



Epidemiology and clinical characteristics of acute malnutrition among under-5 children attending a rural hospital in the Democratic Republic of Congo: a cross-sectional study

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Background: Malnutrition, a public health problem in a low-income country such as the Democratic Republic of Congo (DR Congo), is a major killer among children under 5 who are most at risk of acute malnutrition. This study aims to describe the epidemiological and clinical characteristics of acute malnutrition in children under 5 years old.

Methods: The authors conducted a retrospective and descriptive cross-sectional study on children under 5 with acute malnutrition from April 2022 to April 2023. A total of 287 malnourished children were consulted, hospitalized in a rural hospital, and registered for participation in this study.

Results: Two hundred eighty-seven (25%) children were victims of acute malnutrition. The age group between 13 and 24 months is the most affected by acute malnutrition with 30%. The male-to-female(M/F) sex ratio was 1.17. Kwashiorkor is the most common form of acute malnutrition with 171 (59.6%) cases. Abdominal bloating, weight loss as well as diarrhea and vomiting were the more frequent clinical signs. Shock is the most complication of acute malnutrition. Therapeutic milk (Food 75 and Food 100) was the most effective in management. Twenty-nine (10.1%) other children died from acute malnutrition and 258 (89.9%) children progressed to full recovery.

Conclusion: Acute malnutrition in children remains a public health problem worldwide and particularly in low-income countries such as DR Congo. It is associated with multiple physiological vulnerabilities and has many short- and long-term complications in children who have suffered from it.

Keywords: child, democratic republic of the congo, epidemiology, malnutrition, nutritional status

Introduction

Since malnutrition is a major public health and child health problem worldwide, especially in low-income countries like Democratic Republic of Congo (DR Congo), it remains a major killer among under-5 children who are the most vulnerable and

most exposed to acute malnutrition^[1]. Worldwide, the frequency of malnutrition is 50.3 million malnourished children in 2018 with a very high number of deaths estimated at 45%^[2]. Famine being a humanitarian crisis caused by armed conflict and insecurity, more than five million people are in a situation of

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displacement in DR Congo, three million children are included in this number and ~900 000 children under 5 years suffer from severe acute malnutrition (SAM)^[3]. During the period of the COVID-19 pandemic, a period of 2 years (between September 2021 and March 2022), cases of acute malnutrition experienced an exaggerated increase in DR Congo, the deterioration of this situation as well as factors aggravating acute malnutrition during this period remain unknown until now^[2,4]. In DR Congo, for a long time, many aggravating factors were the root of acute malnutrition, including natural disasters, armed conflicts (which favors a massive displacement of the population), and a lack of hospital equipment^[1].

Approximately more than 17 million children suffer from acute malnutrition (AM) and these children with AM are more likely to die than well-nourished children. Moderate acute malnutrition (MAM) is more common than severe acute malnutrition (SAM) and affects about 60% of all people classified as acutely malnourished^[5,6]. MAM and SAM accounts for about 50% of all deaths in children under 5 years old. SAM is one of the leading nutrition-related causes of death in children under 5^[7]. AM in children under the age of 5 is a health problem in low-income countries such as DR Congo. It is related to multiple physiological vulnerabilities, such as enteric barrier disruption and essential nutrient deficiencies^[1,5]. At the clinical level of AM, bilateral edema, weight loss and inappropriate physical and psychological development are observed. The presence of these edema or emaciation makes it possible to determine SAM^[5]. Acutely malnourished children who have survived the disease are at high risk of developing stunting-related disorders and various diseases like measles, tuberculosis, pneumonia, etc. in adulthood. Children at high risk of AM are at risk for associated morbidity and negative effects on their growth and cognitive development later in adulthood^[8]. The management of AM include two phases, one of which is the initial stabilization and the second is nutritional rehabilitation. In the first phase, the complications are treated for each patient with local F75 therapeutic milk (75 kcal/100 ml), then in order to correct other concomitant deficiencies, the patients also benefit from a single dose of 5 mg of acid folate and vitamin A and antibiotic therapy. The second phase of care begins when the patient has already met the criteria for the return of appetite. In this second phase, breastfeeding patients can continue their feeding through their mothers' breasts, an alternative milk to F100 and the introduction of locally prepared porridge and soy milks are also very important for malnourished children, and antibiotic therapy is always continued^[9].

Therefore, in this present study, we presented the AM in children under-5 in a rural hospital from the eastern region of DR Congo. We presented the different characteristics of the children under-5 who participated in this study (socio-demographic and physical characteristics), the diagnostic methods as well as the principles of the medical and preventive management of acute malnutrition. We also proffered recommendations and implications that should be implemented by the Congolese government and policy-makers in future in the prevention and management of acute malnutrition in DR Congo. We assessed the prevalence and risk factors of acute malnutrition in children under-5 admitted to the pediatrics department in a rural hospital from the eastern region of DR Congo.

HIGHLIGHTS

- In low-income countries like the Democratic Republic of Congo, acute malnutrition is a major public health problem.
- Malnutrition is a cause of a large number of deaths among under-5 children in DR Congo.
- The Congolese government and its Ministry of Public Health must strengthen the health systems for the benefit of children by putting in place quality equipment and qualified personnel for better care and proper management of acute malnutrition.

Methods

The work has been reported in line with the STROCCS criteria^[10].

Study period, area and design

The retrospective study was conducted over a 1-year period from April 2022 to April 2023. The study was carried out in the pediatric department of a rural hospital, located in the eastern region of DR Congo. We conducted a retrospective, descriptive and documentary cross-sectional study among under-5 children with acute malnutrition, a study on the epidemiological and clinical characteristics of acute malnutrition.

Sampling method and size

A total of 1108 children whose age was below 5 years were consulted and hospitalized in the pediatric department and of which 287 children among them benefited from follow-up, monitoring and treatment. These 287 malnourished children were registered for participation in this study.

Variables and criteria of selection

Our research protocol focused on the following variables in this study and these variables were divided into socio-demographic variables (age of the child, sex of the child, residence of the child, level of mother's education, mother's profession), clinical variables such as the forms of acute malnutrition, the related pathologies, the clinical signs as well as the variables on the modalities of therapeutic management and the evolution of the acute malnutrition.

For the inclusion criteria, we included all children suffering from acute malnutrition, which was defined as having bilateral pitting edema, mean upper arm circumference less than 12.4 cm and weight-for-height z-score less than -2 z-score of the WHO criteria, who had been hospitalized in the pediatric department, whose age is between 0 and 5 years old and who had a complete and usable clinical file. The study does not include all children hospitalized in another department other than pediatrics and children over 5 years old admitted to the pediatric department, and children whose files are unusable or incomplete.

The results are grouped and presented in tabular form. We used Microsoft Word 2016 for Windows (Version 19, Microsoft Inc.) and Microsoft Excel 2016 for Windows (Version 19, Microsoft Inc.) to analyze our results.

Ethical consideration and source of data

For ethical consideration, we respected the dignity of our patients. We separated the identification elements of the patients as well as the epidemiological, clinical, and therapeutic elements while using the codes. Since our work is retrospective, we thought it best not to rely on the patients' consent.

The data was collected by consulting the hospital records of patients admitted to the pediatric department. We used sorting as a method of collecting data and the variables that were retained concerning the epidemiology, clinical elements, evolution, and treatment of acute malnutrition.

Results

In our study, 1108 children under 5 years old were admitted to the pediatric department, and 287 malnourished children were registered to participate in our study, that is a frequency of 25% of cases of acute malnutrition compared to other pathologies recorded in the department of pediatrics.

Our first table (Table 1) presents socio-demographic data of children suffering from acute malnutrition, and we found that the age group between 13 and 24 months was mostly affected by acute malnutrition with 86 cases, that is a prevalence of 30% followed by age group between 6 and 12 months with 59 cases or 20.5%. The male sex was mostly affected, with 155 cases (54%), and the female sex also had 132 cases (46%). The male-female sex ratio was 1.17. Children residing in rural areas had the highest number of malnutrition cases, with 211 cases (73.5%). The education level of mothers whose children suffered from malnutrition as well as their professions were useful in this study.

Table 1	
Socio-demographic profile	
Characteristics	n (%)
Age group (in months)	
0–6	33 (11.5)
6–12	59 (20.5)
13–24	87 (30)
25–36	57 (19.9)
37–59	52 (18.1)
Sex	
Male	155 (54)
Female	132 (46)
Residence of the children	
Rural	211 (73.5)
Urban	76 (26.5)
Education level of the mothers	
Primary	91 (31.7)
Secondary	71 (24.7)
University	27 (9.4)
None	98 (34.2)
Occupation of mothers	
Trader	85 (29.6)
Farmer	87 (30.3)
Officer	31 (10.8)
None	84 (29.3)
Family size (persons)	
1–5	79 (27.5)
6–10	111 (38.7)
11–15	77 (33.8)

The educational level of mothers and their occupational profiles were significant variables in the analysis of this study. These socio-demographic factors were correlated with the nutritional status of children, providing insights into the influence of maternal education and employment on child health outcomes. Thereby, for the level of education of the mothers with malnourished children, we found 98 (34.2%) mothers did not have any level of education. Among them, eighty-seven (30.3%) mothers were farmers. Children living in families made up of between 6 and 10 people were victims of acute malnutrition with 111 cases (38.7%).

Table 1 in our study delineates the socio-demographic characteristics of the children with acute malnutrition. Notably, the age group of 13–24 months was disproportionately affected, accounting for 86 cases (30% prevalence), followed by the 6–12 months age group with 59 cases (20.5%). Boys were more frequently affected, with 155 cases (54%), compared to girls who accounted for 132 cases (46%), resulting in a male-to-female sex ratio of 1.17. The incidence of malnutrition was higher among children from rural areas, with 211 cases (73.5%).

A pivotal aspect of our research focused on the educational level and occupational status of mothers with malnourished children. These factors were found to be significant in the analysis. Notably, 98 mothers with malnourished children (34.2%) had not received any formal education. Furthermore, the occupation of farming was the most common amongst these mothers, with 87 cases (30.3%). Additionally, acute malnutrition was prevalent in families with 6–10 members, affecting 111 children (38.7%).

Figure 1 represents the results on the distribution of cases according to the forms of acute malnutrition. We noted 171 (59.6%) cases of Kwashiorkor, followed by Marasmus (24%) and mixed forms of acute malnutrition (16.4%).

Table 2 represents the results on the clinical signs presented by children in our study, the complications of acute malnutrition, and the pathologies present in acute malnutrition. Some of the clinical signs found include; edema, ascites, hepatomegaly, abdominal bloating, diarrhea, vomiting, as well as fever, and weight loss. Complications related to acute malnutrition include coma, state of shock, muscle wasting, kidney damage, and mental disorders were noted in our study. The pathologies present in acute malnutrition were gastroenteritis (33.4%), severe sepsis (15.6%), malaria (14.3%), as well as anemia, dermatosis, tuberculosis, and infections.

The results pertaining to the management of cases of acute malnutrition in this study environment showed that all the

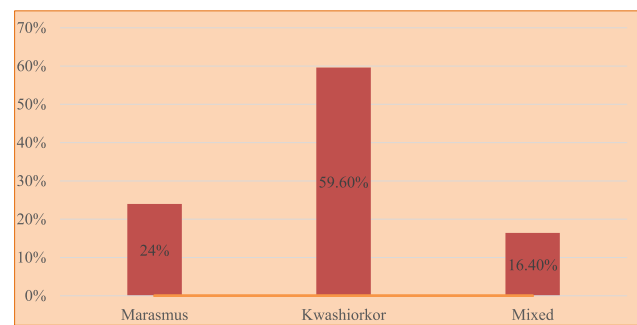


Figure 1. Type of acute malnutrition in children under-5.

Table 2
Clinical characteristics of acute malnutrition in children under-5

Characteristics N = 287	Present n (%)	Absent n (%)
Clinical signs of acute malnutrition		
Ascites	26 (9)	261 (91)
Apathy	243 (84.6)	44 (15.4)
Abdominal bloating	287 (100)	0
Abdominal pain	269 (93.7)	18 (6.3)
Cough	201 (70)	86 (30)
Diarrhea	238 (83)	49 (17)
Edema	211 (73.5)	76 (26.5)
Fever	189 (65.8)	98 (34.2)
Hepatomegaly	172 (60)	115 (40)
Irritability	120 (41.8)	167 (58.2)
Splenomegaly	89 (31)	198 (69)
Skin lesion	211 (73.5)	76 (26.5)
Vomiting	256 (89.2)	31 (10.8)
Weight loss	259 (90.2)	28 (9.8)
Pathologies associated with acute malnutrition		
Anemia	47 (16.4)	240 (83.6)
Dermatosis	41 (14.3)	246 (85.7)
Infections	158 (55)	129 (45)
Malaria	101 (35.2)	186 (64.8)
Severe sepsis	71 (24.7)	216 (75.3)
Tuberculosis	31 (10.8)	256 (89.2)
Complications of acute malnutrition		
Coma	8 (2.8)	279 (97.2)
Kidney damage	29 (10.1)	258 (89.9)
Mental disorder	223 (77.7)	64 (22.3)
Muscle wasting	4 (1.4)	283 (98.6)
Shock	78 (27.2)	209 (72.8)

children were treated with therapeutic milk (Food 75 and Food 100). All children suffering from malnutrition who participated in this study received antibiotic treatment and food supplements. Soymilk was given as an additional treatment in malnourished children.

For the follow-up, monitoring, and treatment of acute malnutrition in the study area, children suffering from this pathology were recommended to be hospitalized for better care. Concerning the length of hospitalization, 113 (39.4%) of the children had a stay of 5 to 10 days in the hospital, 95 (33.1%) of children had a stay of more than 10 days, and 79 (27.5%) stayed in the hospital for less than 5 days. According to the evolution of malnourished children, 258 (89.9%) children were completely cured. Unfortunately, 29 (10.1%) other children died from acute malnutrition.

Discussion

Key findings

The frequency of acute malnutrition was higher compared to other pediatric pathologies, with a 25% prevalence. Children aged 13–23 months were victims of acute malnutrition. The male sex was mostly affected, and the male-to-female sex ratio was 1.17. The majority of malnourished children were residents of rural areas and their mothers were primarily farmers with no formal education. Kwashiorkor was the most common form of acute malnutrition in this study area. Abdominal bloating, weight loss as well as diarrhea and vomiting were the clinical signs

presented by malnourished children. Muscle wasting, mental disorders and shock were the complications of acute malnutrition. Therapeutic milk (Food 75 and Food 100) was the most effective in management.

Selection criteria

Children diagnosed with acute malnutrition under the age of 5 were included in the selection criteria for this study. The study specifically included children who sought medical attention at the rural hospital's pediatric department between April 2022 and April 2023. There were no limitations according to socio-economic or gender status. To further guarantee the validity and reliability of the results, children with incomplete medical records or missing data pertinent to the study variables were not included in the analysis.

Interpretation

In our study, we have 287 malnourished children out of 1108 children under 5 admitted to the pediatric department, a frequency of 25%. This higher frequency was normal compared to the living conditions that are observable in the population of DR Congo^[1]. The reason for this might be the low socioeconomic and educational status of the parents (especially the mothers) of these children. Low socioeconomic status refers to individuals with low educational achievement and/or low household income. The parents with a very low economic status have difficulty obtaining quality food for their children under 5 years old. Research has revealed that there is a direct relationship between the socio-demographic of parents and the nutrition of their children^[1,2]. Children with high levels of acute malnutrition in DR Congo would be more vulnerable to other childhood problems such as measles, pneumonia, dysentery, tuberculosis, etc^[11].

In this study, the age group between 13 and 24 months, which is the preschool age, was mostly affected by acute malnutrition. These results were similar to the results found by Karim *et al.*^[5] in a study carried out in Bangladesh (a country as poor and where acute malnutrition reigns) on children of preschool age. The reason for this finding might be due to the fact that children between 13 and 24 months have low immunity or perhaps their mothers weaned off abruptly from breastfeeding. Early weaning off from breastfeeding is the result of many distinct factors, such as large household, low socioeconomic status, fear of breast deformations and most importantly, illiteracy. All the aforementioned factors have a significantly negative influence on the duration of breastfeeding of a child, thus making these children more prone to acute malnutrition^[12]. The implication of this that, children affected with acute malnutrition would have delayed developmental milestones such as; delayed dentition, poor anthropometry measurements, mental retardation, etc. compared to other well-nourished children in DR Congo. In this regard, the most immediate intervention the government can make is to provide prenatal education to mothers about the role of breastfeeding in their child health and nourishment^[12]. This study found that male sex was more affected than the female sex. There is no obvious explanation for this gender disparity^[13–15]. This finding is keeping with similar studies by several researchers in the province of South Kivu and the city of Bukavu in DR Congo^[9,11,16,17]. Male children in DR Congo affected with acute malnutrition would have both short-term and long-term

consequences to both their parents and DR Congo in terms of family dominance and economic productivity of DR Congo^[1,11].

In DR Congo, a poor country with low economic income, famine being a humanitarian crisis that reigns in the country especially in rural areas^[1]. Armed conflicts and insecurity cause this humanitarian crisis of famine; a sufficient number of the population is in a situation of displacement, of which under-5 children are victims, and of which the number of cases of childhood problems is high in the rural regions of the country^[3,16]. This is evidenced in this present study, where we found a very high frequency of children suffering from acute malnutrition living in rural areas. A meta-analysis conducted in 2023 found that under-5 children who are internally displaced persons (IDP) from the African region are most vulnerable to malnutrition and stunting. This owes to the proximity of IDP camps to the conflicts or sometimes, being trapped within the conflict zones. The high vulnerability among IDPs may be due to non-adherence of the respective country to the international norms on IDPs^[18]. This aspect should be of particular concern for the Congolese government and law-enforcement agencies to safeguard the IDPs, especially under-5 children, from malnutrition. Another meta-analysis conducted in 2023 revealed that children from countries with a long duration of armed conflict, such as DR Congo, are 2.6 times more likely to suffer from wasting and malnutrition as compared to countries without armed conflicts^[19]. This further highlights the need to prioritize the physical health and development of young children by the global health authorities along with the Congolese government. Similarly, a scoping review conducted in 2023 identified the increased prevalence of malnutrition in IDP children under 5 and also highlighted the need to address the micronutrient deficiencies, most notably iron deficiency, which has consequently led to widespread anemia among this population and other important micronutrient deficiencies that stunt growth and physical development. This finding underscores the urgent need for targeted nutritional interventions tailored to the unique challenges faced by IDP children^[20]. In similar findings, countries like Botswana, Sudan, South-Africa, including Ghana and Nigeria (the most populous African country), battle with acute malnutrition among under-5 children^[17,21-24]. This is a big shame and mess for African leaders in the sense that acute malnutrition is a preventable condition. A systematic review conducted in 2024 had a key finding that Community Health Worker (CHW) models were cost-effective and feasible in the prevention, identification and management of child malnutrition. However, this study also revealed the dire need for further studies to assess the cost-effectiveness and feasibility of CHW models in prevention, identification, and management of child malnutrition in conflict affected regions such as DR Congo^[25]. A study by Gooding *et al.*^[20] in 2023 also identified gaps in caregiver knowledge regarding infant and child nutrition which signifies the vital role of nutrition education and awareness programs targeting the caregivers within these communities.

Marasmus and kwashiorkor are caused by calorie and protein deficiency. Marasmus-kwashiorkor (the mixed form) exhibits reduced protein levels. Acute malnutrition can manifest as marasmus which is non-edematous, which Michael *et al.*^[26] in South-Kivu observed in about 69% of all cases of acute malnutrition in their study and kwashiorkor (edematous in 23.8% of cases). These results are very different from this present study; (where the cases of kwashiorkor were higher in this study than the cases of Marasmus). The study by Michael and colleagues acknowledges

that clinical as well as immunological studies of children with kwashiorkor are not easy due to limited collection of clinical samples from these subjects. In addition, less cases of kwashiorkor were reported in study by Michael *et al.*^[26] as impoverished areas like DR Congo have less accessibility of research facilities and technologies. Moreover, higher cases of kwashiorkor than marasmus in this present study could be due to the high poverty level of the parents. The implication of this is that; children with kwashiorkor would be vulnerable to other common childhood problems like iron deficiency anemia (IDA), pellagra, vitamin A, B, C, D deficiencies^[17,21-24].

Ramírez Prada *et al.*^[27], in a descriptive retrospective study carried out on the files of 100 children in Colombia during the evaluation of the effectiveness of the WHO-HILA protocol in children hospitalized between January 2007 and December 2008 for acute malnutrition revealed that the frequency of marasmus was low compared to the frequency of kwashiorkor. These results are close to the results of this present study. According to Ramírez Prada and colleagues, the application of the WHO-HILA protocol has been associated with a reduction in morbidity and mortality in children with acute malnutrition. Therefore, it is recommended that this protocol be implemented in all hospitals treating children suffering from acute malnutrition^[27]. Kwashiorkor and marasmus are the two clinical syndromes of severe acute malnutrition. A depletion of vitamins and minerals has been observed in kwashiorkor compared to marasmus. An alteration of the intestinal tract and liver is characterized by edema and splenomegaly^[28].

The clinical signs, complications, and pathologies present in acute malnutrition were analyzed in this study. In comparison with the clinical signs highlighted in the literature, we noted edema, hepatomegaly, abdominal bloating, diarrhea, fever and weight loss as the common presentation symptoms. Body weight loss was also observed in a study by Löser Christian in Germany^[29]. Similarly, with respect to complications, we noted coma, shock, and mental disorders. Diseases associated with acute malnutrition in our study included gastroenteritis, severe sepsis, malaria, microcytic anemia, dermatosis, tuberculosis, and infections. These findings are in concurrence with the study of Kambale and colleagues. In their randomized study of 400 acutely malnourished children in DR Congo, diarrhea and pneumonia were the predominant co-morbid factors of acute malnutrition. As well as stunting in infancy reset long-term complications of acute malnutrition^[31]. High mortality rates could result from a combination of clinical signs, complications, and pathologies present in malnutrition among under-5 children, which could be more devastating to the parents, the family, and the society at large. Loss of a child in the world especially in Africa can cause psychological problems to the parents^[32].

In this study, we found that therapeutic milk (Food 75 and Food 100) with antibiotic therapy and local food supplements (soymilk) were used to manage acute malnutrition in under-5 children. In line with this finding, Sarfraz *et al.*^[33] in Pakistan showed that there was a reduction in the rates of severe and moderate acute malnutrition among Pakistani children following the use of specially formulated products such as ready-to-use therapeutic foods (a sachet of 500 kilocalories) and ready-to-use dietary supplements.

Similarly, Abebe *et al.*^[34], in their prospective cohort study in Ethiopia, which was based on 476 children under 5 suffering from acute malnutrition and conducted from September 2021 to

January 2022, revealed that during the transition and rehabilitation phase during the treatment of acute malnutrition, the children received therapeutic milk (Food 100) and ready-to-use therapeutic foods which promote weight gain. More so, many researchers have likewise described that therapeutic milk (Food 100 and Food 75) was vital in the management of acute malnutrition^[35–37]. There are a couple of significant reasons why ready-to-use therapeutic foods (RUTF) have been unable to tackle the issue of acute malnutrition in DRC. These are affordability and availability. For instance, peanut RUTF costs at least \$40 per child. The exorbitant cost of raw materials, shipment and manufacturing are major hurdles to increasing the availability of RUTF^[38].

Socioeconomic factors

The socioeconomic factors that contribute to malnutrition in children under 5 in the Democratic Republic of the Congo (DR Congo) are briefly discussed in the manuscript. Further investigation of household income, parental education, access to healthcare, and food security may yield insightful information for actions. Low parental education influences awareness of appropriate nutrition and childcare practices, whereas low household poverty restricts access to nutritious food and healthcare. Malnutrition rates are further exacerbated by food instability and inadequate access to healthcare treatments. Investigating these variables might help focus interventions, like community-based nutrition Programs, education campaigns to improve mother and child health, and economic support programs. Interventions can successfully lower the rate of malnutrition and enhance the general health and wellbeing of children in the Democratic Republic of the Congo by targeting these underlying variables, ultimately leading to better outcomes of families.

Limitation of the study

During the study period, we had many limitations in realizing this work, among them the loss of certain patient files yet recorded in the patient registers, the absence of several elements in the patient files that we prepared in our protocol, and poor access to the hospital's annual statistical data. The study's limitations encompass several key areas. Firstly, its reliance on data from a single rural hospital may hinder generalizability to urban areas or other regions within the Democratic Republic of Congo (DR Congo). Secondly, the retrospective design, based on hospital records, may overlook cases not seeking medical care, potentially underestimating acute malnutrition prevalence. Thirdly, missing data and incomplete documentation within patient files pose challenges to the study's comprehensiveness and accuracy. Accessing hospital records also encountered obstacles like incomplete documentation and inconsistencies, impacting data quality. Lastly, potential biases, including selection bias due to hospital-based sampling and reporting bias within records, could skew the findings' validity and limit their applicability to the broader population of malnourished children. These limitations underscore the need for caution in interpreting the study's conclusions and emphasize the importance of considering contextual factors in future research and interventions.

How this study might affect research, practice or policy?

This study presents current data on the prevalence of acute malnutrition among under-5 children and discusses the difficulty of providing children with a constant food intake due to massive displacements in areas where there is armed conflict and the inability of nutritional centers to take care for patients admitted for malnutrition due to lack of equipment.

What this study adds?

This present study revealed more understanding of problems associated with acute malnutrition in rural area of South Kivu province including common clinical characteristics of pediatric patients with severe or moderate acute malnutrition in rural hospital from the eastern region of the Democratic Republic of Congo and how to manage them.

What is already known on this topic?

Malnutrition is a major public health and child health problem, worldwide, especially in low-income countries like the Democratic Republic of Congo.

Conclusion and recommendations

AM remains a serious public health problem, as evidenced by various statistics from the WHO. Children are more vulnerable to the risk of acute malnutrition, and many children lose their lives because of this pathology, which can be preventable. An improvement of the living conditions of the population by the Congolese government is therefore necessary. The Congolese government should improve the living conditions of the Congolese by creating more lucrative jobs and improving the agricultural sector of the country while providing good food security to its population. These developments should be the actions that would allow good development of the country as well as limit the number of cases of malnutrition because of the development of the agricultural sector, which will make it possible to guarantee food security and healthy diets among the Congolese. Soymilk prepared by craftsmen in DR Congo is a good food supplement. A study conducted in South Kivu, DR Congo showed that high-quality complementary foods such as locally prepared soymilk can be utilized for improving health of infants and young children in adjunction to breastfeeding^[39]. Another study demonstrated that soya-based RUTF, in addition to being less expensive and more effective in treating anemia, was non-inferior to peanut and milk-based RUTF to treat severe acute malnutrition in children aged 6–59 months^[40]. Therefore, we recommend the Congolese government provide more farming incentives, funding, fertilizers, etc., for these farmers to enhance the abundance and availability of Soya in DR Congo, which will be useful in supplementing the diet of malnourished and healthy children living in rural areas of DR Congo.

Ethical approval

Ethical approval for this study (Ethical Committee Ref/ 0197/ CNES002/DPSK/2023) was provided by the Ethical Committee of the Faculty of Medicine, Official University of Bukavu.

Consent

Written informed consent was obtained from the patients' parents for publication and any accompanying images. A copy of the consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

Conception: A.A. and R.F.B. Design: C.B. Project administration: A.A. Supervisor: A.M.B. Funding acquisition: R.F.B. Resources: A.A. Visualization: C.B. Literature search: C.B. Provision of study materials or patients: R.F.B., V.F.B. Collection and assembly of data: F.M.O., M.M.C. and Collaborators. Data analysis and interpretation: D.B., M.O.O., A.A. and Collaborators. Software: M.O.O. Manuscript preparation: M.O.O., R.F.B. and A.A. Manuscript editing: A.A. Manuscript review: all authors. Final approval of manuscript: all authors.

Conflicts of interest disclosure

The authors declare that there no conflict of interest.

Research registration unique identifying number (UIN)

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Collaborators

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References

- [1] Akilimali A, Banga S, Oduoye MO, *et al.* Malnutrition among under-five children in Democratic Republic of the Congo: a plague of the health system. *Ann Med Surg* 2022;82:104260.
- [2] Rapport de deux (02) ans d'appui de l'OMS au Gouvernement de la République Démocratique du Congo dans la réponse à la COVID-19 (10 mars 2020 au 10 mars 2022) - Democratic Republic of the Congo | ReliefWeb [Internet]. Accessed 10 February 2024. <https://reliefweb.int/report/democratic-republic-congo/rapport-de-deux-02-ans-d-appui-de-l-oms-au-gouvernement-de-la-r>.
- [3] Murhima'Alika CC, Balemba GM, Lyabayungu PMB, *et al.* Human Milk output among mothers previously treated for severe acute malnutrition in childhood in Democratic Republic of Congo. *BMC Nutr* 2021;7:6.
- [4] Cazes C, Phelan K, Hubert V, *et al.* Simplifying and optimising the management of uncomplicated acute malnutrition in children aged 6–59 months in the Democratic Republic of the Congo (OptiMA-DRC): a non-inferiority, randomised controlled trial. *Lancet Glob Health* 2022; 10:e510–20.
- [5] Karim MR, Al Mamun ASM, Rana MM, *et al.* Acute malnutrition and its determinants of preschool children in Bangladesh: gender differentiation. *BMC Pediatr* 2021;21:573.
- [6] Ghimire U, Aryal BK, Gupta AK, *et al.* Severe acute malnutrition and its associated factors among children under-five years: a facility-based cross-sectional study. *BMC Pediatr* 2020;20:249.
- [7] Uauy R, Desjeux J, Ahmed T, *et al.* Global efforts to address severe acute malnutrition. *J Pediatr Gastroenterol Nutr* 2012;55:476–481.
- [8] Puett C, Sadler K, Alderman H, *et al.* Cost-effectiveness of the community-based management of severe acute malnutrition by community health workers in southern Bangladesh. *Health Policy Plan* 2013;28: 386–399.
- [9] Nguéfack F, Adjahoung CA, Keugoung B, *et al.* Prise en charge hospitalière de la malnutrition aigue sévère chez l'enfant avec des préparations locales alternatives aux F-75 et F-100: résultats et défis. *Pan Afr Med J* 2015;21:329.
- [10] Mathew G, Agha R, Albrecht J, *et al.* STROCCS 2021: Strengthening the reporting of cohort, cross-sectional and case-control studies in surgery. *Int J Surg Open* 2021;37:100430.
- [11] Bavurhe RF, Akilimali A, Muhoza B, *et al.* What are the challenges and the possible solutions to fight Malaria in the Democratic Republic of Congo? *New Microbes New Infect* 2023;54:101160.
- [12] Abintegenke AI. The unfavorable factors for exclusive breastfeeding in The Albert Bartel Health Area, Karisimbi Health Zone, Goma; Democratic Republic of the Congo. *Br J Multidiscip Adv Stud* 2023;4: 149–65.
- [13] Kandala NB, Madungu TP, Emina JB, *et al.* Malnutrition among children under the age of five in the Democratic Republic of Congo (DRC): does geographic location matter? *BMC Public Health* 2011;11:261.
- [14] Kismul H, Hatløy A, Andersen P, *et al.* The social context of severe child malnutrition: a qualitative household case study from a rural area of the Democratic Republic of Congo. *Int J Equity Health* 2015;14:47.
- [15] Luzingu JK, Stroupe N, Alaofe H, *et al.* Risk factors associated with under-five stunting, wasting, and underweight in four provinces of the Democratic Republic of Congo: analysis of the ASSP project baseline data. *BMC Public Health* 2022;22:2422.
- [16] Behl R, Ali S, Altamirano J, *et al.* Rebuilding child health in South Kivu, Democratic Republic of Congo (DRC): evaluating the Asili social enterprise program. *Confl Health* 2022;16:21.
- [17] Health and nutrition | UNICEF Botswana [Internet]. Accessed 10 February 2024. <https://www.unicef.org/botswana/health-and-nutrition>
- [18] Choudhary P, Padhi BK, Mital AK, *et al.* Prevalence of stunting among under-five children in refugee and internally displaced communities: a systematic review and meta-analysis. *Front Public Health* 2023;11: 1278343.
- [19] Azanaw MM, Anley DT, Anteneh RM, *et al.* Effects of armed conflicts on childhood undernutrition in Africa: a systematic review and meta-analysis. *Syst Rev* 2023;12:46.

- [20] Gooding C, Musa S, Lavin T, *et al.* Nutritional challenges among African refugee and internally displaced children: a comprehensive scoping review. *Children* 2024;11:318.
- [21] Malnutrition in Sudan | UNICEF Sudan [Internet]. Accessed 10 February 2024. <https://www.unicef.org/sudan/malnutrition>
- [22] Govender I, Rangiah S, Kaswa R, *et al.* Malnutrition in children under the age of 5 years in a primary health care setting. *South Afr Fam Pract* 2021; 63:e1–6.
- [23] Poor diets damaging children’s health worldwide, warns UNICEF [Internet]. Accessed 10 February 2024. <https://www.unicef.org/ghana/press-releases/poor-diets-damaging-childrens-health-worldwide-warns-unicef>
- [24] Nutrition | UNICEF Nigeria [Internet]. Accessed 10 February 2024. <https://www.unicef.org/nigeria/nutrition>
- [25] Bridge R, Lin TK. Evidence on the impact of community health workers in the prevention, identification, and management of undernutrition amongst children under the age of five in conflict-affected or fragile settings: a systematic literature review. *Confl Health* 2024;18:16.
- [26] Michael H, Amimo JO, Rajashekara G, *et al.* Mechanisms of Kwashiorkor-associated immune suppression: insights from human, mouse, and pig studies. *Front Immunol* 2022;13:826268.
- [27] Ramírez Prada D, Delgado G, Hidalgo Patiño CA, *et al.* Using of WHO guidelines for the management of severe malnutrition to cases of marasmus and kwashiorkor in a Colombia children’s hospital. *Nutr Hosp* 2011;26:977–83.
- [28] Pham TPT, Alou MT, Golden MH, *et al.* Difference between kwashiorkor and marasmus: comparative meta-analysis of pathogenic characteristics and implications for treatment. *Microb Pathog* 2021;150:104702.
- [29] Löser C. Ursachen und Klinik der Mangelernährung. *Ther Umsch* 2014; 71:135–9.
- [30] Kambale RM, Ntagazibwa JN, Kasengi JB, *et al.* Probiotics for children with uncomplicated severe acute malnutrition (PruSAM study): a randomized controlled trial in the Democratic Republic of Congo. *Am J Clin Nutr* 2023;117:976–84.
- [31] Thompson DS, Francis-Emmanuel PM, Barnett AT, *et al.* The effect of wasting and stunting during severe acute malnutrition in infancy on insulin sensitivity and insulin clearance in adult life. *J Dev Orig Health Dis* 2022;13:750–6.
- [32] The death of a child is a devastatingly common experience for many African mothers [Internet]. USC Today. 2020. Accessed 10 February 2024. <https://today.usc.edu/child-loss-mortality-rates-african-mothers/>
- [33] Sarfraz A, Ahmed S, Muhammad S, *et al.* Standard RUTF vs. locally-made RUSF for acutely malnourished children: a quasi-experimental comparison of the impact on growth and compliance in a rural community of Pakistan. Vousden G, editor. *PLOS ONE* 2023;18: e0287962.
- [34] Abebe A, Simachew Y, Delbiso TD. Effect of ready-to-use therapeutic foods on time to recovery among children with severe acute malnutrition in Ethiopia: a prospective cohort study. *BMC Pediatr* 2023;23:340.
- [35] Kidane GF, Zereabruk K, Aberhe W, *et al.* Time to recovery from severe acute malnutrition and its predictors among under five children admitted to therapeutic feeding units of general and referral hospitals in Tigray, Ethiopia, 2020: a prospective cohort study. *BMC Pediatr* 2023;23:325.
- [36] Kangas ST, Coulibaly IN, Tausanovitch Z, *et al.* Post-recovery relapse of children treated with a simplified, combined nutrition treatment protocol in mali: a prospective cohort study. *Nutrients* 2023;15:2636.
- [37] Rashid MA, Rahman ME, Kamruzzaman M, *et al.* Efficacy of F-75 & F-100 recipes in the treatment of severe acute malnutrition: a randomized controlled trial. *Mymensingh Med J MMJ* 2019;28:887–93.
- [38] Akinmoladun OF, Bamidele OP, Jideani VA, *et al.* Severe acute malnutrition: the potential of non-peanut, non-milk ready-to-use therapeutic foods. *Curr Nutr Rep* 2023;12:603–16.
- [39] Owino VO, Bahwere P, Bisimwa G, *et al.* Breast-milk intake of 9–10-month-old rural infants given a ready-to-use complementary food in South Kivu, Democratic Republic of Congo. *Am J Clin Nutr* 2011;93:1300–4.
- [40] Bahwere P, Akomo P, Mwale M, *et al.* Soya, maize, and sorghum-based ready-to-use therapeutic food with amino acid is as efficacious as the standard milk and peanut paste-based formulation for the treatment of severe acute malnutrition in children: a noninferiority individually randomized controlled efficacy clinical trial in Malawi. *Am J Clin Nutr* 2017; 106:1100–12.