

**Research Article**
**Open Access**

## Research on the Correlation Between Anemia and Chronic Malnutrition in School-Age Children in Rural Areas of the Toumodi Health District in Côte d'Ivoire

BOUKALO AMON Renaude Janine<sup>1\*</sup>, ROHNER Fabian<sup>2</sup>, NIGUE Luc<sup>3</sup>, TANO AKE Sassor Odile<sup>4</sup>, DOANNIO Julien<sup>4</sup> and TIEMBRE Issaka<sup>5</sup>

<sup>1</sup>National Center for Blood Transfusion, Abidjan, Côte d'Ivoire

<sup>2</sup>GroundWork, Fläsch, Suisse

<sup>3</sup>Félix Houphouët Boigny University, Abidjan, Côte d'Ivoire

<sup>4</sup>National Institute of Public Health, Abidjan, Côte d'Ivoire

<sup>5</sup>National Institute of Public Hygiene, Abidjan Côte d'Ivoire

### ABSTRACT

**Introduction:** Anemia and chronic malnutrition are widespread in sub-Saharan Africa and constitute public health problems. This study was carried out to assess the association between chronic malnutrition and anemia in rural school-age children.

**Method:** This is a descriptive and analytical cross-sectional study carried out in the Toumodi health district in central Côte d'Ivoire. Study subjects were selected from children aged 6 to 15 years from rural school areas, according to inclusion and exclusion criteria, resulting in a sample of 588 pupils.

**The study was carried out in two stages:**

- The first step was to screen all consenting children for anemia using a Hemocue<sup>®</sup>-System.
- The second step was to collect anthropometric and biological data: the result of the presence of the malaria parasite in the blood by malaria test and the presence of helminths in the stools.

Data entry and statistical analysis were carried out using Excel and SPSS version 12.0 software respectively.

**Results:** Chronic malnutrition (weight-by-age) accounted for 22.4% of children, while the prevalence of anemia was 70.7%. The percentage of children with a positive malaria test was 57.5%. Helminths were observed in the stools of 52.8% of children. Anemia was correlated with chronic malnutrition and malaria.

Moreover, chronically malnourished children were about twice (OR = 1.81) as likely to develop anemia as those who were not.

**Conclusion:** This study revealed a strong association between chronic malnutrition and anemia.

### \*Corresponding author

Renaude Janine Amon Boukalo, National Center for Blood Transfusion, Abidjan, Côte d'Ivoire.

**Received:** July 12, 2023; **Accepted:** July 17, 2023; **Published:** July 26, 2023

**Keywords:** Anemia, Chronic Malnutrition, Malaria, Helminthiasis, School-Age Children

### Introduction

Malnutrition is a major public health problem in sub-Saharan Africa and is strongly linked to living standards [1]. Malnutrition is particularly high among pre-school children, resulting in mortality and morbidity [2]. In developing countries, an estimated 31% of children under 5 are stunted and 19% underweight [3]. Africa has higher rates of stunting and underweight, at 39% and 20%

respectively. In Côte d'Ivoire, the percentage of children under five suffering from chronic malnutrition and underweight in 2006 was 34% and 20% respectively [4]. Stunted growth during the pre-school phase is associated with later developmental delays [5]. A study on school children published by Best C et Coll. revealed that 22% were stunted and a third were anemic [6].

Malnutrition is currently defined as a multi-faceted condition that takes into account not only protein-calorie deficiency, but also micronutrient deficiency, including iron. Iron deficiency is

common in young children, as this population group has a high demand for iron for growth [7].

The consequences of iron-deficiency anemia on human health are well known; in addition to the typical clinical symptoms, anemia also causes school failure, reduced cognition, increased mortality and overall morbidity in children, as well as reduced work capacity [8].

Most studies carried out in Côte d'Ivoire show the significance of anemia and malnutrition among children, especially those under the age of five. However, data on anemia and chronic malnutrition among school-age children are scarce.

Staubli Asobayire F et al, and Rohner F et al, found significant prevalence rates of anemia and malnutrition of around 50% and 10% respectively [9,10]. However, the relationship between anemia and children's nutritional status has been poorly documented.

The aim of the present study was to gain a better understanding of the causes of anemia and its consequences, by investigating the association between malnutrition and anemia in school-age children.

**Materials and Methods**

**• Study environment and population**

The survey was carried out in December 2006 in the Toumodi health district in the elementary school of five villages: Bringakro, Taffissou, Aluiminankro, N'Dakouassikro and Gbohua. Subjects were recruited from children aged 6 to 15 attending these schools. Children who had given oral consent in addition to written parental approval were included in the study. As this cross-sectional survey was part of an intervention study, all children had been screened for moderate anemia (using the HemoCue® device two weeks prior to the survey itself), and only children who tested positive for moderate anemia were selected.

**• Type of study and procedure**

This is a cross-sectional study with a descriptive and analytical purpose. The following variables were recorded for each child using questionnaires: school, class, sex, age, weight, height, hemoglobin level, thick blood drop, stool examination for helminths.

Weight was measured on an electronic scale to an accuracy of 100 grams, and height on a vertical measuring tape to an accuracy of 0.5 centimeters. These measurements were converted into a World Health Organization z-score [11].

For biological data, hemoglobin (Hb) levels were determined from venous samples using an AcT8 Counter (Beckman Coulter, Krefeld, Germany) on the day of sampling. From whole blood, a malaria test and blood smear were taken to detect malaria parasites using the Giemsa staining method [12,13].

Two Kato-Katz thick smears were prepared for each stool sample. The slides were examined immediately after preparation under a light microscope [14].

Moderate anemia was defined as Hb > 80 and < 115 grams/Liter (g/L) in children aged 6 to 12 years, and > 80 and < 120 g/L in children aged 12 years and older [15]. Chronic global malnutrition and underweight were determined by a z-score <-2, and severe chronic malnutrition by a z-score <-3.

**• Data analysis**

Data entry and statistical analysis were carried out using EPI Data version 3.1 and Stata version SE/9.0 respectively.

The Pearson chi-square test<sup>2</sup> was used to compare proportions. The significance level of the statistical tests used was set at 5%.

**• Study limits**

Our study is drawn from the clinical trial project on cookies iron fortification conducted by the Swiss Centre for Scientific Research in Côte d'Ivoire in partnership with the National Institute of Public Health of Côte d'Ivoire.

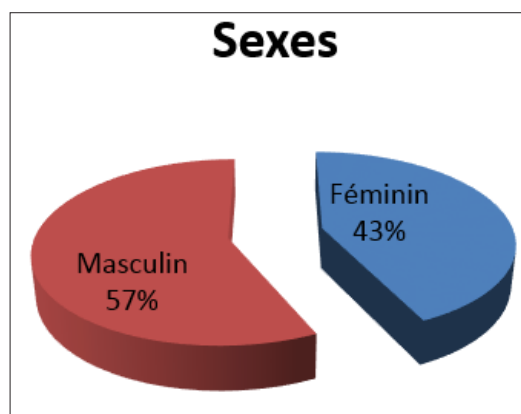
As part of this project, children were pre-selected two weeks before the trial began, on the basis of haemoglobin levels.

**• Ethical aspects**

The study was carried out in accordance to the ethical rules relating to investigations involving human beings in Côte d'Ivoire.

**Results**

A total of 588 pupils were included in the study, with a mean age of 9.8 ± 2.3 years. The children were predominantly male (57.1%), with a sex ratio of 1.3 (Figure 1).



**Figure 1:** Distribution of Children by Gender

The breakdown by place of origin and level of education is shown in Table 1.

**Table 1: Socio-Demographic Characteristics of The Survey Population**

	Headcount	Percentage (%)
<b>School</b>		
Aluiminankro	76	12,9
Bringakro	110	18,7
Gbohua	132	22,4
N'Dakouassikro	133	22,6
Taffissou	137	23,3
<b>Class</b>		
CP1	116	19,7
CP2	137	23,3
CE1	127	21,6
CE2	85	14,5
CM1	57	9,7
CM2	66	11,2

Table 2: shows the distribution of the survey population according to the results of biological and anthropometric tests:

**Table 2: Distribution of Survey Population According to Biological and Anthropometric Test Results**

	Headcount	Percentage (%)
<b>Anemia</b>		
yes	410	70.7
no	170	29.3
<b>Malaria test</b>		
Positive	330	56.9
Negative	250	43.1
<b>Helminths</b>		
yes	318	54.9
non	261	45.1
<b>Chronic global malnutrition</b>		
yes	110	22.4
no	382	77.6

The mean hemoglobin level was  $111.4 \pm 10.0$  g/L (table 2); anemia was found in 70.7% (95% confidence interval [CI] 67.0-74.4) of them, and 56.9% had a positive thick drop (95% CI 52.9-60.9). Stool helminths were found in 54.9% of children (95% CI 50.9-59.0).

In the study population, 22.4% of children had chronic global malnutrition.

Table 3: shows the correlation of malaria, helminths and chronic malnutrition with anemia using Pearson's  $\chi^2$  test:

Anemia is associated with chronic malnutrition (Pearson's  $\chi^2= 5.480$ ;  $p = 0.019$ ).

Anemia is correlated with malaria (Pearson's  $\chi^2= 9.016$ ;  $p=0.003$ ).

**Table 3: Relationship Between Anemia and Parasitological and Anthropometric Results**

	Anemia				p
	No		Yes		
	Headcount	Percentage	Headcount	Percentage	
<b>Helminths</b> (Pearson's $\chi^2 = 2.994$ )					
No	65	27,0	176	73,0	>0,05
Yes	89	34,1	172	65,9	
<b>Malaria test</b> (Pearson's $\chi^2 = 9.016$ )					
negative	81	38,0	132	62,0	0,003
positive	74	25,5	216	74,5	
<b>Chronic malnutrition</b> (Pearson $\chi^2= 5.480$ )					
no	130	33,5	258	66,5	0,019
yes	24	21,8	86	78,2	

The analysis of chronic malnutrition as a risk factor for anemia is presented in table 4. Children with chronic malnutrition were about twice as likely (OR = 1.81) to develop anemia as those without.

**Table 4 : Association between anaemia and chronic malnutrition**

Variable	Odds ratio	IC95%	p-value
<b>Chronic malnutrition</b>			
Yes	1,81	1,10-2,97	
No	1,00	-	0,019

## Discussion

In Côte d'Ivoire, the causes of anemia in school-age children have not been extensively researched. The few studies that have looked into the subject have found that only half of all anemias are due to iron deficiency [9, 10]. Other studies, on the other hand, have cross-referenced anemia with the morphological characteristics of

erythrocytes (hypochromic, microcytic, etc.) and found a strong association between hypochromia and microcytosis with anemia [16]. The aim of our study was not to provide an estimate of the nutritional and health status of school-age children, but to investigate the relationship between anemia and chronic malnutrition, malaria and helminthiasis.

In this regard, the rate of malaria and helminth parasitaemia is comparable to, and even slightly lower than, the results revealed in a survey carried out in the Agnéby region of southern Côte d'Ivoire: Yapi et al. found a helminth prevalence of 68% among schoolchildren [16], while with regard to malaria, the Toumodi District annual report in 2005 reported a prevalence rate of 63% among school-age children.

Concerning the anthropometric results, the frequency of chronic malnutrition or stunting increased with age. This is due to the fact that, after the age of two, there is little chance of any intervention improving growth; thus, stunted growth acquired at an early age can hardly be recovered.

The relationship between anemia and chronic malnutrition shows that anemic children are twice as likely to be stunted (chronically malnourished) as non-anemic children. In fact, chronic malnutrition results from a long-term unfavorable nutritional situation, as well as from repeated infections. Thus, infections accompanied by anorexia and a consequent drop in food intake, both quantitative and qualitative, can be responsible for stunted growth, which in time can lead to anemia. A diet that is poor in micronutrients (iron, vitamin A, calcium, zinc) and macronutrients (protein, lipids, carbohydrates) has an impact not only on the child's stature (stunted growth), but also on the clinical state, manifested by certain syndromes, including anemia.

### Conclusion

Chronic malnutrition and anemia among rural schoolchildren in the Toumodi Health District are closely linked. It would therefore be necessary to insist on nutritional education of the population for a healthy and balanced diet, but also on hygiene and environmental sanitation measures to reduce anemia.

### References

1. Gwatkin DR, Rutstein S, Johnson K, Suliman E, Wagstaff A, et al. (2007) Socio-economic differences in health, nutrition, and population within developing countries - an overview. In: *Country reports on HNP and poverty*. Edited by The World Bank. Washington: The World Bank 10: 1-301.
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, de Onis M, et al. (2008) Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 371: 243-260.
3. ACC/SCN (2010) Sixth Report on the World Nutrition Situation. In. Geneva: UN ACC/SCN [https://www.unscn.org/files/Publications/RWNS6/report/SCN\\_report.pdf](https://www.unscn.org/files/Publications/RWNS6/report/SCN_report.pdf).
4. National Institute of Statistics, UNICEF (2006) Côte d'Ivoire, 2006 - Multiple Indicator Cluster Survey 3 ([http://www.childinfo.org/mics3\\_surveys.html](http://www.childinfo.org/mics3_surveys.html)). In Abidjan, Côte d'Ivoire <https://www.unicef.org/northmacedonia/reports/multiple-indicator-cluster-survey-2005-2006>.
5. Berkman DS, Lescano AG, Gilman RH, Lopez SL, Black MM (2002) Effects of stunting, diarrhoeal disease, and parasitic infection during infancy on cognition in late childhood: a follow-up study. *Lancet* 359: 564-571.
6. Best C, Neufingerl N, van Geel L, van den Briel T, Osendarp S (2010) The nutritional status of school-aged children: why should we care? *Food Nutr Bull* 31: 400-417.
7. Allen L, Casterline-Sabel J (2001) Prevalence and causes of nutritional anemias. In: *Nutritional anemias*. Edited by Ramakrishnan U: CRC Press 7-21. <https://www.taylorfrancis.com/chapters/mono/10.1201/9781420036787-7/prevalence-causes-nutritional-anemias-usha-ramakrishnan>.
8. Boccio JR, Iyengar V (2003) Iron deficiency: causes, consequences, and strategies to overcome this nutritional problem. *Biol Trace Elem Res* 94: 1-32.
9. Staubli Asobayire F, Adou P, Davidsson L, Cook JD, Hurrell RF (2001) Prevalence of iron deficiency with and without concurrent anemia in population groups with high prevalences of malaria and other infections: a study in Cote d'Ivoire. *Am J Clin Nutr* 74: 776-782.
10. Rohner F, Zimmermann MB, Wegmueller R, Tschannen AB, Hurrell RF (2007) Mild riboflavin deficiency is highly prevalent in school-age children but does not increase risk for anaemia in Cote d'Ivoire. *Br J Nutr* 97: 970-976.
11. WHO Multicentre Growth Reference Study Group (2006) WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr Suppl* 450: 76-85.
12. WHO (1990) *Diagnosis of malaria*. Geneva: PAHO Scientific Publication, No 512. <https://www.amazon.in/Diagnosis-Malaria-PAHO-Scientific-Publications/dp/9275115125>.
13. Rohner F, Zimmermann MB, Amon RJ, Vounatsou P, Tschannen AB, et al. (2010) In a randomized controlled trial of iron fortification, anthelmintic treatment, and intermittent preventive treatment of malaria for anemia control in Ivorian children, only anthelmintic treatment shows modest benefit. *J Nutr* 140: 635-641.
14. Katz N, Chaves A, Pellegrino J (1972) A simple device for quantitative stool thick-smear technique in schistosomiasis mansoni. *Rev Inst Med Trop Sao Paulo* 1972: 397-400.
15. WHO/UNICEF/UNU (2001) *Iron deficiency anaemia. Assessment, prevention and control. A guide for programme managers*. Geneva: WHO/NHD/01.3 <https://www.who.int/publications/m/item/iron-children-6to23--archived-iron-deficiency-anaemia-assessment-prevention-and-control>.
16. Yapi HF, Ahiboh H, Monnet D, Yapo AE (2005) Intestinal parasites, haematological profile and anthropometric status of schoolchildren in Cote d'Ivoire. *Sante* 15: 17-21.

**Copyright:** ©2023 Renaude Janine Amon Boukalo. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.