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Nutritional Status and Infant and Young Child Feeding Practices among Children Aged 6–23 Months in the Maradi Region, Niger: A Geographic-Unit Cross-Sectional Analysis

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Abstract *Child malnutrition and suboptimal infant and young child feeding (IYCF) practices remain major public health challenges in Niger. This study assessed the nutritional status and IYCF practices of children aged 6–23 months in the Maradi Region and examined geographic disparities and factors associated with complementary feeding. A cross-sectional study based on the SMART methodology was conducted between September and October 2025. Using a two-stage cluster sampling design, 1,353 children aged 6–23 months were included. Nutritional status was assessed using WHO growth standards, while complementary feeding practices were evaluated using minimum dietary diversity (MDD), minimum meal frequency (MMF), and minimum acceptable diet (MAD). Global acute malnutrition affected 21.9% of children, including 6.5% severe acute malnutrition. Stunting affected 59.1%, underweight 49.4%, and anemia 39.0% of children. Significant geographic disparities were observed across the nine study units. Only 18.7% of children met MDD and 17.1% met MAD, although 84.6% achieved MMF. Multivariable analyses showed that maternal education was positively associated with MDD and MAD, while associations varied across feeding indicators. No significant association was found between anemia and the assessed IYCF indicators. These findings highlight a substantial burden of malnutrition and inadequate complementary feeding practices among young children in Maradi, with marked geographic inequalities. Targeted nutrition interventions that promote dietary diversity and maternal education are needed to improve child nutrition outcomes in the region.*

Keywords *Anemia, Maradi, Child Malnutrition, Infant and Young Child Feeding, Minimum Dietary Diversity, Minimum Meal Frequency, Minimum Acceptable Diet, Niger, Stunting, Underweight, Wasting.*

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Introduction

The period from 6 to 23 months represents a critical window for child growth, development, and the establishment of dietary patterns [1]. During this period, nutritional requirements increase rapidly as children progressively transition from predominantly breast milk-based feeding to complementary foods. The adequacy, quality, and diversity of complementary foods are therefore essential for meeting nutritional requirements, supporting healthy growth and development, and preventing malnutrition and micronutrient deficiencies. Inadequate feeding practices during this period may contribute to poor dietary quality and increase children's vulnerability to growth faltering and other adverse nutritional outcomes.

Child malnutrition remains a major public health challenge, particularly in low- and middle-income countries and in sub-Saharan Africa. Its occurrence reflects the interaction of multiple and interconnected factors, including household food insecurity, poverty, maternal and child characteristics, inadequate childcare and feeding practices, limited access to healthcare, and unfavorable water, sanitation, and hygiene conditions [2-4]. Nutritional vulnerability is therefore not determined by a single factor but by the interaction of individual, household, environmental, and structural conditions. In this context, infant and young child feeding practices constitute an important component of child nutrition and are particularly relevant during the complementary feeding period.

Niger continues to face a substantial nutritional burden among young children. According to the 2022 SMART Niger survey, the national prevalence of global acute malnutrition was 12.2%, while severe acute malnutrition affected 2.4% of children. Chronic malnutrition also remains highly prevalent, with national estimates indicating persistent levels of stunting over time. These findings reflect the continuing vulnerability of children to acute and chronic forms of malnutrition in a context characterized by poverty, rapid population growth, agroecological fragility, and recurrent food insecurity.

The Maradi Region is of particular public health and programmatic importance because of its high nutritional and socioeconomic vulnerability. In the 2022 SMART Niger survey, Maradi recorded a GAM prevalence of 13.6%, while severe acute malnutrition affected 3.9% of children, both exceeding the corresponding national estimates. The region is also characterized by high population density, substantial vulnerability among rural households, and dependence on markets for part of household food supplies, limited diversification of agricultural production and food consumption, and recurrent exposure to food and health crises [5-7].

Evidence from Niger and other West African settings indicates that child feeding practices are influenced by a combination of child, maternal, household, and contextual characteristics. Previous studies conducted in Maradi and other regions of Niger have highlighted the importance of dietary diversity, household food security, agricultural production, sanitation, and women's autonomy in shaping children's nutritional conditions [4, 8, 9]. However, despite the availability of national and regional nutritional surveillance data, detailed information simultaneously describing nutritional status, anemia, and IYCF practices at the subregional level remains limited.

This evidence gap is particularly important for complementary feeding. Existing research has identified maternal education, household characteristics, child age, and other socioeconomic factors as potential correlates of MDD, MMF, and MAD. Nevertheless, there is limited evidence systematically examining these indicators together with anthropometric outcomes and anemia across the nine geographic units of the Maradi Region. Such

subregional evidence is important because regional averages may conceal substantial inequalities between local populations.

The present study was therefore designed to provide a disaggregated assessment of the nutritional status and IYCF practices of children aged 6–23 months in the Maradi Region of Niger. Specifically, the study aimed to estimate the prevalence of GAM, stunting, underweight, and anemia; assess breastfeeding and complementary feeding practices using standard IYCF indicators; examine differences across the eight departments and the urban municipality of Maradi City; identify factors associated with MDD, MMF, and MAD; and explore the relationship between anemia and IYCF practices.

Methods

Study Design and Setting

A quantitative cross-sectional descriptive and analytical study was conducted from mid-September to mid-October 2025 using the SMART methodology in the Maradi Region of south-central Niger. The region comprises eight departments: Aguié, Bermo, Dakoro, Gazaoua, Guidan-Roumdji, Madarounfa, Mayahi, and Tessaoua, and the urban municipality of Maradi City. Each geographic unit was treated as a distinct study domain.

Study Population and Sampling

The source population consisted of households within enumeration areas established during the 2012 General Population and Housing Census. The survey used a two-stage cluster sampling design stratified by geographic unit. In the first stage, clusters were selected systematically using probability proportional to size. In the second stage, households were listed and selected systematically. Large localities were segmented where necessary.

Sample Size

Sample size was calculated using ENA for SMART software (January 2020 version), assuming an expected GAM prevalence of 13.6%, absolute precision of 3.5%, a 95% confidence level, a design effect of 1.06, and a 5% anticipated non-response rate.

This resulted in an operational target of 420 households per geographic stratum, corresponding to 28 clusters of 15 households and 3,780 households overall. Following data collection, 1,353 children aged 6–23 months were included in the present analysis.

Eligibility Criteria

Children aged 6–23 completed months who resided in selected households and for whom informed consent was obtained were eligible.

Households were required to have been resident in the locality for more than six months. Households declining participation and children whose condition prevented anthropometric or hemoglobin assessment were excluded.

Data Collection and Measurements

Data were collected by trained teams using electronic questionnaires with built-in consistency checks. Age was verified from available records or, when necessary, estimated using a local events calendar following SMART procedures. Weight, length/height, and MUAC were measured using standardized equipment calibrated daily. ENA for SMART was used to assess anthropometric plausibility and identify outliers.

Nutritional Status and Anemia

Anthropometric indices were calculated according to WHO Child Growth Standards [10]. GAM was defined as WHZ < −2 standard deviations and/or MUAC < 125 mm and/or bilateral pitting edema; severe acute malnutrition was defined as WHZ < −3 and/or MUAC < 115 mm and/or bilateral edema. Stunting was defined as HAZ < −2 and severe

stunting as HAZ < −3. Underweight was defined as WAZ < −2 and severe underweight as WAZ < −3. Anemia was defined as hemoglobin < 11 g/dL, with severity categorized according to WHO thresholds.

IYCF Indicators

IYCF practices were assessed using standardized WHO/UNICEF indicators based on a 24-hour dietary recall [1]. MDD was defined as consumption of at least five of eight food groups. MMF was defined according to age and breastfeeding status. MAD was defined as the composite indicator incorporating MDD and MMF according to breastfeeding status. Early initiation of breastfeeding, colostrum feeding, and continued breastfeeding among children aged 12–23 months were also assessed.

Statistical Analysis

Data were analyzed using ENA for SMART and Stata. Categorical variables were summarized using frequencies and percentages. Pearson's chi-square tests were used for geographic comparisons. Separate multivariable binary logistic regression models were fitted for MDD (n = 1,343), MMF (n = 1,295), and MAD (n = 1,295), with adjusted odds ratios and 95% confidence intervals. Spearman correlation coefficients were used to assess monotonic associations between anemia and IYCF indicators. Statistical significance was defined as $p < 0.05$.

Results

Sociodemographic Characteristics of the Study Population

A total of 1,353 children aged 6–23 months were surveyed across the eight departments and the urban municipality of Maradi City. Madarounfa accounted for the largest number of enrolled children (221; 16.3%), followed by Gazaoua (173; 12.8%), whereas Maradi City contributed the smallest proportion (97; 7.2%). The study population was nearly balanced by sex, with 684 boys (50.6%) and 669 girls (49.4%). Children aged 6–11 months accounted for 30.2%, those aged 12–17 months for 31.9%, and those aged 18–23 months for 38.0%. The sociodemographic characteristics of study participants are presented in Table 1.

Table 1. Distribution of Children Aged 6–23 Months by Geographic Unit, sex, and Age Group, Maradi Region, Niger (n = 1,353)

Geographic Unit	n	% of total	Girls (%)	Boys (%)	6–11 Months (%)	12–17 Months (%)	18–23 Months (%)
Aguié	128	9.5	55.5	44.5	32.8	24.2	43.0
Bermo	111	8.2	48.7	51.4	22.5	38.7	38.7
Dakoro	134	9.9	49.3	50.8	26.9	36.6	36.6
Gazaoua	173	12.8	46.2	53.8	30.6	31.2	38.2
Guidan-Roumdji	159	11.8	52.2	47.8	31.5	34.6	34.0
Madarounfa	221	16.3	52.0	48.0	33.9	31.7	34.4
Mayahi	165	12.2	47.9	52.1	24.2	32.7	43.0
Tessaoua	165	12.2	47.9	52.1	29.7	29.1	41.2
Maradi City	97	7.2	43.3	56.7	39.2	27.8	33.0
Total	**1353**	**100.0**	**49.4**	**50.6**	**30.2**	**31.9**	**38.0**

Note: *Percentages for sex and age groups are calculated within each geographic unit. Percentages may not sum exactly to 100% because of rounding. Maradi City is the urban municipality; the other eight geographic units are departments.*

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Overall Nutritional Profile of Children Aged 6–23 Months

The nutritional profile revealed a high burden of malnutrition. GAM affected 295 of 1,347 children (21.9%), including 6.5% with severe acute malnutrition. Stunting affected 795 of 1,345 children (59.1%), including 28.5% with severe stunting. Underweight affected 666 of 1,348 children (49.4%), including 20.5% with severe underweight. Anemia affected 528 of 1,353 children (39.0%), including 12.3% mild, 25.1% moderate, and 1.6% severe anemia. The overall prevalence of malnutrition and anemia is summarized in Table 2.

Table 2. Overall Prevalence and Severe forms of Malnutrition and Anemia among Children Aged 6–23 Months, Maradi Region, Niger

Indicator	n	N	Prevalence (%)	Severe form (%)
Global acute malnutrition	295	1347	21.9	6.5
Stunting	795	1345	59.1	28.5
Underweight	666	1348	49.4	20.5
Anemia	528	1353	39.0	1.6

Note: *The severe-form column refers, as applicable, to severe acute malnutrition, severe stunting, severe underweight, or severe anemia. Indicator-specific denominators differ because of missing or unavailable measurements.*

Geographic Disparities in Malnutrition and Anemia

Significant geographic heterogeneity was observed. GAM ranged from 14.9% in Dakoro to 32.9% in Tessaoua ($\chi^2(8) = 24.17$; $p = 0.002$). Severe acute malnutrition ranged from 2.1% in Maradi City to 11.0% in Tessaoua ($\chi^2(8) = 15.90$; $p = 0.044$). Stunting ranged from 37.1% in Maradi City to 70.6% in Aguié ($\chi^2(8) = 64.20$; $p < 0.001$), while severe stunting ranged from 14.4% in Maradi City to 39.8% in Gazaoua ($\chi^2(8) = 40.69$; $p < 0.001$). Underweight ranged from 25.8% in Maradi City to 64.8% in Tessaoua ($\chi^2(8) = 22.78$; $p = 0.004$), while severe underweight ranged from 12.4% in Maradi City to 28.5% in Tessaoua ($\chi^2(8) = 55.61$; $p < 0.001$). Overall anemia ranged from 27.7% in Guidan-Roumdji to 48.4% in Madarounfa. The distribution of anemia severity categories differed significantly across geographic units ($\chi^2(24) = 58.98$; $p < 0.001$). Geographic variations in nutritional indicators are shown in Table 3.

Table 3. Prevalence of Global Acute Malnutrition, Stunting, Underweight, and Anemia by Geographic Unit, Maradi Region, Niger

Geographic Unit	GAM (%) [95% CI]	Stunting (%) [95% CI]	Underweight (%) [95% CI]	Anemia (%)
Aguié	24.6 [17.9–32.9]	70.6 [62.1–77.9]	55.2 [46.4–63.7]	37.5
Bermo	30.0 [22.2–39.2]	51.4 [42.0–60.6]	53.6 [44.3–62.7]	36.9
Dakoro	14.9 [9.8–22.0]	66.2 [57.7–73.7]	49.6 [41.2–58.1]	41.8
Gazaoua	21.0 [15.6–27.8]	69.6 [62.3–76.0]	56.1 [48.6–63.3]	40.4
Guidan-Roumdji	20.1 [14.6–27.1]	45.3 [37.7–53.1]	39.0 [31.7–46.8]	27.7
Madarounfa	17.6 [13.2–23.2]	52.5 [45.9–59.0]	42.1 [35.7–48.7]	48.4
Mayahi	19.4 [14.0–26.1]	64.6 [57.0–71.6]	53.3 [45.7–60.8]	34.0

Tessaoua	32.9 [26.2–40.5]	68.5 [61.0–75.1]	64.8 [57.3–71.8]	43.0
Maradi City	18.5 [12.0–27.5]	37.1 [28.1–47.1]	25.8 [18.0–35.4]	36.1
Maradi Region	21.9	59.1	49.4	39.0

Note: *Pearson's chi-square tests: GAM, $\chi^2(8) = 24.17$, $p = 0.002$; stunting, $\chi^2(8) = 64.20$, $p < 0.001$; underweight, $\chi^2(8) = 22.78$, $p = 0.004$. The distribution of anemia severity categories differed significantly across geographic units ($\chi^2(24) = 58.98$; $p < 0.001$). GAM, global acute malnutrition; CI, confidence interval.*

Geographic variation in the prevalence of global and severe forms of malnutrition is illustrated in Figure 1.

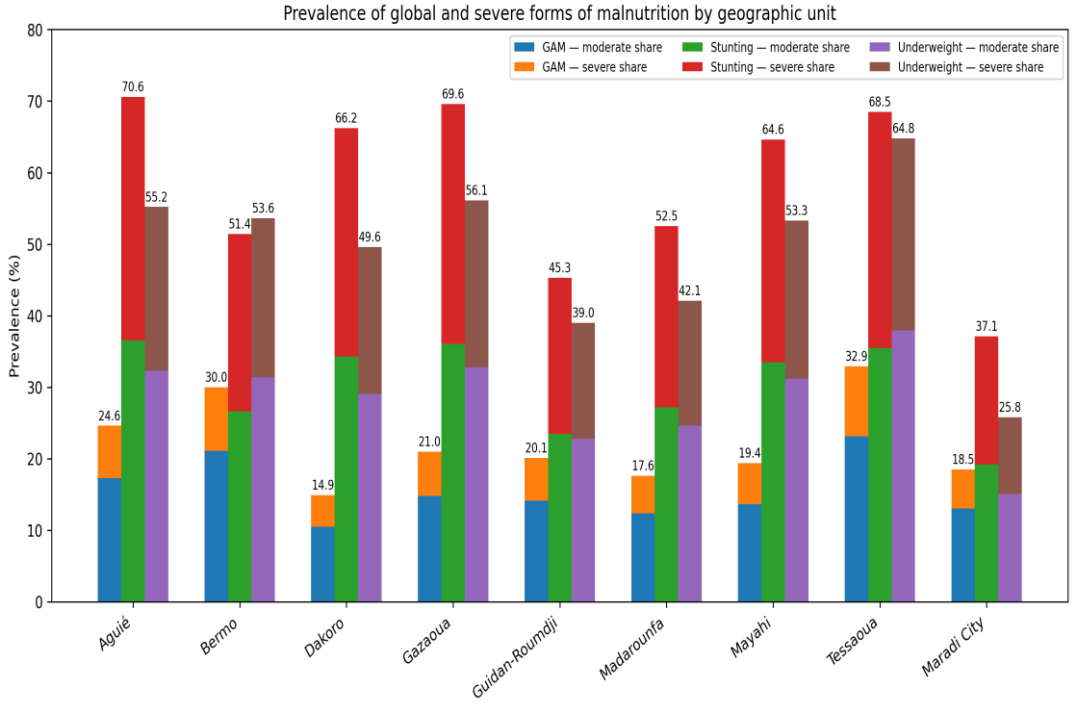


Figure 1. Prevalence of Global and Severe forms of Malnutrition by Geographic Unit, Maradi Region, Niger

Note: *Values are expressed as percentages and are based on the indicator-specific denominators reported in Table 3.*

Breastfeeding Practices

Overall, 69.0% (934/1,353) of children were breastfed within the first hour after birth and 93.7% (1,268/1,353) received colostrum. Among children aged 12–23 months, 76.6% (780/1,018) were still being breastfed. Significant geographic differences were observed for early initiation ($\chi^2(8) = 64.63$; $p < 0.001$), colostrum feeding ($\chi^2(8) = 20.57$; $p = 0.008$), and continued breastfeeding ($\chi^2(8) = 24.59$; $p = 0.002$). Breastfeeding practices by geographic unit are presented in Table 4.

Table 4. Breastfeeding Practices among Children Aged 6–23 Months by Geographic Unit, Maradi Region, Niger (%)

Geographic Unit	Early Initiation	Colostrum Feeding	Continued Breastfeeding (12–23 Months)
Aguié	88.3	96.1	72.5
Bermo	46.8	95.5	88.9
Dakoro	64.2	93.3	83.5

Gazaoua	80.3	87.9	72.8
Guidan-Roumdji	69.2	97.5	75.4
Madarounfa	68.8	95.9	83.3
Mayahi	61.8	93.9	69.5
Tessaoua	70.9	92.7	75.4
Maradi City	64.9	89.7	65.7
Maradi Region	69.0	93.7	76.6

Note: *Early initiation and colostrum feeding were assessed among all 1,353 children. Continued breastfeeding was assessed among children aged 12–23 months (n = 1,018).*

Complementary Feeding

Only 18.7% (251/1,343) of children met the MDD criterion, compared with 84.6% (1,095/1,295) who met MMF and 17.1% (222/1,295) who met MAD. Significant geographic differences were observed for MDD ($\chi^2(8) = 143.70$; $p < 0.001$), MMF ($\chi^2(8) = 245.47$; $p < 0.001$), and MAD ($\chi^2(8) = 120.25$; $p < 0.001$). MDD ranged from 4.5% in Bermo to 51.0% in Maradi City, MMF from 48.1% in Gazaoua to 99.4% in Tessaoua, and MAD from 3.1% in Gazaoua to 42.7% in Maradi City. Complementary feeding indicators across geographic units are shown in Table 5.

Table 5. Complementary Feeding Indicators among Children Aged 6–23 Months by Geographic Unit, Maradi Region, Niger (%)

Geographic Unit	**MDD (%)**	**MMF (%)**	**MAD (%)**
Aguié	7.8	99.2	7.1
Bermo	4.5	97.0	4.0
Dakoro	20.8	87.7	17.7
Gazaoua	5.2	48.1	3.1
Guidan-Roumdji	11.4	89.5	11.9
Madarounfa	23.1	75.8	20.1
Mayahi	16.7	91.8	15.8
Tessaoua	33.3	99.4	32.9
Maradi City	51.0	84.4	42.7
Maradi Region	18.7	84.6	17.1

Note: *MDD was calculated among 1,343 children, whereas MMF and MAD were calculated among 1,295 children. MDD, minimum dietary diversity; MMF, minimum meal frequency; MAD, minimum acceptable diet.*

The geographic distribution of MDD and GAM is presented in Figure 2.

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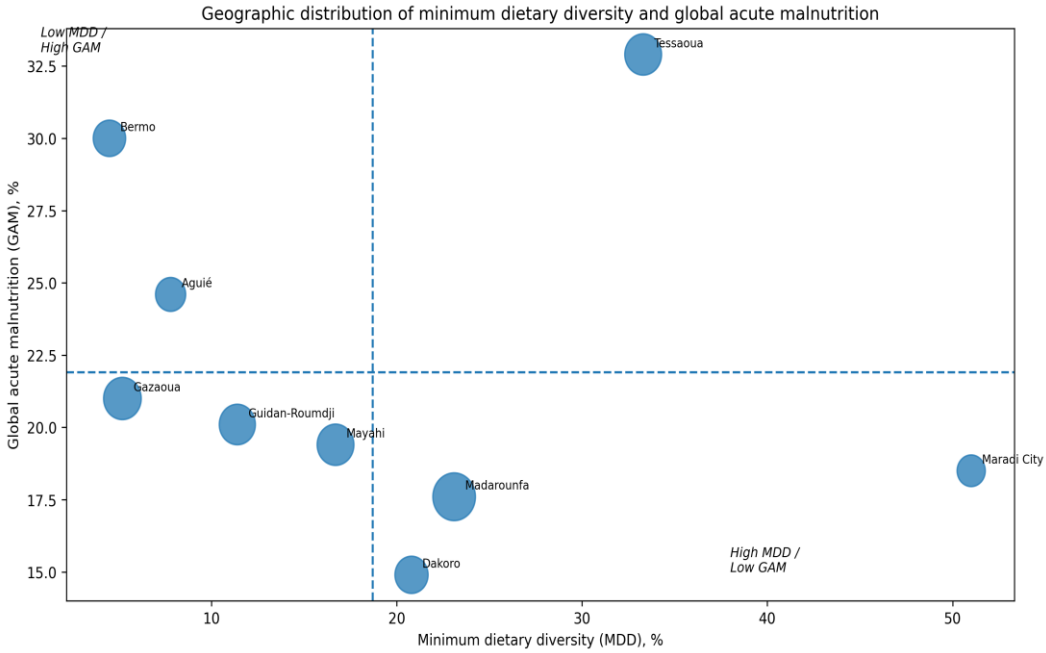


Figure 2. Geographic Distribution of Minimum Dietary Diversity and Global Acute Malnutrition across the Nine Study Units, Maradi Region, Niger

Note: *The figure is descriptive and does not constitute evidence of a statistically tested or causal association between MDD and GAM.*

Factors Associated with Complementary Feeding Practices

Separate multivariable logistic regression models were fitted for MDD (n = 1,343), MMF (n = 1,295), and MAD (n = 1,295). The models were adjusted for child age, household size, maternal marital status, and maternal education.

For MDD, children aged 18–23 months had higher odds of meeting the criterion than children aged 6–11 months (aOR = 1.39; 95% CI: 1.01–1.90; p = 0.041). Maternal education was positively associated with MDD: primary education (aOR = 1.53; 95% CI: 1.05–2.24; p = 0.027) and secondary or higher education (aOR = 2.69; 95% CI: 1.83–3.96; p < 0.001). Children of mothers in union had lower odds of meeting MDD (aOR = 0.17; 95% CI: 0.12–0.23; p < 0.001).

For MMF, household size of 5–9 members (aOR = 1.53; 95% CI: 1.12–2.10; p = 0.008) and 10–14 members (aOR = 2.01; 95% CI: 1.25–3.25; p = 0.004) were positively associated with meeting MMF. Maternal union status was also positively associated with MMF (aOR = 3.02; 95% CI: 2.25–4.05; p < 0.001). The association between age 18–23 months and MMF was not statistically significant at the 5% level (p = 0.053).

For MAD, maternal education was positively associated with meeting the criterion, with aOR = 1.55 (95% CI: 1.05–2.30; p = 0.029) for primary education and aOR = 2.54 (95% CI: 1.70–3.82; p < 0.001) for secondary or higher education. Maternal union status was negatively associated with MAD (aOR = 0.16; 95% CI: 0.12–0.22; p < 0.001). No statistically significant association was observed between child age or household size and MAD. Factors associated with MDD and MMF are presented in Table 6, and factors associated with MAD are presented in Table 7.

Table 6. Factors Associated with Minimum Dietary Diversity and Minimum Meal Frequency: Multivariable Logistic Regression Models

Variable	MDD aOR	95% CI	p	MMF aOR	95% CI	p
Age 6–11 months	Ref.	—	—	Ref.	—	—
Age 12–17 months	1.06	0.76–1.49	0.722	1.19	0.84–1.69	0.327
Age 18–23 months	1.39	1.01–1.90	0.041	1.39	1.00–1.94	0.053
Household < 5 members	Ref.	—	—	Ref.	—	—
Household 5–9 members	1.03	0.77–1.39	0.827	1.53	1.12–2.10	0.008
Household 10–14 members	0.83	0.54–1.28	0.403	2.01	1.25–3.25	0.004
Household >14 members	0.55	0.25–1.23	0.144	1.83	0.87–3.85	0.113
Mother not in union	Ref.	—	—	Ref.	—	—
Mother in union	0.17	0.12–0.23	<0.001	3.02	2.25–4.05	< 0.001
No maternal education	Ref.	—	—	Ref.	—	—
Primary education	1.53	1.05–2.24	0.027	1.26	0.81–1.97	0.304
Secondary or higher	2.69	1.83–3.96	<0.001	1.69	0.99–2.90	0.055

Note: *MDD model: n = 1,343; Wald $\chi^2(8) = 423.71$, $p < 0.001$. MMF model: n = 1,295; Wald $\chi^2(8) = 460.50$, $p < 0.001$. Models were adjusted for child age, household size, maternal marital status, and maternal education. aOR, adjusted odds ratio; CI, confidence interval.*

Table 7. Factors Associated with Minimum Acceptable Diet: Multivariable Logistic Regression Model

Variable	MAD aOR	95% CI	p-value
Age 6–11 months	Ref.	—	—
Age 12–17 months	1.02	0.72–1.46	0.897
Age 18–23 months	1.32	0.95–1.82	0.097
Household < 5 members	Ref.	—	—
Household 5–9 members	0.94	0.69–1.28	0.69
Household 10–14 members	0.88	0.57–1.37	0.568
Household >14 members	0.51	0.22–1.18	0.116
Mother not in union	Ref.	—	—
Mother in union	0.16	0.12–0.22	<0.001
No maternal education	Ref.	—	—
Primary education	1.55	1.05–2.30	0.029
Secondary or higher	2.54	1.70–3.82	<0.001

Note: *Model n = 1,295; Wald $\chi^2(8) = 433.07$, $p < 0.001$. The model was adjusted for child age, household size, maternal marital status, and maternal education. aOR, adjusted odds ratio; CI, confidence interval.*

The adjusted odds ratios from the multivariable models are displayed in Figure 3.

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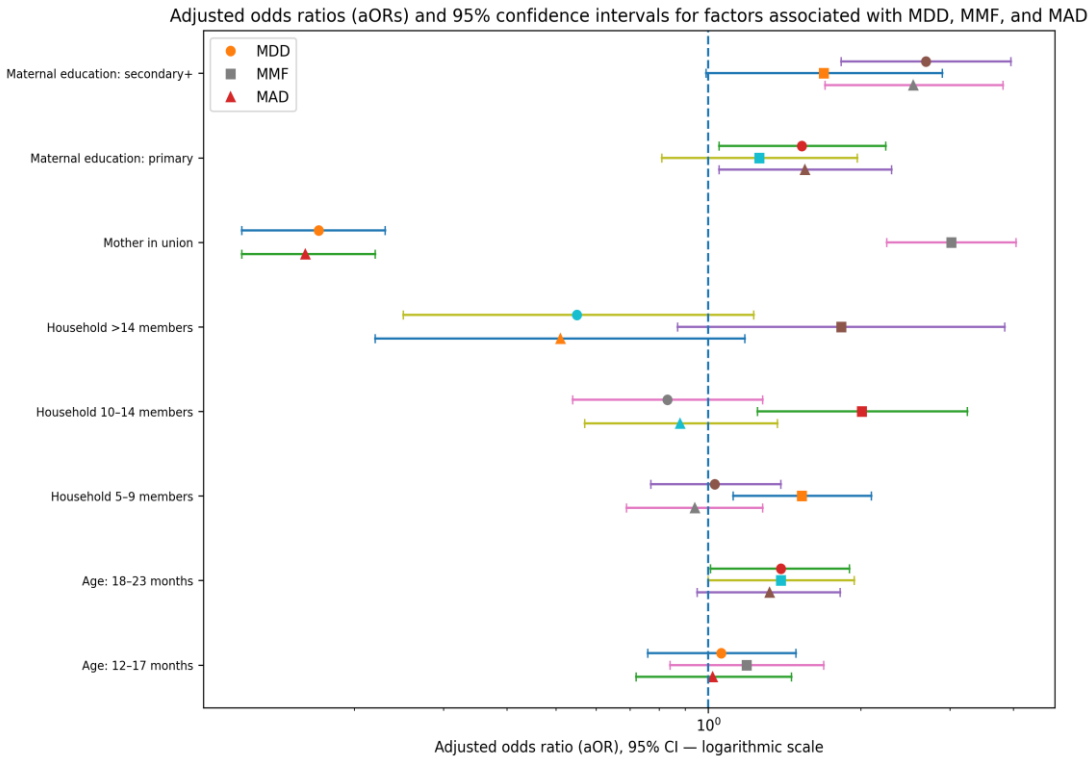


Figure 3. Adjusted Odds Ratios and 95% Confidence Intervals for Factors associated with Minimum Dietary Diversity, Minimum Meal Frequency, and Minimum Acceptable Diet

Note: *Separate multivariable logistic regression models were fitted for MDD (n = 1,343), MMF (n = 1,295), and MAD (n = 1,295). The vertical reference line represents aOR = 1. The x-axis is logarithmic. Reference categories are not plotted.*

Anemia and Infant and Young Child Feeding (IYCF) Practices

No statistically significant monotonic association was observed between anemia and any of the assessed IYCF indicators. Correlations were non-significant for early initiation of breastfeeding (Spearman's $\rho = -0.019$; $n = 1,353$; $p = 0.475$), colostrum feeding ($\rho = 0.037$; $n = 1,353$; $p = 0.172$), continued breastfeeding among children aged 12–23 months ($\rho = 0.023$; $n = 1,018$; $p = 0.462$), MDD ($\rho = -0.016$; $n = 1,343$; $p = 0.556$), MMF ($\rho = -0.031$; $n = 1,295$; $p = 0.265$), and MAD ($\rho = -0.014$; $n = 1,295$; $p = 0.625$).

These findings indicate no evidence of a statistically significant monotonic association in this study population; they should not be interpreted as evidence that feeding practices have no role in anemia.

Coverage of Selected Nutrition Interventions and Recent Morbidity

Vitamin A supplementation coverage was 81.8% (914/1,117), ranging from 52.6% in Bermo to 96.7% in Madarounfa ($\chi^2(8) = 147.39$; $p < 0.001$). Mebendazole deworming coverage was 69.0% (927/1,343), ranging from 44.1% in Bermo to 92.8% in Madarounfa ($\chi^2(8) = 199.43$; $p < 0.001$). During the two weeks preceding the survey, diarrhea prevalence was 42.1% (566/1,343), fever prevalence was 27.3% (367/1,343), and acute respiratory infection prevalence was 61.8% (578/936). Geographic comparisons for the morbidity indicators were statistically significant ($p < 0.001$). Coverage of nutrition interventions and morbidity indicators is summarized in Table 8.

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Table 8. Coverage of Selected Nutrition Interventions and Prevalence of Recent Morbidity by Geographic Unit, Maradi Region, Niger (%)

Geographic unit	Vitamin A	Deworming	ARI	Diarrhea	Fever
Aguié	87.5	87.5	94.2	39.1	23.4
Bermo	52.6	44.1	46.5	26.1	12.6
Dakoro	76.1	67.7	60.0	37.7	23.8
Gazaoua	79.0	52.9	39.5	24.4	18.6
Guidan-Roumdji	80.6	84.8	88.0	73.4	55.7
Madarounfa	96.7	92.8	80.1	34.8	23.5
Mayahi	83.9	53.7	46.7	25.9	19.8
Tessaoua	88.8	56.4	48.3	69.1	30.9
Maradi City	74.4	70.8	48.3	49.0	38.5
Maradi Region	81.8	69.0	61.8	42.1	27.3

Note: *ARI, acute respiratory infection. Percentages use indicator-specific denominators: vitamin A supplementation n = 1,117; deworming and diarrhea/fever n = 1,343; ARI n = 936. Geographic comparisons were statistically significant at p < 0.001.*

Discussion

This study provides a disaggregated assessment of the nutritional status and infant and young child feeding (IYCF) practices of children aged 6–23 months in the Maradi Region of Niger. The main findings were a high burden of malnutrition, marked geographic heterogeneity across the nine study units, low dietary diversity despite relatively adequate meal frequency, and the absence of a statistically significant monotonic association between the assessed IYCF indicators and anemia. The findings also show that the factors associated with complementary feeding differed according to the indicator considered. A conceptual framework illustrating the pathways linking contextual factors, IYCF practices, nutritional status, and anemia is presented in Figure 4.

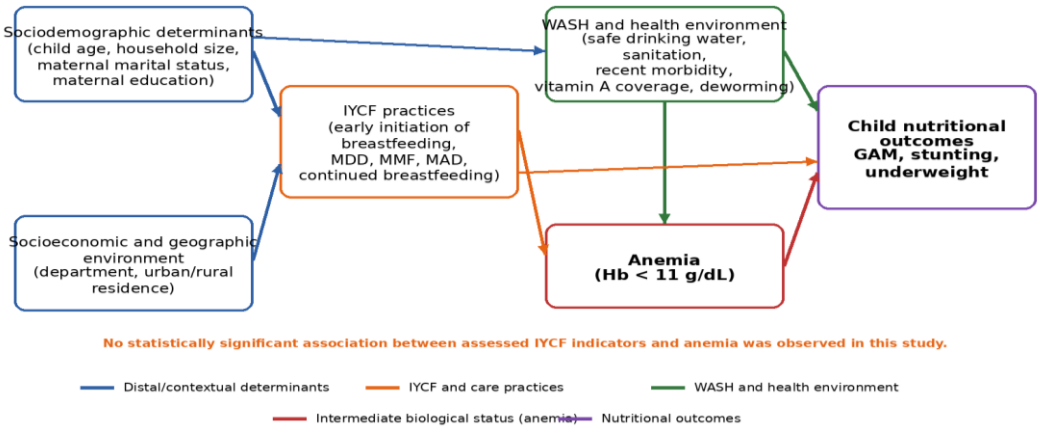


Figure 4. Conceptual Framework of Factors Influencing Child Nutritional Status and IYCF Practices in Maradi Region, Niger

Note: *The framework is adapted from the UNICEF Conceptual Framework on Maternal and Child Nutrition [11] and tailored to the variables assessed in this study. Arrows represent conceptual relationships and do not imply causal effects established by this cross-sectional study. The study found no statistically significant monotonic association between the assessed IYCF indicators and anemia.*

Magnitude and Disparities of Malnutrition

The prevalence of global acute malnutrition (GAM) in this study was 21.9% among children aged 6–23 months, which is substantially higher than the 13.6% reported for the Maradi Region in the 2022 SMART survey among children aged 6–59 months [5]. This comparison should be interpreted cautiously because the age ranges differ and the present study focused on the particularly vulnerable complementary-feeding period.

The difference may also reflect differences in survey timing and contextual conditions. It should therefore not be interpreted as evidence of a temporal increase in malnutrition.

Stunting affected 59.1% of children, a prevalence close to the 61.7% reported in 2022 among children aged 6–59 months in the region [5]. This persistence is consistent with the multifactorial and cumulative nature of chronic malnutrition, which is influenced by long-term nutritional, infectious, socioeconomic, sanitation, and health-service conditions [3]. Underweight was also highly prevalent (49.4%), indicating that both acute and chronic dimensions of nutritional vulnerability are substantial in this population.

The comparison with other West African settings further highlights the severity of the nutritional burden. In Burkina Faso, for example, a study conducted across 24 health districts reported prevalences of 40.1% for stunting, 25.1% for wasting, and 34.0% for underweight [12]. The higher prevalence of stunting and underweight observed in Maradi should nevertheless be interpreted in light of differences in age structure, study period, setting, and methodology.

Marked geographic disparities were observed across the nine study units. Tessaoua had the highest GAM prevalence (32.9%), while Aguié had the highest stunting prevalence (70.6%); Tessaoua also had the highest underweight prevalence (64.8%). In contrast, Maradi City generally showed the most favorable anthropometric profile, with 18.5% GAM, 37.1% stunting, and 25.8% underweight. These differences support a territorialized interpretation of child malnutrition. They are compatible with evidence from other Sahelian and sub-Saharan settings showing that differences in living conditions, access to health services, water and sanitation, and food environments can contribute to substantial subnational inequalities [12]. Because the present study is cross-sectional, these geographic patterns should be interpreted as differences in observed nutritional status rather than as evidence of causal effects of residence.

IYCF Practices: Magnitude and Determinants

Breastfeeding practices were relatively favorable for colostrum feeding and continued breastfeeding. Overall, 93.7% of children received colostrum and 76.6% of children aged 12–23 months were still breastfed. Early initiation of breastfeeding was lower, at 69.0%, and all three breastfeeding indicators varied significantly across geographic units. These findings indicate that, although several breastfeeding practices were widely maintained, important territorial differences remain.

The principal concern was complementary feeding quality. Only 18.7% of children met the minimum dietary diversity (MDD) criterion and 17.1% met the minimum acceptable diet (MAD) criterion, whereas 84.6% met minimum meal frequency (MMF). The contrast between relatively adequate meal frequency and low dietary diversity indicates that a high frequency of meals does not necessarily imply a sufficiently varied diet [1]. Compared with the 2022 national estimates for Niger (8.7% for MDD and 6.7% for MAD) [5], the estimates observed in Maradi were higher, but they nevertheless indicate that most children did not achieve recommended complementary feeding standards.

Substantial geographic variation was also observed. MDD ranged from 4.5% in Bermo to 51.0% in Maradi City, while MAD ranged from 3.1% in Gazaoua to 42.7% in Maradi City. These differences reinforce the importance of subregional analysis because regional averages can conceal areas where complementary feeding practices are particularly inadequate.

The adjusted analyses showed that the determinants differed by indicator. For MDD, children aged 18–23 months had higher odds of meeting the criterion than those aged 6–11 months (aOR = 1.39; 95% CI: 1.01–1.90; p = 0.041), and maternal education showed a positive gradient, with aOR = 1.53 (95% CI: 1.05–2.24; p = 0.027) for primary education and aOR = 2.69 (95% CI: 1.83–3.96; p < 0.001) for secondary or higher education. In contrast, children whose mothers were in union had lower odds of meeting MDD (aOR = 0.17; 95% CI: 0.12–0.23; p < 0.001). For MMF, household size of 5–9 and 10–14 members and maternal union status were positively associated with meeting the criterion, whereas the association with age 18–23 months was not statistically significant at the 5% level. For MAD, maternal education was positively associated with meeting the criterion, while maternal union status was negatively associated [1].

The positive association between maternal education and dietary diversity is consistent with evidence from West Africa and sub-Saharan Africa showing that maternal education is an important correlate of complementary feeding practices [13, 14, 19, 20]. Education may facilitate access to nutrition information, understanding of dietary recommendations, and the capacity to make informed feeding choices. The positive association with child age may reflect the progressive integration of older children into family meals and the gradual expansion of the range of foods offered [13-15, 21].

The inverse association between maternal union status and MDD and MAD was unexpected and should be interpreted cautiously.

It may reflect residual confounding by household characteristics or unmeasured dimensions of women's workload, autonomy, decision-making, or socioeconomic status. It should not be interpreted as evidence that marital or union status itself causes poorer feeding practices. The different patterns observed for MDD, MMF, and MAD also support analyzing these indicators separately rather than treating complementary feeding as a single homogeneous construct.

Childhood Anemia

Anemia affected 39.0% of children in the study, representing a substantial public health burden. This estimate is close to the approximately 40% prevalence reported globally among children under five years of age in pooled population-representative analyses [16]. The prevalence observed in Maradi therefore confirms that anemia remains an important component of the nutritional burden among young children.

No statistically significant monotonic association was observed between anemia and any of the assessed IYCF indicators, including early initiation of breastfeeding, colostrum feeding, continued breastfeeding, MDD, MMF, and MAD. This finding differs from studies reporting relationships between feeding practices and anemia or iron status [17, 18]. However, it is biologically plausible given the multifactorial etiology of childhood anemia in Sahelian settings. Malaria, helminth infections, inflammation, micronutrient deficiencies, and the bioavailability of dietary iron may all contribute to anemia and may not be adequately captured by a single 24-hour dietary recall [17, 22].

The absence of a statistically significant association should therefore not be interpreted as evidence that feeding practices have no role in anemia. Hemoglobin concentration alone cannot distinguish iron deficiency from

malaria, parasitic infection, inflammation, or other causes of anemia. Future studies should incorporate biological and infectious determinants, including symptomatic and asymptomatic malaria and parasitic infections, together with more detailed dietary and micronutrient assessments [22]. From a programmatic perspective, anemia prevention should consequently combine improved diets with appropriate infection prevention and treatment, deworming according to applicable recommendations, micronutrient interventions where indicated, and access to essential health services.

Implications for Nutrition Policies and Programs

The findings support a geographically differentiated approach to nutrition programming in the Maradi Region.

Departments with particularly high anthropometric burdens, notably Tessaoua, Aguié, and Gazaoua, warrant intensified nutrition surveillance and strengthened prevention and management activities. At the same time, the high anemia prevalence observed in several areas, including Madarounfa, supports maintaining strong anemia prevention and control within routine child-health and nutrition services.

Complementary feeding interventions should place greater emphasis on dietary quality and diversity rather than focusing only on meal frequency. Programs should promote the regular consumption of diverse and nutrient-dense foods that are locally available and culturally acceptable, while addressing the economic and household constraints that may limit access to such foods [1]. Maternal education should be incorporated into nutrition-sensitive and social and behavior change interventions, given its consistent positive association with MDD and MAD in the adjusted analyses.

The strong geographic differences observed in both nutritional status and IYCF practices also support the use of geographic-unit data for planning, targeting, monitoring, and resource allocation. Interventions should be adapted to local conditions rather than assuming that a single regional strategy will adequately address the needs of all communities. An integrated approach combining nutrition, health services, infection prevention, water and sanitation, food access, and other relevant determinants is likely to be more appropriate than isolated behavior-change interventions.

Strengths and Limitations

This study has several strengths. First, it used a two-stage probabilistic cluster sampling design stratified by geographic unit, allowing nutritional and IYCF indicators to be examined across the eight departments and the urban municipality of Maradi City. Second, the survey used the SMART methodology and internationally standardized anthropometric and IYCF indicators, facilitating comparison with other studies. Third, the study combined descriptive analyses with separate multivariable binary logistic regression models for MDD, MMF, and MAD, allowing the determinants of each indicator to be examined according to its specific definition. Finally, anthropometric measurements were collected using standardized procedures, with daily equipment calibration and quality assessment through ENA for SMART.

Several limitations should be considered. First, the cross-sectional design does not establish temporality and therefore does not permit causal inference.

The adjusted odds ratios describe associations with the probability of meeting each feeding criterion and should not be interpreted as causal effects. Second, IYCF indicators were based largely on a 24-hour dietary recall and may be affected by recall and social desirability bias; a single day may not represent habitual intake, particularly in a context of seasonal variation in food availability [1].

Third, several potentially important determinants, including detailed household socioeconomic status, household food security, women's autonomy, and some environmental and health-related factors, were not included in the final multivariable models. Residual confounding is therefore possible, particularly for the unexpected associations involving maternal union status. Fourth, the anemia analysis was based on hemoglobin concentration and did not allow differentiation among the major biological causes of anemia. Finally, the survey was conducted during a specific seasonal period, at the end of the rainy season and beginning of the post-harvest period, which may limit the direct extrapolation of the observed feeding and morbidity patterns to other seasons.

Despite these limitations, the study provides useful and geographically disaggregated evidence on the nutritional status and feeding practices of children aged 6–23 months in the Maradi Region. The combination of standardized measurement, geographic disaggregation, and indicator-specific multivariable analysis provides a strong basis for identifying priority areas and informing nutrition programming.

Conclusion

This cross-sectional study among 1,353 children aged 6–23 months in the Maradi Region of Niger documented a high burden of malnutrition, with GAM affecting 21.9% of children, stunting 59.1%, underweight 49.4%, and anemia 39.0%. Significant geographic disparities were observed across the nine study units, with particularly high anthropometric burdens in Tessaoua, Aguié, and Gazaoua, while Maradi City generally showed more favorable nutritional profiles.

Breastfeeding practices were relatively favorable for colostrum feeding and continued breastfeeding, but complementary feeding remained inadequate in terms of dietary quality. Only 18.7% of children met minimum dietary diversity and 17.1% met minimum acceptable diet, despite 84.6% meeting minimum meal frequency. The determinants of complementary feeding differed by indicator.

Maternal education was positively associated with MDD and MAD, child age was associated with MDD, and maternal union status showed different associations across indicators.

No statistically significant monotonic association was observed between the assessed IYCF indicators and anemia. This finding should be interpreted in the context of the multifactorial etiology of childhood anemia and the limitations of a cross-sectional study and 24-hour dietary recall. Overall, the findings support geographically targeted and integrated nutrition strategies that combine improved complementary feeding quality with anemia prevention, infection control, health services, and attention to the socioeconomic and environmental conditions shaping child nutrition.

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Conflict of Interest

The authors declare no conflict of interest related to this study.

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Authors' Contributions

All authors contributed to the conduct of the study and preparation of the manuscript. All authors reviewed and approved the final version of the manuscript.

Ethical Approval

Ethical approval for this study was obtained from the National Health Research Ethics Committee of Niger. Administrative authorization was also secured from relevant regional and local health authorities. Written informed consent was obtained from caregivers before participation. All collected data were anonymized prior to analysis, and confidentiality was maintained throughout the study.

Data Availability

The dataset analyzed during the current study is not publicly available due to data governance and confidentiality requirements. However, anonymized data may be made available by the corresponding author upon reasonable request and subject to the necessary approvals.

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