngolri ayu yi okozu/ebezu i ya?
1= Clay pot
2= Saucepan
3= Jerry can
4= Metallic pot/can
5= Others specify
79c. Mi 'ba/oji afazu nderi (96b) geriko cini si

10= Protected spring 11= Unprotected spring 12= Rainwater collection 13= Tanker-truck 14= Cart with small tank/drum 15= Surface water (river, stream, dam, lake, pond, canal, channel) 16= Bottled water 17= Other (specify) _____ 18= Don't know oleri/engazu ngoari i ya?	**erini ecazu alaru raya?** 1= Yes 2= No 3= don't know **79d. Ka adri Ee: Ngoni ngoni ruya?** 1= Use of water and soap (clean container) 2= Other 3= Don't know/no answer
80. Mi eco ece mi yima ta mba ngoni ngoniru yaari raya? 1= Clean container or jar 2= Covered container or jar 3= Clean and covered container or jar 4= Other_____ 5= Don't know/no answer	**81. Mi yi 'baa geriko cini si erini ecazu alaru mvuzaru raya?** 1= Yes 2= No 3= Don't know/no answer
82a. Ka adri Ee: **Mi oku yi 'ye a'diru erini ecazu alaru mvuzaru yaa?** 1= Boil it 2= Add bleach/chlorine 3= Strain it through a cloth 4= Use a water filter (ceramic, sand, composite) 5= Use solar disinfection 6= Let it stand and settle 7= Other specify_____ 8= Don't know/no answer	
Knowledge	
83. Mika nira kini yi mini mu ayule nyaka 'yizu kaniku mvuza ruri ovuni alaru ku kaniku engani pari alaru rima alia ku, le mima 'ye a'dini ya? 1= Boil it 2= Add bleach/chlorine 3= Strain it through a cloth 4= Use a water filter (ceramic, sand, composite, etc.) 5= Use solar disinfection 6= Let it stand and settle 7= Discard it and get water from a safe source 8= Other 9= Don't know	

THANK YOU FOR YOUR RESPONSES

Appendix E Food security assessment questionnaire

Adult Food Security Survey questions .Yes =1; No = 0	
1 In the last one month, did you worry food would run out before you got money to buy more?	
2 In the last one month, food that you bought did not last?	
3 Was there any money to get more food?	
4 In the last one month, you could not afford to eat balanced meals?	
5 In the last one month did you ever cut the size of meals consumed?	
6 If yes to question 3.5; why a) there was not enough food; b) there was no money to buy food; c)others, please specify	
7 In the last one month did you skip meals?	
8 If yes to question 3.7; why? a) there was not enough food; b) there was no money to buy food; c) others, please specify	
9 In the last one month did you ever eat less than you felt you should because there was no food?	
10 In the last one month were you ever hungry but did not eat because there was no food?	
11 In the last one month did you ever not eat for the whole day because there was no food?	
12 In the last one month did you lose weight because you did not eat enough food?	

Appendix F: Malted sorghum based porridge sensory evaluation form

English version

Research Project Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

Date: ……..... Time: ……

You are requested to make sensory evaluation of the porridge samples as presented to you. You are requested to evaluate their general acceptability basing on the parameters shown below. Please grade the samples on the scale of 1 to 9 by placing your score in the box next to the sensory parameter under each sample in the table.

Rinse your mouth with water provided before tasting, re-tasting and in between products, then evaluate the porridge samples in front of you.

Score the porridge samples using hedonic scale below	
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

Quality attributes	**Porridge Samples Codes**					
	……...	**…….**	**…….**	**…….**	**…….**	**……..**
Appearance						
Colour						
Flavor						
Taste						
Thickness						
Consistency						
Mouth feel						
Sweetness						
Acceptability						

Which porridge sample (s) would you buy for household use and why?

.....

Comments:

.....……

Thank you for participating in this exercise

Lugubrati version

Kokobi E'di Edele Ondu E'dopi Engapi Rakaka Risiri 'Bizu Ri

Research Project Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

Mba o'du: …… **Sawa: ……**

'Ba aimi ecozu e'di 'diyi ma esele 'bizu ekile 'bani fele mini rile. 'Ba aimi 'bizu e'yo nizu letaani worori ma dria ekile e'dale andraleru 'dile. Ka ecorasi mi 'ba esele 'diyi ratili ma dria e'dozu 1 cazu 9 mini pezu bokisi afa 'bileri a'dini yaari ma alia esele alualusi.

Mi o'ya mima ti yi fele mini risi denga mi 'bini ku, mika 'bii-dikaria, azini e'di ndundu

yima eselia ria, vutinia mi ‘badi esele mi drilia diyi ratili ma dria.

Mi o’bi e’di ‘diyi ma esele kalafe ratili le andraleru ‘diyisi	
Le saaru tu	9
Le saaru	8
Le agavusi	7
Le were	6
Kani lera kaniku leniku	5
Leniku were	4
Leniku agavusi	3
Leni ku agara	2
Leniku tua ‘dasi ‘dale	1

Quality attributes	**E’di ma esele Codes**					
	……...	**…….**	**…….**	**…….**	**……**	**……..**
E’dataani						
Wurani						
Alutaani						
‘Bitaani						
Kutaani						
Olitaani						
Enikini ni tiari						
Kalikalini						
Letaaniri						

E’di ‘diyi ma eselia mini eco jele ayuzaru mivile akuari ngo I ya azini a’di e’yosi ya?

……

E’yo o’baza: .....**.....**

.....

Awa’difoo mini ovuzu e’yo ‘dima alia indirisi

Appendix G: Anthropometric and morbidity data collection form for IYC

English version

Date of visit	**Child identification number**	**Address**
Name of child	Age (months)	Gender
Weight (kg)	Length (cm)	Z-score
Anemia (HB)	MUAC (cm)	Oedema
Diagnosis	Porridge appetite	HIV (VCT)
Has the index child suffered from any of the following disease in the last two weeks		
Disease	**Yes**	**No**
Malaria		
Diarrhea		
Respiratory Infection		
Skin Infection		
Has the index child been given any of the following treatment during supplementation		
Drug/supplement	**Yes**	**No**
Anti_Malarial		
Vitamin A		
Mebalbenda		
Amoxyline		
Folic Acid		

Appendix H: Focus group discussion guide of mothers of IYC with MAM

English version

Research Project Title:

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

Instructions

Date: _____

District: _____

Sub Country: _____

Parish: _____

Village: _____

Discussion Place: _____

Introduction:

The purpose of this meeting is to evaluate the supplementation feeding intervention you participated in. There is no wrong or wrong answer. We are interested in knowing and understanding the experience you had with this supplementation feeding intervention in order to improve their future treatment of children with moderate acute malnutrition (MAM). We will be taking notes during our discussion to help us understand the information that you will be giving us. This discussion is confidential and we will not use any names in the report. Hereby we request that you are audible and speak one at a time so that all your views are understood. We also request you to accept us to use a tape recorder to ensure that your answers are recorded accurately and incase an important issue has not been written; may we use it?

Questions

1. Please tell us about what you do to earn a living?

In your Moderator _____Recorder / Scriber_____

Language(s) _____Time began_____

Time ended _____

Participants:

Type of participant _____Age_____

Other relevant characteristics_____

2. I your opinion as a mother, what weight would you prefer your baby to have, medium or heavy?
3. Looking back, before the baby was started on this porridge supplementation program and now, how do you feel about the baby's weight and health? Probe if the mother thinks there is a relationship between the current weight of their children and the **porridge supplementation.**
4. Looking back, before the baby was started on this porridge supplementation program and now, how do you feel about the baby's weight and health? Probe if the mother thinks there is a relationship between the current weight of *their children and* the **nutrition education**?
5. Based on available foods in your household, what do you think would be the preferred food for your baby to continue gaining weight/growing well? Probe for what mothers think about the prospect of your baby… continue gaining weight after the supplementation program.
6. Looking at the people you interact or deal with (i.e. family members, friends, and colleagues), what did they think about the porridge supplementation feeding intervention? Probe for; socio-cultural acceptance of the porridge supplementation in treatment of malnourished children.
7. What made it easy or what motivated you to follow the porridge supplementation feeding to completion? (Probe meal frequency, child's porridge appetite, porridge cooking time).
8. What difficult did you encounter during the porridge supplementation feeding up to completion?
9. Looking back at your baby's breast feeding practice before the porridge supplementation, share with us your current child feeding practice; (Probe: porridge supplementation to complement breast milk).
10. So in summary you are saying…
11. Thank you for your time; do you have any questions you would like to say?
12. Thank you for your time.

Focus Group discussion interview guide for Mothers of IYC with MAM

Lugubrati version

Research Project Title

Effect of Malted Sorghum-Based Porridge on Nutritional Status of Moderately Malnourished Breastfed Infants and Young Children Aged 6 to 18 Months in Arua, Uganda

Instructions

Date _____District_____

Sub Country _____Parish_____

Village_____Place of Discussion_____

Moderator _____Recorder / Scriber_____

Language(s) _____Time began_____

Time ended _____

Participants:

Type of participant _____Age_____

Other relevant characteristics_____

Introduction

Asisle amani dri fuzuri ecozu e'yo onizu nyaka 'bani ndra fele anzi yidri emini ovuzu alenia indiri nga azi ngoni yaari ma dria. Omvitaa azini 'yozu kini eri onzi 'dileni yo. Ama ovu avabe e'yo onizu azini ovazu e'yo emini isule nyaka 'bani ndra feleri ma dria ecozu otuzu cika ewu drileria anzi nyiri rua alupi tuku (MAM) 'diyi ma azakozu geriko nyaka vurisi. Amani o'yoria, amanga e'yo azini 'diyi osi vaa ngazu ama azakozu e'yo mini ecele amani 'diyi vazu kililiru beni. E'yo o'yoza 'diri siriru, ama ngani 'ba azini maru ayu ripoti siria ku. Ama emi zi o'yozu o'duko kililisi azini o'yozu alu alu amani e'yo eceza emini vazu beni. Ama vini emi zi emini aizu kini ama ma 'du emi o'duko ci nizu kini omvitaa emi vile 'diyi 'ba osi kililiru azini 'ba ka e'yo azini opkoru ni avii sizura 'ba eco ani ayu raya?

Questions

1. Ka ecorasi me ece amani azi mini 'yele sende isuzuri
2. Mima egataa siria ekile ayia le, mi le adanisi mva mivileri ma nziza ma ovute ngole, agavusi kaniku nziza angiri?

3. Mika e'yo ega vile ria, 'bani nga ndra mva dri e'di 'di e'dozu fezu kuria azini curu'do ria, mi ega/ndre mva 'dima nziza azini alata rua niri ngoni? (Probe if the mother thinks there is a relationship between the current weight of *their children and* the **nutrition education**?)
4. Mika e'yo ega vile ria, 'bani nga ndra mva dri e'di 'di e'dozu fezu kuria azini curu'do ria, mi ega/ndre mva 'dima nziza azini alata rua niri ngoni? (Probe if the mother thinks there is a relationship between the current weight of *their children and* the **nutrition education**?)
5. Nyaka mivile ci akua risi ria, mini egalerisi nyaka mini te lele mi mvani ecozu ima nziza/kilo o'bazu drile erini zozu kilili ruri ngo i ya? Probe for what mothers think about the prospect of your baby… continue gaining weight after the supplementation program.
6. Mika 'ba mini e'yo 'yezu yibe tualu kaniku o'yozu yi pie 'diyi 'duria (i.e. 'ba familia 'diyi, agyi azini 'ba trotro mile 'diyi pie), ega e'yo e'di ndra 'bani fele anzi yini okpo fepiri ma dria ngoia? Probe for; socio-cultural acceptance of the porridge supplementation in treatment of malnourished children.
7. Afa fepi ma eca midri ewa kokoru kaniku afa midri ava fepi e'di nderi ma vuti obizu kpere otitaa 'dini deria ri a'dini ya? (Probe meal frequency, child's porridge appetite, porridge cooking time).
8. E'yo mini isule ewaru e'di okpo fepiri feria kpere otitaa nderini deria 'diyi ngoni ya?
9. Mika angu ndre vile geriko mva mivile rini ba ndruzu risi ria denga mi feni e'di opko fepiri kuria, mi ece amani geriko curu'do mini mva dri nyaka fezuri ma dria; (Probe: porridge supplementation to complement breast milk).
10. E'yo 'diri 'bazu aliru ria mi 'yo kini……
11. Awa'difoo mini mi sawa fezu amani risi; mivu zitaa azini mini lele zile ni ciya?
12. Awa'difoo mini mi sawa fezu amani risi

Appendix I: In-depth interview guide for breastfeeding mother of IYC with MAM

English version

Instructions

Date _____District_____

Sub Country _____Parish_____

Village _____Place of Discussion_____

Moderator _____Recorder / Scriber_____

Language(s) _____Time began_____

Time ended _____

Participants:

Type of participant _____Age_____

Other relevant characteristics_____

Introduction:

The purpose of this meeting is to evaluate the supplementation feeding intervention you participated in. There is no wrong or wrong answer. We are interested in knowing and understanding the experience you had with this supplementation feeding intervention in order to improve their future treatment of children with moderate acute malnutrition (MAM). We will be taking notes during our discussion to help us understand the information that you will be giving us. This discussion is confidential and we will not use any names in the report. Hereby we request that you are audible and speak one at a time so that all your views are understood. We also request you to accept us to use a tape recorder to ensure that your answers are recorded accurately and incase an important issue has not been written; may we use it?

Questions

1. Did you prefer this porridge supplementation feeding intervention for your baby?
2. If you baby gained, what did it mean to you? Looking back before and after giving this porridge supplementation to your baby, what did you think was involved when you were recruited for the supplementation feeding?
3. Why did you keep coming to the porridge supplementation feeding? Probe for motivation factors?

4. Looking at the people you deal with (family, friends, and colleagues), what did they think about the porridge supplementation feeding intervention?
5. What made it easy for you to follow the porridge supplementation feeding to completion?
6. What made it difficult for you to follow the supplementation feeding visits to completion?
7. Based on available foods in your household, what do you think would be the preferred food for your baby to continue gaining weight/growing well?
8. Is there anything else you would like to say?
9. Do you have any questions? 10. Thank you for your time.

In-depth Interview guide for breastfeeding mother of IYC with MAM

Lugubrati version

Instructions

Date _____District_____

Sub Country _____Parish_____

Village_____Place of Discussion_____

Moderator _____Recorder / Scriber_____

Language(s) _____Time began_____

Time ended _____

Participants:

Type of participant_____Age_____

Other relevant characteristics_____

Introduction:

Asisle amani dri fuzuri ecozu e'yo onizu nyaka 'bani ndra fele anzi yidri emini ovuzu alenia indiri nga azi ngoni yaari ma dria. Omvitaa azini 'yozu kini eri onzi 'dileni yo. Ama ovu avabe e'yo onizu azini ovazu e'yo emini isule nyaka 'bani ndra feleri ma dria ecozu otuzu cika ewu drileria anzi nyiri rua alupi tuku (MAM) 'diyi ma azakozu geriko nyaka vurisi. Amani o'yoria, amanga e'yo azini 'diyi osi vaa ngazu ama azakozu e'yo mini ecele amani 'diyi vazu kililiru beni. E'yo o'yoza 'diri siriru, ama ngani 'ba azini maru ayu ripoti siria ku. Ama emi zi o'yozu o'duko kililisi azini o'yozu alu alu amani e'yo eceza emini vazu beni. Ama vini emi zi emini

aizu kini ama ma ‘du emi o’duko ci nizu kini omvitaa emi vile ‘diyi ‘ba osi kililiru azini ‘ba ka e’yo azini opkoru ni avii sizura ‘ba eco ani ayu raya?

Questions

1. Mi pe/le ndra e’di okpo fepiri ma otitaa mva mivile rini i ya?
2. Mva mivileri ka rua ejiraa efile mini ngonia ya? Mika angu ndre vile ria oko azini vutinia mini e’di okpo fepiri fezu mivile mva dri ‘borisi, mi ega ndra a’di e’yo eco ovu niya ‘bani mi ofizu otitaa e’di okpo fepiri ma alia ‘boria?
3. Mi e’bi acii otitaa e’di okpo fepiri niria a’di e’yo siya? Probe for motivation factors?
4. Mika ‘ba mini e’yo ‘yezu yibe tualu kaniku o’yozu yi pie ‘diyi ‘duria (i.e. ‘ba familia ‘diyi, agyi azini ‘ba trotro mile ‘diyi pie), ega e’yo e’di ndra ‘bani fele anzi yini okpo fepiri ma dria ngoia? Probe for; socio-cultural acceptance of the porridge supplementation in treatment of malnourished children.
5. Afa fepi ma eca midri ewa kokoru kaniku afa midri ava fepi e’di nderi ma vuti obizu kpere otitaa ‘dini deria ri a’dini ya? (Probe meal frequency, child’s porridge appetite, porridge cooking time).
6. E’yo mini isule ewaru mini emuzu e’di okpo fepiri duria kpere otitaa nderini deria kuri ngoni ya?
7. Nyaka mivile ci akua risi ria, mini egalerisi nyaka mini te lele mi mvani ecozu ima nziza/kilo o’bazu drile erini zozu kilili ruri ngo i ya?
8. E’yo azini mini lele ‘yole ni ciya?
9. Mivu zitaa azini ciya?

Awa’difoo mini mi sawa fezu amani risi.