

# Prevalence and Associated Factors of Anemia in Children Aged 6 to 59 Months in the Eastern Region of Burkina Faso

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## Abstract

**Background.** Anemia in children aged 6 to 59 months is a public health problem in Burkina Faso with a prevalence well above the 40% estimated by WHO globally for this age group. **Aim.** The objective of this study was to evaluate the prevalence and associated factors of anemia in children aged 6 to 59 months. **Methods.** This was a cross-sectional descriptive and analytical study. The rapid diagnostic test “hemocue” was used to measure the hemoglobin level in the blood of 486 children aged 6 to 59 months. The cut-off point for any anemia was a hemoglobin level of less than 11.0g/dL. The chi-square test was used to analyze the anemia prevalence differences in different characteristic groups, and the multivariate logistic regression was used to analyze the relationship between the household and sociodemographic characteristics and anemia in children. The data was processed using the SPSS software. **Results.** Nine out of 10 children were anemic, with a prevalence of 90.9%. Prevalences were high in both Gnagna and Gourma, respectively 89.9% and 91.6%. The results of the bivariate analysis showed that the age of the child, the household head education level and the participation of the mother in activities to prevent malnutrition were significantly associated with anemia. In multivariate analysis, children aged 6 to 12 months were 3 times more likely to have anemia than children aged over 36 months. Those aged 13 to 36 months were twice as likely to have anemia as those aged over 36 months. **Conclusion.** There was a need to strengthen anemia interventions taking into account the age of children.

## Keywords

anemia, children aged 6 to 59 months, eastern region of Burkina Faso, associated factors

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## Introduction

Iron deficiency is the main cause of anemia, which remains a public health problem in both industrialized and developing countries.<sup>1</sup> According to the World Health Organization (WHO), anemia is a pathological condition in which the number of red blood cells is insufficient to meet the body’s physiological needs. Anemia is confirmed in children under 5 years of age if the blood hemoglobin level is below 11.0g/dL.<sup>2</sup> It affects all age groups, with a predominance in children under 5 and women of childbearing age. Anemia has many causes. Although it can be caused by parasitosis, hemorrhage, congenital conditions, chronic or infectious diseases, it is most often due to dietary deficiency, with iron deficiency at its root. The main risk factors for

anemia are inadequate micronutrient intake (iron, vitamin B9, vitamin B12, vitamin A, vitamin C), poor absorption of these micronutrients in diets rich in phenolic compounds, nutritional interactions affecting iron

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bioavailability, infectious diseases (malaria, ascariasis, schistosomiasis, hookworm), chronic diseases (tuberculosis, HIV AIDS) and the period of life when iron requirements are highest (growth and pregnancy). Anemia has considerable negative effects on the health and economic well-being of nations and communities. It affects physical growth, cognitive development, reproduction and physical work capacity.<sup>3</sup> It has been ranked by the WHO as one of the ten most serious problems facing the modern world, and is the most widespread form of micronutrient deficiency worldwide.<sup>4</sup> Worldwide, the prevalence of anemia in the general population according to WHO is 24.8%, and an estimated 1.8 billion people suffer from anemia.<sup>5</sup> Most studies carried out in Burkina Faso are limited to presenting the prevalence of anemia without performing an analysis to identify the associated factors. To effectively control anemia through the development of effective strategies, it is necessary to identify risk factors. This requires an approach that integrates the multifactorial and multisectoral dimensions of anemia to address this public health issue.

The present study aimed to assess the prevalence of anemia in the provinces of Gnagna and Gourma and to identify its associated factors in children aged 6 to 59 months.

## Methods

### Setting and Type of Study

This study was carried out in the Gourma and Gnagna provinces in the Eastern region of Burkina Faso. It was a descriptive and analytical cross-sectional study that carried out from September 23 to October 17, 2021.

### Study Population

The study population consisted of children aged 6 to 59 months. All children aged 6 to 59 months residing in the study area were included in the study. Not included in the study were children aged 6 to 59 months who were ill or whose parents refused to participate.

### Sample and Sampling

The survey was based on a 2-stage stratified sample design, with primary units being villages or sectors and households being secondary units. The main sampling frame was the administrative village file from INSD's General Population and Housing Census (RGPH 2019). A statistically significant sample of households was drawn for both provinces.

The minimum sample size was determined according to the following formula:

$$n = deff \times \frac{Npq}{\frac{d^2}{Z^2}(N-1) + pq}$$

( $n$ =sample size,  $deff$ =calculation factor (1.5),  $N$ =total population,  $p$ =estimated proportion (83.8%),  $Z=1.96$ ,  $q=1-p$ ), and  $d$  is the precision error set at 5%.

With a population of children aged 6 to 59 months estimated at 152 339 (INSD projection on RGPH 2019) in the 2 provinces and a non-response rate of 10%, the sample size was estimated at 343 children aged 6 to 59 months to be sought in 460 households (proportion of children was estimated at 19% in the region by the RGPH 2019). Household size was adjusted to 800 to reflect the region's food consumption score. In the selected households, a single child aged between 6 and 59 months was randomly selected from the household members eligible for this survey.

### Data Collection Methods and Tools

Direct interviews were used to collect quantitative data using a tablet questionnaire via Open Data Kit (ODK) from the children's parents (head of household, mothers, or nannies). The information collected covered the following topics: demographics, education, access to drinking water and hygiene, household equipment, main activities, household expenditure, shock management strategy and household food consumption.

A reminder of the depletion of assets during the 30 days was carried out in each household through questions. Household asset depletion reflects the stress on their livelihoods. The answers to the various questions were used to understand the stress and insecurity faced by households, and to describe their capacity for future productivity.<sup>6</sup>

The share of food expenditure was simply calculated by dividing total food expenditure by total household expenditure. However, the denominator and numerator must include the value of food consumed but not purchased.

To determine the household's share of food expenditure, a 30-day recall was carried out in each household on food expenditure in cash and credit, and food consumed but not purchased. For each household, the sum of total food expenditure (cash and credit) for the 30-day recall period was added to the total value of food consumed during the last 30 days that had not been purchased. This sum forms the total value of the household food basket for the last 30 days. The sum of short-term (30 days) and long-term non-food expenditure was

calculated for each household, excluding savings. Thus, the share of food expenditure is the ratio between the total value of the household food basket over the last 30 days and the sum of the total value of the food basket and the total of short- and long-term household food and non-food expenditure.<sup>6</sup>

A 7-day open recall of household food consumption was carried out in order to assess household food consumption. This recall was administered to the person usually in charge of preparing meals for the household (assisted by others if necessary) by direct interview.<sup>6</sup>

Hemoglobin determination was performed in households using the rapid diagnostic test HemoCue™ (Hb201+, HemoCue, Angelsborg, Sweden) by interviewers. It has been validated and recommended in population-based surveys. It is non-invasive and requires a small amount of blood. It is highly sensitive and specific, with a positive predictive value for assessing hemoglobin levels in blood. For blood sampling, a finger prick was made with a lancet and a droplet was collected with a microcuvette. Hemocue quality control was carried out daily using both low and medium control blood samples, which were kept cold throughout the collection period

### *Dependent Variable*

In this study, the dependent variable was the occurrence of anemia in children aged 6 to 59 months. Indeed, according to WHO, the presence of anemia is detected when the hemoglobin level is  $\leq 11.0$  g/dL. Firstly, when this level is between 10.0 and 10.9 g/dL, we speak of mild anemia. When it's between 7.0 and 10.9 g/dL, it's called moderate anemia, and when it's  $\leq 7.0$  g/dL, it's called severe anemia.<sup>2</sup>

### *Independent Variables*

These factors may explain the onset of anemia in children. For this study, several variables were involved. At context level, place of residence was selected. At household level, survival strategy, share of food expenditure, household food consumption, and wealth quintile were included.

All survival strategies were classified into 3 general groups, including stress strategies, crisis strategies, and emergency strategies.<sup>6</sup>

Based on the results of the food consumption score, households were grouped into poor, borderline, and acceptable levels of food consumption.<sup>6</sup>

The wealth quintile was calculated using the durable goods owned by each household and divided into quintiles on unweighted data.

At the individual level, the characteristics of children aged 6 to 59 months were retained. These included the children's mothers' marital status, the household head's level of education, the mother's membership of the infant and young child feeding learning and monitoring group (GASPA), the child's iron and/or folic acid supplementation, the household head's age and sex, and the child's sex and age.

### *Data Processing and Statistical Analysis*

Data entered on the tablets and sent directly to the kobotoolbox server were exported, processed and analyzed. The data were analyzed using SPSS v.25 software, based on a specially designed analysis plan.

Univariate analysis using Pearson's Chi-square test was used to test for correlation between anemia (dependent variable) and each of the independent variables. All variables whose significance was less than 0.20 ( $P < .20$ ) in the bivariate analysis were included in the multivariate analysis (logistic regression).

Binary logistic regression involved the various candidate variables from the descriptive bivariate analysis, in order to identify factors associated with anemia at the 5% threshold.

## **Results**

### *Socio-Demographic Characteristics of the Sample*

Around 7 out of 10 households were rural. Over a third of households were very poor in relation to their assets, and 7 out of 8 were indigenous households. About 1 in 6 households had adopted a stress strategy, and 6 out of 10 had an acceptable food consumption score. Food expenditure for 6% of households was greater than or equal to 75% of the total budget (Table 1).

Of the households selected, >9 out of 10 were headed by men. Around 4 out of 10 heads of household had no formal education.

Among the women selected, around 7 out of 10 were aged between 20 and 34.

More than half of the children were girls, aged between 13 and 36 months. More than 9 out of 10 children took iron/folic acid supplements at the time of the survey (Table 2).

### *Prevalence of Anemia in Children Aged 6 to 59 Months*

In the Gnagna and Gourma provinces, out of a total of 486 children aged between 6 and 59 months, 442 of

**Table 1.** Household Characteristics.

Variables	Modality	n	%
Province	Gnagna	199	40.9
	Gourma	287	59.1
Place of residence	Rural	341	70.2
	Urban	145	29.8
Household type	Aboriginal	421	86.6
	100% de IDPs	30	6.2
	Hosts (Aboriginal and IDPs)	35	7.2
Household size	≤6	338	70.7
	≥7	140	29.3
Household food consumption	Poor	28	5.8
	Borderline	171	35.2
	acceptable	287	59.1
Household survival strategy	No strategy adopted	326	67.1
	Stress strategy	77	15.8
	Crisis strategy	61	12.6
	Emergency strategy	22	4.5
Share of household food expenditure	Less than 50%	297	61.1
	Between 50% and 65%	105	21.6
	Between 65% and 75%	54	11.1
	Over 75%	30	6.2
Household poverty quintile	Very poor	179	36.8
	Poor	94	19.3
	Average	83	17.1
	Rich	52	10.7
	Very wealthy	78	16.0

Abbreviation: IDPs, internally displaced persons.

them suffered from anemia of any kind. In fact, 90.9% of the children were anemic, with 63% suffering from moderate anemia, 10.5% from severe anemia and 17.5% from mild anemia. The prevalence of all forms of anemia was 91.6% in Gourma and 89.9% in Gnagna. For moderate anemia, the prevalence was 64.2% in the Gnagna and 62.0% in the Gourma. The prevalence of severe anemia was 7.5% in Gnagna and 12.5% in Gourma. The mild form of anemia was 18.1% in Gnagna and 17.1% in Gourma (Table 3).

### *Household Characteristics and Anemia in Children Aged 6 to 59 Months*

The proportion of household food expenditure was associated with anemia in children aged 6 to 59 months at 5% (Table 4).

### *Sociodemographic Characteristics and Anemia in Children Aged 6 to 59 Months*

The age of the children, the level of education of the head of the household and membership of a IYCF promoting

group had a statistically significant association with anemia in children aged 6 to 59 months (Table 5).

### *Determinants of Anemia in Children Aged 6 to 59 Months*

Binary logistic regression showed that child age was a determinant of anemia in children aged 6 to 59 months in the Eastern region. Children aged 6 to 12 months were 3 times more likely (OR=3.218; 95% CI=1.119-9.258;  $P=.030$ ) to be anemic than children aged at least 37 months. Children aged between 13 and 36 months were twice as likely (OR=2.033; 95% CI=1.014-4.077;  $P=.046$ ) to be anemic than those aged at least 37 months (Table 6).

## **Discussion**

Among children surveyed in the Gnagna and Gourma provinces, the prevalence of anemia was 89.9% and 91.6% respectively. According to WHO, anemia was a serious public health problem. The demographic and health survey carried out in the same year revealed that 81.2% of children in the Eastern region suffered from

**Table 2.** Individual Characteristics.

Variables	Modality	n	%
Sex of household head	Female	29	6.0
	Male	457	94.0
Level of education of household head	None	209	43.0
	Primary or Koranic or literate	147	30.2
	Secondary or higher	130	26.7
Marital status of household head	Single	4	0.8
	Divorced	4	0.8
	Married	467	96.1
	Widowed	11	2.3
Age of household head	≤35.0	221	45.5
	35.1-72.5	254	52.3
	≥72.6	11	2.3
Age class of mothers (years)	≤19	32	6.6
	20-34	349	72.4
	≥35	101	21.0
Mothers' level of education	None	228	47.2
	Primary or Koranic or literate	88	18.2
	Secondary or higher	167	34.6
Mothers' marital status	Single	19	3.9
	Divorced	4	0.8
	Married	455	93.6
	Widowed	5	1.0
Child's sex	Girl	263	54.1
	Boy	223	45.9
IYCF promoting group member	No	415	85.9
	Yes	68	14.1
Current use of iron/folic acid supplements in children	No	474	97.5
	Yes	12	2.5
Children's age group (months)	6-12	104	21.4
	13-36	261	53.7
	≥37	121	24.9

**Table 3.** Prevalence of Anemia in Children Aged 6 to 59 Months.

Indicators	Gnagna	Gourma	Total
Proportion of children aged 6 to 59 months with normal hemoglobin ( $\geq 11.0$ g/dL)	10.1	8.4	9.1
Proportion of children aged 6 to 59 months with all forms of anemia	89.9	91.6	90.9
Proportion of children aged 6 to 59 months with mild anemia (10.0-10.9g/dL)	18.1	17.1	17.5
Proportion of children aged 6 to 59 months with moderate anemia (7.0-9.9g/dL)	64.3	62.0	63.0
Proportion of children aged 6 to 59 months with severe anemia ( $<7.0$ g/dL)	7.5	12.5	10.5

anemia.<sup>7</sup> In 2014, Burkina Faso's national iodine and anemia survey found 83% of children suffering from anemia in the same region.<sup>8</sup> These differences of anemia prevalence between this study and other studies in the same area can be explained by the different data collection periods for these studies. The etiologies of anemia are multifactorial, particularly in a context of malaria hyper-endemic and high levels of chronic infection. At the beginning of the rainy season malaria transmission is low, while this study was carried out between September

and October, after the rainy season with a period of high malaria transmission.<sup>8</sup> The malaria parasites, entering the blood after an infective mosquito bite, infect red blood cells. At the end of that infection cycle, red blood cell ruptures. This process lowers the amount of red blood cells and can in a severe stage cause severe anemia.<sup>9-12</sup>

Prevalence's lower than the results of this study have been found in other countries. The results of a study carried out in Togo also showed that the overall prevalence of anemia in children was 75%, that is, 77% in boys and

**Table 4.** Household Characteristics and Anemia in Children Aged 6 to 59 Months.

Variables	Modality	No anemia		Anemia		P-value
		n (%)	n (%)	n (%)	n (%)	
Province	Gnagna	20 (10.1)	179 (89.9)			.524
	Gourma	24 (8.4)	263 (91.6)			
Place of residence	Rural	27 (7.9)	314 (92.1)			.181*
	Urban	17 (11.7)	128 (88.3)			
Household type	Aboriginal	40 (9.5)	381 (90.5)			.676
	100% de IDPs	2 (6.7)	28 (93.3)			
	Hosts (Aboriginal and IDPs)	2 (5.7)	33 (94.3)			
Household size	≤6	31 (9.2)	307 (90.8)			.969
	≥7	13 (9.3)	127 (90.7)			
Household food consumption	Poor	4 (14.3)	24 (85.7)			.494
	Borderline	13 (7.6)	158 (92.4)			
	Acceptable	27 (9.4)	260 (90.6)			
Household survival strategy	No strategy adopted	30 (9.2)	296 (90.8)			.453
	Stress strategy	4 (5.2)	73 (94.8)			
	Crisis strategy	8 (13.1)	53 (86.9)			
	Emergency strategy	2 (9.1)	20 (90.9)			
Proportion of household food expenditure	Less than 50%	33 (11.1)	264 (88.9)			.048**
	Between 50% and 65%	5 (4.8)	100 (95.2)			
	Between 65% and 75%	6 (11.1)	48 (88.9)			
	Over 75%	0 (0.0)	30 (100.0)			
Household poverty quintile	Very poor	13 (7.3)	166 (92.7)			.850
	Poor	9 (9.6)	85 (90.4)			
	Average	8 (9.6)	75 (90.4)			
	Rich	5 (9.6)	47 (90.4)			
	Very wealthy	9 (11.5)	69 (88.5)			

\*Candidate for logistic regression,  $P < 20\%$ .

\*\*Significance at 5%.

73% in girls.<sup>13</sup> The prevalence of anemia in children under 5 was 51.8% in Cape Verde in 2014<sup>14</sup> and 48.9% in an Ethiopian hospital in 2021.<sup>15</sup> The prevalence of anemia in children under 5 was 43% according to a quantitative cross-sectional study carried out in the Lao People's Democratic Republic in 2017.<sup>16</sup>

In a bivariate analysis of this study, the occurrence of anemia in children aged 6 to 59 months was associated with the household's proportion of food expenditure, the level of education of the household head, the child's age, and participation in malnutrition prevention activities such as the IYCF promoting group (GASPA). Studies have also shown that the prevalence of anemia in children varied according to the mother's level of education. For example in Senegal, this prevalence was low among children of mothers with schooling, while it was high among children of mothers without schooling.<sup>5</sup> The higher the level of education of mothers, the better she looks after his/her child's health, which could considerably reduce the prevalence of anemia.

The onset of anemia in children aged 6 to 59 months was also linked to the household's proportion of food expenditure, although in bivariate and multivariate analysis this was not significant. Indeed, analysis of the results revealed that all children from households with a proportion of food expenditure greater than 75% suffered from anemia. This could be explained by the fact that these households were food insecure and had difficulty in obtaining a diversified, nutrient-rich diet.

Although family environment was not associated with the occurrence of anemia in the present study, it remains an associated factor according to several authors.<sup>17-19</sup> This could be explained by the high level of undernutrition in rural areas, due to low dietary diversity among households and individuals, limited access to health infrastructure, and inadequate feeding and care practices.

In the binary logistic regression model, the child's age was retained as the explanatory variable. This study showed that anemia was significantly associated with child age at the 5% level. Children aged between 6 and

**Table 5.** Sociodemographic Characteristics and Anemia in Children Aged 6 to 59 Months.

Variables	Modality	No anemia	Anemia	P-value
		n (%)	n (%)	
Sex of household head	Female	26 (9.9)	237 (90.1)	.487
	Male	18 (8.1)	205 (91.9)	
Children's age group (months)	6-12	5 (4.8)	99 (95.2)	.009**
	13-36	20 (7.7)	241 (92.3)	
	≥37	19 (15.7)	102 (84.3)	
Age class of mothers (years)	≤19	2 (6.3)	30 (93.8)	.831
	20-34	33 (9.5)	316 (90.5)	
	≥34	9 (8.9)	92 (91.1)	
Sex of household head	Female	2 (6.9)	27 (93.1)	.676
	Male	42 (9.2)	415 (90.8)	
Level of education of household head	None	13 (6.2)	196 (93.8)	.049**
	Primary or Koranic or literate	20 (13.6)	127 (86.4)	
	Secondary or higher	11 (8.5)	119 (91.5)	
Mothers' marital status	Single	4 (21.1)	15 (78.9)	.208
	Divorced	39 (8.6)	416 (91.4)	
	Married	0 (0.0)	4 (100.0)	
	Widowed	1 (20.0)	4 (80.0)	
Mothers' level of education	None	16 (7.0)	212 (93.0)	.152*
	Primary or Koranic or literate	7 (8.0)	81 (92.0)	
	Secondary or higher	21 (12.6)	146 (87.4)	
IYCF promoting group member	No	42 (10.1)	373 (89.9)	.047**
	Yes	2 (2.9)	66 (97.1)	
Current use of iron/folic acid supplements in children	No	44 (9.3)	430 (90.7)	.268
	Yes	0 (0.0)	12 (100.0)	
Age of household head	≤35.0	19 (8.6)	202 (91.4)	.949
	35.1-72.5	24 (9.4)	230 (90.6)	
	≥72.6	1 (9.1)	10 (90.9)	

\*Candidate for logistic regression,  $P < 20\%$ .

\*\*Significance at 5%.

12 months and those aged between 13 and 36 months were at greater risk of developing anemia than their peers aged 37 months and over. Indeed, children aged 6 to 12 months were 3 times more likely (OR=3.218; 95% CI=1.119-9.258;  $P=.030$ ) to be anemic than children aged at least 37 months. Children aged between 13 and 36 months were twice as likely (OR=2.033; 95% CI=1.014-4.077;  $P=.046$ ) to be anemic than those aged at least 37 months. According to the 2021 Burkina Faso Demographic and Health Survey, the prevalence of anemia decreased progressively with age, from 84% among children aged 12 to 23 months to 59% among those aged 48 to 59 months.

These results can be explained by the fact that from 6 months onward, breast milk is no longer sufficient to cover the child's nutritional needs, including iron requirements. This period marks the beginning of the introduction of complementary foods, which is a difficult phase for some mothers to provide their child with a

diversified diet containing the quantity of iron required for hemoglobin production. In the Democratic Republic of Congo, authors have also shown that age was a factor associated with anemia in children.<sup>20</sup> A similar study in Senegal also showed that age was a factor associated with anemia.<sup>5</sup> According to the Cape Verde study, having less than 24 months tripled the risk of anemia (OR 3.23; 95% CI=2.03-5.15) in children aged between 6 and 59 months.<sup>14</sup>

In Equatorial Guinea, authors found that the prevalence of anemia was higher in children aged 6 to 12 months than in those aged 13 months or older.<sup>21</sup>

Despite the results obtained, this study has a number of limitations that should be highlighted. In terms of limitations, it should be emphasized that we cannot have all the information likely to explain anemia in children. It is possible that missing community or individual variables could affect the explanatory variables and even the variable being explained.

**Table 6.** Binary Logistic Regression.

Variable	Modalité	B	OR	Intervalle de confiance	P-value
Mothers' level of education	None	0.677	1.967	0.886-4.367	.096
	Primary or Koranic or literate	0.845	2.328	0.874-6.206	.091
	Secondary or higher®	-		-	-
Place of residence	Rural	0.143	1.153	0.580-2.294	.684
	Urban®				
Level of education of household head	None	-0.174	0.840	0.319-2.217	.725
	Primary or Koranic or literate	-0.818	0.441	0.182-1.071	.071
	Secondary or higher®	-		-	-
Children's age group (months)	6-12	1.169	3.218	1.119-9.258	.030*
	13-36	0.710	2.033	1.014-4.077	.046*
	≥37®	-		-	-
IYCF promoting group Member	Non	-0.901	0.406	0.091-1.818	.239
	Oui®				
Proportion of household food expenditure	Less than 50%	-18.592	0.000	0	.998
	Between 50% and 65%	-17.862	0.000	0	.998
	Between 65% and 75%	-18.764	0.000	0	.998
	Over 75%®	-		-	-

Abbreviations: ®, Reference; OR, odds ratio.

\*Significance at 5%.

## Conclusions

At the end of this study, the results show that the prevalence of anemia among children aged 6 to 59 months in this study area was very high. It was also explained by variables relating to the child, the mother/father and the household. The aim of the present study was to assess the prevalence of anemia and identify its associated factors in children aged 6 to 59 months in the Eastern region. It covered the Gnagna and Gourma provinces. Anemia was very prevalent in the East region, with a very high prevalence affecting children aged between 6 and 36 months. Indeed, 92% and 89.9% of children had some form of anemia in the Gourma and Gnagna provinces respectively.

These analyses showed that children's age was associated with their anemia status. Younger children were more likely to suffer from anemia than older children. The age of children needs to be taken into account when devising strategies to combat anemia, in order to make an effective contribution to reducing its prevalence in this region, and indeed throughout the country.

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## Author Contributions

Conceptualization and methodology O. O., E. W. R. C, O. O.; data collection : O. O., E. W. R. C, M. H. D; data analysis and interpretation O. O., E. W. R. C, O. O., drafting of article O. O. O., E. W. R. C; critical revisions of article O. O., M. K. The final article is approved by M. H. D. All authors have read and approved the final manuscript.

## Availability of Data and Materials

The database used in this study can be supplied by the corresponding author on request.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Ethical Approval and Informed Consent

The study protocol was validated by the Burkina Faso Health Research Ethics Committee under the number 2021-10-224. Free written consent was obtained from the children's parents before the interview and blood sampling. Participants were



informed of their full right to withdraw or refuse to participate in the study at any time. Cases of severe anemia were referred to the nearest health center for appropriate treatment. Data confidentiality was ensured in accordance with ethical and moral standards. In fact, privacy and confidentiality of information given by respondent were guaranteed by omitting names or any personal identifiers.

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