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Anthropometric and Biochemical Indicators for Protein Energy Malnutrition in Children Aged 0-36 Months in Douala, Cameroon

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Abstract Malnutrition is still a major public health problem in Cameroon. Children, pregnant women, and lactating mothers are the most affected groups. The diagnosis is usually made clinically, but the interest of some clinical essays areimportant to evaluate the severity and facilitate an early detection of albuminemia. This study was designed to assess some anthropometric and biochemical indicators of protein-energy malnutrition (PEM) on children aged from 0-36 months in two hospitals in Douala, using descriptive and analytical methodology. A sampling of 366 children was carried out in two hospitals in Douala namely, the Bonassama District Hospital (HDB) and the Ndogbati Protestant Hospital. A questionnaire related to sociodemographic data such as breastfeeding and complementary feeding practices, was used. Anthropometric measurements of the children were taken. Subsequently, blood samples were taken from children whose parents gave their consent. The classification of protein-energy malnutrition (PEM) according to Waterlow showed that 3.57% of children suffered from PEM without oedema. Gomez's classification showed that 12.75% of children were underweight. The Z-score's classification showed that wasting (4.1%), underweight (5.12%), stunting (11.2%) and global malnutrition (7.65%) were present among the children. In addition, biochemical analyses showed that 8.77% of underweight, 14.03% of wasted children and 12.28% of stunted children were hypo albuminemic. There was also a statistically strong significant relationship between weight for height (W/H), weight for age (W/A) and serum albumin concentration. The nutritional status of the children was therefore significantly influenced by childhood diseases, sociodemographic parameters, breastfeeding and complementary feeding practices of mothers.

Keywords: *breast feeding, children 0-36 months, complementary feeding, protein-energy malnutrition, serum albumin, Cameroon*

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1. Introduction

Nutrition plays an important role in the health and development of individuals [1,2]. Currently, approximately 6.3 million of children less than five years old are dying every year, with malnutrition as one of the main causes. World Health Organization data in 2017 showed that about 31.4%, or 16 million out of 51 million children under five years old were malnourished. Malnutrition remains a major health problem of children under 59 months in developing countries, including Sub-Saharan Africa countries [3]. According to the latest data from Demographic Health Survey (DHS) in Cameroon, the prevalence of children with malnutrition was as high as 29 % [4]. In children, one of the clinical manifestations of malnutrition was underweight, which could lead to delayed physical growth, undeveloped intelligency, behavioral problems and impaired social skills. If this condition was not thoroughly treated, severe malnutrition condition susceptible to infectious diseases, increasing morbidity and mortality rate were unavoidable [5,6].

During the first 1000 days of life, the child is very sensitive to the insufficiency of nutrients and/or imbalance of the diet. Overall, excessive intake of certain nutrients can have consequences, either immediately or in the long term [7]. Insufficient and unbalanced dietary intakes are the most prevalent causes of malnutrition in developing countries. They generate several nutritional diseases including protein-energy malnutrition [8]. Protein-energy malnutrition (PEM) is a pathological condition resulting

from an inadequacy between the needs and intakes of macronutrients (proteins, carbohydrates and fats) [9]. It is also defined as a specific state of deficiency in energy, proteins, or any other macronutrient. It is characterized by a measurable change in physiological body functions, and very often associated with infections [10]. According to WHO in 2018, among children under 59 months of age worldwide, 52 million are wasted; 155 million are stunting, while 41 million are overweight or obese. In Africa, 58 million of children under 59 months of age are stunted, 13.9 million wasted and 10.3 million are overweight and none of these children are growing up healthy [11].

In Cameroon, among children under 59 months global acute malnutrition is approaching the emergency threshold of 15% (EDS, 2018). In Douala, 15.7% of children under 59 months were stunted, 3.3 % wasted and 3.2 % underweight [12], highlighting that this is not an issue of food access, but caring practices and diseases control. Malnutrition causes excruciating human suffering, kills five million children each year, and costs countries billions in loss of productivity and income [1]. To reduce this heavy burden of malnutrition, UNICEF, WHO and NGOs have been organizing several regional workshops and international conferences on nutrition in recent decades [13]. The preschool children are a particularly vulnerable group to malnutrition in Cameroon, as well as in other developing countries [14]. WHO published in 1998 that the nutritional status of young children reflects that of the population. Hence, the need to pay particular attention to their diet from birth is crucial. Although several studies reported on the association between nutritional and health status of preschool children in Cameroon [2,4,15], very few exists that explain optimal complementary feeding practices among these children. However, few data on PEM for these children are available in Douala [14]. Even though Douala is the economic center of Cameroon, a large percentage of its inhabitants live below the poverty line. Recent data shows that about 30% of population lives in poverty. Poverty is a growing problem for Douala citizens due to its steadily increasing populations. Unlike the rural populations of Cameroon that can grow their own foods to lessen their expenses, Douala citizens are disadvantaged by living in the port city where there are not many opportunities for monetary gain [16]. Therefore, this research aimed at assessing some anthropometric and biochemical indicators of PEM in children aged 0-36 months in Douala, Cameroon.

2. Methodology

2.1. Study Area

The study took place in the Douala city. It is the economical capital of Cameroon with about three million inhabitants Douala city is divided into seven districts and it has more than 120 neighborhoods.

2.2. Type of Study

It is a descriptive and analytical study carried out from June to September 2018 where 196 children were enrolled in Bonassama District Hospital (HDB) and Ndogbati Protestant Hospital.

2.3. Study Design

A nutritional survey was conducted to enrolled mothers or caregivers with their young infants aged from 0 to 36 months. Participants were identified in the integrated health centers (IHCs), in the Maternal and Child Protection (MCH) services and in the pediatric department of the following hospitals: Bonassama District Hospital (HDB) and Ndogbati Protestant Hospital. Two categories of data were collected: the anthropometric data with emphasis on nutritional status and the origin of nutritional diseases and the biochemical indicators. Before the laboratory analyses, a survey and the anthropometric parameters of the children were carried out using questionnaires and blood samples were collected in these medical institutions and hospitals.

2.4. Anthropometric Parameters Collection

The Anthropometric parameters recorded during the survey were the height, age, weight, sex, brachial circumference (BP) and nutritional edema.

2.5. Body Mass Measurement

Weight measurements were taken using a SALTER brand baby scale with an accuracy of 100 grams, in a sitting or lying position depending on the child's ability. Shoes and heavy clothes were removed and the weight measurements read were recorded on the survey form. Weighing was done when the stomach was almost empty.

2.6. Size Measurement

Height measurements were taken using the height gauge. Children were asked to stand or lie down without shoes on the horizontal or vertical platform. With the feet parallel, the heels, buttocks, shoulders, and back of the head were to touch the vertical portion of the device. The head was held comfortably upright in the same horizontal or vertical plane as the external hearing meter. The height measurement was read and then recorded on the survey form.

2.7. Brachial Perimeter (BP) Measurement

The brachial perimeter (BP) was measured at the height between the shoulder and the elbow with the child's arm hanging and relaxed with a special wristband 0.1 cm of accuracy.

2.8. Nutritional Edema

Edema was assessed on the tops of both feet, back, and both hands. We applied gentle pressure, using the thumbs, to both feet, counting 121, 122, 123. Edema was present if there was a depression in the child's skin when the thumb was removed. We recorded an individual as having edema only if it was bilateral.

2.9. Assessment of the Nutritional Status of Children

After the anthropometric parameters were taken, the weight/age, weight/height and height/age indices were calculated for the evaluation and classification of individuals according to their nutritional status. This evaluation was done according to the classification of Gomez, Waterlow and Z-scores. The Data collected from anthropometric measurements were analyzed using standard references from WHO, [17]. Malnourished children were reported when any of their anthropometric indices were abnormal (less than -2 z-scores below the mean reference). Children were considered wasted if their weight-for-height index was less than -2 z-scores below the WHO standard reference. Children were considered underweight if their weight-for-height index was less than -2 z-scores from the mean reference. Children were considered stunted if their height-for-age index was less than -2 z-scores from the mean reference.

2.10. Clinical Examination

It was focused on the search for cutaneous-pathological disorders, muscle wasting, the presence of edema, and detectable tare. In case of edema, particular attention was paid to cardiac auscultation and palpation of the liver in search of signs that could explain the edema.

2.11. Biochemical Analysis

Blood samples were collected only on children whose parents gave their consent and signed the consent form. Nurses collected the blood samples of these children. Thus, the blood samples of 57 children were taken on an empty stomach in the morning between 8 and 10 am. Approximately 2 ml of venous blood were collected from each child. The blood collected was inserted inside dry tubes for analyses at the biochemistry laboratory of the University of Douala. Centrifugation of the blood was performed using a Sigma 2-6 E Centrifuge type at the speed of 3600-x G for 20 min for serum isolation. The serum (supernatant) was extracted using a micropipette and introduced into cryotubes. The serum obtained was then used to determine the albumin content according to the Doumas methods [18].

2.12. Ethical Approval

Ethical approval and permission were obtained from the Institutional Research Ethics Committee for Human Health of the University of Douala (N°1298 CEI-Udo/02/2018/M). Written informed consent was also obtained from the mothers, caregivers.

2.13. Statistical Analysis

Data from anthropometric measurement and biochemical were analyzed using *Statistical Package for Social Sciences* (SPSS) 20. Chi^2 test and Pearson correlation were used to compare the values of different parameters. Results were given as mean ± standard deviation and differences were considered significant from $P < 0.05$.

3. Results and Discussion

3.1. Results of the Survey

3.1.1. Distribution of Children

In this study, male sex was the most represented with 106 boys (54.1%) against 90 girls (45.9%). In addition, nearly 2.6% of children aged to 25-36 months were the least represented of the other age groups. Table 1 shows that, the 25-36 months age group was the least (2.6%).

Table 1. Distribution of children according to their ages

Age (months)	**Distribution N (%)**
0-6	134 (68.4)
7-12	44 (22.4)
13-24	13 (6.6)
25-36	5 (2.6)
Total	196 (100)

3.1.2. Breastfeeding

Concerning the distribution methods of breastfeeding practiced by mothers, it appeared from our survey that the prevalence of breastfeeding was 56.6 % for exclusive breastfeeding 39.8 % for mixed breastfeeding and 3.6 % for artificial feeding.

3.1.3. Foods Consumed between 0-6 Months

Regarding children's food consumption during the first 6 months, it was observed that 35.2% of children consumed breast milk in addition to artificial milk while 7.14 % of children consumed breast milk and water. However, 1% of children consumed breast milk and others foods (cereals).

3.1.4. Complementary Feeding

Figure 1 shows the complementary foods used by mothers in the population. It is observed that, the majority of complementary foods (66.83 %) was introduced before 6 months of age. The majority of this diet consisted of cereals (22%), beverages (21%), meat, fish and eggs (8 %). Fats (oil and fats) were not used much, only 1%.

3.1.5. Socio-demographic characteristics

Table 2 describes the sociodemographic characteristics that influence PEM. It shows that 87.8% of respondents lived in modern buildings and 12.2% in buildings made of shaky materials. In the different households, the number of children under five years varied from one to three, with 51.5% of households having two children; 40.8% of households, had one child and 7.7% had three children. Regarding access to water, 4.1% of households, used well water; 33.7% used water from boreholes, and 62.2% used water from the national network distribution. In terms of primary health care use, 79.6% of the study population used hospitals, 15.8% used health centers, and 4.6% used self-medication. Vaccination coverage was based on the Expanded Program on Immunization (EPI) of Cameroon. Nearly 87.2%, of children had taken all their doses of vaccine on time and 12.8%, had overdue doses and the various childhood diseases could be a focal point for the PEM.

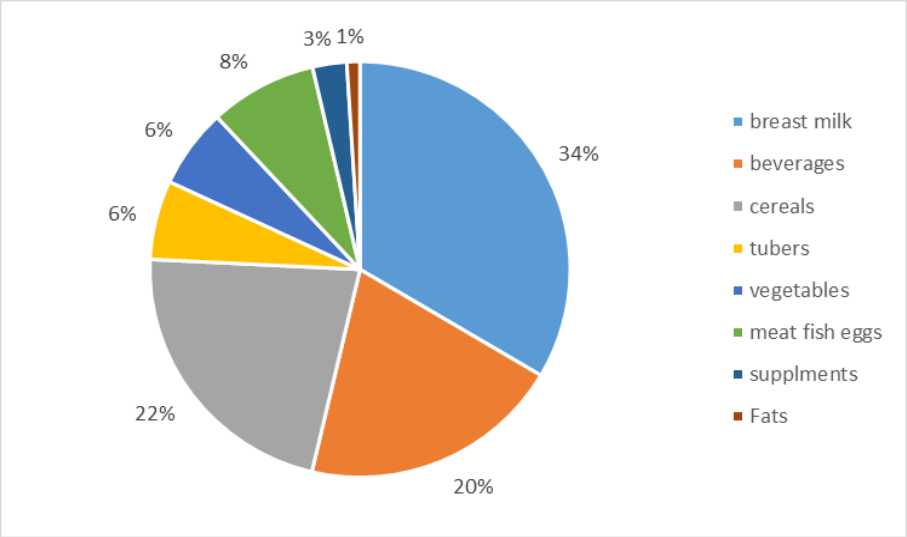

Figure 1. Distribution of complementary foods

Table 2. Type of housing, access to water and health care for children

Parameters	Characteristics	Distribution N (%)
Dwellings	Hard	172 (87.8)
Family	Wood	24 (12.2)
Number of children under five per household	A	80 (40.8)
	Two	101 (51.5)
	Three	15 (7.7)
Access to water	CDE	122 (62.2)
	Drilling	66 (33.7)
	Well	8 (4.1)
Access to health care	Hospital	156 (79.6)
	Health Center	31 (15.8)
	Self-medication	9 (4.6)
EPI	Follow-up	171 (87.2)
	Delay	25 (12.8)

EPI: Expanded Program on Immunization.

3.1.6. Clinical Signs

Concerning the knowledge about the clinical signs of the different forms of PEM in mothers, we noted that 82.1% of mothers had no knowledge of the clinical signs of marasmus and 43.9 % of mothers had no knowledge of kwashiorkor.

3.2. Results of Anthropometric Parameters

3.2.1. Distribution of Children by the Gomez Classification

This classification uses the indicator of weight for age and allowed us to determine the proportion of underweight individuals.

3.2.2. Classification of Children by Gender

Figure 2 shows the distribution of children by gender using the Gomez classification. From this figure, it can be seen that: 11.2% of girls and 6.63% of boys were underweight respectively.

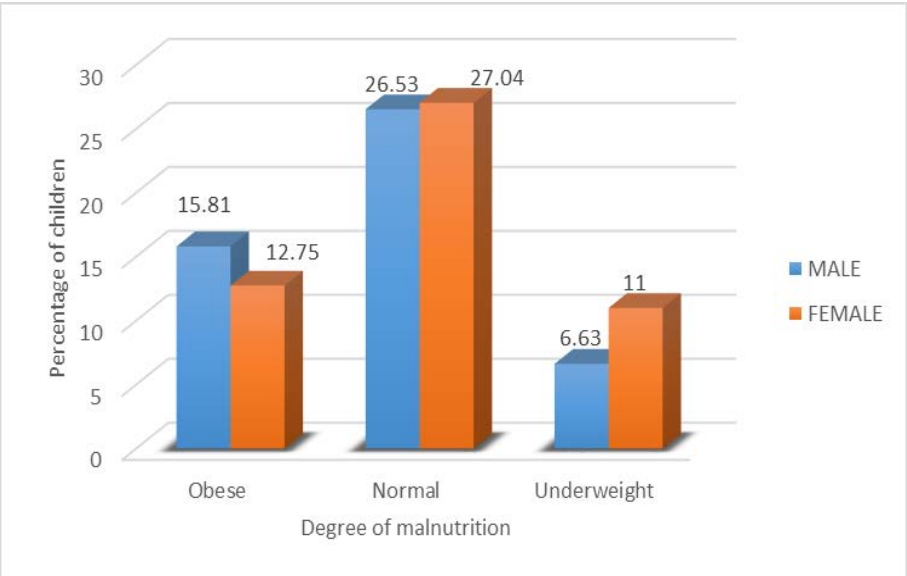

Figure 2. Distribution of children according to gender using the Gomez classification

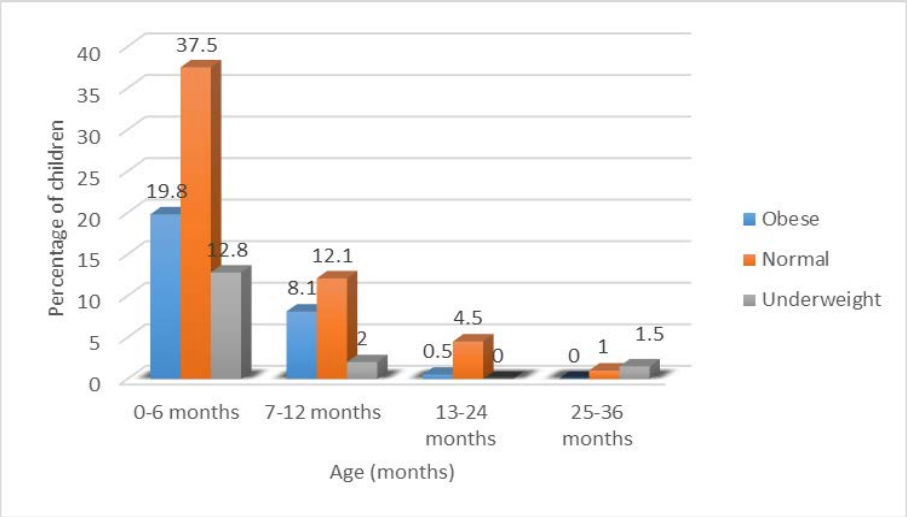

Figure 3. Distribution of children according to age by Gomez

3.2.2. Distribution of Children by Age Group

Figure 3 shows the distribution of individuals according to age groups based on the Gomez classification. From this figure, it appeared that: 12.8% of children between 0-6 months were underweight. While 2% and 1.5% of children between 13-24 months and 25-36 months respectively were underweight.

3.2.3. Distribution of Children According to Waterlow's Classification

Figure 4 shows the different nutritional states encountered according to the Waterlow's classification**.** It appeared that 18.89% of children were malnourished. However, 3.57 % of children suffering from both stunting and wasting.

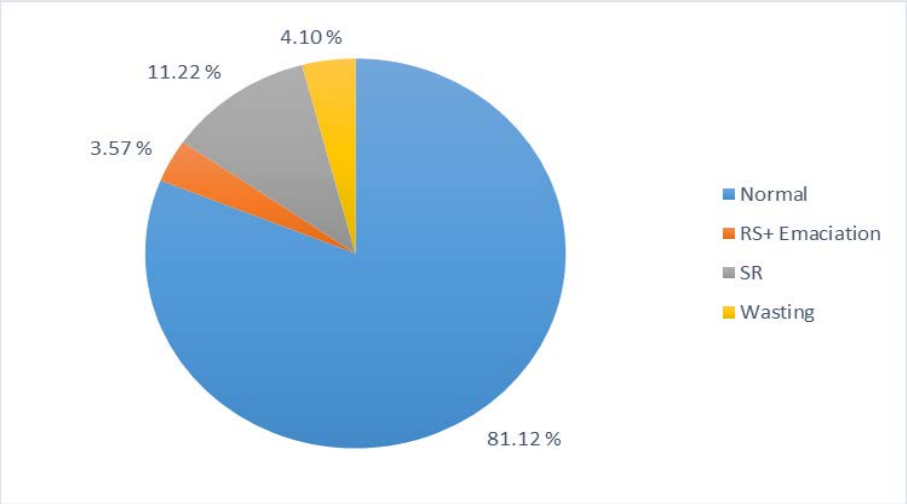

Figure 4. Nutritional levels using the Waterlow classification (RS= stature delay)

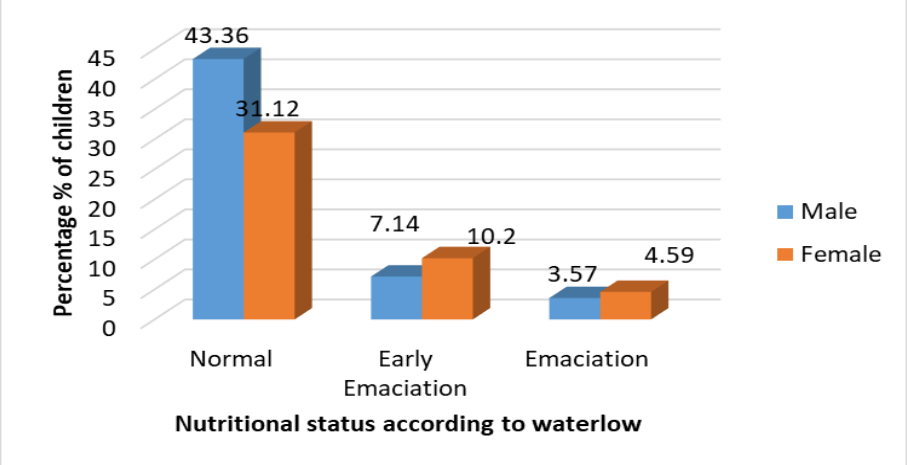

Figure 5. Distribution of children by gender and nutritional status according to Waterlow (***M*** = malnutrition)

3.2.4. Distribution by Gender

Figure 5 shows the distribution of children according to gender based on the Waterlow's classification. From this figure, it appears that 10.2% of girls were wasted for the early stage and 4.59% of boys were wasted for the moderate form. In boys, the prevalence was 7.14% for the early stage and 3.57% for the moderate form.

3.2.5. Evolution Forms of Malnutrition with Age

Figure 6 shows the distribution of children by age groups according to WATELOW's classification. From this figure, we observed that 61% of children aged 0-6 months were the most affected by wasting. 7-12 and 13-25 months age groups showed the same proportion of malnourished children with 1%, but it should be noted that no child in the 25-36 months age group suffered from wasting during the collection period. The figure also shows that the risk of developing wasting decreases with increasing age.

3.2.6. Distribution of Children by WHO Classification: Z-score

Indices allowed us to determine the proportion of malnourished children. We observed that 31.63% of children were suffering from malnutrition in different forms. Table 3 below shows the distribution of children by Z-scores. We noted that 5.1% of children were underweight, 20.4% of children were at risk, 60.2% of children were normal and 14.3% of children were overweight. However, the children between 0-6months were the most affected (4.1%) by underweight. On the other hand, we did not observe any underweight children in the 7-12 months age group. Regarding Weight/Height indices, we noted that 4.1% of children were wasted or acutely malnourished. We observed that 15.3% of children were at risk; 59.2% of children were normal and 21.4% of children were overweight. However, 3.1% of children between 0-6 months were the most affected by wasting. We did not observe any wasting children over 12 months of age. Also, we noted that 11.2% of children were stunted or chronically malnourished. We also observed that chronic malnutrition affected mostly children in the 0-6 months age group, with 7.1% of children. Among children in this age group, 17.3% of children were at risk and 6.5% of children were overweight.

3.2.7. Distribution of Children by Gender

Figure 7 shows nutritional status by gender according to Z-scores. From this figure, it appears that malnutrition was more present among boys (20.96%) compared to the 14.51% among girls. In addition, 11.29% and 4.83% of boys and girls were underweight respectively. As for children suffering from PEM, boys were the most affected at 8.06%.

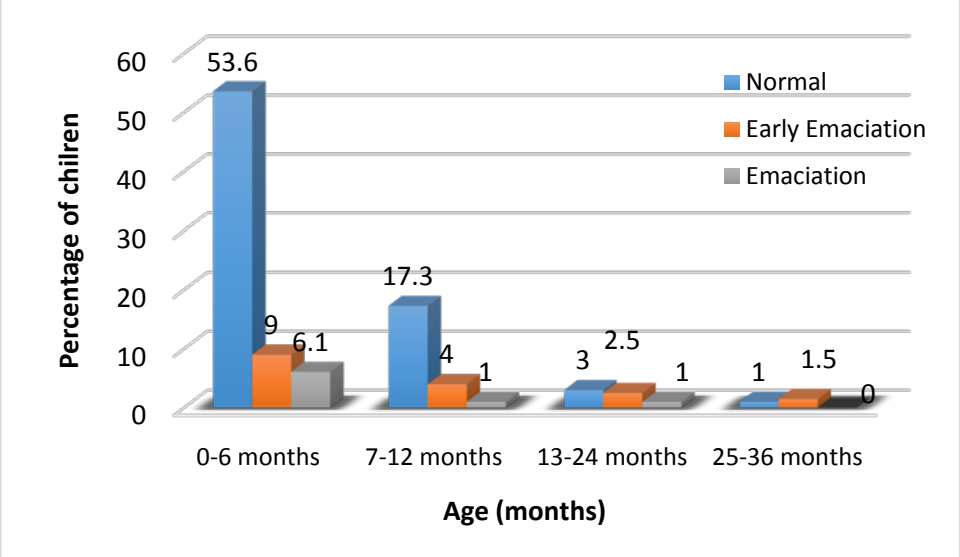

Figure 6. Distribution of children by age groups according to the Waterlow classification

Table 3. Distribution of children by Z-score

Malnutrition indices		0 - 6	7 - 12	13 - 24	25 - 36
Weight / Age indices	Underweight	8 (4.1)	0 (0)	1 (0.5)	1 (0.5)
	At risk	25 (12.8)	8 (4.1)	4 (2)	3 (1.5)
	Normal	83 (42.3)	27 (13.7)	7 (3.6)	1 (0.5)
	Overweight	18 (9.1)	9 (4.6)	1 (0.5)	0 (0)
	Total	134 (68.36)	44 (22.45)	13 (6.63)	5 (2.55)
Weight / height indices	Emaciation	6 (3.1)	2 (1)	0 (0)	0 (0)
	At risk	19 (9.8)	3 (1.5)	5 (2.5)	3 (1.5)
	Normal	75 (38.1)	31 (15.7)	8 (4)	2 (1)
	Overweight	34 (17.3)	8 (4)	0 (0)	0 (0)
	Total	134 (68.36)	44 (22.45)	5 (2.55)	5 (2.55)

N = Number; (%)= percentage.

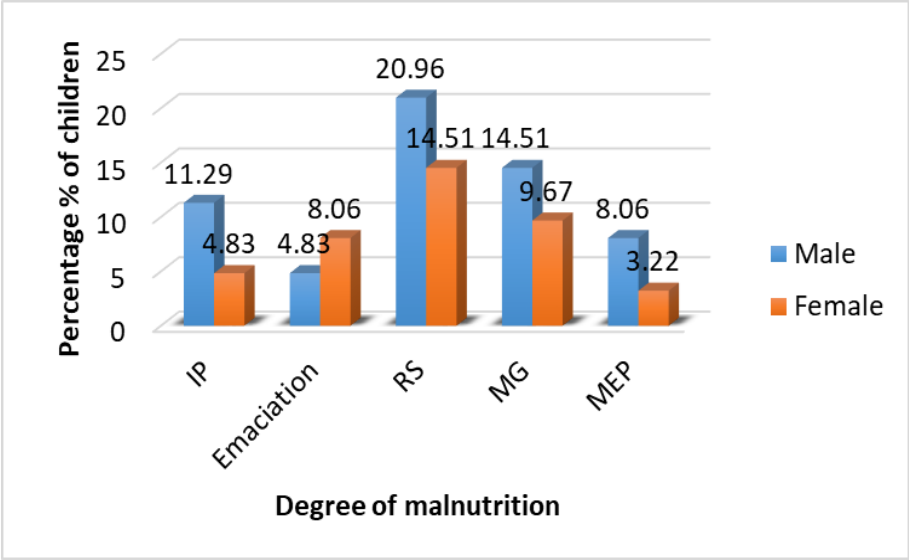

Figure 7. Prevalence of forms of malnutrition by gender (***IP*** = underweight; ***RS*** = stunting; ***MG*** = global malnutrition)

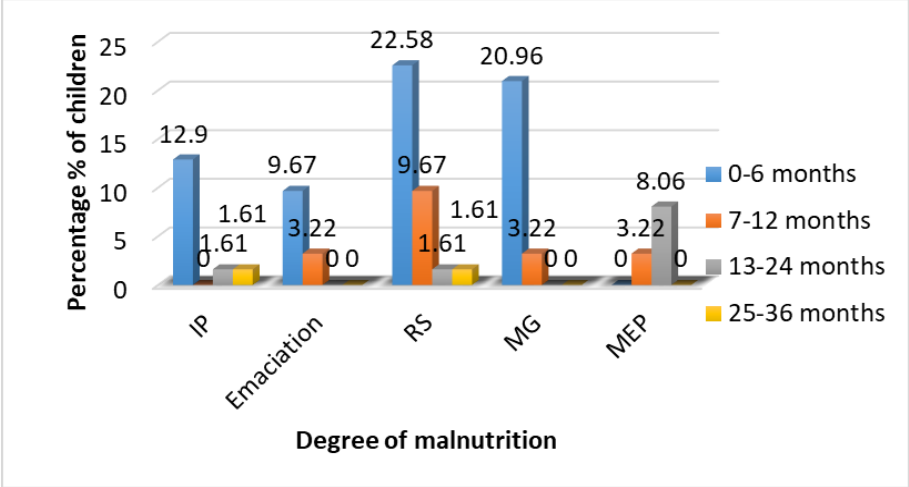

Figure 8. Distribution of the different forms of malnutrition based on the nutritional index according to age groups (IP = underweight; RS = stunting; MG = global malnutrition; PEM = protein-energy malnutrition)

3.2.8. Evolution Forms of Malnutrition according to Age

Figure 8 presents the distribution of the different forms of malnutrition according to age groups.

We observed that 12.9% of children aged 0 to 6 months were underweight, 9.67% of children were wasted and 22.58% of children were stunted. Moreover, we did not observe any children underweight for the 7-12 months period

3.3. Biochemical Analysis

3.3.1. Characteristics of the Children

Samples analyzed were from 37 boys (64.9%) and 20 girls (35.1%). The mean albumin level was 3.65 g/dL. We observe that 45.6% of children had hypoalbuminemia, while 33.3% of children had hyper albuminemia.

We note that 8.77% of children with hypo albuminemia were underweight, 17.54% of children in the early stage and 14.3% of children with normal W/A index showed hypo albuminemia (Table 4). However, in the hyper albuminemia group, 14.03% of children showed normal W/A index; 15.78% of children were overweight and 1.75% of children was underweight. From this table (Table 4), it appears that 14.03% of children with hypo albuminemia were wasted. While, 10.52% of children were in the early stage of malnutrition and 15.78% of children with normal W/H status were also wasted. However, in children with normal albumin levels, we did not observe any wasting. On the other hand, among those with a normal W/H index, we have 12.28% of children with normal albuminemia and 8.77% of children were overweight. However, the group of children with hyperalbuminemia showed no wasting and 3.50% of children with early wasting. Concerning albumin levels by H/A index, it can be seen that 12.28% of children with stunting were hypoalbuminemic, whereas 8.57% of children with early onset and 22.80%, of children with normal H/A were also hypoalbuminemic. Among children with normal albumin levels, 8.77% of children with stunting and 7.01% of children with early onset of the disease. However, for the group of children with hyper albuminemia, 7.01%, of children, were stunted. It should be noted that among the children with the nutritional form combining the W/H and H/A index, suffering from PEM 5.26% were hypo albuminemic.

Table 4. Albumin levels in relation to nutritional indices

Malnutrition indices		Hypo albuminemia	Normal albuminemia	Hyper albuminemia	Chi² test	Total
Weight /Age indices	Underweight	5 (8.77)	1 (1.75)	1 (1.75)	P=0.022	12.27
	Early stage	10 (17.54)	1 (1.75)	3 (5.26)		26.3
	Normal	7 (12.28)	9 (15.78)	8 (14.03)		42.09
	Overweight	2 (3.50)	0(0)	9 (15.78)		19.28
Weight / height indices	Emaciation	8 (14.03)	0 (0)	0 (0)	P=0.001	14.03
	Early stage	6 (10.52)	0 (0)	2 (3.50)		14.02
	Normal	9 (15.78)	7 (12.28)	9 (15.78)		43.83
	Overweight	3 (5.26)	5 (8.77)	8 (14.03)		28.06
Height/ Age indices	Underweight	7 (12.28)	5 (8.77)		P=0.435	28.06
	Early stage	5 (8.57)	4 (7.01)	3 (5.25)		20.83
	Normal	13 (22.80)	3 (5.25)	10 (17.54)		45.6
	Overweight	1(1.75)	0 (0)	2 (3.5)		5.25

N = Number; ***%=*** percentage.

Table 5. Relationship between breastfeeding and nutritional status

Breastfeeding	W/H index				**Chi² test**
	Emaciation N (%)	Early stage N (%)	Normal N (%)	Overweight N (%)	
EMBF	4 (2.04)	19 (9.69)	66 (33.7)	22 (11.2)	P = 0.598
NEMBF	4 (2.04)	11 (5.61)	46 (23.5)	17 (8.67)	
AF	0 (0)	0 (0)	4 (2.04)	3 (1.53)	
Total	4.08	15.3	59.24	21.4	

EMBF = Exclusive Maternal Breastfeeding; ***NEMBF*** = Non-exclusive Maternal Breastfeeding; ***AF*** = Artificial Feeding.

3.3.2. Relationship between Breastfeeding and Nutritional Status of Children

Table 5 shows the relationship between breastfeeding and nutritional status of children according to the W/H index. It appears that 33.7% of children with normal W/H index were subjected to the EMBF, 23.5%, of children in NEMBF and 2.04%, of children in AF. On the other hand, for those in wasting, 2.04%, of children were subjected to EMBF, 2.04%, of children to NEMBF were in wasting.

4. Discussion

This study confirms the higher prevalence of stunting in Douala particularly among young children aged 0-36 months. During this study, we have seen a decrease in the prevalence of low birth weight in children from 10% according to the last MICS survey [12], to 8.67%. This presence of low birth weight children could be explained by prematurity, poor health and nutrition of mothers, lack of prenatal care, unhealthy environment. Gomez's classification based on the W/A index showed a predominance of underweight in female children. The same observation was true for the Waterlow's classification, which also showed the girls predominance for wasting. This could perhaps be explained by restriction or prohibitions for girls of some foods in many of our communities. This result was also similar to that of Iboudo, [19].

However, both classifications showed for the children aged 0-6 months prevalence of 6.1% for wasting and 12.8% for underweight. It also showed the early nature of malnutrition in the study area. Malnutrition was not very common at this age group because the majority of mothers practice breastfeeding, which is sufficient to cover the child's nutritional needs at this age. At this age, several parameters could explain the occurrence of malnutrition in these children. Some are low birth weight which is one of the main factors favoring malnutrition; failure to comply with WHO and UNICEF recommendations for breastfeeding infants within one hour of birth and exclusive breast feeding for the first six months of life [12,20]. This result was similar to that of [14] who observed comparable values regarding both nutritional states in infants under two years of age, and different from those of [21], reporting that the most affected age groups were 12 -23 months followed by 24 - 59 months.

Based on the Waterlow's classification with W/H and H/A indices PEM without edema or severe acute malnutrition (SAM) was present in 3.57% of the children in our study. This presence of SAM in the population of children aged 0-36 months in Douala could be due to inappropriate infant and young child feeding (IYCF) practices consisting of meals with insufficient energy density or nutrient content not appropriate for their ages [22,23], lack of knowledge of the mothers about the nutrient needs of the child [24]. This result was similar to those of [25]. They were different from those of Rytter [26] in Nigeria reporting in his series a high frequency of SAM with oedema in slightly older children (17 months).

Children aged 13-24 months were the most affected by PEM without edema or SAM. This situation could be explained by several factors: eating inappropriate foods, and stopping of breastfeeding from this age, the lack of knowledge of mothers refarding appropriate infant feeding patterns. Similar observations in other studies have been documented earlier, where PEM in children of the same age group was observed [14,25]. However, [27] in Ethiopia, reported a higher frequency of 19.9% at the same age.

The WHO classification based on Z-scores showed a decrease in stunting from 15.7% to 11.2%, an increase in

the prevalence of wasting from 3.3% to 4.1% and also, that of underweight from 3.3% to 5.12% for children under 0- 36 months [12]. The stunting affects mostly infants in the 0-6 months age group and could be explained by the lack of exclusive breastfeeding for children in this age group associated to early complementary feeding children using infant formula. This result is similar to those of Musimwa [25] who observed the stunting in children aged 0-5 months.

Underweight was notable in the 0-6 months age group, but the absence of this nutritional affection in the age group of 7-12 months children could be explained by the good transition from breastfeeding to complementary feeding. However, its occurrence at an age above 12 months can result by the absence of the caregiver during feeding, as the child was deemed fit to feed himself.

Wasting was present in the 0-6 and 7-12 months age groups and absent in children over 12 months of age. At this age, the child eats normally and consumes the family meal which may have a good protein and nutrient intake, in addition to breast milk in one hand, or in another hand, is fed with meals of appropriate energy density for his age [28]. This result is different from the one obtained by [2] who observed wasting beyond 12 months of age.

With regard to global malnutrition, the 0-6 months age group was the most affected. The presence of global malnutrition is the result of low birth weight, prematurity, lack of sucking reflex for feeding during the first days of life, and also of the loss of 1/10 of birth weight during the first month of life. This findings are different from those of some authors [12,14] who observed this nutritional state in children older than 6 months.

The different forms of malnutrition by sex showed a high prevalence among boys for underweight, stunting, global malnutrition, and early-onset PEM. We believe that the predominance of boys could be explained by the fact that during our study, we retained more males than females. On the other hand, certain studies revealed that at this stage, boys are often more fragile than girls [29]. Concerning malnourished boys, our results were similar to those of [21] and [30] having observed a greater boys involvement and different from those of [25], [19] having observed a high prevalence in girls children.

In the proportion of individuals who agreed to give samples for biochemical analysis, it was found that 13.26% of children were hypo albuminemia (ALB < 3.8 g/dL), 6.12% with normal albuminemia (3.8 ≤ ALB ≤ 4.4 g/dL) and 9.69% were hyper albuminemia (ALB > 4.4 g/dL). These different albumin concentration values are relative to this study. The albuminemia according to the different indices showed us children in a state of moderate malnutrition, in the beginning form and normal in hypo albuminemia according to different indices. This low albuminemia could be due to the mother's lack of knowledge of the child's needs, to a diet not rich enough in protein or of insufficient energy density to cover the child's needs and to the loss of appetite of the children shortly before the collection period. However, albuminemia based on W/A and H/A indices showed children with normal albuminemia and hyper albuminemia who were underweight and stunted in the moderate and early stages. Genetic factors, environmental, dietary, socio-political and cultural differences between the reference population and our study population would justify these results.

An inflammatory and/or infectious state shortly before the collection period could lead the low albuminemia observed in both nutritional states for both the moderate and early stage. These results are similar to those of [31] who showed a lowering of albuminemia during moderate and minor malnutrition compared to normal subjects. Different from those of [32] and [25] showing a decrease in severe forms.

5. Conclusion

In conclusion, the findings of this study indicate that more than half of the children studied received exclusive breastfeeding during the first six months. Complementary foods were early introduced in the diet of some children. Mothers still poorly understood the clinical signs of marasmus and kwashiorkor. Anthropometric indicators showed the presence of PEM without edema (SAM) and the presence of other malnutrition according to Z-scores. Biochemical analyses showed a decrease in serum albumin in the moderate and early stages of the different nutritional states. Nutrition surveillance is important, particularly in this age group, in the promotion of appropriate infant and young child feeding practices from birth to the second year of life, proper nutritional management of childhood illnesses and increased feeding during recovery from acute infections, and micronutrient supplementation in women of childbearing age.

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Conflict of Interest

The authors declared no conflict of interest among them.

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