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Food consumption of children of weaning age in central-eastern and north-eastern Ivory Coast

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Abstract

The objective of this study was to determine the prevalence of malnutrition among children of weaning age in the Centre-East and North-East Ivory Coast and their feeding practices in order to offer them quality and low-cost instant infant flours from local products. Methods: The study was carried out using a structured questionnaire. The aim was to collect information on the socio-economic characteristics of households. Sampling was calculated using the Vaughn-Morrow equation. A total of 952 households were surveyed. Results: The results of the survey showed that the prevalence of chronic malnutrition ranged from 22.69 to 43.28 %, that of acute malnutrition from 7.98 to 14.29 %, and underweight from 16.81 to 33.19 %. Flour made by households was generally millet or maize. Dipping was the most applied technological treatment by households (71.43 to 83.33 %). Also, the energy density of the majority of the porridges prepared by households was less than 100 Kcal/100 g. The food products grown in households in general were plantain (1.37 to 30.08 %), cassava (2.40 to 34.86 %), groundnuts (24 to 36.67 %), maize (10.29 to 42.67 %) and millet (0.26 to 39.04 %). These local products would undoubtedly make it possible to formulate composite flours that are better suited to children in a weaning situation.

Keywords: Local products; Formulated flours; Malnutrition; Composition; Ivory Coast; Germination

1. Introduction

Malnutrition is a medical condition caused by the excess or defect in one or more nutrients [1]. It is responsible for nearly half of all deaths in children under 5 years of age [2]. These deaths occur mainly in low-income countries. The negative effects of malnutrition on intellectual and physical development, health and life expectancy have been established by several studies [3]. In Ivory Coast, about 30 % of children under the age of five suffer from stunting, which is the most common form. Underweight affects 15% of children, while 7.5 % of them suffer from acute malnutrition [4]. Although efforts have been made by the Government and its partners with a trend of improvement at the national level, child malnutrition remains a concern in most regions of the North, North-East and West, with a critical stage prevalence above 40 % at the level of chronic malnutrition. Causes include poverty, lack of time for parents or caregivers, lack of knowledge, and often inappropriate complementary feeding practices [5, 6].

The objective of this study was to determine the prevalence of malnutrition among children of weaning age in the Centre-East and North-East Ivory Coast and their feeding practices in order to offer instant flours from available local food products.

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2. Material and methods

The study took place in the localities of Bouna, Bondoukou, Agnibilekro and Abengourou. The Northeast region is subject to a Sudanese-type climate with two (2) very opposite seasons, a dry season that runs from November to March and a rainy season from March to November. The Centre-East region is subject to an Attian climate characterized by four (4) seasons: a long rainy season that runs from mid-March to mid-July, followed by a short dry season from mid-July to the end of September, then a short rainy season from the end of September to November and finally a long dry season from November to mid-March.

2.1. Survey on the feeding pattern of children of weaning age

2.1.1. Selection of survey areas

The survey areas were chosen on the basis of the prevalence of chronic malnutrition, the most common form Ivory Coast [4]. It is in this context that the North-East area, which is the most affected by chronic malnutrition, was chosen to conduct this study. As for the Centre-East zone, it is one of the areas affected by malnutrition. It is also the closest area to the northeast, which facilitates the investigation by reducing travel time and costs. Thus, the largest cities in these areas, namely: Abengourou, Agnibilekro, Bondoukou and Bouna were chosen to conduct the study.

2.2. Sampling method

2.2.1. Determining the sample size

The sample size was calculated from equation [7]:

$$N = t^2 \times P \times (1\text{-}P)/e^2$$

- N: expected sample size
- t: 1.96 at 95% confidence level
- p: Estimated proportion of the population (50%)
- e: Margin of error (3.18%). Thus, the sample size was 952.

2.2.2. Sampling and sampling design

In the North-East and Centre-East zone, four towns (Abengourou, Agnibilekro, Bondoukou and Bouna) were chosen taking into account the highest prevalence of chronic malnutrition. Four districts and three villages in each city were randomly selected. Fifty-two (52) children per neighborhood and ten (10) children per village were also surveyed using the same method. The target population for this survey was children aged 6 to 24 months.

2.2.3. Survey Methodology

The study was carried out using a structured questionnaire. Anthropometric measurements (height,weight and precise age) of the children, maternal characteristics and feeding practices were recorded. Anthropometric measurements were taken on children by recruits with a secondary level or higher. These measurements were determined using standard measurement tools.

2.3. Statistical data processing

The Chi-square test of independence was used to highlight the relationship between the categorical variables relating to the survey on the feeding method of children of weaning age. The statistical significance of the test was defined at the threshold $\alpha \leq 0.05$. The anthropometric data were analyzed with the ENA 2011 software (Emergency Nutrition Assessment) given the numerous calculations and comparisons to be made for the z-scores.

3. Results

3.1. Distribution of children by nutritional status and weaning age

The prevalence of chronic malnutrition was significantly associated with the city (p<0.05). The proportion of children suffering from chronic malnutrition ranged from 22.69 to 43.28 % (Table 1), with the highest prevalence recorded in the city of Bouna. A significant difference was observed between the prevalence of underweight by city (p < 0.05). These

proportions ranged from 16.81 to 33.19 %, and the highest prevalence was also recorded in the city of Bouna. No significant difference was observed between the prevalence of acute malnutrition by city (p ≥ 0.05). The proportion of children affected ranged from 7.98 to 14.29 %. The highest prevalence was recorded in the city of Abengourou.

Weaning age varied significantly by city (p< 0.05). The city of Agnibilekro had the highest weaning rate (42.62 %) for ages between 7 and 12 months. The city of Abengourou recorded the highest weaning rate (63.04 %) for ages between 13 and 18 months. The city of Bouna reported the highest weaning rate (70.49 %) for ages 19 to 24 months (Table 1).

Table 1 Distribution of children by nutritional status and weaning age

Variables	Abengourou	Agnibilekro	Bondoukou	Bouna	Chi-square parameters		
	%	%	%	%	dl	X²	P
Nutritional status Acute malnutrition							
Yes	7.98	11.34	12.61	14.29	3	4.97	0.17
No	92.02	88.66	87.39	85.71			
Chronic malnutrition							
Yes	22.69	28.15	38.66	43.28	3	28.69	0.00
No	77.31	71.85	61.34	56.72			
Underweight							
Yes	16.81	21.1	26.89	33.19	3	19.66	0.00
No	83.19	78.99	73.11	66.81			
Weaning age							
1 ≤ age ≤ 6	8.70	6.56	1.92	3.28	9	93.76	0.00
7 ≤ age ≤ 12	15.22	42.62	2.89	8.20			
13 ≤ age ≤ 18	63.04	32.79	46.15	18.03			
19 ≤ age ≤ 24	13.04	18.03	49.04	70.49			

% : Percentage ; dl: Degree of freedom; X²: Chi-square; P: Probability; Significance level α = 5%

3.2. Distribution of malnourished children according to the mother's level of education

Table 2 Distribution of malnourished children according to the mother's level of education

Variables	Mother's education level			Chi-square parameters		
	None	Primary	Secondary or more	dl	X²	P
Abengourou						
P/A (%)	36.76	8.97	8.89	4	14.57	0.01
T/A (%)	29.41	21.79	18.89			
P/T (%)	23.53	2.56	1.11			
Agnibilekro						
P/A (%)	32.26	15.46	8.70	4	11.43	0.02
T/A (%)	36.56	27.84	13.04			
P/T (%)	24.73	2.06	2.13			
Bondoukou						
P/A (%)	37.84	17.65	11.90	4	11.30	0.02

T/A (%)	41.44	37.65	28.57			
P/T (%)	22.52	4.71	2.38			
Bouna						
P/A (%)	50.71	4.76	9.09	4	24.07	0.02
T/A (%)	46.43	46.03	24.24			
P/T (%)	20.71	4.76	3.03			

P/A: Underweight; T/A: Chronic malnutrition or growth retardation; P/T: Acute malnutrition or wasting; P: Probability; Significance level α = 5%; X²: Chi-square

A significant difference was observed between the number of malnourished children according to the mother's level of education (p< 0.05). The highest prevalence was recorded among the children of mothers with no education in general. The prevalence of underweight ranged from 32.26 to 50.71 %. The locality of Bouna had the highest prevalence while Agnibilekro indicated the lowest. For the prevalence of chronic malnutrition, it ranged from 29.41 to 46.43 %. The locality of Abengourou recorded the lowest prevalence while Bouna had the highest. For acute malnutrition, the prevalence ranged from 20.71 to 24.74 %. The locality of Bouna recorded the highest prevalence while Agnibilekro reported the highest (Table 2).

3.3. Distribution of malnourished children according to the origin of the flour

Table 3 Distribution of malnourished children according to the origin of the flour

Regions	Origin of flours			Chi-square parameters		
	Industrial	**Market**	**Household**	**dl**	**X²**	**P**
Abengourou						
P/A (%)	4.17	17.24	32.35	4	12.40	0.04
T/A (%)	12.50	37.93	14.71			
P/T (%)	4.17	5.17	17.65			
Agnibilekro						
P/A (%)	10	13.43	61.54	4	10.54	0.04
T/A (%)	15	34.33	23.08			
P/T (%)	5	17.91	7.70			
Bondoukou						
P/A (%)	5	19.35	47.06	4	10.23	0.03
T/A (%)	10	62.37	41.18			
P/T (%)	5	9.68	41.18			
Bouna						
P/A (%)	11.11	13.04	55.56	4	10.84	0.04
T/A (%)	27.78	56.52	50			
P/T (%)	11.11	13.04	11.11			

P/A : Underweight; T/A: Chronic malnutrition or growth retardation; P/T: Acute malnutrition or wasting; P: Probability; Significance level α = 5%; X²: Chi-square

A significant difference was observed between the nutritional status of children according to the origin of the flours used to feed them (p < 0.05). Children fed with market-bought flour or household-made flour have a high propensity for malnutrition regardless of the region. The prevalence of chronic malnutrition ranged from 4.17 to 61.54 %. The lowest prevalence was recorded among children fed from industrial flours, while those fed from meals made by households had the highest prevalence. In terms of acute malnutrition, the prevalence was between 10 and 62.37 %.

The lowest prevalence was recorded among children fed from industrial flours, while those fed meals purchased at the market had the highest prevalence. As for underweight, the prevalence ranged from 4.17 to 41.18 %. The lowest prevalence was recorded among children fed from industrial flours, while those fed from meals made by households had the highest prevalence (Table 3).

3.4. Distribution of porridges prepared by households by ingredient

A significant difference was associated with the porridges prepared by households by ingredient (p < 0.05). The majority of porridges prepared by households were millet-based, regardless of the origin of the flour. Regarding flours bought at the market, the rate of millet-based porridge varied from 60.34 to 81.52 %. The highest rate (81.52 %) was recorded in households in the locality of Bouna while the lowest (60.34 %) was in Abengourou. Corn-based porridge was the second most prepared of the porridges with rates ranging from 11.96 to 31.25%. The highest rate was recorded in households in the locality of Agnibilekro while the lowest rate was in Bouna. As for flour made by households, the rate of millet-based porridge varied from 29.41 to 77.78 %. The highest rate was recorded in households in the locality of Bouna while the lowest rate was in Abengourou. Corn-based porridge was the second most prepared porridge with rates ranging from 11.96 % to 52.94%. The highest rate was recorded in households in the locality of Abengourou, while the lowest rate was in Bouna (Table 4).

Table 4 Distribution of prepared Mixtures by ingredients

Variables	Abengourou (%)	Agnibilekro (%)	Bondoukou (%)	Bouna (%)	Chi-square parameters		
					dl	X²	p
Boiled from flours bought at the market							
Corn	29,31	31,25	26,88	11,96	9	22,98	0,01
Millet	60,34	64,58	62,37	81,52			
Rice	6,90	2,08	1,08	4,35			
Corn / Millet	3,45	2,08	9,68	2,17			
Porridge from flour made by households							
Corn	52,94	42,86	17,65	11,11	6	15,24	0,02
Millet	29,41	42,86	70,59	77,78			
Rice	17,65	14,29	11,76	11,11			

%: Percentage; dl: Degree of freedom; P: Probability; X²: Chi-square; Significance Level α = 5%

3.5. Distribution of food crops grown in the household in the past year

Table 5 Distribution of food crops grown in the household during the last year

Variables	Abengourou (%)	Agnibilekro (%)	Bondoukou (%)	Bouna (%)	Chi-square parameters		
					dl	X²	p
Food crops							
Cassava	26.39	34.86	4.67	2.40	12	507.20	0.00
Plantain	30.08	29.14	4	1.37			
Corn	10.55	10.29	42.67	31.85			
Millet	0.26	1.71	12	39.04			
Peanut	32.72	24	36.67	25.34			

% : Percentage ; dl: Degree of freedom; P: Probability; Significance level α = 5%, D: Average expenditure ; X²: Chi-square

A significant difference was associated with food products grown in households by locality (p < 0.05). At the plantain level, the cultivation rate varied from 1.37 to 30.08 %. The highest rates were recorded in the cities of Abengourou and

Agnibilekro with rates of 30.08 % and 29.14 % respectively. In cassava, the rates varied from 2.40 to 34.86 %. The highest rates were recorded in households in the locality of Agnibilekro and Abengourou with successive rates of 34.86 % and 26.39 %. For maize, the crop rate ranged from 10.29 to 42.67 %.

The highest rates were recorded in households in the locality of Bondoukou and Bouna with successive rates of 42.67 and 31.85 %. For millet, the cultivation rate ranged from 0.26 to 39.04 %. The highest rates were recorded in households in the locality of Bouna and Bondoukou with rates of 39.06 and 12 % respectively. Finally, for groundnuts, the rates varied from 24 to 36.67 % and the highest rate was recorded in the localities of Bondoukou (Table 5).

3.6. Distribution of prepared porridge in households according to the technological processes applied and their energy densities

No significant differences were observed between technological treatments by location ($p \geq 0.05$). Dipping was the most applied treatment by households in all localities, and its application rate ranged from 71.43 to 83.33 %. Households in the locality of Bouna applied soaking more (83.33 %) while those in Agnibilekro applied less (71.43 %). Regarding germination, it was applied at rates varying from 5.56 to 14.29 % from one locality to another. The highest rate of application (14.29 %) was carried out in the locality of Agnibilekro while the lowest (5.56 %) was carried out in Bouna. As for fermentation, it was applied at rates ranging from 5.88 to 14.29 %, and households in the locality of Agnibilekro applied it more, while those in the localities of Abengourou and Bondoukou did so less (5.88 %) (Table 6).

No significant difference was associated with the energy density of the mixtures by city ($p \geq 0.05$). The energy density of the majority of the mixtures prepared by households was less than 100 Kcal/100 g of mixture. The percentage of slurry with energy densities between 60 and 80 Kcal/100 g of slurry ranged from 35.29 to 47.06 %. The highest rate was recorded in the locality of Bondoukou while the lowest was in the locality of Abengourou. For energy densities between 80 and 100 Kcal/100 g of slurry, the rate varied from 28.57 to 47.06 %. The highest rate was recorded in the locality of Abengourou while the lowest was in the locality of Agnibilekro.

Table 6 Distribution of prepared porridge in households according to the technological processes used and their energy densities

Variables	Abengourou (%)	Agnibilekro (%)	Bondoukou (%)	Bouna (%)	Chi-square parameters		
					dl	X²	p
Energy densities (Kcal / 100 g)							
[60 ; 80[	35,29	42,86	47,06	38,89	9	2,09	0,99
[80 ; 100[	47,06	28,57	35,29	38,89			
[100 ; 120[	11,76	14,29	11,76	16,67			
[120 ; 140[	5,88	14,29	5,88	5,56			
Technological processes							
Soaking	82,35	71,43	82,35	83,33	6	2,62	0,96
Germination	11,76	14,29	11,76	5,56			
Fermentation	5,88	14,29	5,88	11,11			

%: Percentage; dl: Degree of freedom; P: Probability; Significance Level α = 5%

The energy density of the minority of porridges prepared by households was greater than 100 Kcal/100 g of porridge. The slurry rates varied from 11.76 to 16.67% for energy densities between 100 and 120 Kcal/100 g of slurry. The highest rates were recorded in the locality of Bouna while the lowest were in the localities of Abengourou and Bondoukou. The slurry rates varied from 5.88 to 14.29 % for energy densities between 120 and 140 Kcal/100 g of slurry. The highest rate was recorded in households in the locality of Agnibilekro, while the lowest was in Bouna (Table 6).

4. Discussion

A significant difference was observed between the prevalence of malnutrition by locality. This may be because some regions are difficult to access, quality food from these neighboring regions is scarce on the market. Mothers' choice of food depends on the availability of food and this can influence the nutritional status of children [8].

The age of weaning varied significantly depending on the locality. In general, the majority of children are not weaned before twelve months and this rate varies from one locality to another. This low weaning rate is justified by the fact that African custom in general requires that breastfeeding be prolonged over a relatively long period of time. The proportion of children weaned between 13 and 18 months is significant and varies from 18.03 % to 63.04 %. Above 18 months, only 3.7 % of children remain breastfed [9].

Children of mothers without education had the highest prevalence of malnutrition. Indeed, several studies have analyzed the influence of the mother's level of education on the nutritional status of the child and have shown that child malnutrition is more frequent among mothers without education [10]. Education makes it possible to break with practices that result from traditional views on food, such as prohibiting women and girls from eating before men and prohibiting children from eating eggs and meat [11]. The lack of education of women encourages negligence and the non-application of the notions of hygiene and good manufacturing practices [12].

In addition, education allows the mother to have access to paid work and therefore to make choices oriented towards the purchase of goods and products of good nutritional quality [13]. For example, in Thailand, the nutritional status of children has improved remarkably over the past 20 years thanks to the increase in women's literacy levels [14].

Children fed with flour bought at the market or with flour made by households have a high propensity for malnutrition regardless of the region. In addition, poverty, aggravated by the economic crisis of the 1980s, gives a particular dimension to the situation. As a result, food, although available on the market, is still not within the reach of disadvantaged households [15].

The nature of the main ingredients used to make the porridge purchased depends on the locality. In general, millet is the main ingredient used to make flours on the market [16]. This choice is due to the eating habits and preferences of the people [17].

For the distribution of porridge produced by the household by ingredient, $p \leq 5\%$, this means that each locality has its own way of feeding its children. Millet has been the most widely used food product for household food [16], which could be explained by the fact that it is part of the eating habit of all these regions and its appreciated taste. Incorporating it into flour reduces the length of linear portions of amylose and amylopectin [18]. In Ivory Coast, maize is used in human food [19], in animals, in industry for the manufacture of infant flour and beer [20].

A significant difference was associated between the distribution of the raw materials grown according to the localities. In some parts of the same country, there are varieties of foods that are rich in nutrients, in others they are almost non-existent due to unfavorable climatic conditions [8]. These food products contribute to food security.

Awareness-raising programmes on technological know-how in the field of food would improve the quality of flour produced by households [21]

5. Conclusion

Malnutrition remains an alarming problem in Ivory Coast, the survey conducted in the Centre-East and North-East region revealed that Bouna and Bondoukou are areas of critical prevalence, Abengourou and Agnibilekro are areas of low prevalence in terms of chronic malnutrition. Most households in these regions mainly use low-density market flour for children's food. Knowledge of the food products grown in households in each area surveyed will undoubtedly make it possible to formulate foods that are better adapted to children in a weaning situation.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Baudin B. Malnutrition and undernourishment. French-language laboratory review. 2014; 2014 (466), 25-37.

[2] WHO World Health Organization: Malnutrition. https://www.who.int/fr/news room/fact-sheets/detail/malnutrition. Consulted in March 2024.

[3] Darsene H, Ayele G, Abebaw G, Solomon M. Magnitude and predictors of undernutrition among children aged six to fifty-nine months in Ethiopia: a cross sectional study. Archives of public health 75: 29, 2017.

[4] INS/ICF. Ivory Cost Multiple Indicator Demographic and Health Survey 2011-2012. Maryland, USA: INS et ICF International. 2012, 20p.

[5] Gbogouri GA, Bamba MS, Dibeu DY, Brou K. Development of an infant flour based on local ingredients from Ivory Coast: omega-3? polyunsaturated fatty acid enrichment strategies? International Journal of Biological and Chemical Sciences. 2019; 13(1): 63-75.

[6] N'Zi FJA, N'Guessan FK, Kouakou-Kouamé CA, Teyssie C, Monte D. Practice of production, preparation and storage of artisanal infant flours in Ivory Coast. J. Appl. Biosci. 2023; 183 :19212-19232. What strategies for enrichment in omega-3 polyunsaturated fatty acids?

[7] Vaughan JP, Morrow RH. Handbook of epidemiology for district health management. Ed. Jouve, WHO, Geneva p. 187, 1991.

[8] Agbessi-Dos-Santos H. African nutrition manual: Applied basics, ed. Karthala 22-24, bd Arago 75013 Paris, 1987.

[9] Cornu A, Treche S, Massamba JP, Delpeuch F. Weaning food and nutritional interventions in Congo. Notebooks: Health 3, 168-177, 1993.

[10] Brou-Tanoh AM, Etiegne MS, Bosso P, Kourouma R, Boa A, Amalaman K, Angaman E, Nancy K. Infant and young child feeding practices in Ivory Coast: the case of complementary feeding of children aged 6-24 months. Public Health Notebook, 2010; 9(2): 69-82.

[11] Mudubu L. Infant and child mortality in Togo: contribution of socioeconomic and cultural factors; IFORD publications. 1996; no 11, Yaounde, p. 85.

[12] INS/ENV. Survey of household living standards in Ivory Coast (ENV, 2015). Report by the Ministry of Planning and Development. 91 pp.

[13] Sahn ED. Malnutrition in Ivory Coast: Prevalence and Determinants. Washington, The World Bank, p. 30, 1990.

[14] UNICEF, The State of the World's Children, New York, NY 10017, p. 141, 1998.

[15] Zannou-Tchoko VJ, Ahui-Bitty LB, Kouamé K, Bouaffou KGM, Dally T. Use of maize germ flour, a source of alpha amylases, to increase the energy density of cassava-based weaning porridges and its derivative, Attieke. Journal of Applied Biosciences. 2011 ; 37 : 2477-2484.

[16] Bamba MS, Gbogouri GA, Agbo AE, Digbeu DY, Brou K. Infant feeding practices using local flours in relation to nutritional status of children aged 6 to 24 months surveyed in maternal and child protection centers of Abidjan (Ivory Coast). International Journal of Child Health and Nutrition. 2018 ; 7 : 102-108.

[17] Akoto EM, Hill A. Child morbidity, malnutrition and mortality. in : Tabutin D ; Population and Society in Sub-Saharan Africa, l'harmattan, paris, pp. 309-334, 1988.

[18] Tou EH, Mouquet-Rivier C, Picq C, Traoré AS, Treche S, Guyot JP. Improving the nutritional quality of ben- saalga, a traditional fermented millet-based gruel, by co-fermenting millet with groundnut and modifying the processing method. Food Science and Technology. 2007 ; 40 (9), pp. 1561-1569.

[19] Nago CM. Traditional food processing of maize in Benin: determination of the physico-chemical characteristics of the varieties in use; relationships with the production and quality of the main by-products. Thesis for the doctorate in science, University Paris7-Denis Diderot Biochemistry Faculty, 199p, 1997.

[20] Boone PS, Charles JD, Wanzie LR. Sub-regional assessment of the maize value chain, technical report ATP n°1. Abt Associates Inc, Bethesda, MD. 2008.

[21] Besançon P. (1999). Safety of complementary foods and bioavailability of nutrients. In Dop MC, Benbouzid D, Trèche S, de Benoist B, Verster A, Delpeuch F. éds: Complementary feeding of young children in Africa and the Middle East; 1999 Geneva, WHO, pp. 59-73.