Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 7 Issue 1 January 2023

Research Article

Complementary Feeding Practices Associated with Malnutrition in Children Aged 6-23 Months in the Tshamilemba Health Zone, Haut-Katanga, DRC, 2021

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DOI: 10.31080/ASNH.2022.06.1163

Received: November 29, 2022

Published: December 02, 2022

Abstract

Objective: The objective of this study was to assess the strength of association between inappropriate complementary feeding practices and malnutrition in children aged 6-23 months in the Tshamilemba health zone in Haut Katanga, DRC.

Method: In a cross-sectional household survey, using multistage random sampling, we assessed 575 mother-child pairs 6-23months. We recruited and trained supervisors from among the Assistant Nutritionists and interviewers from among the Community Relays. We used Excel for data entry and ENA for Smart, SPSS, and Open Epi for analysis.

Results: Malnutrition (chronic, acute, and underweight) was commonly observed twice as much in children whose complementary diet was non-diversified than in those who consumed the diversified complementary diet (RP = 2.025 CI: 1.326-3.143; RP = 2.152 CI : 1.436-3.219 and RP = 2.221 CI : 1.013-5.468). In addition, acute malnutrition was twice as prevalent among children whose mothers did not practice minimal handwashing (PR = 2.633 CI : 1.784-3.891), among those whose households used unimproved toilets (PR = 2.284 CI : 1.535-3.395), but also among male children (PR = 2.48 CI : 1.332-4.783), and three times more among those born to unmarried mothers (PR = 3.268 CI : 2.060-5.186). Underweight was about three and four times more prevalent in male children (PR = 2.978 CI : 1.561-5.944) and in children who were not optimally breastfed (3.934 CI : 1.501-13.080), but four and three times more prevented respectively among children whose households had a high socioeconomic level (PR = 0.228 CI : 0.118-0.453) and among those whose mothers had attended antenatal care (PR = 0.339 CI : 0.143-0.881).

Conclusion: Poor complementary feeding practices are potential causes of all forms of deficiency malnutrition in children 6-23 months. Sustainable local solutions must be envisaged by designing recipes based on nutritional principles, and on avthe ailability, accessibility, and acceptance of ingredients in every area.

Keywords: Socio-Demographic Characteristics; Haut-Katanga; Malnutrition; Complementary Feeding Practices; DRC; Tshamilemba Health Zone

Introduction

Maternal and child nutrition during the first 1000 days of life, from conception to the child's second birthday, is an issue that has been identified as a priority program for Unicef to guide its strategies between 2020 and 2030. The aim is to provide optimal breastfeeding (OBF), including exclusive breastfeeding (EBF) for the first six months of birth followed by continuous breastfeeding (CBF) with complementary feeding (CF) from 6 months to two

years or beyond, in both development and humanitarian contexts [1]. During this first 1,000-day period, the child may be affected by acute malnutrition, which can lead to mortality (due to decreased immunity) or stunting if the child consumes insufficient amounts of poor-quality complementary foods for a long time, even if the child had received optimal breastfeeding [2-4]. In their global strategy, the World Health Organization (WHO) and the United Nations Children's Fund (Unicef) recommend the use of locally produced foods as complementary foods for infants and young children to ensure optimal complementary feeding for their optimal growth, development and well-being [5-7]. Despite the WHO recommendations on infant and young child feeding (IYCF) on the one hand and several improvements in child health on the other, malnutrition is still a major public health concern.

In 2020, the triple burden of malnutrition was still a major public health problem, especially in low- and middle-income countries (LMICs). In LMICs, about 200 million children are affected by stunting or wasting and almost twice as many children are deficient in vitamins and other essential micronutrients. Overweight and obesity are increasing in the poorest households at the same time. Together, undernutrition (stunting and wasting), widespread micronutrient deficiencies and high prevalence of overweight and obesity constitute the triple burden of malnutrition in children worldwide [1]. Globally, 149.2 million children under five are stunted, 45.4 million are wasted and 38.9 million are overweight. Over 40% of all men and women (2.2 billion people) are now overweight or obese. Some countries are making encouraging progress. For example, of the 194 countries assessed, 105 are on track to meet the target for child overweight and more than a quarter are on track to meet the targets for stunting and wasting. However, anaemia levels have stagnated or even worsened in 161 countries [8].

In 2016, acute malnutrition affected almost 51.5 million children under 5 years of age worldwide and was a attributed cause to 12.6% of 6.9 million deaths, with more than one-third linked to inadequate complementary feeding. Nineteen million of these 51.5 million children were severely affected and at higher risk of mortality, the vast majority in sub-Saharan African countries [9]. Inadequate complementary feeding (CF) and worrying childcare practices remain a challenge in many households, particularly in low-and middle-income countries [10]. At the same time, food insecurity as an underlying cause of malnutrition was reported in approximately 80 million households in 2015 and 108 million households in 2016 [11].

The Democratic Republic of Congo (DRC) is one of the 34 countries in the world with the highest prevalence of malnutrition. Almost one in two children under 5 is stunted [12]. Approximately 600,000 children under five die each year as a result of malnutrition. Nearly 35528 children under 5 years of age suffering from severe acute malnutrition were under treatment, including 2401 in the Intensive Therapeutic Nutritional Units (ITNU), and 33127 in the Ambulatory Therapeutic Nutritional Units (ATNU) in October 2019 [13].

In the DRC 857,000 children under 5 years of age were emaciated, of whom 26%, or 21,900 children, were in a severe form, and 468,000 pregnant and breastfeeding women were in a state of acute malnutrition [14]. It has been estimated that nearly 900,000 children under five and more than 400,000 pregnant and lactating women were likely to be acutely malnourished until August 2022 for the 70 health zones analysed by the technical working group out of a total of 519 health zones. These estimates included more than 200,000 severely malnourished children requiring urgent care. This precarious nutritional situation is the result of a combination of several factors, mainly, poor feeding quality due to poor child feeding practices (ANJE), acute food insecurity, high prevalence of childhood diseases (malaria and diarrhoea) and measles and cholera outbreaks, poor hygiene conditions (inaccessibility to adequate sanitation facilities), very low coverage of access to drinking water, and the negative effects of the security situation which leads to massive population displacement [14].

According to WHO recommendations, by the 6th month of life, breast milk becomes quantitatively insufficient to meet the nutritional needs of children. In the Pacific Region of Asia, 9 studies had shown early initiation of complementary foods compared to the recommendations of [15]. On the South Indian coast, 68% of mothers who initiated complementary feeding at 6 months of age gave an inadequate and nutrient-poor amount [2]. Africa is not immune to the nutritional problems associated with complementary feeding. In Ethiopia, about 60% of children were introduced to CFs at 6 months of age. And the mean prevalence of introducing complementary foods at the recommended age of 6 months was associated ($p < 0.007$) with the high level of education of the children's mothers [16].

In DRC, the Demographic and Health Survey (DHS) and the MICS 2018 survey showed that the prevalence of chronic malnutrition was 43% and 42% respectively and that national indicators of complementary feeding practices were below the 80% coverage recommended by [12,17,18]. This is despite multiple trainings and interventions carried out by the National Nutrition Programme (PRONANUT) in DRC every year for decades. Several authors have highlighted complementary feeding as one of the main causes that

potentially impact on nutritional status worldwide and in Africa [10,19,20]. However, studies on the measures of association between complementary feeding practices and the nutritional status of children aged 6-23 months in Haut-KATANGA in DRC are still insufficient and much needed.

The objective of this study was to assess the associative power between inappropriate complementary feeding practices and malnutrition in children aged 6-23 months in the Tshamilemba HZ, Upper Katanga, DRC.

Specifically, the study aimed to 1° identify the complementary feeding habits, formulas or mixtures of local food products known and used by mothers/caretakers as complementary foods; 2° determine the prevalence of inadequate complementary feeding practices of mothers towards their children aged 6-23 months; 3° determine the nutritional status of children aged 6-23 months; and 4° assess the associative power of complementary feeding practices and socio-economic-demographic characteristics with the nutritional status of mother-child pairs 6-23 months.

Methods

Study setting

This study was conducted in the Democratic Republic of Congo, Haut Katanga Province, in the Tshamilemba Health Zone. This health zone is one of the 11 health zones of the former Health District of Lubumbashi resulting from the 2004 division. It is one of the four sister health zones resulting from the division of the Kampemba health zone. At the time of our investigations in August-September 2021, its total population was 28,3944, spread over 15 functional health areas. The main health problems were endemic malaria, recurrent measles epidemics and high mortality due to malnutrition, of which chronic malnutrition accounted for 40%, acute malnutrition for 6.5% and underweight for 20.8% [12]. The main staple foods commonly consumed in the health zone were maize, rice, vegetables, beans, groundnuts, soybeans and many foods imported from border countries. The mining boom has led to an exodus of people from Haut Katanga province, resulting in reduced local food production, dependence on imported food from Zambia, Tanzania or South Africa (border countries) and severe acute food insecurity of 16% [21].

Study design

We conducted a cross-sectional descriptive observational study through a household survey from August to September 2021. Five hundred and seventy-five (575) mother-child pairs 6-23 were assessed on complementary feeding (CF) practices, habits of local food mixtures known and used as CF locally and on the nutritional status of their children aged 6-23 months.

Sampling

The ENA software for SMART software, version 2011 updated in 2015 and the following formula $n \geq Z2.P.Q/d2$ had allowed us to determine our minimum sample size which should be = $n \geq 428$ mother-child pairs from 6 to 23 months. The calculations of this minimum sample size considered Z = 1.96; P = 40% (prevalence of stunting in Haut Katanga [12]; Q = 60% and d = 0.05 and a correction factor of 20% (for refusals, erroneous data and incomplete questionnaires). For practical purposes and to increase the power of the study, we assessed 575 mother-child pairs in the Tshamilemba health zone.

Sampling techniques

We used a probability sample, giving each mother-child couple aged 6-23 months the same chance to participate in our study. We conducted the household survey using a multistage random sample. The health zone of Tshamilemba was selected by simple random sampling among the 11 health zones of the former Health District of Lubumbashi (1st stage). Six hundred mother-child pairs were planned for the study and surveyed.

Ten health areas out of the 15 in the health zone were selected by simple random sampling (stage 2). Per health area, 60 mother-child pairs participated in the study (600/10 AS = 60). Six avenues per health area, selected by simple random sampling, hosted our investigations (3rd stage). Per avenue, 10 households were assessed (60/6 avenue = 10 households/avenue). The 10 households were selected by Systematic Random Sampling (4th stage) with a sampling step PS = k = N/10; N = total households counted on the avenue. In each selected household, 1 mother-child pair 6-23 months was surveyed.

The first (1st) household to be surveyed on the avenue corresponded to the random number chosen between 1 and k or the value of k. On the avenue, the 10 children were assessed by anthropometry and the 10 mothers were interviewed about KT practices and socio-demographic and economic characteristics. After surveying the first household, the next household was selected by locating it at the number of the previously selected household plus the value of Survey (+ k). If the selected household did not have a targeted child or a targeted respondent, the interviewer selected the next household by systematic random sampling. The process continued until the required sample size was reached. Unavailable mother-child pairs were allowed 3 repeat visits after which the interviewer could decide to replace them with those from other households to be selected by the same process.

Study variables

We considered the following variables in our study.

Nutritional status: is a composite variable assessed from the following other variables

- Global acute malnutrition defined by weight-for-height index below -2 standard deviation (WHZ <-2)
- Global underweight defined by weight-for-age index less than -2 standard deviation (WAZ <-2)
- Chronic global malnutrition is defined by a height-for-age index below -2 standard deviation (HAZ <-2)
- The three variables or types of malnutrition have severe (WHZ <-3, WAZ <-3 and HAZ <-3) and moderate (-3 < WHZ <-2, -3 < WAZ <-2 and-3 < HAZ <-2,) forms.
- Age of introduction of solid, semi-solid foods: At the 6th month of age
- Minimum meal frequency (MMF): 2 times at 6 to 11 month, and 3 times at 12 to 24 months if EBFeed
- Minimum dietary diversity (MDD): If at least 4 food groups consumed
- Minimum acceptable diet (MAD): If 4 food groups consumed at the acceptable frequency for child's age
- Adequate supplementary feeding : If it is a minimum acceptable diet initiated at the 6th month of age
- Main source of drinking water supply: Protected or unprotected
- Type of toilets used by households: Improved or unimproved
- Minimum Practices Hand Washing (MPHW): if hands washing at at least 4 key moments
- Low birth weight (LBW): If born with less than 2,5kg
- Non-optimal breastfeeding (NOBF): If not exclusivelly breastfeed nor continu breastfeed
- Recurrent infection (RI): If the child had diarrhea in the last 14 days before our survey
- First weaning food given to the child: Type of food group
- Feed mix used by mothers given to the child locally
- Use of maize and soya (MASO) in the health zone
- Availability of maize and soya in the health zone

Data collection

Data collection was preceded by the recruitment of supervisors from among the Nutritionist Assistants of the ESP/UNILU and the ISTM/LSHI and interviewers from among the Community Relais in the health zone to guarantee the security of households at a time when insecurity was feared in the city of Lubumbashi.

We spent two days training on taking anthropometric measurements and on the administration of the household questionnaire that we pre-tested and revised during the pre-survey. The Head of Works, NGOY BULAYA Emmanuel, a nutritionist with a Master's degree in nutrition, was the trainer for this training, which ended with the standardization of anthropometric measurements and a pre-survey. Ten teams of two data collectors each were formed and supervised by five nutritionists during three days of investigation. During all stages of the study process, we took into account the barrier measures provided in the general methodology. Standardized tools : recommended by PRONANUT/DRC and WHO were obtained from the coordination of Pronanut Haut-Katanga and used in the data collection.

Data quality control measures

The quality of the data in this study was controlled and assured by several upstream and downstream measures, including.

- The two-day training organised prior to data collection and facilitated by aAbstract senior lecturer, MPH-Disease control, MPH-Nutrition and PhD student in Nutrition/UNILU.
- The use of a pre-tested and revised household questionnaire
- Standardisation of anthropometric measurements and pre-survey
- Field supervision to verify all data collected each day by Nutritionist Assistants from the Institut Supérieur des Techniques Médicales of Lubumbashi and the School of Public Health of the University of Lubumbashi.
- The collaboration and supervision of PRONANUT as well as the partnership with UNICEF which enabled us to obtain standardised anthropometric equipment.

Data management and analysis

All the data collected was encoded in Excel and then imported into SPSS IBM version 23 Computer. We calculated the anthropometric indices (LAZ, WLZ and WAZ) by ENA for Smart software before importing them into SPSS for descriptive and multivariate statistical analyses. To interpret the results of the statistical analyses, we used the WHO recommendations and standards.

Potential biases and measures to mitigate them

In this study, we identified potential biases and took the following steps to control them

We reduced Type I and Type II errors through the use of ENA for Smart software and/or the formula for calculating the minimum sample size n for the study and, most importantly, through our sample of 600 mother-child pairs. We controlled for misinformation and misclassification bias (differential and non-differential) by using standardised anthropometric equipment, WHO norms, well-trained interviewers for two days by a Nutritionist, Master in Nutrition, PhD in Nutrition and by clearly defining the study variables. We avoided selection bias by setting clear inclusion and

exclusion criteria, training data collectors and calculating anthropometric indices by software (ENA). On the other hand, memory biases related to the 24-hour diet recall instead of the 7-day recall were neutralized by using logistic regression adapted from the nutritional status (confounding) model.

Results

Table 1 shows that more than 8 out of 10 mothers were married, two thirds of the mothers had completed secondary school (incomplete or complete), more than half were housewives. Almost half of the mothers were from the revivalist church. The majority of the mothers (93.2%) reported having attended antenatal care for their children in our study. More than half (51.1%) of the households of the mother-child pairs assessed had a medium socio-economic level, one third had a low socio-economic level and one in eight households (12.3%) had a high socio-economic level.

Variable	Frequency	%	IC to 95%	
			Lower	Upper
Matrimonially Status of the mother (n = 575)				
Married	478	83,1	80,2	86,3
Single	51	8,9	6,4	11,7
Civil union	22	3,8	2,4	5,6
Divorced	13	2,3	1,0	3,7
Widow	11	1,9	0,9	3,0
Mother's level of education (n = 575)				
Level-up	21	3,6	1,9	4,7
Primary	29	5,0	3,3	6,8
Uncomplete secondary	197	34,3	30,4	38,3
Complete secondary	199	34,6	30,8	38,6
Superior or academic	129	22,4	19,3	25,9
Principal occupation of the mother (n = 575)				
House wife	339	59,0	53,9	64,2
Saleswoman or seller	93	16,2	13,2	19,5
Dressing table or braid	65	11,3	8,9	13,9
Trading woman	39	6,8	4,9	8,9
Other	18	3,1	1,7	4,7
State agent	14	2,4	1,2	3,8
Health professional	7	1,2	0,3	2,3
Religion practiced by the mother (n = 575)				
Awakening church	284	49,4	45,2	53,2
Catholic church	123	21,4	17,1	26,2
Protestant church	61	10,6	8,2	13,2
Brahnamist church	58	10,1	7,7	12,5
Jehovah church	20	3,5	2,1	5,0
Kimbanguist church	19	3,3	1,9	4,7
Islamic church	10	1,7	0,7	2,8
Socioe-conomic level of the household (n = 575)				
Low level (household's wealths < 4)	210	36,6	32,0	41,4
Middle level (4 ≤ household's wealths < 7)	294	51,1	47,1	55,0
Higher level (household's wealths ≥ 7)	71	12,3	9,6	15,1
Monitoring of the prenatal consultation for the child (n = 575)				
Has followed the prenatal consultation	536	93,2	90,6	95,2
Has'nt followed the prenatal consultation	39	6,8	4,5	9,0

Table 1: Socio-demographic and economic characteristics of mother-child pairs and their households in the Tshamilemba health zone in August-September 2021, Haut Katanga, DRC.

The results in table 2 give the prevalence of nutritional and health status, in particular low birth weight at 34.6% ; underweight at 8.5%, of which 2.8% is severe ; chronic malnutrition or stunted growth at 33.3%, of which 23.1% is severe ; global acute malnutrition (according to the weight-for-height index) at 10%, of which 3% is severe ; and severe acute malnutrition due to the presence of oedema at 25.9%. The same results show that there are overweight (7.8%) and obese (22.1%) children. Recurrent infections represent 54.8% and non-optimal breastfeeding 75.1%. In detail, the indicators of optimal breastfeeding identified in this table show that 67.5% of children were breastfed early ; 56.7% were breastfed exclusively during the first six months of birth and 57.4% were still breastfeeding on the day of our investigations.

Variable	Frequency	%	IC to 95%	
			Lower	Upper
Child born with low birth weight (n = 575)				
No, born with normal weight	376	65,4	61,2	69,9
Yes, born with low weiht	199	34,6	30,6	38,6
Nutritional status by WAZ (underweight) (n = 575)				
Severe underweight (WAZ < -3)	16	2,8	1,6	4,3
Moderate underweight (-3 ≤ WAZ < -2)	33	5,7	3,1	6,6
Normal nutritional status (WAZ ≥ -2)	526	91,5	89,0	93,7
Nutritional status by HAZ (n = 575)				
Severe stunting (HAZ< -3)	133	23,1	19,8	26,6
Moderate stunting (3 ≤ HAZ <-2)	59	10,2	7,0	13,8
Normal nutritional status (HAZ ≥ -2)	383	66,6	62,8	70,6
Nutritional status by WHZ (wasting or acute malnutrition) (n = 575)				
Severe acute malnutrition (WHZ < -3)	17	3,0	1,6	4,3
moderate acute malnutrition (3 ≤ WHZ<-2)	40	7,0	2,6	6,1
Normal nutritional status (WHZ ≥ -2)	518	90,0	87,7	92,5
Nutritional status by œdema (severe acute malnutrition) (n = 575)				
Severe acute malnutrition by oedema	149	25,9	22,6	29,4
Normal nutritional status without oedema	426	74,1	69,8	78,4
Nutritional status by BMIZ (n = 575)				
Severe malnutrition (BMIZ< -3)	26	4,5	2,8	6,3
Moderate malnutrition (3 ≤ BMIZ < -2)	40	6,9	4,2	9,9
Normal nutritional status (-2 ≤ BMIZ ≤ 2)	337	58,6	54,6	62,4
Overweight (2 < BMIZ ≤ 3)	45	7,8	5,7	10,3
Obesity (BMIZ ≥ 3)	127	22,1	18,8	25,6

Table 2: Prevalence of malnutrition and other health deficiencies in children aged 6-23 months in the Tshamilemba health zone in August-September 2021, Haut Katanga, DRC.

Based on table 3, the prevalence of inappropriate complementary feeding practices was identified. The frequency of complementary feeding was not acceptable according to age for 52.7% of the children assessed ; for 26.4% of children the complementary feeding was not diversified (had less than 4 food groups). The minimum diet consumed was not acceptable for more than six out of ten children (63.7%). More than half of the children (59.8%) were introduced to complementary foods before the age of 6 months and less than one tenth (6.1%) were introduced to complementary foods later than 6 months. More than four fifths of children (81.2%) were subjected to inadequate complementary feeding. Unimproved toilets were used by more than a quarter (28.2%) of households surveyed ; unprotected drinking water sources supplied a minority (3%) of households ; while about a third of children's mothers washed their hands at fewer than four key times recommended by WHO.

Variable	Frequency	%	IC à 95%	
			Lower	Upper
Minimum Meal Frequency (MMF) acceptable (n = 575)				
Has received the MMF acceptable	272	47,3	43,1	51,5
Has received the MMFnon-acceptable	303	52,7	48,0	57,5
Minimum Diversity Diet MDD (≥ 4 food groups) (n = 575)				
Has received the MMD	423	73,6	69,9	77,2
Has not received the MMD	152	26,4	22,8	30,1
Minimum Acceptable Diet (MAD) (n = 575)				
Has received the MAD	209	36,3	32,3	40,2
Has not received the MAD	366	63,7	59,8	67,7
Age of Complementary Feeding initiation (ACFI) (n = 575)				
CF early initiated before 6 months	344	59,8	55,8	63,8
CF initiated at recommended age at 6 months	196	34,1	30,4	38,3
CF initiated late after 6 months	35	6,1	4,2	8,2
Complementary Feeding (CF) adequation (n = 575)				
CF was adéquate	108	18,8	15,8	22,3
CF not adequate	467	81,2	77,7	84,2
Type of toilet facility used (n = 575)				
Improved toilet facility used	412	71,7	68,0	75,3
Unimproved oilet facility used	163	28,3	24,7	32,0
Type of principal source of drinking water supply (n = 575)				
Protected Source of drinking water supply	558	97,0	95,7	98,4
Unprotected Source of drinking water supply	17	3,0	1,6	4,3
Minimum Practices of Hands Washing (MPHW) (n = 575)				
Yes (if MPHW ≥ 4 key moments)	394	68,5	65,0	72,5
No (if MPHW < 4 key moments)	181	31,5	27,5	35,0

Table 3: Prevalence of inappropriate complementary feeding practices in the Tshamilemba health zone in August-September 2021.

The results in table 4 show that the first complementary food given to the child as an introduction to complementary feeding was an imported food (such as D'Elite, cerélac, maïzena, Phosphatine, ….) for more than one child in two (56.0%) and a cereal (such as maize flour, rice, etc.) for less than a quarter of children (24.7%). At least three quarters (77%) of the mothers used to use food mixtures as supplementary foods ; among them, 64% used cereal + legume mixtures and particularly 59.5% used the MAIS flour + SOYA flour mixture. The majority (88.2%) of the mothers reported that maize and soybean are locally produced and available.

The test of independence carried out, the results of which are presented in table 5, illustrates the socio-demographic and economic characteristics associated with the different forms of malnutrition. The child's sex (p = 0.015), the mother's level of education (p = 0.023), the mother's religion (p = 0.018) and the prenatal consultation attended by the mother (p = 0.004) were significantly associated with global acute malnutrition. On the other hand, the mother's marital status (p = 0.000), the mother's level of education (p = 0.021), the mother's main occupation (p = 0.011) and the household's socio-economic level (p = 0.001) were significantly related to the presence of oedema in the health zone. Global underweight was significantly associated with the child's sex (p = 0.001), the household's socio-economic level (p = 0.000) and the mother's prenatal consultation attendance (p = 0.000). Finally, chronic malnutrition was significantly associated with the mother's marital status (p = 0.010), the household's socio-economic level (p = 0.021) and the mother's prenatal consultation follow-up (p = 0.042).

Variable	Frequency	%	IC à 95%	
			Lower	Upper
First food given to the child after the exclusive breastfeeding (EBF) (575)				
Imported Food	322	56,0	51,7	59,8
Cereals	142	24,7	21,2	28,3
Other food	40	6,9	3,7	9,7
Familial food	33	5,7	3,7	7,7
Tubers	22	3,8	2,3	5,4
Legume	16	2,8	1,4	4,2
Using the food mixture as complementary foods by mother (575)				
Yes she uses the food mixture	443	77,0	75,1	82,3
No, she does'nt use the food mixture	132	23,0	17,2	25,6
Principal foods mixtures used in CF (575)				
Cereals (maize, rice) + Légume (soya, peanuts, apples)	368	64,0	59,8	67,8
Other foods	132	23,0	17,6	28,2
Tubers (manioca) + other food	75	13,0	9,9	16,4
Using maize + soya by the mother (575)				
Yes she uses the maize + soya mixture	342	59,5	55,5	63,5
No she does'nt use mais + soya mixture	233	40,5	35,1	43,3
Availability of maize and soya ingredients (local product) (575)				
Yes, maize and soya are available	507	88,2	85,6	90,8
No, maïs and soya are not available	68	11,8	9,2	14,3

Table 4: Supplementary feeding habits of mothers towards their children in the Tshamilemba health zone in August-September 2021, Haut Katanga, DRC.

Variable	Global Wasting (WHZ < -2)			Global Underweight (WAZ < -2)			Global stunting (HAZ < -2)			Malnutrition aiguë par présence des œdèmes		
	KHI-2	Ddl	p	KHI-2	Ddl	P	KHI-2	ddl	p	KHI-2	ddl	p
Sex of the child	8,424	2	0,015	11,424	1	0.001	1,067	1	0,302	0,76	2	0,684
Matrimonial status of mother	5,086	10	0,885	8,446	5	0,133	15,06	5	0,010	40,348	10	0,000
Education level of the mother	20,75	10	0,023	6,895	5	0,229	5,158	5	0,397	20,96	10	0,021
Principal occupation of the mother	5,264	16	0,994	6,513	8	0,589	12,34	8	0,137	31,665	16	0,011
Socio-economic level of household	9,556	6	0,144	22,548	3	0,000	9,728	3	0,021	23,976	6	0,001
Religion of mother	30,03	16	0,018	14,694	8	0,065	13,34	8	0,101	13,488	16	0,636
Followed prenatal Consultation	22,38	6	0,004	28,376	4	0.000	9,923	4	0,042	2,742	8	0,949

Table 5: Socio-demographic and economic characteristics associated with malnutrition in the Tshamilemba health zone in August-September 2021, Haut Katanga, DRC.

In table 6, Global stunting was associated with undiversified complementary feeding (p = 0.001) and inappropriate age of initiation (p = 0.000). The presence of oedema was significantly associated with non-diversified complementary feeding (p = 0.001), the use of unimproved toilets (p = 0.000) and the minimum hand-washing practice not respected by the mothers of the children evaluated (p = 0.000). Underweight was significantly associated with sub-optimal breastfeeding (p = 0.005). And global acute malnutrition was significantly associated with low birth weight (p = 0.026).

Variable	Global Wasting (WHZ < -2)			Global Underweight (WAZ < -2)			Global stunting (HAZ < -2)			Acute malnutrition by œdema		
	KHI-2	ddl	P	KHI-2	ddl	P	KHI-2	ddl	P	KHI-2	ddl	P
Minimum diversity diet	5,743	2	0,057	3,783	1	0,052	10,64	1	0,001	4,463	2	0,001
Minimum Meal Fréquency	0,474	6	0,998	0,239	3	0,971	2,523	3	0,471	3,827	6	0,700
Age of C.F. Initiation	1,441	4	0,836	2,282	2	0,319	18,04	2	0,000	7,965	4	0,092
Type of toilet facility household	0,891	2	0,640	0,641	1	0,423	0,381	1	0,536	17,451	2	0,000
Type of source supply of drinking water	0,221	2	0,895	1,596	1	0,206	0,040	1	0,841	2,223	2	0,329
Minimum Practices of Hands Washing	1,162	2	0,559	2,751	1	0,097	2,222	1	2,222	24,859	2	0,000
Optimal Breastfeeding	3,93	2	0,140	7,665	1	0,005	0,024	1	0,878	4,493	2	0,105
Récurrent Infection	0,442	4	0,978	3,789	2	0,15	0,925	2	0,140	5,411	4	0,247
Low Birth Weight	10,98	4	0,026	3,290	2	0,192	1,015	2	0,601	82,921	4	0,187

Table 6: Inappropriate supplementary feeding practices strongly associated with malnutrition in the Tshamilemba health zone in August-September 2021, Upper Katanga, DRC.

In table 7, Non-compliance with the Minimum Dietary Diversity is a risk factor for underweight (p = 0.051 ; PR = 2.221 ; CI : 1.013- 5.468), stunting (p = 0.001 ; PR = 2.025 ; CI : 1.326- 3.143) and the acute malnutrition by oedema (p = 0.000 ; PR = 2.633 ; CI : 1.784- 3.891) The use of unimproved toilets (p = 0.000 ; PR = 2.284 ; CI : 1.535- 3.395) and the failure of mothers to follow minimum hands washing practices (p = 0.000 ; PR = 2.633 ; CI : 1.784- 3.891) were powerful predictors of the presence of oedema. The socio-demographic characteristics that were strongly predictive of malnutrition were male sex and unmarried mother's marital status, while low and medium household socio-economic level, mother's main occupation outside the household, and mother's non-attendance at antenatal clinic were protective factors for malnutrition. Male sex was a risk factor strongly associated with acute malnutrition and underweight ; the marital status of the unmarried mother was also a risk factor strongly associated with the presence of oedema in children. Low and medium household socio-economic level, mother's main occupation outside the household, mother's attendance at antenatal clinic and unmarried mother's marital status were protective factors strongly associated with underweight (p = 0,000, PR = 0.228 with CI = 0.118 - 0.453), presence of oedema (p = 0.000, PR = 0.463 with CI = 0.292 - 0.738), underweight (p = 0.044, PR = 0.339 with CI = 0.143 - 0.881) and stunting (p = 0.036, PR = 0.495 with CI = 0.251- 0.977) respectively.

Discussion of Results

The average age of the children included in the study was 13 (+/-4.67) months. This average is similar to that observed in our previous study conducted in Lualaba Province which was 14.44 (+/-5.18) months (Ngoy Bulaya E., *et al,* 2020) but it is lower than that of Kouamé who reported an average age of 19 months in Côte d'Ivoire [22]. The average age observed in our study (13 months) is in line with the age ranges of 12-24 months and 12-23 months observed respectively by Mathieu Guindo and Doumbia Fatouma-ta.M.Traore in their studies [23,24]. These studies targeted the same age group as ours. Malnutrition varies significantly (at the one percent threshold) from one age group to another in children under 5 years of age [25] as nutritional needs vary with age, especially from 6 to 18 months of age.

Associated Factors	p	Prév.Ratio	IC de PR
	Global acute malnutrition (WHZ < -2)		
Sex of the child (female = 1)	0,002	2,48	1,332 - 4,783
	Global underweight (WAZ < -2)		
Sex of the child (female = 1)	0,001	2,978	1,561-5,944
Socio-economic level of household (low and middle = 1)	0,000	0,228	0,118- 0,453
Prenatal Consultation follow up by the mother (no followed up = 1)	0,044	0,339	0,143- 0,881
Minimum Diversity Diet (MDD respected = 1)	0,051	2,221	1,013- 5,468
None Optimal Breast Feeding	0,005	3,934	1,501- 13,08
	Global stunting (HAZ < -2)		
Matrimonial status of the mother (not maried = 1)	0,036	0,495	0,251- 0,977
Minimum Diversity Diet (MDD respected = 1)	0,001	2,025	1,326- 3,143
	Acute malnutrition by œdema		
Statut matrimonial de la mère (non mariée = 1)	0,000	3,268	2,06 - 5,186
Principal occupation of the mother (house wife = 1)	0,000	0,463	0,292- 0,738
Minimum Diversity Diet (MDD respected = 1)	0,000	2,152	1,436- 3,219
Type of toilet facility used by household	0,000	2,284	1,535- 3,395
Minimum Practices of Hands Washing (MPHW not respected = 1)	0,000	2,633	1,784- 3,891

Table 7: Complementary feeding practices and socio-w characteristics significantly associated with malnutrition in the Tshamilemba health zone in August-September 2021, Haut Katanga, DRC.

The average age of initiation of children to complementary foods by mothers was 4.8 months. This result is similar to that of Oumarou Aboubacar who found in his study an average age of 5 months for the initiation of children to complementary foods [26]. The same result was observed by Aké-Tano who in his study found that 32.7% of mothers introduced their children to complementary foods before 6 months [27]. This is not in line with WHO and UNICEF recommendations concerning the age of initiation of children to complementary foods. On the other hand, Doumbia Fatoumata M. Traore and Den Princilia Mouissi found 6-12 months and 6-8 months respectively as the age of initiation to complementary foods [24,28]. These results are at odds with those reported in our study conducted in an urban health zone where 56% of mothers use imported foods as supplements before 5 months of age.

More than a third (34.6%) of the children's mothers had a full secondary education and 3% had no education. This last result is much lower than those reported by Doumbia Fatoumata M. Traore, Kouamé and Mathieu Guindo who observed respectively 57.19%, 77.77% and 77.3% of mothers not attending school [22,24].

More than half (59%) of the mothers of children were housewives. This predominance was also found in Bamako, MALI in 2014 and 2020 [24,23].

The prevalence of low birth weight is 34.6%. This prevalence disagrees with those of other authors 6.3% in Lualaba [18], 7.1% in France [29], 6.4% in Lubumbashi [30], 6% in Senegal [31], 13, 27% in Kinshasa DRC [32]. In our study, the results are justified by the low (36.6%) and medium (51.1%) socio-economic level of the majority of households.

The prevalence of overall underweight is 8.5%, of which 2.8% is severe. These results are much lower than those reported by Action Against Hunger in Maniema (23.9%, of which 5.1% is severe) [33], in the Pitoa Health District in Cameroon (83.6%, of which 50.3% is severe) [34], and it is about three times lower than the national average for the DRC (23%) [12]. However, it is close to that observed in Lualaba (14.9%, of which 4.3% is severe) [18] and is similar to that observed in Togo (8.6%) [35]. The difference noted is due to the fact that Action contre la faim in Maniema and Benjamin Azike., *et al*. in Cameroon assessed children aged 6-59 months, whereas in Togo, Lualaba Province and in our study in Haut Katanga Province in the DRC we assessed children aged 6-23 months in an urban health zone. Secondly, our sample size was different from theirs.

Chronic malnutrition or stunting represents 33.3% of which 23.1% is severe. Our results are largely superior to those found

in the Algerian EST, i.e. 9.17% [36], but lower than those observed in Bujumbura in BURUNDI, i.e. 56% of global stunting [37] (IPC, 2017), in the Health District of Pitoa in Cameroon, i.e. 75.1% including 43,4% severe [34] (Benjamin Azike., *et al*, 2019), in Maniema Province in DRC, 49.1% including 18.7% severe [33] (Action contre la faim, 2021) and in the Kapolowe health zone in the same Haut Katanga Province in DRC, 37% including 16.9% severe [38] (Emmanuel B. Ngoy., *et al*, 2022) despite fish production in Kapolowe.

The prevalence of stunting in the Tshamilemba health zone, Haut Katanga Province corroborates that observed in the town of Kolwezi in Lualaba Province (32.4% of which 15.3% in severe form) in 2017 [18]. However, in the two provinces of Grand Katanga, the prevalence of overall stunting is lower than the national prevalence in the DRC (43%). This difference in prevalences would be linked to the fact that our study in the Tshamilemba health zone targeted the 6-23 month age group, unlike other studies which usually target the 6-59 month age group. Nevertheless, our research in the Tshamilemba health zone in Haut Katanga at present and in the Dilala and Manika health zones in Lualaba in 2017 shows almost the same prevalence rates, a similarity between the two provinces (33.3% and 32.4%) that would be due to the targeting of the same age group and the presence of the same mining characteristics.

Global acute malnutrition (according to the weight-for-height index) is 10%, of which 3% is severe. This rate is higher than the provincial average for Haut Katanga (6.5%) and the national average for the DRC (7%) [12], even compared to the rate found in Lualaba Province (8.2%) [18], in Burundi (5.1%) [37] and in Maniema (5.8%) [33]. In contrast to the latter, the prevalence of global acute malnutrition reported in our study is at odds with that observed in Côte d'Ivoire in Abidjan which is 55.86% [22].

In relation to the severe form of acute malnutrition, our prevalence (3%) is close to that found in Bamako, Mali, which is 2.6% [24]. In Maniema, however, the prevalence of this severe form is 0.9% [33], which is much lower than ours (3%). The higher prevalences of severe acute malnutrition 11.3% and 20.65% are observed respectively in Mali and in the Health District of Pitoa in Cameroon [23,34]. Our study was cross-sectional using community data, while in Cameroon Benjamin., *et al*. undertook a case-control study and in Mali Mathieu used hospital data.

Our results show that there are overweight (7.8%) and obese (22.1%) children. The rate of overweight remains close to that reported in Algeria of 8.66% [36]. These similar results confirm that these two low-income countries (DRC and Algeria) belong to the sub-Saharan and South Saharan region, which is currently undergoing a nutritional transition, one of the consequences of which is the emergence of chronic non-communicable diseases.

Recurrent infections (diarrhoea) represent 54.8%. This rate is higher than those reported in Cameroon in the Pitoa Health District and in Mali in Bamako, respectively 49.6% and 29.1% [23,24].

Our research conducted in the community was more likely to identify all cases of diarrhoea that did not go to hospital and were treated at home. In addition, the 6-23 month age group is the most exposed to infections due to the introduction of unsafe food into the diet. The two studies conducted in Cameroon (case control) and Mali (cross-sectional) used administrative data from hospitals, which generally only receive severe diarrhoea cases.

The non-optimal breastfeeding rate is 75.1%. In detail, the indicators of optimal breastfeeding in this study show that 67.5% of children were breastfed early; 56.7% were breastfed exclusively during the first six months of birth and 57.4% were still breastfeeding at the time of our investigations. For early breastfeeding (within one hour of delivery), the rate in Mali is 73.3% [39], which is slightly higher than that reported in our study (67.5%). The lowest rates of early breastfeeding are observed in Abidjan (3.61%), Niger (2%) and Senegal in Dakar (30.3%) [26,40,41]. The exclusive breastfeeding rate in our study of 56.7% is very close to the provincial average of 54%.

The Tshamilemba health zone is a convergence zone for health projects where the capacities of providers were strengthened in infant and young child feeding in Haut Katanga Province.

The exclusive breastfeeding rate (56.7%) observed in our study is higher than those of other authors, which are 40%, 10%, 19%, 6.7%, 39.62, 44.4% [26,28,39,42,40,41].

The continuous breastfeeding rate in our study (57.4%) is much lower than the rates of 96% observed in Senegal [41] and 80.4% observed in the commune of KAOLACK in Senegal [28]. This low continuous breastfeeding rate is correlated with the low socio-economic level of the households, which sacrifice their children to their economic or household occupations.

The minimum acceptable diet was consumed by more than three out of ten children (36.3%). This observation is at odds with that of Senegal where 71.3% of children consumed a minimum acceptable diet compared to 28.7% who consumed a non-acceptable diet [28].

This would be due to the low and medium socio-economic conditions of the majority of households and the early initiation of food supplements by about six out of ten mothers (59.8%) in our study.

Regarding the factors associated with malnutrition, the child's sex, the mother's level of education, the mother's religion and the prenatal consultation attended by the mother were significantly associated with global acute malnutrition. On the other hand, the mother's marital status, the mother's level of education, the mother's main occupation and the socio-economic level of the household were significantly related to the presence of oedema. Global underweight was significantly associated with the sex of the child, the socio-economic level of the household and the mother's prenatal consultation. Finally, chronic malnutrition was significantly associated with the mother's marital status, the socio-economic level of the household and the mother's prenatal consultation.

We found that after mitigation of confounding factors inappropriate complementary feeding practices were significantly associated with malnutrition, including minimum dietary diversity, type of toilet used by the household and minimum handwashing practices of mothers.

These inappropriate complementary feeding practices were also found to be strongly associated with malnutrition in the Kapolowe health zone, where undiversified complementary feeding was significantly associated with acute malnutrition and stunting, while the use of unimproved toilets was predictive of chronic malnutrition [38].

In these two health zones located in the same Haut Katanga Province, similar complementary feeding practices explain the occurrence of malnutrition, although the Kapolowe health zone is characterised by the abundant production of fish with the same name. It is also worth noting the increased consumption of imported food, which is substituted for the primary supplementary food given to children in the two health zones (Tshamilemba and Kapolowe) by 56% and 46% of mothers respectively.

Non-compliance with the Minimum Dietary Diversity was a risk factor for underweight (p = 0.051 ; PR = 2.221 ; CI : 1.013- 5.468), chronic malnutrition (p = 0.001 ; PR = 2.025 ; CI : 1.326- 3.143) and the presence of oedema (p = 0.000 ; PR = 2.633 ; CI : 1.784- 3.891). In other words, children who consumed a non-diversified diet (less than 4 food groups) were about twice as likely to develop underweight (PR = 2.221 ; CI : 1.013- 5.468), chronic malnutrition (PR = 2.025 ; CI : 1.326- 3.143) and acute malnutrition with oedema (PR = 2.633 ; CI: 1.784- 3.891) than those who consumed a diversified diet (more than 4 food groups).

This non-diversified diet was also a risk factor for acute malnutrition in Lualaba Province where it was commonly observed that children who did not consume a diversified diet (less than 4 food groups consumed) were three times more likely to be malnourished than those who consumed a diversified diet (more than 4 food groups consumed) [18].

These results are consistent with those found in Ghana, where acute malnutrition was associated with non-diversified complementary feeding [43]. Our results are justified by the medium to low socio-economic level of households, the low food production due to the mining boom in Greater Katanga and the policy of an extroverted economy. Hence the majority of supplementary foods used for these children aged 6-23 months in the Tshamilemba health zone are imported for the majority of mothers.

The use of unimproved toilets (p = 0.000 ; PR = 2.284 ; CI : 1.535-3.395) and the non-respect of minimum washing practices by mothers (p = 0.000 ; PR = 2.633 ; CI : 1.784- 3.891) are powerful explanatory factors for the presence of oedema. In other words, children from households using unimproved toilets and those whose mothers did not wash their hands at four or more recommended key times were twice as likely to develop acute oedema malnutrition as those from households using improved toilets and those whose mothers washed their hands at four or more key times (PR = 2.284 ; CI : 1.535-3.395 and PR = 2.633 ; CI : 1.784 - 3.891 respectively). In Cameroon in 2009 and Mali in 2013, a significant association between thinness and toilet type was established [25,44].

Dietary diversification prevents deficiencies in various nutrients, handwashing and unimproved toilets contribute to the nutritional insecurity of complementary foods by reducing the quality and quantity of nutrients that the body should absorb and incorporate into living matter. Hence the very inadequate supply of plasma proteins, including albumin and fibrinogen, coupled with infections caused by handwashing and flies from unimproved toilets results in the accumulation of fluid in the extracellular medium (presence of nutritional oedema).

The socio-demographic characteristics that were most predictive of malnutrition were male gender and the marital status of unmarried mothers. Male children were twice as likely to be acutely malnourished (PR = 2.48 CI : 1.332 - 4.783) and underweight (PR = 2.98 CI : 1.561-5.944).

In Burkina Faso, a link between chronic malnutrition and gender was also established [45]. These results show a discrepancy related to the study setting, as in Mali the researcher used clinical data while our study was based on community data. In the hospital setting, chronic non-nutritional patients often develop chronic malnutrition with a predilection for boys under two years of age whose nutrient requirements per kilogram of weight are higher than those of girls.

Children of unmarried mothers were twice as protected from chronic malnutrition (PR = 0.495 CI : 0.251- 0.977) and three times as likely to be acutely malnourished by the presence of oedema (PR = 3.268 CI : 2.06 - 5.186) compared to children of mothers who were married. This fact is justified by the fact that unmarried women had a low socio-economic level that did not allow them to regularly provide their children with imported infant foods such as chyps yoyo, Appy tot, Maïzena, Blédine, Phosphatine, D'lite, ... The latter, being rich in salt or sugar or fat, are sometimes responsible for chronic illnesses including stunted growth in children.

Children from households with a low and medium socio-economic level were 4 times more protected against underweight (PR = 0.228 with CI = 0.118 - 0.453) compared to those from households with a high socio-economic level. In Cameroon, acute malnutrition was significantly associated with household socioeconomic level and the type of drinking water consumed [25]. The difference between our results and those of Cameroon is that our study targeted children aged 6-23 months, while in Cameroon the study included children under 5 months and did not specify the socio-economic level (low, medium or high) that was associated with acute malnutrition.

Children of mothers working mainly outside the household were twice as likely to be prevented from acute malnutrition by the presence of oedema (PR = 0.463 with CI = 0.292 - 0.738) compared to children of female household mothers. Our results corroborate those found in Cameroon where a significant association (p = 0.0046) was observed between working in occupations such as civil servant/employee, resourcefulness and female farmer and malnutrition. Children of female farmers were six times more likely to be malnourished (OR = 6.95 CI : 1.82-26.54) [34]. This is because the supplementary food given by these mothers is often monotonous, non-diversified, underestimated in frequency for the age of the child and introduced before the age of 6 months.

In Burkina Faso, a link between chronic malnutrition and the occupation of mothers was demonstrated in a hospital study [45].

In our community-based study, this prevention would be justified by work outside the household, which provides financial means to mothers who will be able to give their children more adequate supplementary food. On the other hand, mothers who are housewives are dependent on their husbands. Especially since there are only 12.3% of households with a high socio-economic level according to our results.

Children whose mothers had attended antenatal care were three times more likely to be prevented from being underweight (PR = 0.339 with CI = 0.143 - 0.881) compared to children whose mothers had not attended antenatal care during their intrauterine life.

Some variables in our study were not statistically significantly associated with malnutrition, but were found to be linked elsewhere by other authors. In Mali, a statistically significant association between wasting and handwashing with soap by mothers after the 5 key moments was observed (p = 0.036) (Diawara F., *et al*, 2013). The association between malnutrition and diversification before 6 months of age was observed by Rania Laadje [36].

Conclusion

Complementary feeding practices still remain poor or below the 80% coverage target of WHO and are strongly linked to malnutrition in all its forms. Children who receive a non-diversified minimum diet are routinely more than twice as likely to be acutely malnourished or chronically malnourished or underweight compared to children who receive a diversified minimum diet in the Tshamilemba health zone. Similarly, children whose households do not have improved toilets and children whose mothers do not practice minimal handwashing at key times are more than twice as likely to have bilateral oedema as those whose households have improved toilets and whose mothers practice minimal handwashing.

Inappropriate complementary feeding practices are due to the low socio-economic level of households, male gender, and marital status of mothers. To avoid the culinary practices of local foods, the majority of mothers use inappropriate imported infant foods as complementary foods. Hence, a locally designed and appropriate blended food formula ready for use as a complementary food, MASO31, is proving to be a sustainable solution that is geographically, culturally, and financially accessible.

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