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REVIEW PAPER

Addressing the use of RUTF in Mitigating Malnutrition among Children: A Narrative Review

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ABSTRACT

The global burden of malnutrition cause increase rate of mortality and proves to be a life-threatening disease among 6-to-59-month children. Severe acute malnutrition is more prevalent and have higher chances of nutrient deficiencies in children than chronic malnutrition that leads towards impaired immune, cognitive and neurological development. Standard indicators like Anthropometric measurements, MUAC and biochemical markers are used to diagnose SAM. This review utilized a narrative approach, synthesizing data from clinical trials, peer-reviewed articles (2000-2024), and national/international nutrition reports were employed in the narrative review. Sources included WHO, UNICEF and Pakistan's National Nutrition Survey. The diagnostic criteria of MUAC assessment that is <11.5cm, 11.5-12.5cm or >12.5cm, helps to indicate the referral to out-patient or in-patient. Findings indicate that effectiveness of RUTF was evaluated in reducing SAM, enhancing recovery time and decreasing the incidence of repeat incidents , with success varying from 70 to 90% depending on the level of adherence and context. RUTF can be employed to address SAM in children in community settings for short-term prevention. To maximize impact, RUTF programs should be incorporated with local food-based, and sustainable nutrition policies is necessary to address the broader impact of malnutrition in Pakistan. Active engagement of families, health care workers and provision of budget to low socio-economic community from National and Provisional level would enhance the diagnosis, treatment, prevalence rate and intervention of malnutrition.

KEYWORDS Severe Acute Malnutrition (SAM), Ready-To-Use Therapeutic Food (RUTF), CMAM

Introduction

Malnutrition is one of the leading causes of child morbidity and mortality worldwide. Children growth and development are strongly influenced by Nutrition and Health status, due to the combined effect of disease . According to WHO database, 19 million children under age 5 are suffering from SAM, making a mortality rate of 400,000/year. Usually, 20% SAM is complicated and 20% is uncomplicated. From 2017 to 2021, usage of RUTF flourished speedily on average of 50,000 tons treating 4.6 million children, yearly. With global funding, UNICEF received US200$ million and treated 9.3 million children with severe wasting. Several factors cause morbidity and mortality which includes lack of maternal education, awareness of breastfeeding initiation, impaired nutrient absorption and increase loss, low socio-economic status, poor dietary intake, lack of infra-structure, prolonged hospital stays, poor mother and children health, and improper complementary feeding (Lapidus et al., 2009;De Onis, 2017). Globally, 45 million children and annually 20 million children living in South and South- East Asia are suffering from Severe Acute Malnutrition (wasting; low wt. to ht.), as reported by WHO. Children with Severe Acute Malnutrition (SAM) have high mortality rate then chronic malnutrition and have high risk of macronutrient as well as micronutrient deficiencies that leads towards delayed cognitive development, compromised immune system and growth [WHO & UNICEF, 2007]. SAM can be categorized with several medical conditions like hypoglycemia, hypothermia, edema, dehydration, loss of appetite, lower respiratory tract infection, low grade fever and anemia

(Akparibo et al., 2020). Children should overcome SAM in less than 28 days as per SPHERE standard (Sphere Association, 2021). There are several indicators like Anthropometric measurement, MUAC, Biochemical markers that used in clinical or emergency settings, to diagnose children with SAM.

SAM can be deal with public health strategy referred as The Community Based Management of Acute Malnutrition (CMAM) introduced in 2001 (Saleem et al., 2021). It suggests two standards of care for children with SAM that includes RUTF, to promote optimal heath, wellbeing, growth and recovery (Imdad et al., 2022). It deals with earlier diagnosis and treatment of children in local community-based settings due to its easy implication, cost effectiveness and larger population coverage area. Previous research result shows the improvement in wasting and stunting among children by use of this management program along with RUTF and RUSF that depends on local needs to fulfil dietary recommendation. The use of RUTF increase the acceptability of CMAM program in the management of SAM among children in low and effective economic manner (Fetriyuna et al., 2023). RUTF are those food items which do not require any cooking or preparation, that can be consumed directly after opening packaging (Diop et al., 2003). These are usually energy rich dry and powdered ingredients containing high protein and carbohydrates, covered by lipid matrix. RUTF formulation should be standardized according to WHO specifications.

Children aged 6-59 month are being assessed on Middle-Upper Arm Circumference (MUAC) standards, if the value <11.5cm, it means he is severely malnourished and will be referred to OTP, if it is >12.5cm, it means child is stable, if the measurements fall between 11.5-12.5cm indicates Moderate acute Malnutrition (MAM) of patient. They are given treatment to take RUFT from six to eight weeks according to their body weight, as per WHO recommendations [Briend.A,2001]. Children with SAM and medical complications are treated as inpatients or outpatients by using different RUTF formulations. An appetite test is conducted to place patients in different treatment units, those who pass the test indicates they can ingest specific amount of food and can be treated as outpatients. While if the OTP patient has no medical condition but has loss of appetite or bilateral edema, they are referring to inpatient stabilization center sometimes due to lack of expertise and facilities in local areas (WHO & UNICEF, 2007).

Fortification of high energy rich milk with vitamins and minerals called F-75 and F-100 that fulfills major nutritional requirements of SAM patients. RUTF is a paste made of peanut while milk-oriented formulas are F-75 and F-100 (Abebe et al., 2023). RUFT provides exact amount of nutrients as F-100 with addition of 14 mg/100 g of iron. RUTF involves strategy of alternating dried milk that used in F-100 with peanut butter (WHO, 2013). Outpatients in SAM with or without medical complication can be corrected by higher iron content in RUTF formulation. They are intervened with plumpy nuts that provides required number of Kcals to fulfill their specific energy demands (Federal Ministry of Health, 2019). Those who do not pass appetite test and have one or more medical complications like loss of appetite or bilateral edema are given inpatient clinical therapy. The treatment involves three stages: stabilization, transition and rehabilitation. The main goal of stabilization phase is to make child stable by refeeding F-75 whereas, in transitional or rehabilitation phase, F-100 and RUTF are given to overcome weight loss and attain optimum growth of children.

RUTF production usually requires food sources that are locally produced mainly are peanut-milk spread/butter, plant-based oil, sugar and various micronutrients premix to enhance the nutritive value of product (Manary, 2006). The RUTF should be selected on the basis of targeting group familiarity, choices and availability of resources in the local market. Furthermore, its sustainability and accessibility should be ensured by the availability of RUTF production technology. The program effectiveness is indicated by several nutrition

and health status, prevalence rate of recovery, provision and acceptability of food supplements, nutritional content and bioavailability of the provided food (Akomo et al., 2019).

In this review, we have briefly discussed about the production, sources, classification and formulation of RUTF in different food combination and taste, that will help to increase its acceptability among local population. Various clinical trials have been conducted in several settings to evaluate the usefulness of RUTF program in treatment of malnutrition. Furthermore, the mechanism, community implementation, cost effectiveness and non-effectiveness of RUTF in stabilization and recovery phase to mitigate malnutrition among 6-to-59-month children is also being discussed.

Literature Review

A comprehensive understanding of the causes and effectiveness of available interventions is necessary to address children's malnutrition. Community-based management of acute malnutrition (CMAM) requires the use of ready-to-use therapeutic food (RUTF) as a critical component, as evidenced by current research. RUTF has demonstrated promise in improving recovery rates, decreasing the likelihood of relapse, and supporting growth outcomes in children with severe acute malnutrition (SAM) through observational studies and multiple clinical trials. Various studies have been conducted to analyses the efficiency of use of RUTF in the management of children with SAM as well as program evaluation to give an evidence based perspective of how people use RUTF in different contexts.

In 2022, a study was conducted in Burkina Faso to determine the impact of RUTF dose upon its daily consumption and availability for the treatment of 516 children with SAM having no medical complication. These children were divided into two controlled groups. In first week, 16 sachets of RUTF were prescribed to both groups, making the reach of 98 children. Children in controlled group received 15 sachets as compared to children in intervention group, who received 9 sachets at 4 and 8 weeks. The impact of less dosage of RUTF did not affect its availability, but increase its left-over frequency. The trial shown that children taking RUTF dosage was getting recovered with each passing week, and the amount of consumption of sachet also reduced with it (Nikièma et al., 2021).

In rural Sierra Leone 2020, a controlled triple blind study was conducted on 1406 children to analyses the effect of oat RUTF with standard RUTF for the treatment of SAM. The composition of s- RUTF was mainly hydrogenated vegetable oil, peanut paste, milk powder and sugar, whereas, the composition of oat-RUTF contain oats and vegetable oil with no hydrogenated additives. The study result shows improved Anthropometric measurements with no side effects. The oat-RUTF shows improvement of 3.4g/kg/d weight gain than s-RUTF having weight gain of 2.5g/kg/d due to no hydrogenated vegetable oil and presence of bioactive compounds of oats to treat SAM with reduced duration of hospital stay (Hendrixson et al., 2020).

The chances of becoming malnourished is high in individual with HIV, especially in the region of sub-Saharan, Africa. In 2023, a retrospective cohort study, 419 HIV-positive patients above 35 yr. of age having ratio of 59% female and 41% male from Hawassa University Specialized Hospital and three health care centers of city of Ethiopia were diagnosed with malnutrition and were treated with Anti-retrieval therapy (ART). On diagnose, prescription food therapy was given to them along with ART therapy which was ongoing for 12 months, in which 25% patient were treated as SAM, and 30% patient were treated as MAM for 6 months. The study result shows the BMI value of these HIV-positive patients were increased to 18.6kg/m2 from 16.9 kg/m2, and those patients who were

already on ART therapy shows 2.7 times improved response as compared to those patients who just took admission for therapy in Hospital at the start of clinical trial. 53% patients recovered from malnutrition after taking prescription therapy and male participants have 3.7 times less recovery rate as compared to female participants [Tadesse & Toma, 2023]. On the other hand, similar previous study was conducted in Mekelle, where recovery rate was 62.2% after using RUTF. Both studies were categorized as successful in treating HIV-patient with malnutrition (Berhe et al., 2014).

Another study was conducted to formulate different RUTF products by mixing various sources, obtained from the local market, Pakistan. After initial trials, total 14 formulation were made by mixing different quantities and combination of main ingredients (peanut, mung beans and chickpea), then mixed this with ingredients of standard formula. The fresh RUTF formula was first kept in room temperature to determine the microbiological activity (mold count), water activity, peroxide value and thiobarbituric acid value by keeping in aluminum packaging for 90 days. The water activity changed from 0.39 to 0.32Aw, total plate count (TPC) from 2.53 to 2.30CFU/g and Mold count from 1.65 to1.93CFU/g. The study outcome shows that the RUTF formulation of peanut, chickpea and mung beans are shelf stable, and has nutrition that helps to eliminate Protein Energy Malnutrition and aid in recovery from acute moderate malnutrition (Javed et al., 2021).

In 2020, Hossain, et al lead a double blinded study on 260 children (130 each group) to evaluate the efficacy of RUTF by using soy protein isolate for almost 8 months on children under 5yr suffering from SAM in Bangladesh. He compared the taste and efficacy of soy based RUTF with milk based RUTF. The treatment was given after completion of their stay in stabilization phase. The study trial shows that both RUTFs has same result in term of anthropometric measurements like weight gain 0.6g/kg/d vs 0.4g/kg/d, weight to height score 1.1 vs 1.2 and MUAC score 0.9cm vs 0.9cm without any side effect. Soy based RUTF is more cost effective than milk based RUTF, and can be recommended in low economic community settings for the treatment of SAM (Hossain et al., 2020).

In Malnourished children with severe iron deficiency Anemia, the primary interest of the study was blood Hb concentration and SAM recovery, while the secondary interest was wasting Z-score, relapse, cognitive development, serum ferritin level and stunting. The treatment of SAM in the community settings was intervened using higher iron content of RUTF according to WHO standards (Walsh et al., 2023). To prevent Malnutrition among children of 6 to 23 month, a non-randomized community-based trial of 110 children was conducted in KPK by Kurram agency, from January 2018 to December 2020, targeted the low socio-economic tribes of city Kurram of Khyber Pakhtunkhwa, Pakistan (BMC Nutrition, 2017). The malnourished children were given 50g sachet of supplement named Wawa-mum for 1 year, that fulfills the exact micronutrient requirement and provides 255kcal. These sachets package was provided to lady healthcare worker, she made assurance of delivery to the targeted children on daily basis. The study result shows the high effectiveness of supplementary food on children growth parameters, improved Hb concentration from 10.2g/dL to 12.2g/dL and micronutrient status specifically zinc from 49.8µg/dL to 91.8µg/dL, vitamin A from 17.3µg/dL to 24.8µg/dL and vitamin D from 28.8ng/mL to 37.0ng/mL (Khan et al., 2023).

Another cohort study was conducted from September 2021 to January 2022 in the Sidama region, Ethiopia among the children aged between 6 to 59 months. All 476 children were diagnosed with SAM and admitted into TFU center with 100% response rate. The recovery rate of children consuming RUTF was 97.3% as compared to the 90.8% rate of children taking F-100 in the TFU center (Federal Ministry of Health, 2019). Large sample size is required for future studies to ensure the effectiveness of RUTF/RUSF in malnourished community settings.

A clinical investigation in Nigeria compared two RUTF formulations to a conventional product. The first formulation (F1) contained soy, groundnut, and dates, whereas the second (F2) contained maize, soy, groundnut, and sugar. Both recipes produced comparable or greater metabolized energy than the normal RUTF of 434 kcal (F1 produced 465 kcal, F2 produced 405 kcal). While the macronutrient profiles were identical between groups, F2 performed better in sensory testing. Furthermore, both local RUTFs had much more calcium (2.58 to 2.83 grams) than the usual formulation (0.63 grams), implying that they may be more effective in correcting micronutrient deficits. The study discovered that community-made RUTF could be nutritionally and culturally appropriate for large-scale production in order to lower childhood malnutrition (Ishaq et al., 2025).

Hypothesis

RUTF is effective in reducing malnutrition among children, particularly in Pakistan, where malnutrition rates remain critically high.

Material and Methods

The selected review articles criteria were based on relevancy of research objectives. The studies targeted SAM and MAM children aged between 6-to-59-month, written languages of the papers were in English, published from 2000-2024. The review was conducted using data from clinical trials, peer-reviewed articles, both national/international nutrition reports. Sources included WHO, UNICEF, PubMed, Google Scholar and Pakistan's National Nutrition Survey.

Children with chronic medical complication like HIV/AIDS, CHF and RF were excluded from the study. Because study result might get effected by their state of delayed recovery and illness. The selected basic ingredients for the development of RUSF/RUTF (Ready to Use Supplementary Food/Ready to Use Therapeutic Food), was mainly based on local resources. The basic information related to RUTF was taken from the WHO/WFP/UNSSCN/UNICEF guidelines for the intervention and treatment of SAM and MAM for targeted children (WHO & UNICEF, 2007). Some results of management program of RUTF/RUSF were also shown with dominant changes in malnourished children. By the search of relevant keywords "Ready to use Therapeutic Food Formulation" OR "Ready to use Food for Malnutrition".

Results and Discussion

RUTF Composition

For the production of RUTF/RUSF, those foods are being selected which are available in local markets like peanuts, milk, butter, plant based edible oils and sugar. The purpose of addition of these ingredients is to improve the nutritive value according to dietary recommendations. The alteration in recipes can be made on the basis of local population preferences and food source availability. These recipes are usually developed in Asian and African continents. Because of the lack of hygiene practices, lack of access to health care centers, drastic climate changes and domestic food insecurities leads to SAM among children of these continents, whereas in European continents they are on the initial stage of development of RUTF with more advanced technology (Imdad et al., 2022). Maize, sorghum and chickpeas are modified with amino acids-enriched plant for the development of RUTF in Africa, while in Pakistan omega-6 and omega-3 food sources, rice, cereals and legumes are used for its production (Armini et al., 2018).

Initially 30% milk, 28% sugar, 15% vegetable oil, 25% peanut butter and 2% vitamin and minerals were used for RUTF recipes. As with the passage of time, higher economic rate of milk compelled people to change their preferences and shift to other protein sources like cereal, legume and fish. For the people with lactose intolerance and allergy of milk protein (casein), other preparation method is being used in formulations of RUTF and RUSF (Brenna et al., 2015).

General preparatory processes include sorting, cleaning, roasting, drying and milling. The purpose of these processes is to increase its usage in various food item production, promotion of shelf life and easier packaging and storage. There are higher chances of protein retention in fish because of these processes, sun drying is another method that can be used in replacement of these processes.

Despite, having high protein ratio in legumes, it also contains phytic acid that hinder the absorption of few micronutrients. Roasting is another successful way to reduce phytic acid content in legumes (Tenyang et al., 2020).

Carbohydrates

Carbohydrates in the form of glucose is the major source of energy, but it can also be used as energy reserves like glycogen in animals and starch in plants. During digestion, carbohydrates are converted into simpler sugar as a form of readily available energy [Agume et al., 2017]. It can treat SAM, due to its usage as a high available energy source. In stabilization stage, lactose and maltodextrin are used in F-75 as an energy source for malnourished children. Due to high chances of metabolic disorders in under-nourished children, readily available carbohydrates like glucose and galactose are mostly preferred to fulfill their required energy need.

For the production of RUF, sugar from glucose and fructose are mainly used in RUFT preparation due to its high content of sweetness and preference by children. Sugar present in carbohydrates helps to build the structural properties of the food product by enhancing its density (Gillison et al., 2022).

Lipids

Lipids are fats and oils, that helps in weight gain and resolve other health concerns in malnourished children due to presence of essential fatty acids. Lipid based RUTF are used for the intervention of malnourished children, in which lipid based nutrient supplement are given in high doses as the whole source of energy. While, fat-based supplement is usually given in moderate amount to treat SAM. However, low level lipid-based supplements are usually given to infants and children, that gives <50% of total energy intake to prevent wasting and stunting (Bobade et al., 2022). These dietary supplements help in speedy recovery, promote growth and reduce risk of infection in children.

Amina acids

RUTF formulation should have highly bioavailable amino acid as they serve as essential requirement for growth and development in children. For the production of RUTF formula, the particle size of particular protein ingredient should be <200μm, as it helps in sustainability and stability of the powder mixture during processing and storage (Das et al., 2018). Furthermore, it also improves product quality as it has the capacity of water holding and swelling, that is essential for the production of cookies and biscuits that are common product of protein RUTF. Plant based sources of amino acids like legume and cereal are enriched sources of macronutrient and micronutrient, but they can be adulterated by the

presence of aflatoxin, that can cause high risk of impaired immune function, infection, liver cancer and malnutrition (Belorio et al., 2019).

Micronutrients

Micronutrients deficiencies can cause anemia that can lead towards the occurrence of various other diseases. Lack of energy and protein causes lack of mineral, vitamins and essential fatty acids in the body and these deficiencies cause disruption in child growth and make child prone to numerous disorders (Wagh, 2018). Apart from the Carbon, Hydrogen, Oxygen and Nitrogen dietary minerals are essential for sustaining optimal health of living organisms. Some micronutrients are required in large amount and some are required in small amounts depending on need of body as they promote nerve transmission, cellular integrity and healthy circulation of blood. During preparation of RUTF mineral availability and absorption get affected, so they are required to prepare under moderate processing conditions (Laplante & Sabatini, 2012).

Formulations of RUTF

F-75 and F-100 formulations are recommended by WHO to treat malnutrition in children. These formulations are enriched with milk sugar, essential micronutrients and other readily absorbed ingredients. Each RUTF formulation provides approximately 500-540 Kcal/100 grams (Hrubša et al., 2022).

Classification

On broad perspective, RUTF are classified into four major classes, that is recommended to malnourished children according to their body and dietary demands. These therapeutic and fortified foods are available in high bulk and density that improves nutrition and energy content in body.

These classifications are as follows;

Table 1
Classification of RUTF

Classification of RUTF	Description
RUSF	• Micronutrients fortification, can be taken without cooking or added water. • Should be consumed in sufficient quantity, treats MAM. • It includes Blanket supplementary feeding and targeted supplementary feeding (de Pee & Bloem, 2009).
RUCF	• Denser then RUSF, fortified usually, provides lesser nutrient, need of cooking (Huybregts et al., 2012). • It includes Micronutrient Powder, Powdered CFS and Lipid-based nutrient supplement (Anderson et al., 2001).
FBF	• Contains 20-25% soy, 75-80% corn/wheat along with micronutrient fortification. • May have anti-nutrient factors (World Food Program, 2013).
RUF-H	• 50% increased energy req. for HIV pt. (Menon et al., 2007).

Types

RUTF formulas are shelf stable and can be stored up to 3 to 4 months at room temperature, as they don't require mixing with water. They reduce the risk of bacterial adulteration and infection. These products provide essential nutrition and rapid recovery to children upon consumption. RUFT formulas should have characteristics features, that they do not need any preparation, easy to use, long shelf life, easily transported and

distributed (Bahwere et al., 2009). They are produced locally as well as commercially, depends upon the availability of resources and in case of emergency situation.

Local Production of RUTF

During local production, shelf life is not the main target because food is being prepared in that specific amount which is needed by local community at that time, under the guidance of respected organizations.

The basic main ingredients are; fat milk(full), sugar, vegetable oil, butter made from peanuts and minor amount of vitamin and minerals (Jadhav et al., 2019).

Commercial Production of RUTF

During commercial production, solid (powders, blend, biscuits, nutritive bars), semi-solid (paste, creams) and liquid therapeutic formulas are being prepared under the guidelines of WHO (Wagh, 2018).

Principal of RUTF Formulation

To fulfill the criteria for SAM and MAM, RUTF formulation is started with ingredients preparation according to the nutrition status and standards of the targeted children. In local production, general principals are being followed to mix liquid and dry solid powder ingredients in multiple individual steps. Generally, small amount of lipid and protein are present in liquid ingredients, whereas carbohydrates, protein, minerals and vitamins are present in powder ingredient. According to the principal, both ingredients mixed together and powdered ingredients are mixed with liquid ingredients for few minutes. In some cases, heating is required in earlier steps to make mixture more stable and homogeneous. The production of RUTF and RUSF are categorized into two domains, baked products (biscuits, nutritional bars) and mixed products (paste, dough). Because of its characteristics of simple preparatory method, long lasting shelf life, non-technical packaging, distribution and its favorable choices among children specifically with micronutrients deficiencies.

Reliable packaging is required to maintain moisture content of the prepared products and have to pack in tight container due to its moisture absorption nature (de Almeida et al., 2018). It protects direct contact with the environment which can affect absorption of moisture content. If moisture is absorbing more than normal rate it will cause drastic impact on product texture and shelf life. Whereas, high content of moisture is associated with undesired microorganisms' growth which shortened the product shelf life and can cause rancidity. Paste and dough have high content of moisture and lipid, which makes its shelf life less as compared to baked items and excess exposure to air/oxygen cause oxidation, which makes products less desirable and the aroma of products will be damage (Gama et al., 2018).

Experimental Evidence

Recent studies show the formulation of RUTF with added functional foods for the treatment of Malnutrition. The objective of study is to produce a high energy and nutrient dense formula. In this study, the ingredients used for protein replacement are soybeans flour and milk protein solid concentrates, for carbohydrates, simple sugar, for lipid substitute, cacao butter and as functional food, sesame seeds and black cumin is used with micronutrient mixture (beta-alanine and arginine). The total formulation gave 525kcal/100grams (Hadi et al., 2022). The study concluded that, the mentioned ingredients

gave the exact required total energy content suggested by Institute of Medicine (IOM) and World Health Organization (WHO) standards.

RUTF Cost Effectiveness

Results regarding cost effectiveness of RUTF are indefinite and inconclusive and varies greatly in term of different formulations and need of targeted groups. A study was conducted in South Sudan, which has higher prevalence of SAM than other countries shows that the use of RUTF is more economical when given in lower quantity to children with SAM. In Kenya the cost of RUTF was usually overlooked as the prevalence of SAM was lower than MAM, however the Kenya Medical Supplies Agency (KEMSA) handles all the supply of RUTF/RUSF thus it lessens the chances of a single product to manage and maximize cost effectiveness. While in South Sudan where RUTF is generally supplied by UNICEF and RUSF is supplied by WFP it improves the chances of single product for cost savings (Bailey, 2021).

Several studies were conducted to show a detailed cost analysis in treating and preventing malnutrition by managing RUTF dosage. A clinical randomized trial study conducted in Burkina Faso on 399 children of 6-59 months of age shows the cost effectiveness of treatment program by comparing the standard dose with controlled reduced dose along with various other factors. The reduced dose of RUTF have no negative impact on treatment care, while by reducing dose from the onset of 3rd week it would save up to $6,140 or 16.8% and causing $15.4 per child treated. The general cost of the RUTF sachet used was $0.33, while the average drugs cost was about $0.2 and facility cost during treatment was $1.9 that makes an average costs per treatment $11.6 in the standard dosage and $9.6 in reduced dosage, while the transport and storage RUTF accounts for 56% and 47% of the total treatment. The total cost of the treatment of 399 children were $36,550 ($91.6 per child) in the standard dose and $30,411($76.2) in the reduced arm dose which accounts the net total savings of 16.8% per child over standard dosage treatment. The resources saved from this treatment can be used in other procedures and treatment activities of program (N'Diaye et al., 2021).

The cost of RUTF interventions remains a critical factor, especially when resources are limited. However, according to recent Ethiopian findings in 2024, recovery rates for a streamlined fixed-dose RUTF regimen were nearly identical (97.8%) to the classic weight-based strategy (97.7%). Most importantly, this modification reduced program expenditures by cutting the average cost of SAM treatment per child from $56.55 to $42.78. Simplified dosing has been found to be a more cost-effective solution for large-scale malnutrition programs than previously thought, while yet preserving therapeutic effectiveness. As a result, cost-effective approaches like RUTF procedures may be critical to expanding coverage and ensuring that limited resources reach a larger number of children in need through more efficient funding (Maru et al., 2024).

Community implementation

To manage acute malnutrition, many health systems become more flexible to make a better strategy by taking into consideration of finances and health system of national government. Globally, CMAM is considered a well-established program, but some studies shows that limited access to all the essential nutrient may affect the implementation of program as reported by staff. For successful implementation, several input specially trained staff/HCW, routine drugs supply and logistics are required. Many health official shows dissatisfactions to the CMAM, due to lack of resources, but they showed contentment in the CMAM treatment with the working of healthcare worker. The counselling of parents by healthcare worker helped them to follow the guidelines of RUTF, as some parents from

different community do not get its idea and sometimes, they don't prefer to take health care worker suggestions into account for their children (Akuu & Amagnya, 2023).

RUTF supplementation in Malnutrition

Indication for malnutrition

The effective anthropometric criterion used in CMAM programs to identify children with high risk of malnutrition is MUAC. Its measurements help to define the specific intervention doses of RUTF, required by the children. For children under 5yr of age, MUAC has three criteria for measurement, if measured value of child is <11.5cm (malnourished), 11.5-12.5cm (moderate malnutrition) and >12.5cm (well-nourished) (Hossain et al., 2017). While using MUAC, it helps in determination of detection and progress of ongoing treatment. Whereas, weight for height is measured and the obtained value is compared with the WHO standards, it means that a child with a specific age should have same height and weight compared to other children of same age. It is usually used in a clinical setting, where child is being assessed in more detail. It requires more cost, time and energy as compared to than MUAC and required proper attention during measurement. MUAC is used in community settings, to deal with the large number of populations in less time, easy to use and require less expertise; For children, whose MUAC value is <11.5cm are referred to OTP center and treated with nutrient dense RUTF (plumpy nuts, nutritive energy bar). While children having medical complication (bilateral edema, severe diarrhea, pneumonia) are referred to inpatient/SC (stabilization center), they are given F-75 formula, that gives 75kcal/100gram. When medical condition subsides (SC), then the patient is given F-100 formula (recovery phase). The children who are being treated in OTP, should have estimated weight gain of 4.5-6.8g/kg/day. While, the patient in SC setting gained weight of approximately 10-15g/kg/day (WHO, 2021).

RUTF as intervention in Malnutrition

Previous studies show that intervention with RUTF has positive impact on growth and recovery of children in outpatient/inpatient program. RUTF is the combination of high energy dense therapeutic foods enriched with bioactive components that enhanced the nutritional profile like F-100 does.

Discussion

The primary purpose of this review is to highlight the effect of using RUTF in prevention of malnutrition in children either acute or chronic among children under 5 years of age. The role of healthcare worker in providing RUTF to in-patient are crucial as previous studies have shown that, the children who were intervene and guided timely and taking prescribed RUTF recovered rapidly and showed a reduced dependency on prolonged consumption of RUTF as their recovery progressed. Various factors like limited time, resources, inadequate knowledge, lack of awareness of formulations and not considering people choices become a hindrance in management of MAM and SAM, when its being implementing in wide range of local community settings. In 2023, a randomized controlled trial on the pediatric ward was performed in Uganda, where 160 children having kwashiorkor (57% children) and severe acute malnutrition were admitted to hospital and given two types of feedings which includes legume-enriched feeding (fermentable carbohydrates, lactose free, chickpea enriched paste) and WHO recommended milk-based feeding. The legume-enriched feeding gives total of 200kcal, which contains 18g carbohydrates, 5.6g protein and 12g fat per 100ml, the macronutrient concentration of this formulation is nearly double the macronutrient density to F-100. Children having SAM with MUAC value of <11.5cm were included. They took these feedings for approximately 90 days

and children who took legume-enriched feeds shown improved anthropometric results of 12.5cm MUAC value and gained weight of >5g/kg/day with no edema as compared to the one who were on milk-based feeds. Some of the children showed delayed recovery due to having underlying complication of pneumonia and diarrhea. While the ingredients used in legume-based feeds promote gut wellbeing and enhanced bodily functions. Despite of the positive recovery rate, few children faced complication when they were transferred from the milk feeding to legume-enriched feeding primarily due to poor palatability of legumes (Manary, 2006).

WHO recommended that 6-59 months children suffering from SAM do not need high intensity micronutrient dense supplementation as they are consuming RUTFs, which contains exact number of needed vitamins and minerals. Several delayed outcomes of therapeutic feeding programs occur in the community settings, if the WHO guidelines are not efficiently followed. In 2021, a controlled retrospective study was conducted in El-Obeid Specialized Pediatric Hospital on 296 SAM in-patients with severe PEM, to monitor the implementation of program and early exit from SC to recovery phase and implementation program. At a time of admission in hospital, 91.9% patients were given folic acid dosage and initial feeding started with F-75 till they reached to Stabilization phase. 84.8% children intervened from F-75 took more than three days to shift into recovery phase (F-100). While 15.2% children took less than three days. This can be due to the inefficiency of taking therapeutic milk less then prescribed amount, which leads towards longer stay in hospital (Musa & Mustafa, 2021). Whereas, in comparison, a study conducted in Columbia showed the adherence to WHO guidelines gives improved outcome of the SAM treatment and these guidelines can be followed in countries having high occurrence rate of malnutrition (Prada et al., 2011).

In 2024, programmatic data from Afghanistan showed that a non-weight-based, fixed daily RUTF dosage (1000 kcal/day for SAM and 500 kcal/day for MAM) was identical to the usual regimen in terms of recovery and treatment duration. The simpler strategy not only decreased clinical outcomes, but it also increased caretaker adherence, decreasing supply chain demands. These findings serve as convincing evidence that clinically and operationally economical dosage regimens can be more effective in resource-constrained circumstances (Bahwere et al., 2024).

RUTF is highly effective in the short-term management of Severe Acute Malnutrition among children and has shown measurable success in Pakistan. The result shows the effectiveness of RUTF evaluated along with the goal of reducing SAM, improving recovery time, and lowering the likelihood of repeat occurrences, with success rates varying from 70 to 90% depending on adherence intensity and setting. RUTF can be used in community settings to address SAM in children as a short-term prevention strategy. The adequate training of health care workers implementing CMAM is necessary to reduce the severity of acute malnutrition. However, for sustainable improvements, it must be integrated with preventive nutrition strategies, local food-based approaches, and supportive policies addressing poverty and food insecurity.

Conclusion

Malnutrition is a global burden that caused due to the over-nutrition and under-nutrition. The prevalence rate of malnutrition is specifically high in under-developed countries due to the food insecurity. Globally, children under age 5 are more prone to severe acute malnutrition due to lack of food availability, accessibility and utilization, poor food quality control, improper healthcare infrastructure. Humanitarian organizations are working on a wide range of programs to prevent occurrence of multiple disorder/diseases, in which CMAM is one of those programs, to prevent children from intensity of malnutrition

(MAM, SAM). To mitigate malnutrition, ready-to-use-therapeutic foods which do not need any types of cooking and can be consumed after unpackaging, are being used for out-patient and hospitalized in-patients.

These foods are available in various formulations, depends upon the need of the patient. The ingredients of formulation should be according to the resources and choices of local and targeted community, in order to increase the effectiveness of intervention. Various formulations using local food ingredients provide similar amount of energy and nutrient density to treat malnutrition as described by WHO standard guidelines. If the recommendations are not followed, there will be delay in recovery which leads towards the increase presence of microbial content in RUTF. There are many alterative products available in the markets for the children having lactose intolerance and food allergy. In previous years, numerous researches were conducted to evaluate the efficacy of RUTFs in management of malnutrition. These study result shows a positive improvement in Anthropometric measurements specifically in weight gain and the bioactive ingredients used in RUTF preparation helps in enhancing body functions and improvement of quality of life.

Recommendations

RUTF use is essential in the community nutrition centers to lower the risk of mortality, to enhance the livelihood of children and child care behavior. To increase the recovery rate of SAM and MAM patients, more enhanced and detailed approach is required like engagement of families, improving their living standard and altering poor practices towards quality of life.

- For future implementation, locally produced RUTF should be encouraged to manage severe stages of malnutrition and mainly based on food item rather than supplemental forms.
- Cost- effectiveness of RUTF should be implemented by using different substitutes and sources of ingredients. National and provisional budget should be introduced for the treatment of SAM and MAM, to reduce the burden on poor households.
- Integrate RUTF within primary healthcare and community-based nutrition programs.
- Couple therapeutic interventions with preventive strategies (diet modification, maternal and child health, and breastfeeding promotion).
- Motivate healthcare providers to cooperate with patients in teaching related to adherence to recommended therapies and coordinate with them in fulfillment of the task.
- Foster a collaboration among all the relevant organizations of healthcare centers from national to local level, to enhance the diagnosis, treatment and intervention outcomes

References

Abebe, A., Simachew, Y., & Delbiso, T. D. (2023). Effect of ready-to-use therapeutic foods on time to recovery among children with severe acute malnutrition in Ethiopia: A prospective cohort study. *BMC Pediatrics, 23(1),* 340. https://doi.org/10.1186/s12887-023-03969-1

Agume, A., Njintang, N., & Mbofung, C. (2017). Effect of soaking and roasting on the physicochemical and pasting properties of soybean flour. *Foods, 6(2),* 16. *https://doi.org/10.3390/foods6020016*

Akomo, P., Bahwere, P., Murakami, H., Banda, C., Maganga, E., Kathumba, S., Sadler, K., & Collins, S. (2019). Soya, maize, and sorghum ready-to-use therapeutic foods are more effective in correcting anaemia and iron deficiency than the standard ready-to-use therapeutic food: A randomized controlled trial. *BMC Public Health, 19,* 806. https://doi.org/10.1186/s12889-019-6927-0

Akparibo, R., Harris, J., Blank, L., Campbell, M. J., & Holdsworth, M. (2020). Severe acute malnutrition in children aged under 5 years can be successfully managed in a non-emergency routine community healthcare setting in Ghana. *Maternal & Child Nutrition, 13*(1), e12417. https://doi.org/10.1111/mcn.12417

Akuu, J. A., & Amagnya, M. A. (2023). Community-based management of acute malnutrition: Implementation quality, and staff and user satisfaction with services. *Journal of Taibah University Medical Sciences, 18*(5), 988–996. https://doi.org/10.1016/j.jtumed.2023.04.005

Anderson, A. S., Guthrie, C.-A., Alder, E. M., Forsyth, S., Howie, P. W., & Williams, F. L. (2001). Rattling the plate: Reasons and rationales for early weaning. *Health Education Research, 16*(4), 471–479. https://doi.org/10.1093/her/16.4.471

Armini, V., Miele, N. A., Albero, M., Sacchi, R., & Cavella, S. (2018). Formula optimization approach for an alternative ready-to-use therapeutic food. *Food Science and Technology, 6,* 1–8. https://doi.org/10.1590/1678-457X.6603

Bahwere, P., Funnell, G., Qarizada, A. N., Woodhead, S., Bengnwi, W., & Le, M. T. (2024). Effectiveness of a non-weight-based daily dosage of ready-to-use therapeutic food in children suffering from uncomplicated severe acute malnutrition: A non-randomized, non-inferiority analysis of programme data in Afghanistan. *Maternal & Child Nutrition, 20*(4). https://doi.org/10.1111/mcn.13231

Bahwere, P., Sadler, K., & Collins, S. (2009). Acceptability and effectiveness of chickpea sesame-based ready-to-use therapeutic food in malnourished HIV-positive adults. *Patient Preference and Adherence, 3,* 67–75. https://doi.org/10.2147/PPA.S3907

Bailey, J. E. (2021). Simplified, combined protocol for acute malnutrition in children 6–59 months: The ComPAS randomized controlled trial (PhD thesis). *London School of Hygiene & Tropical Medicine*. https://doi.org/10.17037/PUBS.04661808

Belorio, M., Sahagún, M., & Gomez, M. (2019). Influence of flour particle size distribution on the quality of maize gluten-free cookies. *Foods, 8*(2), 83. https://doi.org/10.3390/foods8020083

Berhe, M., Fisaha, H., & Ashenafi, S. (2014). Outcome of ready-to-use food therapy among patients on HIV/AIDS care in Mekelle Hospital, Northern Ethiopia: Retrospective cohort study. *Journal of AIDS & Clinical Research, 5*(1), 268. https://doi.org/10.4172/2155-6113.1000268

Bobade, H., Singh, A., Sharma, S., Gupta, A., & Singh, B. (2022). Effect of extrusion conditions and honey on functionality and bioactive composition of whole wheat flour-based expanded snacks. *Food Processing & Preservation, 46*(1), e15932. https://doi.org/10.1111/fpp.15932

Brenna, J. T., Akomo, P., Bahwere, P., Berkley, J. A., Calder, P. C., Jones, K. D., et al. (2015). Balancing omega-6 and omega-3 fatty acids in ready-to-use therapeutic foods (RUTF). *BMC Medicine, 13*(1), 117. https://doi.org/10.1186/s12916-015-0381-3

Briend, A. (2001). Highly nutrient-dense spreads: A new approach to delivering multiple micronutrients to high-risk groups. *British Journal of Nutrition, 85*(S2), S175–S179. https://doi.org/10.1079/BJN2000307

Das, J. K., Hoodbhoy, Z., Salam, R. A., Bhutta, A. Z., Valenzuela-Rubio, N. G., Weise Prinzo, Z., & Bhutta, Z. A. (2018). Lipid-based nutrient supplements for maternal, birth, and infant developmental outcomes. *The Cochrane Database of Systematic Reviews, 8*(8), CD012610. https://doi.org/10.1002/14651858.CD012610

De Almeida, M. M. C., Francisco, C. R. L., Oliveira, A. de, Campos, S. S. de, Bilck, A. P., Fuchs, R. H. B., et al. (2018). Textural, color, hygroscopic, lipid oxidation, and sensory properties of cookies containing free and microencapsulated chia oil. *Food Bioprocess Technology, 11*(5), 926–939. https://doi.org/10.1007/s11947-018-2163-2

De Onis, M. (2017). Child growth and development. In *Nutrition Health Development World* (pp. 119–141). https://doi.org/10.1007/978-3-319-43739-2_6

De Pee, S., & Bloem, M. W. (2009). Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6-to 23-month-old children and for treating moderate malnutrition among 6-to 59-month-old children. *Food & Nutrition Bulletin, 30*(3), S434. https://doi.org/10.1177/15648265090300 03S07

Diop, E. H. I., Dossou, N. I., Ndour, M. M., Briend, A., & Wade, S. (2003). Comparison of the efficacy of a solid ready-to-use food and a liquid, milk-based diet for the rehabilitation of severely malnourished children: A randomized trial. *American Journal of Clinical Nutrition, 78*(2), 302–307. https://doi.org/10.1093/ajcn/78.2.302

Federal Ministry of Health (FMoH). (2019). *National protocol for the management of acute malnutrition*. Addis Ababa, Ethiopia: FMoH.

Fetriyuna, F., Purwestri, R. C., Jati, I. R. A. P., Setiawan, B., Huda, S., Wirawan, N. N., & Andoyo, R. (2023). Ready-to-use therapeutic/supplementary foods from local food resources: Technology accessibility, program effectiveness, and sustainability, a review. *Heliyon, 9*(12), e22478. https://doi.org/10.1016/j.heliyon.2023.e22478

Gama, T., Wallace, H. M., Trueman, S. J., & Hosseini-Bai, S. (2018). Quality and shelf life of tree nuts: A review. *Scientia Horticulturae, 242*, 116–126. https://doi.org/10.1016/j.scienta.2018.07.039

Gillison, F., Grey, E., Verplanken, B., Barnett, J., & Baber, F. (2022). A rapid review of the acceptability and impact of approaches to reduce the salt, fat, and sugar content of people's diets on consumers and industry. *Food Standards Agency*.

Hadi, S., Amani, R., Tehrani, M. M., Hadi, V., Hejri, S., & Askari, G. (2022). Ready-to-use therapeutic food (RUTF) formulations with functional food and nutrient density for the treatment of malnutrition in crisis. *International Journal of Preventive Medicine, 13*, 16. https://doi.org/10.4103/ijpvm.IJPVM_254_21

Hendrixson, D. T., Godbout, C., Los, A., Callaghan-Gillespie, M., Mui, M., Wegner, D., Bryant, T., Koroma, A., & Manary, M. J. (2020). Treatment of severe acute malnutrition with oat or standard ready-to-use therapeutic food: A triple-blind, randomized controlled clinical trial. *Gut, 69*(12), 2143–2149. https://doi.org/10.1136/gutjnl-2020-320769

Hossain, M. I., Ahmed, T., Arifeen, S. E., et al. (2017). Comparison of mid upper arm circumference and weight-for-height z score for assessing acute malnutrition in Bangladeshi children aged 6–60 months: An analytical study. *American Journal of Clinical Nutrition, 106*(5), 1232–1237. https://doi.org/10.3945/ajcn.117.158366

Hossain, M. I., Huq, S., Islam, M. M., & Ahmed, T. (2020). Acceptability and efficacy of ready-to-use therapeutic food using soy protein isolate in under-5 children suffering from severe acute malnutrition in Bangladesh: A double-blind randomized non-inferiority trial. *European Journal of Nutrition, 59*(3), 1149–1161. https://doi.org/10.1007/s00394-019-01975-w

Hrubša, M., Siatka, T., Nejmanová, Ľ., Vopršalová, M., Kujovská Krčmová, L., Matoušová, K., et al. (2022). Biological properties of vitamins of the B-complex, part 1: Vitamins B1, B2, B3, and B5. *Nutrients, 14*(3), 484. https://doi.org/10.3390/nu14030484

Huybregts, L., Houngbe, F., Salpêteur, C., Brown, R., Roberfroid, D., Ait-Aissa, M., & Kolsteren, P. (2012). The effect of adding ready-to-use supplementary food to a general food distribution on child nutritional status and morbidity: A cluster-randomized controlled trial. *PLoS Medicine, 9*(9), e1001313. https://doi.org/10.1371/journal.pmed.1001313

Imdad, A., Rogner, J. L., François, M., Ahmed, S., Smith, A., Tsistinas, O. J., Tanner-Smith, E., Das, J. K., Chen, F. F., & Bhutta, Z. A. (2022). Increased vs. standard dose of iron in ready-to-use therapeutic foods for the treatment of severe acute malnutrition in a community setting: A systematic review and meta-analysis. *Nutrients, 14*(15), 3116. https://doi.org/10.3390/nu14153116

Ishaq, R. A., Adegbegi, A. J., Okere, S. O., & Anyanwu, G. O. (2025). Evaluation of locally produced ready-to-use therapeutic food (RUTF) for prevention of childhood malnutrition. *Tropical Journal of Phytochemistry and Pharmaceutical Sciences, 4*(3), 136–140.

Jadhav, A. R., Karnik, P., Fernandes, L., Fernandes, S., Shah, N., & Manglani, M. (2019). Indigenously prepared ready-to-use therapeutic food (RUTF) in children with severe acute malnutrition. *Indian Pediatrics, 56*(4), 287–293. https://doi.org/10.1007/s13312-019-1571-9

Javed, F., Jabeen, S., Sharif, M. K., Pasha, I., Riaz, A., Manzoor, M. F., Sahar, A., Karrar, E., & Aadil, R. M. (2021). Development and storage stability of chickpea, mung bean, and peanut-based ready-to-use therapeutic food to tackle protein-energy malnutrition. *Food Science & Nutrition, 9*(9), 5131–5138. https://doi.org/10.1002/fsn3.2479

Khan, A., Ul-Haq, Z., Fazid, S., Fatima, S., Muhammad, N., Ahmed, J., Manoharadas, S., Safi, S. Z., Habib, I., Garzon, C., Ihtesham, Y., Zahid, F., Dad, F., Mahamadou, T., & Lowe, N. M. (2023). Effectiveness of locally produced ready to use supplementary food on hemoglobin, anthropometrics, and plasma micronutrient concentrations of 6 to 23 months age children: A non-randomized community-based trial from Pakistan. *Frontiers in Nutrition, 10*, 1176778. https://doi.org/10.3389/fnut.2023.1176778

Lapidus, N., Luquero, F. J., Gaboulaud, V., Shepherd, S., & Grais, R. F. (2009). Prognostic accuracy of WHO growth standards to predict mortality in a large-scale nutritional program in Niger. *PLoS Medicine, 6*, e1000039. https://doi.org/10.1371/journal.pmed.1000039

Laplante, M., & Sabatini, D. M. (2012). mTOR signalling in growth control and disease. *Cell, 149*(2), 274–293. https://doi.org/10.1016/j.cell.2012.03.017

Manary, M. J. (2006). Local production and provision of ready-to-use therapeutic food (RUTF) spread for the treatment of severe childhood malnutrition. *Food and Nutrition Bulletin, 27*(S1), S83–S89. https://doi.org/10.1177/15648265060270015S15

Maru, Y., Tamiru, D., Baye, K., Chitekwe, S., Laillou, A., Darsene, H., Abdulai, R., Worku, M., & Belachew, T. (2024). Effect of a simplified approach on recovery of children 6–59 months with wasting in Ethiopia: A non-inferiority, cluster-randomized controlled trial. *Maternal & Child Nutrition, 20*(4). https://doi.org/10.1111/mcn.13210

Menon, P., Ruel, M. T., Loechl, C. U., Arimond, M., Habicht, J.-P., Pelto, G., & Michaud, L. (2007). Micronutrient sprinkles reduce anemia among 9-to 24-mo-old children when delivered through an integrated health and nutrition program in rural Haiti. *The Journal of Nutrition, 137*(4), 1023–1030. https://doi.org/10.1093/jn/137.4.1023

Musa, N. A., & Mustafa, A. E. M. (2021). Evaluation of the inpatient therapeutic feeding program used for children admitted with severe protein energy malnutrition in El-Obeid Specialized Pediatric Hospital. *International Journal of Medical Research & Health Sciences, 10*(4), 131–141. https://doi.org/10.22159/ijmrhs.2021v10i4.39477

N'Diaye, D. S., Wassonguema, B., Nikièma, V., Kangas, S. T., & Salpéteur, C. (2021). Economic evaluation of a reduced dosage of ready-to-use therapeutic foods to treat uncomplicated severe acute malnourished children aged 6–59 months in Burkina Faso. *Maternal & Child Nutrition, 17*(3), e13118. https://doi.org/10.1111/mcn.13118

Nikièma, V., Fogny, N. F., Kangas, S. T., Lachat, C., & Salpéteur, C. (2021). Availability, use, and consumption practices of ready-to-use therapeutic foods prescribed to children with uncomplicated severe acute malnutrition aged 6–59 months during outpatient treatment in Burkina Faso. *Appetite, 165*, 105751. https://doi.org/10.1016/j.appet.2021.105751

Prada, D., Ramírez, et al. (2011). Using of WHO guidelines for the management of severe malnutrition to cases of marasmus and kwashiorkor in a Colombia children's hospital. *Nutrition Hospital, 26*(5), 977–983. https://doi.org/10.3305/nh.2011.26.5.5206

Saleem, J., Zakar, R., Bukhari, G. M. J., Naz, M., Mushtaq, F., & Fischer, F. (2021). Effectiveness of ready-to-use therapeutic food in improving the developmental potential and weight of children aged under five with severe acute malnourishment in Pakistan: A pretest-posttest study. *International Journal of Environmental Research and Public Health, 18*(17), 9060. https://doi.org/10.3390/ijerph18179060

Sphere Association. (2021). *The Sphere handbook: Humanitarian charter and minimum standards in humanitarian response*. Sphere Association.

Tadesse, H., & Toma, A. (2023). Nutritional treatment outcomes of therapeutic feeding program and its predictors among HIV patients at Hawassa University Comprehensive Specialized Hospital, Hawassa City, Sidama, Southern Ethiopia: A retrospective cohort study. *HIV/AIDS - Research and Palliative Care, 15*, 83–93. https://doi.org/10.2147/HIV.S395936

Tenyang, N., Ponka, R., Tiencheu, B., Djikeng, F. T., Womeni, H. M., & Ngameni, E. (2020). Effect of traditional drying methods on proximate composition, fatty acid profile, and oil oxidation of fish species consumed in the far-north of Cameroon. *Global Challenges, 4*(8), 2000007. https://doi.org/10.1002/gch2.2000007

Wagh, V. D. (2018). Ready to use therapeutic food (RUTF) formulation and packaging for malnutrition: An overview. *Nutri Food Sci International Journal, 4*(5), 555648. https://doi.org/10.19080/NFSIJ.2018.04.555648

Walsh, K., Kiosia, A., et al. (2023). Legume-supplemented feed for children hospitalized with severe malnutrition: A Phase II trial. *British Journal of Nutrition*. https://doi.org/10.1017/S0007114524000837

World Food Program. (2013). *Evaluating complementary food supplements (CFS) to improve child growth and reduce stunting in rural Bangladesh (Vol. 1)*. World Food Program.

World Health Organization (WHO) & United Nations Children's Fund (UNICEF). (2007). *Community-based management of severe acute malnutrition: A joint statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition, and UNICEF*. World Health Organization.

World Health Organization (WHO). (2013). *Guideline: Updates on the management of severe acute malnutrition in infants and children*. World Health Organization.

World Health Organization (WHO). (2021). *Management of severe malnutrition: A manual for physicians and other senior health workers*. World Health Organization.