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Research Article

Characterization of Anemia in Children Less Than 7 Years Old in the Western Region (Man) of Côte D`Ivoire

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Abstract

Background: Anemia is a major public health problem affecting nearly a quarter of the world's population. Very commonly in the subtropics, helminthes or malaria co-infects the same person, causing morbidities that vary according to age and region. This research study aims to characterize the type of anemia observed in <7 years old children in Western Côte d`Ivoire in order to recommend a better strategy of care. **Methods:** The study was carried out from March 2020 to May 2021 in 22 villages of the "Tonkpi Region" (Man). It involved 451 children; boys and girls aged 3 months to 6 years who provided venous blood samples that were subjected to a FBC for the diagnosis and characterization of anemia. Univariate analysis (Chi-2 test (x2) and P: (Probability) were used for comparison between groups. Significant test was considered at a threshold of 0.05. **Results:** Among 451 selected children who completed the study, 221(49.0%) were girls and 230(51.0 %) were boys. The prevalence of anemia was 248 (55.0%) of which 76(30.7%) was mild, 164(66.1%) moderate and 8(3.2%) severe. It characterization showed the predominance of hypochromic microcytic anemia (HMA) with 195(78.63%) followed by normochromic microcytic anemia 29(11.69%), normochromic normocytic anemia 14(5.65%) and lastly, hypochromic normocytic anemia 10(4.03%).

Conclusion: The prevalence of anemia is high with moderate anemia and HMA being more prevalent in children <7 years of which 30.7% mild, 66.1% moderate and 3.2% severe. Infants ≤2 years and the children ≤5 years were the most affected at a prevalence of 66.0% and 51.5% respectively.

Conflict of interest statement

The authors have declared that no competing interests exist.

Introduction

Parasite infestations such as malaria are common in the tropical and sub-tropical regions. They lead to severe consequences such as Anemia with high morbidity and mortality rates, especially in children [1]. WHO report on Anemia (2020), estimate that the global prevalence of anemia was 39.8% in children aged 6 to 59 months and 29.9% in women of childbearing age (% of women aged 15 to 49). This equates to 269 million anemic children and over half a billion women aged 15 to 49 respectively [2].

In Côte d'Ivoire, Anemia is endemic like Malaria and rages with varying prevalence from one region to another, depending on age and sex. The recent WHO report of year 2020 on anemia indicated that in Côte d`Ivoire a prevalence of 72.2% in children aged 6 to 59 months and 51% in women of childbearing age (women aged 15 to 49) [2,3]. Hence, it seems appropriate, even essential, to conduct research to highlight these morbidities, which represent some public health problems for a better prevention and cure. This community-based research study aims to characterize the type of anemia observed in anemic children in the Tonpki Region (Man), in the Western part of Côte d`Ivoire, in order to recommend better strategy of care.

Methods

Study area and participants

This observational clinical research study was carried out from March 2020 to May 2021 in twenty two (22) villages in Man, the "TONKPI Region" (Figure 1). The sample size of 451 was obtained from Schwartz's formula:

$$n = z^2 \frac{p(1-p)}{e^2} *c$$

Where: P is the expected prevalence of anemia in the target population estimated at 73.4% [4]; E an accuracy of 5%; C a corrective coefficient for the cluster effect of 1.5 and Z a confidence level of 95% (Z = 1.96).
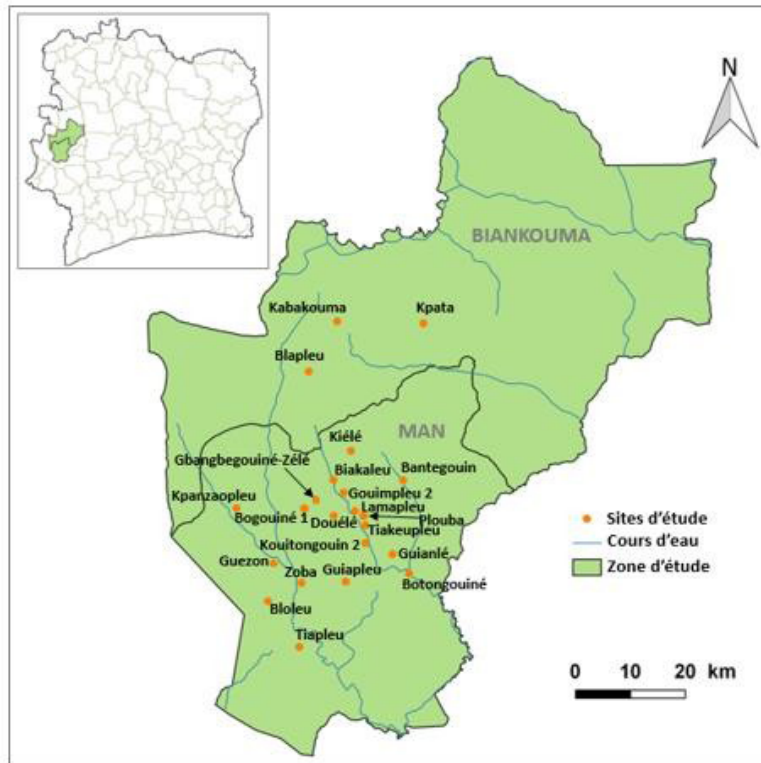

Figure 1: Map of the TONKPI Region indicating the study sites in orange color.

Children aged 3 months to < 7 years were enrolled and provided blood samples for the diagnosis of anemia and malaria. All study participants belong to a variety of ethnical groups (Akan, Gour, Mande, Krou and others from neighboring countries such as Burkina Faso, Mali and Guinea) and reside in rural area with similar life style patterns and their parents earn their living either mostly as farmers or commercial traders.

Socio-demographic

Socio-demographic data including age, sex, height (to the nearest centimeter), weight (to the nearest 0.5 kg) and parent's profession were also collected through a questionnaire administered to each enrolled participant who provided a signed written informed consent or give a fingerprint (illiterates).

Blood collection

2 mL of venous blood were drawn in the morning in EDTA-treated evacuated tubes from each of the 451 consented study participants. Blood samples were kept on ice until transported to the central laboratory at the Centre Hospitalier Regional (CHR) Man for the hematology testing (FBC).

Hemoglobin determination and classification of Anemia

The full blood count (FBC) was performed using URIT 3000 PLUS analyzer, Urit Medical Electronics, China and the result printed and further analyzed and characterized on the basis of the mean corpuscular hemoglobin (MCH) (normal value = 27 to 31 picograms (pg) and mean corpuscular hemoglobin concentration (MCHC) (normal value = 33 - 36 grams per deciliter (g/dL) as Normochromic or Hypochromic and the mean cell volume (MCV) (normal value = 80 - 100 fl) as Normocytic, Microcytic or Macrocytic.

Anemia was assessed and classified according to the age, sex of the participants and the concentration value of the hemoglobin (Hb) as per WHO guidelines (http://www. Who.int/vmnis/indicators/haemoglobin.pdf). Thus, children from 3 months to 6 years with an Hb level of less than 11 g/dL were considered as anemic while those with an Hb level ≥11 g/dL were considered as normal (non-anemic). Anemia was also categorized as mild if the Hb level was less than 10 g/dL, moderate between 7 and 10 g/dL

and severe below 7 g/dL and further characterized on the basis of the MCH and MCHC as Normochromic or Hypochromic and on the basis of the MCV as Normocytic, Microcytic or Macrocytic.

Data management and analysis

Data were entered into a database using the double-entry system in Epi-data version 3.1 (EpiData, Odense Denmark, 2004). Inconsistencies were cleaned and, after validation, the data were exported for the analysis to SPSS version 20 (IBM Corp; 2011) and STATA 16 software (STATA Corporation, College Station, Texas, USA). Univariate analysis (Chi-2 test (x^2) and P: (Probability) were used for comparison between groups. Significant test was considered at a threshold of 0.05.

Ethical consideration

This study was conducted after obtaining an ethical clearance from the "Comité National d'Ethique des Sciences de la Vie et de la Santé (CNESVS) de la Côte d'Ivoire" (N/Ref: 024-21/MSHP/CNESVS-km). Further permission to conduct the study was obtained from each visited village chief`s. In essence, the full study details i.e., the aims, the procedures, the potential risks and the benefits were explained to the physicians, nurses, and assistant nurses of each involved Health Center and the villagers before the start of the study.

Since all the participants were minors, consent from one of the parent was sought and obtained before any study procedure was completed. Only voluntary consented participants were included in the study. Treatment was made available free of charge to all sick participants. Those who required further assistance were referred to the local health center for assistance.

Participants were further informed that their information will be anonymized (confidential) using a coding system instead of their names.

Results

Characteristics of the study populations

A total of 451 children from 22 villages were enrolled in the study. Among them, 230 (51.0%) children were boys and 221 (49.0%) children were girls (Table 1).

Département	Sous-Préfecture	Villages	Masculin	Féminin	Nombre de participants n (%)
BIANKOUMA	Blapleu	Blapleu	20 (62,5)	12 (37,5)	32 (7,1)
	Biankouma	Kabakouma	19 (73,1)	7 (26,9)	26 (5,8)
	Kpata	Kpata	9 (39,1)	14 (60,9)	23 (5,1)
MAN	Gbangbégouiné-Yati	Bogouiné 1	13 (61.9)	8 (38.10)	21(4,7)
		Biakalé	7 (36,8)	12 (63,2)	19 (4,2)
		Kouitongouiné 2	32 (50,8)	31 (49,2)	63 (14,0)
		Douele Dimba	18 (41,9)	25 (58,1)	43 (9,5)
		Tiakeupleu	15 (45,5)	18 (54,5)	33 (7,3)
		Gouimpleu 2	11 (44,0)	14 (56,0)	25 (5,5)
		Gbangbegouiné Zélé	3 (60,0)	2 (40,0)	5 (1,1)
		Guiapleu	31 (45.6)	37 (54,4)	68 (15,1)
	Man	Botongouiné	5 (50,0)	5 (50,0)	10 (2,2)
		Guianle	7 (87,5)	1 (12,5)	8 (1,8)
		Bantegouin	8 (50,0)	8 (50,0)	16 (3,5)
		Kiélé	2 (40,0)	3 (60,0)	5 (1,1)
		Lamapleu	15 (51,7)	14 (48,3)	29 (6,4)
		Plouba	3 (60,0)	2 (4,0)	5 (1,1)
	Sangouiné	Bloleu	1 (100)	0	1 (0,2)
		Zoba	3 (75,0)	1 (25,0)	4 (0,9)
		Tiapleu	1 (50,0)	1 (50,0)	2 (0,4)
		Kpanzaopleu	1 (100)	0	01 (02)
		Guezon	6 (50,0)	6 (50,0)	12 (2,7)
Total	**6**	**22**	**230 (51,0)**	**221 (49,0)**	**451 (100)**

Table 1: Distribution of the study participants per village and sex (N = 451) in TONKPI Region Côte d'Ivoire, from March 2020 to May 2021.

Prevalence of anemic participants

Among 451 children enrolled in the study, 248 (55.0%) children were anemic while 203 (45.0%) were not as shown in Table 2. A further characterization of the observed anemia and their severity showed that 76 (30.7%) of them had a mild anemia, 164 (66.1%) had a moderate anemia while 8 (3.2%) had a severe anemia. Females (56.1%) and males (53.8%) participants are equally affected by anemia. It is also noted that anemia varies by age groups with infants aged 3 months to 2 years (66.0%) being at a higher risk of anemia than older children (3 years to 6 years (28.1 %). In addition, the majority of observed cases of anemia were moderate (66.1%) followed by the mild cases (30.7%) and 3.2% of severe cases. Details are available in Table 2.

	Tested	Anemic	% (CI à 95 %)	X2	P-value	Intensity of anemia		
						Mild	**Moderate**	**severe**
Sex								
Male	230	129	56.1 (49.4-62.6)			34 (26.4)	93 (72.0)	2 (1.6)
Female	221	119	53.8 (48.1-59.5)	0.23	0.633	42 (35.3)	71 (59.7)	6 (5.0)
Age Group								
[3M-2Y]	159	105	66.0 (58.1-73.3)			21 (20.0)	78 (74.3)	6 (5.7)
[3-5Y]	260	134	51.5 (45.3-57.8)			50 (37.3)	82 (61.2)	2 (1.5)
[6-7 Y]	32	9	28.1 (13.7-46.7)	18.42	<0.001*	5 (55.5)	4 (44.4)	0 (0.0)
Total	**451**	**248**	**55.0 (50.3-59.6)**			**76 (30.7)**	**164 (66.1)**	**8 (3.2)**

M: Month, Y: Year, X^2: Chi-2 test, P: Probability, %: Prevalence, CI: Confidence interval, and *Significant test at the threshold of 0.05.

Table 2: Prevalence and intensity of anemia by sex and age, in the western region of Côte d'Ivoire, from March 2020 to May 2021.

Distribution of the type of anemia according to sex and age

The prevalence of the characterized type of anemia according to sex and age shows no difference. Both sex as well as the different age groups are almost equally affected. The only noted variation was the high prevalence of Hypochromic microcytic anemia (78.63%) followed by the Normochromic microcytic anemia (11.69%) and Normochromic normocytic anemia (5.65%). No case of Macrocytic anemia was detected in the study (Table 3).

Type of anemia		Sex		Age Groups		
	Total (N=248)	Male (N=129)	Female (N=119)	[3M-2Y] (N=105)	[3-5Y] (N=134)	[6-7Y] (N= 9)
Hypochromic microcytic anemia	195(78.63)	102(41.13)	93 (37.50)	93 (37.50)	94 (37.90)	8 (3.23)
Normochromic microcytic anemia	29 (11.69)	17 (6.85)	12 (4.84)	7 (2.82)	22 (8.87)	0 (0.0)
Hypochromic Normocytic anemia	10 (4.03)	2 (0.81)	8 (3.23)	3 (1.21)	6 (2.42)	1 (0.40)
Normochromic normocytic anemia	14 (5.65)	8 (3.23)	6 (2.42)	2 (0.81)	12 (4.84)	0 (0.0)
Macrocytic anemia	0 (0.0)	—	—	—	—	—

M: Month, Y: Year

Table 3: Distribution of the type of anemia according to sex and age in the Western region of Côte d'Ivoire, from March 2020 to May 2021.

Discussion

This research article reports finding of an observational community-based research study conducted in children between 3 months to 6 years in twenty-two villages of the Tonkpi region in Man, Western Côte d`Ivoire. The overall prevalence of anemia is shows that more than half of the children observed are anemics. Both genders (boys compare to the girls) are equally affected though Children aged 3 months-2 years are slightly more affected compared to older children (3 to 6 years). Additionally, mild and moderate anemias

are more prevalent among the same age groups. These results are consistent with those reported in many low to middle income country (LMICs) including Côte d`Ivoire [5,6] and are far from the WHO set target goal for 2025 [7]. In fact, our results are in line with what is reported by WHO in West Africa where 51% males vs. 49% females of pre-school age children are anemic [8]. In term of severity, although the trends from mild to severe are also shared, the prevalence in our study are higher for mild and moderate anemias than WHO reported ones in West Africa i.e., in Males 8% severe anemia vs. 1.6%; 50% moderate anemia vs. 72% and 21% mild anemia vs. 26.4% while in the Females 7% severe, 48% moderate and 22% mild versus 5%, 59.7% and 35.3% in our study respectively [8].

We also noted in this study that the prevalence of anemia among children aged less than 5 years, was higher (45.3%) than the global prevalence (42.0%) [9]. Furthermore, 66.0 % of the younger children aged 3 months to 2 years in our study were anemic with the highest prevalence in term of intensity i.e., 5.7% severe and 74.3% moderate compare to the other stratified age groups. This alarming status can be explained by the fact that iron is a major factor of anemia in the first 46 months; the interval from conception of the fetus to 2 years of life is a critical window when the needs of nutrition must be ensured. If not, the child morbidity or mortality may occur [10]. In the children of 6 to < 7 years old group, we noted the highest prevalence of the mild anemia (55.5%) and the lowest prevalence of moderate (44.4%) and severe anemia (0.0%) in comparison to the others stratified age groups. This may be explained by the fact that at this age the children are most of time erranding or playing outside in various environmental settings where there is an additional food supplements such as legumes, nuts and seeds, and fruits and vegetables to be grabbed in addition to their normal shared family food. These extra micronutrients will provide them a healthy iron balance necessary to reduce their absolute deficiency in iron. In fact, as per Gupta et al., [11] Iron deficiency anemia is usually preventable and highly treatable with fortified diet or whole grains, legumes, nuts and seeds, and fruits and vegetables [11]. Similar results were reported by Righetti et al., [12] in 2012 in Côte d`Ivoire where 78.1% infants and 46.8% children were anemic with 61% mild, 32% moderate and 7% severe among the infants population versus 94.6% mild, 5.4% moderate and 0% severe in children population [12].

The consequences of anemia are well established in general and, it has several times been reported that anemia due to iron deficiency affects the intelligence of infants and children irreversibly, the rapid brain development, physical growth, and early learning capacity with a lifelong consequences on the cognition that translates to the equivalent of a 5 - 10-point deficit in intelligence quotient [10,13-18].

When the observed anemia was further characterized on the basis the mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and the mean corpuscular volume (MCV) the highest prevalence was the hypochromic microcytic anemia (78.6%) followed by the normochromic microcytic anemia (11.69%). Indeed, iron deficiency is the most common cause of microcytic and hypochromic anemia [19]. Iron deficiency anemia (IDA) is classically described as a microcytic anemia and appears when iron demand by the body is not met by iron absorption from the diet. In the majority of cases, microcytosis is the result of impaired hemoglobin synthesis. Disorders of iron metabolism and protoporphyrin and heme synthesis, as well as impaired globin synthesis, lead to defective haemoglobin production and to the generation of microcytosis and microcytic anemia [16,20]. These IDAs have previously been reported in Côte d'Ivoire by Franziska et al., in 2001 with an estimated 50% prevalence [21] as well as elsewhere in other studies [5,6,22-24].

Our study has some limitations; firstly, we did not measure serum ferritin levels to assess iron status or the reticulocyte count for confirming if the anemia is regenerative or not and secondly, the small sample size and thirdly, we did not assess the presence of other parasites that may have co-infected the same participant causing the observed anemia.

Conclusion

Based on our results, the prevalence of anemia among children aged less than 7 years is still high with the moderate hypochromic microcytic anemia being more prevalent in children under 7 years in the Western region of Côte d`Ivoire. Therefore, continued and effective efforts are needed to improve the general health of the high-risk population.

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