

Comparative Efficacy of Local Specialized Food Products (PASloc) and Plumpy'Nut in the Nutritional Rehabilitation of Children with Severe Acute Malnutrition in Côte d'Ivoire

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Abstract

Original Research Article

Objective: To evaluate the comparative efficacy of commercially produced Specialized Food Products (SFPs), particularly Plumpy'Nut, and Local Specialized Food Products known as PASloc, (PREMIX made from millet and corn) in the nutritional rehabilitation of children with Severe Acute Malnutrition (SAM) without complications, who are being treated at the Treichville University Hospital (TUH) in Abidjan. **Methods:** A descriptive cross-sectional study was conducted over two months among 126 children aged 0 to 59 months admitted to the Outpatient Therapeutic Nutrition Unit (OTNU). Anthropometric parameters (WHO Z-scores for weight-for-height) were measured at admission and during weekly follow-up. Children with SAM received either Plumpy'Nut or PASloc PREMIX. Recovery rates were compared according to WHO standards. **Results:** The overall prevalence of acute malnutrition was 54%, including 17.5% with Severe Acute Malnutrition (SAM) and 36.5% with moderate malnutrition. Boys were more affected (59.1%) than girls (40.9%). The protein content of PASloc was comparable to that of Plumpy'Nut, but the fat, vitamin, and mineral content was lower. The nutritional recovery rate was 61.54% with Plumpy'Nut compared to 38.46% with PASloc. No deaths were recorded, but ten cases of dropouts were observed. **Conclusion:** Severe acute malnutrition remains a critical problem in Côte d'Ivoire, with a hospital prevalence rate well above the WHO threshold. Commercial therapeutic food products, enriched with micronutrients, ensure more effective rehabilitation than locally produced formulations. However, optimizing locally produced therapeutic foods through vitamin and mineral supplementation could make them a sustainable alternative in the event of stock shortages or economic constraints.

Keywords: Severe acute malnutrition, Plumpy'Nut, Local specialized food products (PASloc), Nutritional rehabilitation, Ivory Coast.

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INTRODUCTION

Nutrition encompasses all the metabolic processes that enable the body to transform and utilize food to ensure its functioning and survival (National Nutrition Committee [NNC], 2015). Malnutrition, defined as a mismatch between dietary intake and nutritional needs, includes both overnutrition and undernutrition. The latter, resulting from insufficient food intake, malabsorption, or limited biological utilization of nutrients, manifests as stunted growth, acute malnutrition, underweight, and micronutrient deficiencies (NNC, 2015).

In West Africa, malnutrition remains a major public health problem, accounting for approximately three million annual deaths among children under five (Sokol, *et al*, 2007). In Côte d'Ivoire, nearly 8% of children under five suffer from acute malnutrition, 2% of whom are severely malnourished (National Institute of Statistics [NIS] & ICF International, 2012). Despite international commitments related to the Sustainable Development Goals aimed at halving the prevalence of malnutrition (Amarakoon, 2017), progress remains limited.

The introduction of Specialized Food Products (SFPs), such as Plumpy'nut, Plumpy'sup, and the

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therapeutic formulations F75 and F100, has transformed the management of Severe Acute Malnutrition (SAM) by promoting rapid nutritional rehabilitation, often at home (Food and Agriculture Organization [FAO], 2006). However, in Côte d'Ivoire, the prevalence of acute malnutrition has remained stable at around 7% for more than a decade, due in particular to limited access to SPFs and frequent stockouts (CNN, 2015). To address these shortcomings, the national nutrition policy now encourages the use of locally produced Specialized Food Products (PASloc).

The central question is whether these PASloc meet the nutritional needs of children with Severe Acute Malnutrition (SAM) and whether their acceptability among mothers is sufficient to ensure their effectiveness. This study aims to analyze the effectiveness of SPFs and PASloc within the national protocol for the nutritional rehabilitation of children with severe acute malnutrition without complications, by assessing the prevalence of different forms of malnutrition and the impact of these products on nutritional rehabilitation within the pediatric department of the Treichville University Hospital in Abidjan.

I. MATERIAL AND METHODS

Study Context

This research is part of a descriptive, cross-sectional study on Severe Acute Malnutrition (SAM) in children under five years of age. The study was conducted at the Treichville University Hospital (TUH), in the Outpatient Therapeutic Nutrition Unit (OTNU), a facility dedicated to the care of SAM cases without medical complications.

Study Site

The OTNU is part of the pediatrics department at the Treichville University Hospital. It provides nutritional rehabilitation at home through an adapted diet based on the use of Specialized Food Products (SFPs) and local products (PASloc). The unit is staffed by a multidisciplinary team comprising a nurse, two midwives, a pediatric nurse, and a nursing assistant. It also has a fully equipped kitchen (stove, sink, storage cabinet, utensils, and a refrigerator for vaccines) used for the preparation and storage of therapeutic foods.

Study Population

The study was conducted over a two-month period (July–August) and included children aged 0 to 59 months admitted to the OTNU. Children who were hospitalized or older than 59 months were excluded.

Inclusion and Exclusion Criteria

- Inclusion: children aged 0 to 59 months admitted to the OTNU.
- Exclusion: hospitalized children and those older than 59 months.

Variables Studied

The variables included were: age, sex, height, and weight-for-height (W/H) expressed as a Z-score according to WHO standards, measured at admission and discharge.

Supplemental Foods

PAS (Specialized Food Products):

The main product used was Plumpy'Nut, a ready-to-eat, high-calorie paste (92 g per 500 kcal), intended for children over six months of age suffering from uncomplicated Severe Acute Malnutrition (SAM). Its composition includes sugar, vegetable fats, peanuts, skim milk powder, whey, stabilizers, minerals, and vitamins.

PASloc (Local Specialized Food Products) : PREMIX blends made from corn and millet were used for nutritional rehabilitation.

Technical Equipment

The equipment used included:

- A locally made wooden height rod for measuring height.
- A Seca Clara 803 medical scale with a tare function for measuring weight.
- Z-score (WHO) weight-for-age and height-for-age charts for assessing nutritional status.
- Growth charts for longitudinal monitoring.
- Kitchen utensils (pots, spoons, ladles) for food preparation.

METHODS

Anthropometric Measurements

Body Weight

Body weight measurement in children is based on standardized protocols to ensure data reliability. For children under two years of age, the “tare” method is used: the mother steps onto the scale, then the tare function is activated before the child is placed in her arms. The weight displayed then corresponds to the child's weight. For children over two years of age who are able to remain still, weight is measured directly while standing. If the child is restless or unable to remain still, the tare method is also used (World Health Organization [WHO], 2006).

Height

Height measurement depends on the child's age and stature. Children under two years of age, or those shorter than 87 cm, are measured while lying down on a wooden measuring board, in accordance with WHO recommendations. Children aged two years or older, or those measuring at least 87 cm, are measured while standing, looking straight ahead (WHO, 2006; UNICEF, 2019).

Management Protocol for Severe Malnutrition

Initial Diagnosis

Upon admission, anthropometric measurements are used to calculate the weight-for-height (W/H) indices and the corresponding Z-scores. The clinical evaluation includes screening for bilateral edema, anorexia, respiratory infections, fever, hypothermia, severe dehydration, severe anemia, open skin lesions, and level of consciousness. Children with severe acute malnutrition and complications are referred to a Therapeutic Feeding Unit (TFU) for hospitalization, while those without complications or with moderate acute malnutrition are managed on an outpatient basis at an Outpatient Therapeutic Feeding Unit (OTFU) or a Nutritional Supplementation Center (NSC) (WHO, 2013).

Appetite Test

The appetite test is conducted in a quiet environment, after the child's hands and mouth have been washed. The child is placed on the mother's lap and given Plumpy'Nut (ready-to-use therapeutic food, RUTF), encouraged but not forced to eat. Water is offered regularly. The test takes less than an hour, and the amount consumed is estimated (WHO, 2013; Collins *et al.*, 2006).

Nutritional treatment of severely malnourished children without complications

Specialized food products

Plumpy'Nut: A ready-to-use therapeutic food, administered daily in five meals. No other foods are recommended during treatment, but breastfeeding should continue on demand for children under two years of age (Briend *et al.*, 1999).

PASloc (Local Specialized Food Products): Prepared from mixtures of corn, millet, cane sugar, oil, and water, without the addition of mineral or vitamin premixes. Preparation includes sorting, washing, soaking, grinding, drying, sifting, and roasting (except for soybeans). The dosage is 6 to 8 meals per day (UNICEF, 2019).

Monitoring and Recovery Criteria

Anthropometric parameters are checked weekly. Nutritional recovery is generally achieved within two to three weeks. A child is considered recovered when their weight-for-height ratio reaches -1

standard deviation from the median of the NCHS/WHO reference (WHO, 2000).

Statistical Analysis

The data collected as part of this study were processed and analyzed using Excel 2016, which was used to enter, clean, and format the results. Descriptive analyses were presented in the form of tables, figures, pie charts, and histograms, providing a clear and concise visualization of the observed trends.

The nutritional value of PASloc PREMIX was calculated by taking the average of the nutritional values of the PREMIX Mil and PREMIX Maïs formulations, for which data are available from local health workers. The nutritional value of Plumpy'Nut was obtained from information provided by the Edesia therapeutic food production site (2016). This comparative approach allows PASloc PREMIX to be situated within a recognized nutritional framework, thereby facilitating the evaluation of its effectiveness in interventions to combat malnutrition.

II. RESULTS

Prevalence of Malnutrition Among Children Aged 0 to 59 Months

During the study period (July–August), 126 children aged 0 to 59 months were seen at the Outpatient Therapeutic Nutrition Unit (UNTA). An assessment of their nutritional status revealed that 42.1% of the children were in good nutritional status (BEN), 4% were overweight, and 54% suffered from acute malnutrition (AM). Of the latter, 17.5% had severe acute malnutrition (SAM) and 36.5% had moderate acute malnutrition (MAM).

Regarding therapeutic management, children with SAM were treated with either PREMIX (n = 8) or Plumpy'Nut (n = 14), in accordance with the protocols recommended by the World Health Organization. (Table I)

Distribution of Severe Acute Malnutrition by Sex

An analysis of the distribution of MAS by sex shows a predominance among males, with 59.1% of cases observed in boys compared with 40.9% in girls, for a sex ratio of 1.4. (Figure 1)

Table I: Distribution of Children by Weight-for-Height Index

Weight-Height	Number of children	Prevalence rate (%)
Normal Nutritional Status	53	42,1
Overweight	5	4
Severe Malnutrition	22	17,5
Moderate Malnutrition	46	36,5
Total	126	100

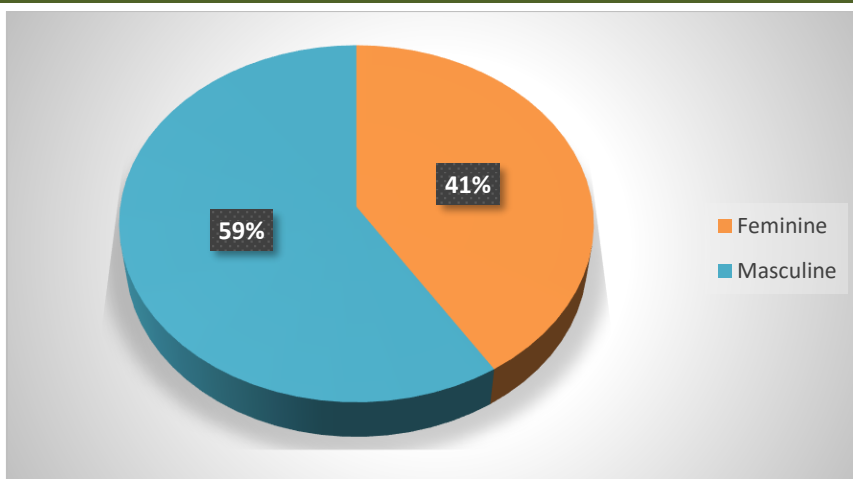


Figure 1: Distribution of Severe Acute Malnutrition by Gender

Nutritional Efficacy of Different PAS:

Nutritional Value of Plumpy'Nut and PASloc Millet-and-Corn Premix

A comparison of the nutritional value between Plumpy'Nut and the millet- and corn-based PASloc PREMIXes shows that the protein content of the

PREMIXes (13.95g and 12g per 100 g) is relatively close to that of Plumpy'Nut (14g per 100g). However, the fat, carbohydrate, mineral, and vitamin contents of the PREMIXes remain lower than those of Plumpy'Nut, which is considered the standard of care for the management of severe acute malnutrition (**Table II**).

Table II: Nutritional Values of Various Food Products

Nutritional Information per 100 g of food	PASloc PREMIX	Plumpy'Nut
Calories (kcal)	419,45 ± 18,17	500
Protein (g)	13,95 ± 0,21	12
Fat (g)	21,70 ± 1,41	30
Carbohydrates (g)	38,60 ± 0,57	45
MINERALS		
Calcium (mg)	42,45 ± 40,09	332
Magnesium (mg)	157,05 ± 70,92	81
Phosphorus (mg)	252,30 ± 27,86	293
Potassium (mg)	618,65 ± 9,12	1239
Sodium (mg)	8,80 ± 1,70	245
Zinc (mg)	2,15 ± 0,35	12
Copper (mg)	0,45 ± 0,07	1,6
Iron (mg)	5,05 ± 1,49	11
VITAMINS		
Vitamin A (µg)	13,20 ± 0,00	1100
Folic acid (µg)	43,90 ± 0,00	231
Vitamin D (µg)	0,00 ± 0,00	18

Nutritional Rehabilitation Outcomes for Children with Severe Acute Malnutrition (SAM)

Follow-up of children with severe acute malnutrition (SAM) shows that the recovery rate with

PREMIX is 38.46%, significantly lower than that achieved with Plumpy'Nut (61.54%). Although no deaths were recorded, ten cases of dropouts were observed during the study. (**Table III**)

Table III: Summary of the Rehabilitation of Malnourished Children Using Food Products

	PREMIX	Plumpy'Nut	Total
Number of children monitored	8	14	22
Frequency (%)	36,4	63,6	100
Cases of abandonment	0	5	5
Cases of death	0	0	0
Number of children rehabilitated	(5) 38,46 %	(8) 61,54%	(13) 100%

III. DISCUSSION

This study, conducted among 126 children admitted to the Outpatient Therapeutic Nutrition Unit (OTNU) at the Treichville University Hospital (TUH), reveals a prevalence of acute malnutrition of 54 percent, including 17.5 percent severe cases and 36.5 percent moderate cases. These results corroborate previous data indicating a high prevalence of acute malnutrition in sub-Saharan African countries, where rates can exceed 10% in certain regions (Black *et al.*, 2013; UNICEF, 2021). This rate far exceeds the critical threshold of 15% set by the World Health Organization (WHO), indicating a high risk of morbidity and mortality (WHO, 2000). By way of comparison, the national prevalence of acute malnutrition among children under five in Côte d'Ivoire was estimated at 7.5% in 2012 (INS & ICF, 2012), which is seven times lower than that observed in our hospital cohort.

These results corroborate the findings of Coulibaly. (2009), who reported a prevalence of 89% in a hospital setting, as well as those of Diallo and Camara (2009), who reported a prevalence of 69.35%. The discrepancy between hospital data and data from the general population can be explained by the fact that hospitalized children already have underlying medical conditions, which exacerbate their nutritional vulnerability (Renner & Andrianasolo, 2014). Furthermore, the small sample size and the limited duration of the study (two months) limit the representativeness of the results.

Another key finding is the gender disparity: boys are more affected (59.1%) than girls (40.9%), with a sex ratio of 1.4. This male predominance in severe malnutrition is consistent with previous studies suggesting that boys are more vulnerable to infections and nutritional deficiencies, leading to higher male mortality. Malnutrition thus appears to be an aggravating factor in this excess mortality (Wamani *et al.*, 2007). Biological and sociocultural differences may explain this disparity, particularly differing dietary practices and immune susceptibility (Prentice, 2017).

With regard to nutritional rehabilitation, local Specialized Food Products (PASloc) have protein contents comparable to those of Plumpy'Nut, the benchmark product. However, differences in micronutrients and energy content account for the performance gaps: 61.54% recovery with Plumpy'Nut versus 38.46% with PASloc after three weeks. These results confirm that, despite some effectiveness, PREMIX products remain less effective than Plumpy'Nut in the nutritional rehabilitation of children with severe acute malnutrition (MAS) (Sandige *et al.*, 2004; UNICEF, 2019; Manary *et al.*, 2004). On the other hand, the magnesium content is higher in the PASloc premix, which could constitute a specific nutritional advantage (Briend *et al.*, 2015). This finding confirms the results reported by Egnon *et al.* in 2016, who

formulated test diets richer in energy and micronutrients by adding vegetable oil and combining rice with fish—sources of calcium, zinc, potassium, and magnesium.

Soy, an ingredient in PASloc, contains phytic acid, which inhibits the absorption of essential minerals such as calcium and iron (Vesanto *et al.*, 1996). This malabsorption could explain the average rehabilitation rate observed. Furthermore, the PASlocs used at Treichville University Hospital were not fortified with vitamins and minerals, unlike in the trials conducted in Man and Korhogo, where recovery rates were close to 100%. This deficiency, combined with inadequate roasting practices that can reduce nutritional value (Saskia & Annoek, 2005), as well as the mothers' economic constraints, helps explain the dropouts and mixed results.

Finally, according to the National Nutrition Program (PNN, 2010), the limitations observed in nutritional rehabilitation with PASloc may also be linked to malabsorption, regurgitation, or underlying medical conditions (congenital anomalies, neurological disorders).

IV. CONCLUSION

This study evaluated the care provided to children with severe acute malnutrition in the Pediatrics Department of Treichville University Hospital, a referral center for the National Nutrition Program (PNN). The therapeutic approach relied on the use of Specialized Food Products (PAS) such as Plumpy'Nut, as well as Local Specialized Food Products (PASloc, PREMIX), administered to children without major medical complications.

The results highlight several key findings:

- The observed prevalence of severe acute malnutrition is significantly higher than the critical threshold defined by the World Health Organization.
- The rate of nutritional recovery among children treated with PASloc remains low, suggesting limitations in the effectiveness of these local formulations.
- The identified causes include an imbalance in micronutrient intake, inadequate preparation practices by mothers when using PASloc, as well as physiological factors specific to the child's metabolism.

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