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Evaluation of Malnutrition in Infants Aged 0 - 59 Months in the Suburbs of Dakar

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Abstract

Introduction: Child malnutrition is a major public health concern worldwide, particularly in low- and middle-income countries. The latest report from Senegal's Continuous Demographic and Health Survey revealed that 18% of children in Senegal were stunted (chronic malnutrition), 8% were wasted (acute malnutrition) and 14% were underweight. Thus, this study aimed to assess the characteristics associated with malnutrition in children according to their nutritional status. **Methods:** This descriptive transverse study was conducted at the Pediatric Social Institute of Pikine/Guediawaye and the National Hospital Center of Pikine, in Senegal between October and December 2019. A total of 94 children were recruited, with the consent of their legal tutors. Descriptive and multivariate analyses of the factors associated with malnutrition were performed. The z-scores for the indices of nutrition were determined with WHO Anthro® software version 3.2.2. All the data analyses were performed using R software version 4.2.2. **Result:** From the 94 children recruited, 51.06% were female, with a sex ratio (male/female) of 0.96. Acute malnutrition was recorded in 62.77% of cases, chronic malnutrition in 41.49%, and underweight in 71.27%. Linear regression analysis showed that many factors, such as the female gender [OR = 1.82 CI (1.02 - 3.3), P-value = 0.04], consanguinity [OR = 2.84 CI (1.14 - 7.65), P-value = 0.03], low birth weight [OR = 4.83 CI (2.15 - 12.89), P-value = 0.0004], were associated with acute malnutrition. Low birth weight (<2.5 kg) [OR = 10.66 CI (3.82 - 44.39) P-value < 0.0001], non-exclusive breastfeeding [OR = 3 CI (1.40 - 7.13)] P-value = 0.007], dietary diversification before six months [OR = 2.04 CI (1.23 - 3.51), P-value = 0.007] and others factors were associated with underweight. The most frequently recorded clinical signs are weight loss (30.85%), fever (23.40%), diarrhea (34.04%), and anemia (70.21%). **Conclu-**

sion: Problems associated with malnutrition are multifactorial. Dietary diversification, consanguinity, and low birth weight are factors associated with malnutrition in children in Senegal. Thus, special attention must be paid to this problem because of its impact on child survival.

Keywords

Malnutrition, Child, Anthropometry, Anemia, Nutritional Status

1. Introduction

Malnutrition is a universal problem with several forms. It affects most of the world's population at some point in the life cycle from childhood to old age. Child malnutrition is a worldwide major public health problem, particularly in low- and middle-income countries [1] [2]. The first 1000 days of a child's life (0 - 24 months) is a crucial period when good nutritional interventions will lead to satisfactory child growth and development [3] [4]. Thus, malnutrition during this critical phase can have irreversible consequences on the child's growth, leading to an increased risk of morbidity and mortality [1].

The World Health Organization (WHO) defines malnutrition as a deficiency, excess, or imbalance in energy and/or nutrient intake relative to a person's needs [5]. Malnutrition covers three broad groups of conditions which are undernutrition, which includes wasting or acute malnutrition; stunting or chronic malnutrition; and underweight [5].

Malnutrition is an underlying cause of morbidity and mortality in children. Children under the age of 5 years are the most vulnerable [6]. Malnutrition contributes to approximately 45% of deaths of children under-five years of age in the worldwide [6] [7]. Moreover, the joint estimates of the United Nations International Children's Fund (UNICEF), WHO, and World Bank published in March 2020 revealed that globally, approximately 6.9% of children were wasted and 21.3% were stunted [8].

Africa and Asia recorded the most cases in the world, with 29.1% and 21.8% of children under 5 years of age suffering from chronic malnutrition defined as stunting, and 6.4% and 9.1% of children suffering from acute malnutrition defined by wasting, respectively [8]. However, sub-Saharan Africa remains the most affected region, with a prevalence of 6.3% for acute malnutrition and 31.1% for chronic malnutrition, thereby supporting the need for urgent intervention [8]. Poverty, food insecurity, maternal education, climatic factors, and socioeconomic conditions are considered potential causes of malnutrition in sub-Saharan countries [9]. A lack of breastfeeding or a shortened breastfeeding period can also lead to malnutrition in children [3].

The latest report from Senegal's Continuous Demographic and Health Survey (EDS-Continue) revealed that 18% of children suffer from chronic malnutrition,

8% are acutely malnourished and 14% are underweight [10]. Severely malnourished children are highly susceptible to life-threatening infections [6] such as diarrhea, pneumonia, and measles [7] [11]. Therefore, reducing child malnutrition is necessary to improve the health status of children, who constitute the core segment of society. This is crucial not only for economic growth but also for the development of society.

In this context, our study assessed the characteristics associated with malnutrition in children according to their nutritional status.

2. Methodology

2.1. Study Setting

Our study was conducted in the suburbs of Dakar in the Departments of Pikine and Guediawaye of the Dakar region, the capital of Senegal. In the department of Pikine and Guediawaye, there is the National Hospital Center of Pikine (CHNP), a health center, and twelve health posts including the Pediatric Social Institute of Pikine/Guediawaye (IPS). The IPS is attached to the Chair of Pediatrics of the Cheikh Anta Diop University of Dakar. Its objective is to ensure the care of children aged 0 - 15 years and pregnant women according to the principles of primary healthcare and community medicine. The IPS has a Nutritional Recovery and Educational Centers that provide malnourished children with the necessary care for their treatment. The CHNP is a level 3 public health institution located in the district of Thiaroye, in the Department of Pikine, 15 km from Dakar. It has a pediatric service in which children with malnutrition are treated for various pathologies.

2.2. Type of Study

This descriptive cross-sectional study was conducted in the Pediatric Department of the CHNP and at the IPS in Senegal between October and December 2019. This study is part of a thesis project on the genetic determinants of childhood malnutrition in Senegal.

2.3. Study Population and Inclusion Criteria

All children aged 0 - 59 months with no distinction of sex, received for consultation and/or care, at the pediatric service of the CHNP and IPS, or at the Nutritional Recovery and Educational Centers of IPS, during the study period and whose legal tutors consented, were included in this study.

2.4. Survey and Data Collection

A total of 94 children were recruited based on informed consent signed by legal tutors. This study was approved by the Ethics and Research Committee of the Cheikh Anta Diop University of Dakar under protocol No. 0340/2018/CER/UCAD.

A two-part survey was used to collect the necessary data. The first part fo-

cused on the sociodemographic characteristics of the children, their dietary practices, the consanguinity of the parents, and the treatments received. The questions in this first part concerning the child were asked directly to the legal tutor. The second part assessed the nutritional status and anthropometry of the children.

2.5. Epidemiological and Sociodemographic Characteristics

Characteristics such as sex, age (months), ethnicity, and birth weight were considered in this study.

2.6. Dietary Practices

The feeding practice questions concerned the breastfeeding mode, weaning, and dietary diversification. The age at which food was introduced was also recorded.

2.7. Anthropometric Measurements and Nutritional Status

The nutritional status of the children was evaluated using anthropometric measurements such as weight, height, and mid-upper arm circumference (MUAC). Weight was measured using an electronic balance (in grams), and height was measured in centimeters using a 100 cm horizontal measuring tape. Children under two years of age were measured while lying down and those over two years of age while standing up. The MUAC was measured using a millimeter tape.

The z-scores for the indices weight-for-height, height-for-age, and weight-for-age were determined in comparison to 2006 WHO reference population, incorporated in the WHO Anthro® software version 3.2.2 [12]. This software provides a curve for the distribution of each anthropometric index of the study population compared with WHO standards. By WHO standards, chronic malnutrition, acute malnutrition, and underweight were defined according to weight-for-height, height-for-age, and weight-for-age (Table 1). In addition to these anthropometric measures and indices, other indicators were used. These included head circumference (HC) and thoracic circumference (TC), which were measured using a tape measure and expressed in centimeters.

Table 1. Classification of the different forms of malnutrition.

	Acute malnutrition (Weight/Height)	Chronic malnutrition (Height/Age)	Underweight (Weight/Age)
None	PTZ ≥ −2	TAZ ≥ −2	PAZ ≥ −2
Moderate	−3 ≤ PTZ < −2	−3 ≤ TAZ < −2	−3 ≤ PAZ < −2
Severe	PTZ < −3	TAZ < −3	PAZ < −3

PTZ: Weight-for-height z-score; TAZ: Height-for-age z-score; PAZ: Weight-for-age z-score.

2.8. Paraclinical Characteristics and Biological Analysis

The clinical signs of each child were determined using the child's diary and the survey. For each child registered, a blood sample was collected in a 4 ml vacutainer tube with ethylenediaminetetraacetic acid (EDTA) during consultation at the IPS or CHNP laboratory. A blood counts analysis ("CBC" or "NFS") was performed to verify whether the child had anemia and the degree of anemia. Anemia was defined by hemoglobin (Hb) level (g/dl) and was determined using a Yumizen-type hematology analyzer connected to a printer and set according to age and sex. Anemia was considered severe if Hb was <8 g/dl and moderate if Hb was <11 g/dl [13].

2.9. Data Entry and Statistical Analysis

All data were entered into Excel, and the results were analyzed using R studio version 4.2.2. Means, standard deviations, and extreme values were determined for all quantitative variables. Proportions were calculated for the qualitative variables.

Bivariate analyses were performed to determine the presence or absence of a relationship between the two variables for each form of malnutrition. Distributions of categorical variables were compared using Fisher's exact test. For the comparison of means, the normality of the variables was verified using the Shapiro-Wilk test. Depending on the distribution of these variables, parametric (t-test or ANOVA) or non-parametric (Wilcoxon or Kruskal-Wallis) tests were used. Univariate and multivariate logistic regression analysis was performed to determine the risk factors associated with nutritional status. The significance of odds ratios (OR) was assessed using Pearson's chi-squared test. The significance level was set at 5%.

3. Results

3.1. Sociodemographic and Epidemiological Characteristics of the Study Population

A total of 94 children under 5 years of age were reported; 51.06% were female and 48.94% were male, with a sex ratio (M/F) of 0.96. The most frequently registered age group was 12 - 23 months (52.13%). The mean age was 14.69 ± 8.1 months. The most represented ethnic group was the Wolof (42.55%). Pulaar children were second, at 26.60% of the malnourished children. We noted that 36.17% of the children had a low birth weight (*i.e.*, weight < 2.5 kg), with an average birth weight of 2.58 ± 0.57 kg. Children from consanguineous marriages represented 37.23% of the study population. The parameters are listed in Table 2.

3.2. Nutritional Status of Malnourished Children

Table 3 shows the children's nutritional status. According to the weight-for-height, 62.77% had acute malnutrition, of which 21.28% had moderate acute malnutrition, and 41.49% had severe acute malnutrition.

Table 2. Epidemiological and sociodemographic characterization of the study population.

Characteristics		Numbers (Total = 94)	Frequencies (%)
Gender	Female	48	51.06
	Male	46	48.94
Age (months)	<12	33	35.11
	12 - 23	49	52.13
	≥24	12	12.76
Ethnic group	Wolof	40	42.55
	Serere	17	18.09
	Pulaar	25	26.60
	Diolas	2	2.13
	Manjaque	2	2.13
	Lebou	2	2.13
	Mandingue	3	3.19
	Maures	3	3.19
Consanguineous marriage	Yes	35	37.23
	No	59	62.77
Birth weight	Insufficient (<2.5 kg)	34	36.17
	2.5 - 2.9 kg	32	34.04
	≥3 kg	28	29.79

Table 3. Malnutrition and anthropometric indices of malnourished children.

	Acute malnutrition (W/H)	Chronic malnutrition (H/A)	Underweight (W/A)
	n (%)	n (%)	n (%)
None (Z > −2)	35 (37.23)	55 (58.51)	27 (28.72)
Moderate (Z < −2)	20 (21.28)	21 (22.34)	19 (20.21)
Severe (Z < −3)	39 (41.49)	18 (19.15)	48 (51.06)

W/H: Weight-for-height; **H/A**: Height-for-age; **W/A**: Weight-for-age; **N**: Numbers.

For height-for-age, 41.49% of the children had chronic malnutrition, of which 22.34% had moderate chronic malnutrition and 19.15% had severe chronic malnutrition.

As for weight-for-age, 71.27% of the children were underweight, of which 20.21% were moderately underweight and 51.06% were severely underweight.

The curves for the global z-score distribution of weight-for-height, height-for-age, and weight-for-age of the population surveyed, compared with the respective WHO reference curves, are shifted to the left in the figures (see Figures 1-3).

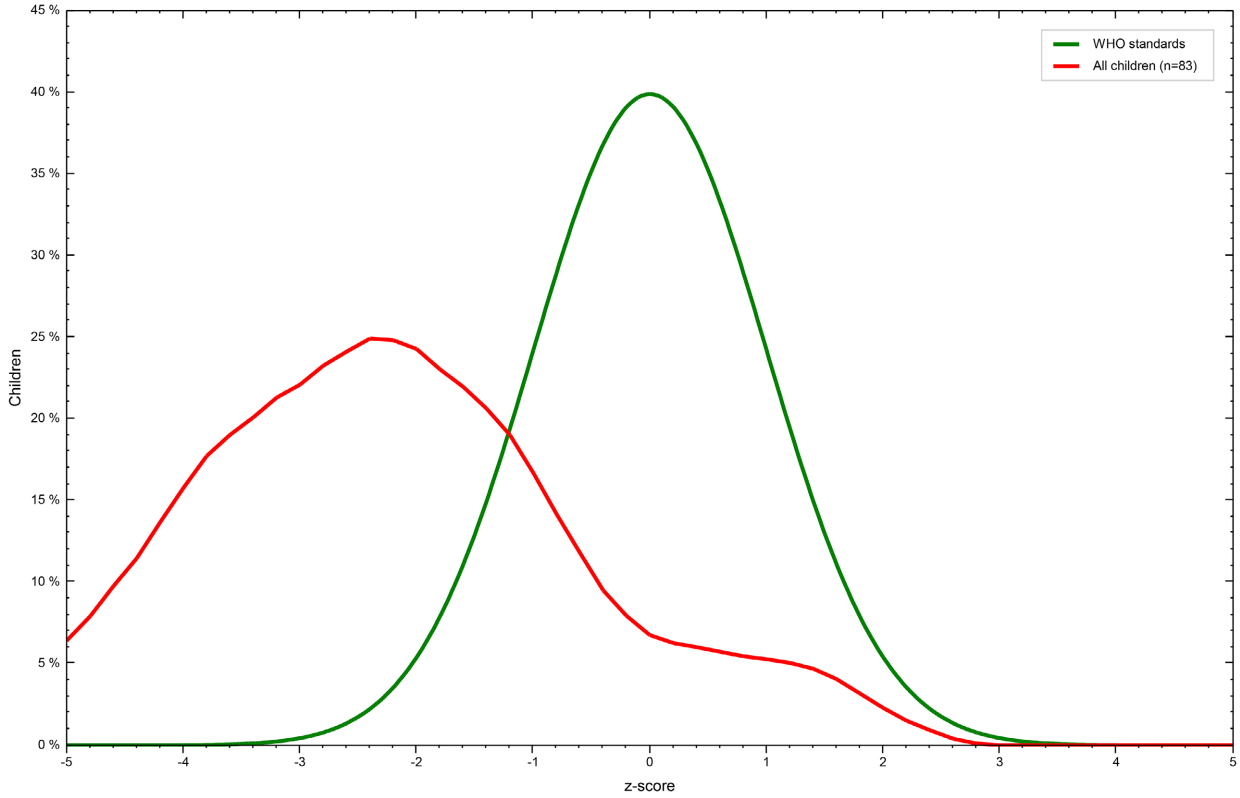

Figure 1. Distribution of z-score for weight-for-height compared with the WHO standard.

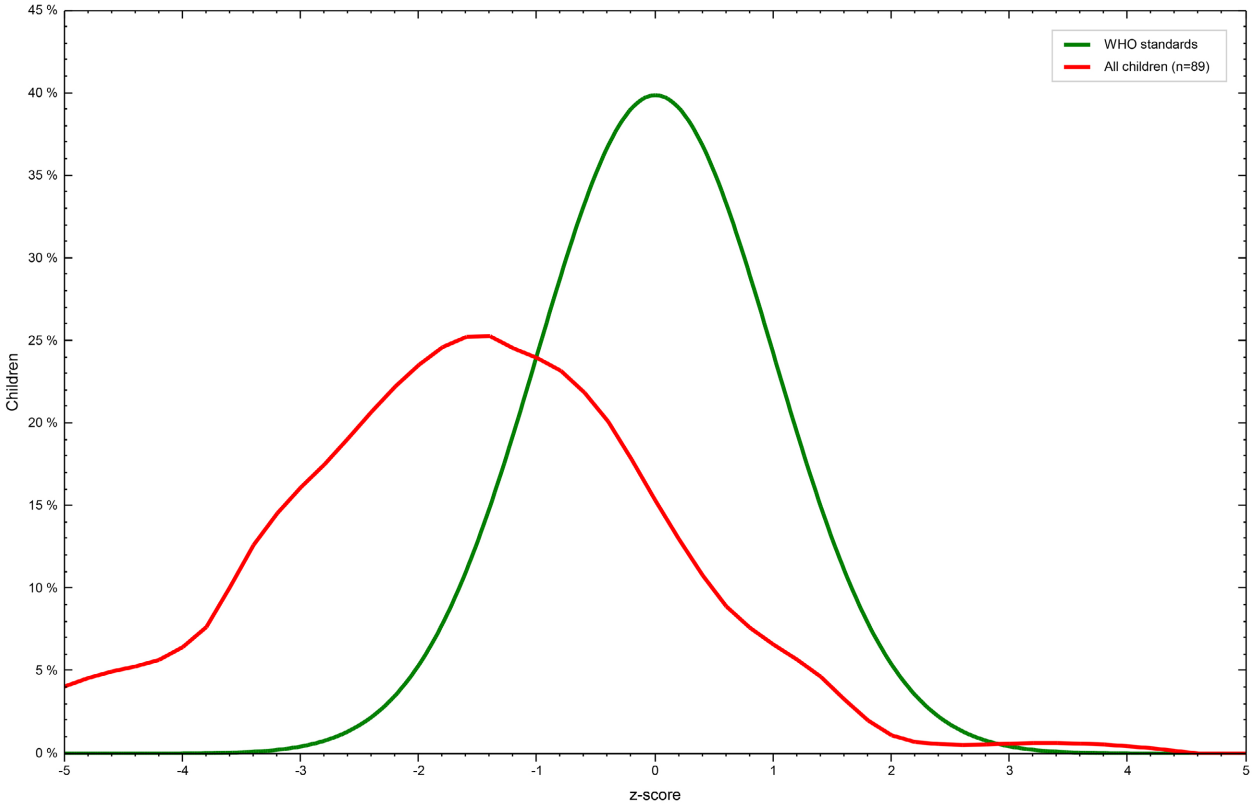

Figure 2. Distribution of z-score for height-for-age in comparison to the WHO standard.

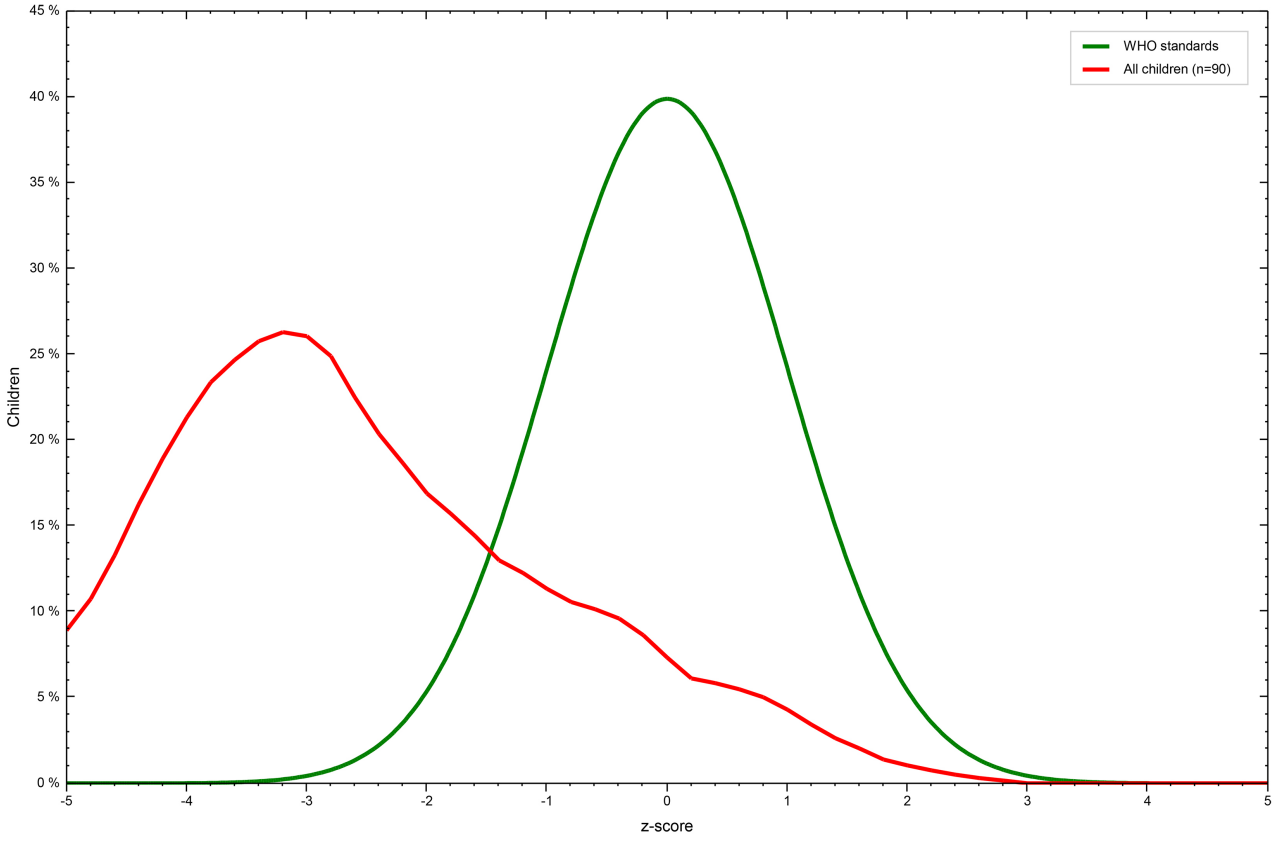

Figure 3. Distribution of z-score for weight-for-age in comparison to the WHO standard.

3.3. Anthropometric Measurements

The mean ages and anthropometric measurements, as well as z-scores of the malnourished children for the three conditions of malnutrition, are listed in Table 4. For children with acute malnutrition, there were significant differences in weight, height, MUAC, TC, and z-scores for the three indicators (WHZ, HAZ, WAZ). For chronic malnutrition, all parameters showed significant differences, except for age and the mean z-score for weight-for-height. For underweight, all measurements showed significant differences according to nutritional status.

3.4. Children's Feeding Practices

Table 5 summarizes the breastfeeding practices and dietary diversification in malnourished children. A large proportion of malnourished children were exclusively breastfed for the first six months. Dietary diversification was initiated in most malnourished children from 6 months after birth. Porridge was the most used food during the diversification of children's diets. Thus, it was introduced early in chronically malnourished and underweight children with an average age of introduction of 6.41 ± 1.93 months and 6.44 ± 2.02 months, respectively. We also noted a fast initiation of children to the family meal. A very large proportion of malnourished children did not consume fruits, vegetables, or dairy products in their diet.

Table 4. Descriptive analysis of anthropometric measures of malnourished children.

	Acute malnutrition		Chronic malnutrition		Underweight	
	Avg ± Sd	P-value	Avg ± Sd	P-value	Avg ± Sd	P-value
Age (months)	13.89 ± 8.75	0.23	14.04 ± 9.48	0.49	13.59 ± 8.07	0.02
Weight (kg)	5.93 ± 2.11	<0.0001	5.67 ± 2.13	<0.0001	5.95 ± 1.89	<0.0001
Height (cm)	69.77 ± 11.93	0.01	65.48 ± 11.06	<0.0001	68.88 ± 10.86	<0.0001
MUAC (cm)	11.52 ± 1.56	<0.0001	11.46 ± 1.82	0.006	11.63 ± 1.53	<0.0001
HC (cm)	42.68 ± 5.03	0.2	41.62 ± 5.49	0.003	42.64 ± 4.79	0.02
TC (cm)	41.64 ± 4.96	0.004	40.77 ± 5.62	0.001	41.7 ± 4.75	<0.0001
WHZ	−3.89 ± 1.68	<0.0001	−3.36 ± 1.81	0.1	−3.54 ± 1.88	<0.0001
HAZ	−2.04 ± 2.07	<0.0001	−3.50 ± 1.42	<0.0001	−2.34 ± 2.03	<0.0001
WAZ	−3.75 ± 1.30	0.009	−3.92 ± 1.23	<0.0001	−3.72 ± 1.21	<0.0001

MUAC: Mid-upper arm circumference; **HC**: Head circumference; **PT**: Thoracic circumference; **Avg:** Average (mean); **Sd:** Standard deviation; **WHZ**: Weight-for-height z-score; **HAZ**: Height-for-age z-score; **WAZ**: Weight-for-age z-score.

Table 5. Breastfeeding and food diversification according to nutritional status.

	Acute malnutrition		Chronic malnutrition		Underweight	
	N (%)	Mean age of introduction	N (%)	Mean age of introduction	N (%)	Mean age of introduction
Breastfeeding						
Exclusive breastfeeding	22 (37.29)		22 (56.41)		50 (64.18)	
Artificial feeding	2 (3.39)		-		2 (2.99)	
mixed breastfeeding	14 (23.73)		12 (30.77)		15 (22.39)	
Weaning	8 (13.56)	15.50 ± 5.5	9 (23.08)	13.12 ± 4.28	11 (16.42)	14 ± 5.57
Dietary diversification						
<6 months	10 (16.95)	7.03 ± 3.23	8 (20.51)	6.65 ± 2.67	10 (14.93)	6.63 ± 2.42
≥6 months	41 (69.49)		24 (61.53)		48 (71.64)	
Diversification foods						
Porridge	33 (64.71)	7.03 ± 3.21	17 (53.13)	6.41 ± 1.93	37 (63.79)	6.44 ± 2.02
family meal	14 (27.45)	7.85 ± 2.28	8 (25)	6.75 ± 1.16	16 (27.59)	7.68 ± 2.18
Milk and milk products	4 (4.71)	6.5 ± 1	4 (12.5)	6.5 ± 1	6 (10.34)	6.3 ± 0.81
Fruits/vegetables	6 (7.06)	6.8 ± 3.5	4 (12.5)	7.25 ± 1.5	8 (13.79)	6.62 ± 3.02
Cereals	15 (17.65)	7.13 ± 3.4	13 (40.63)	7.2 ± 3.60	19 (32.76)	7 ± 3.01

n: frequencies.

3.5. Clinical Characteristics of Malnourished Children

On admission, the most frequently recorded clinical signs were digestive disord-

ers, including diarrhea (34.04%), vomiting (25.53%), and anorexia (10.64%). Weight loss and fever were recorded in 30.85% and 23.40% of the study population, respectively. Edema was noted in only 2.13% of patients. According to the Hb level, 70.21% of the patients were anemic, of which 56.38% had moderate anemia and 13.83% had severe anemia. The most recorded respiratory signs were rhinitis (12.27%) and rhino bronchitis (10.64%). The results are summarized in Table 6.

3.6. Characterization of Child Malnutrition

Linear regression analysis showed that female sex [OR = 1.82, CI (1.02 - 3.3), P-value = 0.04], consanguinity [OR = 2.84, CI (1.14 - 7.65), P-value = 0.03], low birth weight (<2.5 kg) [OR = 4.83, CI (2.15 - 12.89), P-value = 0.0004], non-consumption of milk products [OR = 2.14, CI (1.30 - 3.61), P-value = 0.003] and fruits/vegetables [OR = 0.20, CI (0.06 - 0.57)] P-value = 0.004, weight loss [OR = 5.6, CI (1.95 - 20.99), P-value = 0.003] and fever [OR = 5.47, CI (1.68 -

Table 6. Clinical signs of malnourished children.

	Acute malnutrition (n = 59)	Chronic malnutrition (n = 39)	Underweight (n = 67)	Study population (n = 94)
Digestive signs				
Anorexia	9 (15.25)	4 (10.26)	8 (11.94)	10 (10.64)
Diarrhea	21 (35.59)	14 (35.90)	26 (38.81)	32 (34.04)
Vomiting	19 (32.20)	11 (28.21)	21 (31.34)	24 (25.53)
Respiratory signs				
Rhinitis	5 (8.47)	4 (10.26)	8 (11.94)	12 (12.77)
Rhinobronchitis	5 (8.47)	7 (17.95)	8 (11.94)	10 (10.64)
Respiratory distress	4 (6.78)	5 (12.82)	5 (7.46)	5 (5.32)
Hemodynamic signs				
Dehydration	3 (5.08)	3 (7.69)	3 (4.48)	3 (3.19)
Carential sign				
Oedema	2 (3.39)	2 (5.13)	2 (2.99)	2 (2.13)
Hematologic signs				
Anemia				
Moderate anemia	34 (57.63)	17 (43.59)	37 (55.22)	53 (56.38)
Severe anemia	8 (13.56)	7 (17.95)	10 (14.93)	13 (13.83)
Paleness	3 (5.08)	2 (5.13)	2 (2.99	3 (3.19)
General signs				
Fever	17 (28.81)	10 (25.64)	15 (22.39)	22 (23.40)
Weight loss	25 (42.37)	13 (33.33)	27 (40.30)	29 (30.85)

24.70), P-value = 0.01] were significantly associated with acute malnutrition. No risk factors were found to be associated with chronic malnutrition.

Factors such as age (<12 months) [OR = 3.12, CI (1.47 - 7.40) P-value = 0.005], female sex [OR = 2.43, CI (1.33 - 4.67), P-value = 0.005], low birth weight (<2.5 kg) [OR = 10.66, CI (3.82 - 44.39), P-value < 0.0001], non-exclusive breastfeeding [OR = 3, CI (1.40 - 7.13), P-value = 0.007], dietary diversification before 6 months [OR = 2.04, CI (1.23 - 3.51), P-value = 0.007], non-consumption of milk products [OR = 3.31, CI (1.94 - 5.98), P-value < 0.0001] and fruits/vegetables [OR = 3.4, CI (1.96 - 6.26), P-value < 0.0001], moderate anemia [OR = 2.31, CI (1.31 - 4.27), P-value = 0.005], weight loss [OR = 7.44, CI (1.98 - 48.71), P-value = 0.005], and diarrhea [OR = 7.44, CI (1.98 - 48.71), P-value = 0.04] were found to be significantly associated with chronic malnutrition. The results are summarized in **Table 7**.

3.7. Children's Treatment

Nutritional treatment was the most frequently used method of care, with ready-to-use therapeutic foods (RUTF) used in 59.57% of cases, and fortified porridges and fortified meals used in 60.64% and 62.77%, respectively (**Table 8**). Antibiotic therapy was the most used treatment (59.57%). A well-balanced diet was recommended to manage malnourished children.

4. Discussion

This study examined the characteristics associated with childhood malnutrition in the suburban area of Dakar among children aged 0 - 59 months.

The distribution of malnourished children by age shows that the mean age of our cohort was 14.69 ± 6.75 months for the overall population, 13.89 ± 8.75 months for acute malnutrition, 14.04 ± 9.48 months for chronic malnutrition, and 13.59 ± 8.07 months for underweight. The most represented age group was 12 - 23 months. A study conducted in the district of Guediawaye in 2020 showed a high prevalence in the 6 - 12-month age group [14]. This period of life is marked by dietary diversification; therefore, an inadequate and unbalanced diet at this age could cause malnutrition [15]. The late introduction of complementary foods and foods of low nutritional quality [16] and the negligence of guardians in meeting the optimal dietary needs of their children as they grow could also explain this significance [17] [18]. The sex distribution of children showed that 51.06% of our cohort were female, while 48.94% were male, and the sex ratio (M/F) was 0.96. This study shows that female gender is associated with acute malnutrition and underweight. Our results differ from those of studies conducted by Keur Socé in 2013 [13] and Pikine-Dagoudane in 2012, in which sex [19] was not associated with malnutrition.

The prevalence of malnutrition was 62.77% for acute malnutrition, 41.49% for chronic malnutrition, and 71.27% for underweight. Our results are those obtained in a study carried out in Guediawaye, Senegal, in 2020, which showed a

Table 7. Factors influencing child malnutrition.

		Acute malnutrition		Chronic malnutrition		Underweight	
		OR (CI-95%)	P-value	OR (CI-95%)	P-value	OR (CI-95%)	P-value
Age	<12	1.5 (0.77 - 3.17)	0.22	0.94 (0.47 - 1.87)	0.87	3.12 (1.47 - 7.40)	0.005
	12 - 23	0.6 (0.17 - 2.49)	0.53	0.67 (0.27 - 1.64)	0.38	0.88 (0.31 - 2.42)	0.106
	>24	1.3 (0.53 - 3.37)	0.53	0.53 (0.12 - 2.04)	0.36	0.32 (0.07 - 1.28)	0.81
Gender	F	1.82 (1.02 - 3.3)	0.04	0.84 (0.47 - 1.49)	0.56	2.43 (1.33 - 4.67)	0.005
	M	0.85 (0.36 - 1.97)	0.7	0.69 (0.30 - 1.57)	0.38	1.05 (0.42 - 2.57)	0.92
Birth weight	<2.5 kg	4.83 (2.15 - 12.89)	0.0004	1.5 (0.76 - 3.01)	0.23	10.66 (3.82 - 44.39)	<0.0001
	>2.5 kg	0.21 (0.07 - 0.56)	0.002	0.29 (0.11 - 0.69)	0.005	0.14 (0.03 - 0.43)	0.002
Exclusive breastfeeding	Yes	0.43 (0.16 - 1.07)	0.007	0.48 (0.20 - 1.15)	0.1	0.74 (0.27 - 1.94)	0.56
	No	3 (1.40 - 7.13)	0.08	1.13 (0.56 - 2.30)	0.73	3 (1.40 - 7.13)	0.007
weaning	Yes	0.23 (0.08 - 0.63)	0.004	0.97 (0.35 - 2.54)	0.94	0.28 (0.10 - 0.77)	0.01
	No	2.42 (1.48 - 4.12)	0.0006	0.71 (0.44 - 1.13)	0.15	3.5 (2.05 - 6.30)	<0.0001
Consanguinity	Yes	2.84 (1.14 - 7.65)	0.03	0.90 (0.38 - 2.12)	0.82	1.6 (0.62 - 4.37)	0.33
	No	1.19 (0.71 - 1.99)	0.52	0.73 (0.43 - 1.22)	0.24	2.11 (1.23 - 3.71)	0.007
Dietary diversification	<6 months	1.2 (0.7 - 1.98)	0.45	0.56 (0.33 - 0.92)	0.03	2.04 (1.23 - 3.51)	0.007
	≥6 months	2.65 (0.91 - 8.89)	0.08	1.33 (0.48 - 3.6)	0.57	1.22 (0.42 - 3.83)	0.71
Milk/milk products	Yes	0.14 (0.03 - 0.45)	0.002	0.42 (0.45 - 1.17)	0.17	0.16 (0.05 - 0.50)	0.002
	No	2.14 (1.30 - 3.61)	0.003	0.72 (0.45 - 1.16)	0.19	3.31 (1.94 - 5.98)	<0.0001
Fruits/vegetables	Yes	0.20 (0.06 - 0.57)	0.004	0.32 (0.08 - 0.98)	0.06	0.19 (0.06 - 0.55)	0.003
	No	2.14 (1.29 - 3.66)	0.004	0.78 (0.48 - 1.27)	0.33	3.4 (1.96 - 6.26)	<0.0001
Anemia	Moderate	1.5 (0.88 - 2.68)	0.13	0.47 (0.25 - 0.83)	0.01	2.31 (1.31 - 4.27)	0.005
	Severe	1.05 (0.30 - 3.88)	0.93	2.47 (0.72 - 8.79)	0.15	1.44 (0.38 - 7.06)	0.61
Diarrhea	Yes	1.20 (0.49 - 3.002)	0.68	1.15 (0.48 - 2.73)	0.74	7.44 (1.98 - 48.71)	0.009
	No	1.58 (0.96 - 2.67)	0.07	0.67 (0.40 - 1.11)	0.13	1.68 (1.03 - 2.79)	0.03
weight loss	Yes	5.6 (1.95 - 20.99)	0.003	1.21 (0.49 - 2.95)	0.66	8.4 (2.25 - 55.16)	0.005
	No	1.09 (0.67 - 1.79)	0.7	0.66 (0.40 - 1.08)	0.11	1.6 (0.97 - 2.67)	0.06
Fever	Yes	5.47 (1.68 - 24.70)	0.01	1.40 (0.54 - 3.64)	0.48	2.28 (0.75 - 8.52)	0.17
	No	1.21 (0.76 - 1.96)	0.4	0.65 (0.40 - 1.04)	0.07	2.08 (1.28 - 3.49)	0.004

OR: Odds Ratio; CI: Confidence Interval.

Table 8. Treatment of malnourished children.

	Effective (n = 94)	Frequencies (%)
Nutritional treatment		
Ready-to-use therapeutic foods (RUTF)	56	59.57

Continued

Enriched porridges	57	60.64
Fortified meals	59	62.77
Medicinal treatment		
Antibiotic	56	59.57
Deparasitic	18	19.15
Sro-Zinc	15	15.96
Vitamin	10	10.64

high prevalence of acute malnutrition (29.3%) compared with that of chronic malnutrition (20.4%) and underweight (25.5%) [14]. In terms of acute malnutrition, our results showed that 41.49% of the patients had severe acute malnutrition and 21.28% had moderate acute malnutrition. Chronic moderate malnutrition was recorded in 22.34% of patients with moderate malnutrition and 19.15% with severe malnutrition. Almost half of the children were severely underweight (51.06%) and almost a quarter was moderately underweight (20.21%). These results differed from those of studies in Pikine-Dagoudane [20] and Guediawaye [14], where 11.8% and 5% of children were moderately chronically malnourished, 8.6% and 1% were severely chronically malnourished, 11.9% and 6% were moderately acutely malnourished, and 17.4% and 1% were severely wasted, respectively.

In addition, a comparison of the curves reflecting the Weight-for-Height, Height-for-Age, and Weight-for-Age z-scores with the respective WHO standard reference curves showed that they are shifted to the left about the reference curves. This reflects a less satisfactory nutritional status than that of the reference population, suggesting a tendency towards undernutrition [20] [21]. The z-score values for Weight-for-Height, Height-for-Age, and Weight-for-Age were −3.89 ± 1.68, −3.50 ± 1.42, and −3.72 ± 1.21, respectively. A study conducted in rural areas of Senegal in 2021 found that the mean z-score values for Weight-for-Height and Height-for-Age were −0.3 ± 1.0 and −0.5 ± 1.1 respectively [22].

Regarding anthropometric measurements, significant differences were observed in mean weight, height, brachial circumference, TC, and HC according to different types of malnutrition. A study carried out in Abidjan-Côte d'Ivoire, Senegal's neighboring country, recorded differences in these same parameters, except for mean height, where the P-value was not significant in children with acute malnutrition [23]. Indeed, acute undernutrition can lead to weight loss due to insufficient food intake without stunting stature growth. A child with acute malnutrition may have the same height as a child with good nutritional status, but not the same weight [23].

In our study, a significant association was noted between low birth weight and the different types of malnutrition, which is consistent with that from Pikine-Dagoudane [19]. Low birth weight can be attributed to poor maternal nutrition during pregnancy, premature pregnancy, or placental insufficiency [4].

During the first 6 months, exclusive breastfeeding is recommended by the WHO and the Ministry of Public Health of Senegal because it transmits the mother's antibodies and all the necessary nutrients to the child [10]. In our cohort, exclusive breastfeeding was most frequently observed in cases of chronic malnutrition and underweight. However, many children with acute malnutrition were not exclusively breastfed during the first 6 months. Our cohort showed an association between non-exclusive breastfeeding before 6 months, acute malnutrition, and underweight. Breastfeeding protects the child against infections during and, most likely, after birth, as well as against certain infectious and immunological diseases [3].

The mean age of weaning was 15.50 ± 5.5 months for acute malnutrition and 14 ± 5.57 months for underweight. A study conducted in Guediawaye recorded an average weaning age of 19.7 ± 4.5 months but was not associated with undernutrition [14]. The child not being weaned is a risk factor associated with acute malnutrition and underweight. A study published in 2000 found that longer breastfeeding duration was associated with higher rates of malnutrition in the rural areas of central Senegal [24].

In our study population, nearly three-fourths of the malnourished children were diversified after 6 months of birth, and the mean age of dietary diversification was 7.03 ± 3.23 months for acute malnutrition, 6.65 ± 2.67 months for chronic malnutrition, and 6.63 ± 2.42 months for underweight. There was an association between dietary diversification before 6 months of age and underweight. Our results differ from those of Arimond and Ruel who found a significant relationship between stunting and dietary diversity in children [25] [26].

Early introduction and high prevalence of porridge consumption were documented among children. Our results differ from the recommendations established in the brochure on the integrated management of childhood illnesses in Senegal, elaborated by the Ministry of Health and Social Action of Senegal, Directorate of Reproductive Health and Child Survival, where the average age of introduction of porridge is estimated to be 7 months [27] [28]. In our study, the non-consumption of fruits, vegetables, and dairy products by a large number of malnourished children was a risk factor for acute malnutrition and underweight. In a study conducted in Pikine, only fruit non-consumption was associated with acute malnutrition [14]. The lack of animal products, fruits, and vegetables in the diet leads to a dietary deficiency in micronutrients. Nutritional deficiency can negatively affect the health of children and adults [29].

Clinically, in our study, signs associated with malnutrition were weight loss and fever for acute malnutrition, and weight loss and diarrhea for underweight. Our results differ from a study conducted at the Diamnadio Children's Center in 2021, where the most frequently recorded clinical signs were diarrhea and vomiting, observed in 57.5% and 38.8% of children, respectively [30]. The association between clinical signs and malnutrition is explained as malnutrition leads to the failure of the patient's immune system, making them vulnerable to infections [15]. Severe anemia was recorded in 56.38% of cases and moderate anemia in

13.83% of cases. The EDS Continuous survey in 2017 in Senegal estimated that 39% of children had moderate anemia, and 3% had severe anemia [31]. Moderate anemia was significantly associated with underweight in our study. A study conducted by Keur Socé also showed a significant association between moderate anemia and underweight [13].

Children from consanguineous marriages are 2.84 times more likely to develop acute malnutrition. Our results differ from those of rural Sindh, where consanguinity has been associated with underweight [32].

Nutritional means, including RUTF, fortified porridges, and balanced meals, are the most commonly used means of remediation. Our results are consistent with those of a study by Seck *et al.* [30], in which all malnourished children were treated with F75 in the first phase, followed by F100 and RUTF in the second phase [30]. Antibiotic therapy was recommended in 59.57% of patients. The WHO recommends special energy foods and antibiotics to prevent infections in malnourished children [33]. From this perspective, we observed that 81.16% used fortified porridge and 84.06% used balanced meals provided at the IPS Care Center. This was done to ensure that malnourished children received adequate nutrition and to observe the evolution of their health status.

This study provided useful data on child malnutrition in the Dakar suburbs and for better management of these children. Some factors, including parental consanguinity, were associated with malnutrition for the first time. However, the characteristics of the mothers and the child's birth order were not addressed in this study. The sample size is not large, so an extensive study on a large sample size will permit a better understanding of the problem of child malnutrition.

5. Conclusion

Our study proves that childhood malnutrition is a public health problem in developing countries, particularly Senegal, despite efforts made to achieve the Sustainable Development Goals, which aim to eradicate famine by 2030. Many factors were associated with child malnutrition in our study. These included the female gender, consanguinity, insufficient birth weight (<2.5 kg), non-exclusive breastfeeding, non-consumption of milk products and fruits and vegetables, weight loss, fever, moderate anemia, diarrhea, and dietary diversification before 6 months of age. Thus, special attention must be paid to this problem because of its impact on child survival.

Ethics Committee Statement

This study was approved by the UCAD Research Ethics Board (reference number: 0340/2018/CER/UCAD).

Conflicts of Interest

The authors declare no conflict of interest.

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