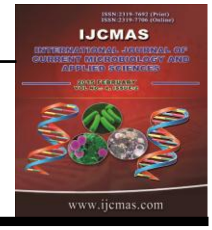

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Original Research Article

Risk factors of anemia among young children in rural Cameroon

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A B S T R A C T

In Cameroon, as in most developing countries, anemia is a public health problem. In young children, this trouble has deleterious consequences on the global health and a weak cognitive development. Young children status in rural area is poorly investigated. The objective of study was to determine biological, nutritional, and socioeconomic risk factors for anemia in this vulnerable age group. A cross sectional study was conducted among children aged 0 to 24 months in six pilot health centers in Bangang rural community. Hemoglobin, serum iron, total iron binding capacity, transferrin saturation, ferritin and C reactive protein levels were determined. A questionnaire was developed to obtain information on the socioeconomic and demographic status of the family, anthropometrics measures and nutritional intake were recorded. Anemia was detected in 66.67 % of the 177 children sampled and iron deficiency was found in 51.41 %. The mean hemoglobin concentration was 10.59 g/dl in boys and 10.46 g/dl in girls, whereas the mean ferritin level was 25.87µg/l in girls and 32.61µg/l in boys. Moreover, we observed a highly significant association ($p < 0.01$) between hemoglobin level and other biological parameters. There was a significant relationship between lower maternal breastfeeding, lower maternal schooling, number of children and anemia among young children ($p < 0.05$). Hemoglobin level was primarily associated with iron status in these rural Cameroonian children. However, maternal breastfeeding, maternal schooling and food insecurity were also important factors. Deeper knowledge about the etiology and nutritional risk factors for anemia in this vulnerable age group is essential to its proper treatment and prevention.

Keywords

Anemia,
Iron deficiency,
Young children,
Cameroon

Introduction

Anemia is considered the most prevalent nutritional deficiency globally, affecting about a quarter of the world population, especially children and women of reproductive age [1,2]. In children, anemia can negatively affect cognitive development, school performance, physical growth, and immunity [3,4]. The prevalence of anemia in the world is 24.8 % [5]. The preschool children are most affected with a prevalence of 47.4 %, followed by pregnant women (41.8 %), non-pregnant women (30.2 %) and school age children (25.4 %). In each age group and sex studied, the highest prevalence is found in Africa [5,6], with a global frequency of 64.6 % in the preschool children and 55.8 % at the pregnant women. The demographic, and Health Surveys in Cameroon [7], reported that 60 % of children aged 6 to 59 months were anemic.

Iron deficiency is believed to be the most important cause of anemia among children and is attributable to poor nutritional iron intake and low iron bioavailability [8]. Others factors, including folate and vitamin A deficiencies, malaria infection [9], hookworm infestation are also associated with childhood [10]. This is the disturbance of physical and mental development often irreversible in infants and children, of least resistance to infections, tiredness and decreased physical and intellectual abilities [11]. Beyond the age of 24 months in rural area in Cameroon, there is very little information on child anemia [12]. Despite the multiple consequences of this disease, few investigations are conducted among young children in rural area in Cameroon.

Most studies were focalized in the characterization of anemia and malaria in urban area [10-13]. This study was undertaken to estimate the prevalence of anemia and iron deficiency among young children in Bangang rural community and to determine the various factors associated with anemia in this population.

Materials and methods

Bangang community in the West Region of Cameroon covers an area of 185 Km^2 and is located on the longitude 12°7' 59' East and the latitude 5°24'0''North. It has a tropical rainy grass field and savannah forest vegetation, humid climate with a population of 250 000 inhabitants. Bangang is one of the rural parts of Batcham council, department of Bamboutos. The major occupation of the local population is farming. They produce most of the food consumed in the whole council.

This study was conducted in six pilot health centers in Bangang health district, namely: Batsintsuet, Bamboue, Baletia, Zemezong, Nzong and King Place (Bangang District Medical Center). Children were recruited for this study with parents consent. The collection of anthropometric data of this study was done from a questionnaire sent to the parents and the informed consent of parents following an explanation of the interest of the study. The socio economic status was defined by the following parameters: the mother educational status, the number of family members and the working status of the mothers. Information on continued and previous breastfeeding practices was obtained with specific questions about whether the child was currently breastfeeding, the duration of exclusive breastfeeding, and the child's age at introduction of complementary foods and age at breastfeeding cessation.

The dietary survey was conducted among the children. Through the questionnaire designed for this purpose, the methods of 24 hours recall, three days weighed food records and dietary history were used to determine dietary habits, the type of food and the usual frequency of consumption of food during a week. Food intakes of children was quantified by using household weighing measuring tools, such as standard measuring cups and spoons, ruler for measuring dimensions. We determined the child's daily intake of food items by weighing their meal before an after each meal.

Body size and growth were assessed through height and weight measurements. Each child's length and weight were measured. Height for age, weight for age, and weight for length were calculated. For these variables, results with z-scores less than -2 were defined as stunting, underweight and wasting, respectively in accordance with the 2012 DHS and WHO child growth standards [14,15].

Children underwent field estimation of capillary hemoglobin level (HemoCue, Angelholm, Sweden). Venous blood (3 mL) was drawn from each child, processed appropriately in the primary health center laboratory within 6 hours of collection, and then packed with ice and transported to the reference laboratory. Samples were analyzed within 48 hours of collection. Laboratory assays were performed as follows: automated complete blood examination URIT 12 Hemoglobinometer (used only for hemoglobin estimation); serum ferritin, transferrin and C reactive protein CRP ([immunoturbidimetric assay], reagents from Biorex diagnostics, [United Kingdom]), serum iron ([colorimetric enzymatic ferene method], reagent from SGMitalia, [Roma, Italia]).

Children with hemoglobin levels < 11.0 g/dl or 14.5 g/dl for infants were considered anemic. The severity of anemia was classified as severe (Hb <7.0 g/dl), moderate (7.0 < Hb ≤ 10.0 g/dl) and mild (10 < Hb < 11g/dl), depending on the hemoglobin value of anemic children. Iron deficiency was defined as plasma ferritin level < 12 µg/L or serum ferritin 20-50µg/L, plus two abnormal values in the following three biochemical parameters: serum iron < 11 µmol/L, total iron binding capacity > 72 µmol/L, transferrin saturation < 16 % or C reactive protein > 5mg/L. Anemia, iron depletion, iron deficiency and iron deficiency anemia were defined according to World Health Organization criteria [4, 5].

Statistical analyses

For statistical analysis, data were analyzed by the Statistical Package for the Social Science (SPSS) version 17. The Chi^2 test and logistic regression analysis were used to investigate the relationship between the prevalence of anemia and the socio demographic factors. The software ENA for Smart 2007 was used to calculate anthropometric index. Differences were considered statistically significant at a p value ≤ 0.05.

Ethical approval

Experimental procedures and protocols used in this study were approved by the National ethics committee of Cameroon and Regional health office. Informed, signed consent to participate in the study was obtained from all participating mothers or caregivers.

Results and Discussion

The distribution of risk factors for anemia between the anemic and non-anemic children is shown in table 1. The findings demonstrate that 45.20 % (80 cases) were boys and 54.80 % (97 cases) girls. Female had a slightly higher risk of presenting anemia than male. The risk of anemia decreased with increasing age of the child, progressively lowering with each age group.

Mother's education showed a similar pattern, with lower risk among children whose mothers had attended a secondary level education (p < 0.05). It appeared that 22.59 % of mothers were active workers. The prevalence of anemia among children whose mothers had a remunerous jobs were 72.50%. Comparatively, the prevalence proportions of anemia in children whose mothers were unemployed were 64.96 %. But no significant ($p > 0.05$) relationship exist between these 2 groups.

Considering the variables related to household composition and number of children, we observed that children were more prone to have anemia if they lived in households with more than five residents. The prevalence of anemia among children whose mothers had less than five children was 60.95 % while for those with more than five children was 75 %.

Others hands, children whose mothers had stopped breastfeeding at the time of study, presented a prevalence of anemia greater ($p < 0.05$) than those whose mothers were still breastfed. However, in this community exclusive breastfeeding is rare. With regard to indicators of nutritional status, anthropometric deficits measured in terms of weight for age, height forage, and weight for height increased the prevalence of anemia.

The mean values of the different iron status parameters in children are presented in table 2. It was observed that all the parameters did not indicate the significant differences between girls and boys ($p > 0.05$). These values were in accordance with the normal physiological references values from the literature except for the rate of hemoglobin (10.52 ± 2.21g/dL) which is lower overall and by sex. Furthermore, mean of iron status is low in male than female. In contrast, mean ferritin and mean of total iron binding protein were higher in male compared to female (32.61 ± 4.09 µg/L and 25.87 ± 3.14 µg/L and 57.08 ± 4.25 µmol/L and 54.05 ± 4.51 µmol/L respectively).

The mean nutritional intake for children is shown in table 3. Mean iron intake from non-breast milk sources consumed during the previous 24 hours was 0.67 mg for infants aged 3 to 4 months which was 67 % of the recommended daily intake for children. Mean daily iron intake of the children was above 50 % for all the children. However their daily zinc and energy intakes were below the daily requirement values.

The overall prevalence of anemia was 66.67 % (table 4). Among these children, 5.08 %, 22.60 % and 36.16 % respectively suffering from severe, moderate and mild anemia. In addition, iron deficiency and iron deficiency anemia were found respectively in 51.41% and 38.8% of the young children.

Table 5 shows that serum ferritin, serum iron concentrations, total iron binding capacity, C reactive protein and transferrin saturation were highly significant associated to hemoglobin level ($p < 0.01$). Anemia was positively associated with maternal education level, breastfeeding, number of children and iron intake ($p < 0.05$).

This work helps to design appropriate minotoring in order to avoid the early onset of anemia among young children in rural area in Cameroon. The present results confirmed the high prevalence of anemia in Cameroon with no significance difference between two sexes. This rate is comparable to the national prevalence reported by The Ministry of Health in 2011 and 2012 [7,16], where the prevalence of anemia among preschool children was 60 % and 57 % among children aged 1 to 59 months. Anemia in this population of children was 27 % mild, 31% moderate and 2 % severe. In addition, the study shows that anemia principally iron deficiency is a reality among young children in this community. Hemoglobin levels in children were primarily related to iron stores.

These different rates are similar to those obtained among young children in rural India [17] and among indigenous children in Brazil [1]. According to the first author India, the prevalence of anemia among young children was 75.3 %. The results of the second authors reveal that 51.2% of indigenous children less than 5 years age in Brazil and approximately one sixth presented moderate/severe anemia (16.4%). Others studies reported the same results on a similar population of children aged 0 to 60 months in Cameroon [9, 18, 19].

The prevalence of anemia in the study population was 66.67 %. Conversely, this rate is higher than that obtained in Morocco in children aged 6 to 16 years (12.2 %) [20], 30.3 % among children aged 5 to 11 years in school canteens in Abidjan [21]. In comparison with our results, others studies reported the same prevalence of anemia among the school children [22, 23]. These findings suggest that the prevalence of anemia in our study is higher than those reported from elsewhere. It could be explained by the fact that the study was extended to the rural population with different demographic characteristics from those of these subjects, the socioeconomic and cultural developments of children in each study areas.

The observed association but non-significant between child's age and anemia in our findings and has been reported in several other studies worldwide [24]. Children under two years of age experience high rates of growth, which increases the demand for micronutrients such as iron and vitamins. The introduction of foods with low iron levels during foods transition and elevated frequencies of infectious and parasitic diseases among young children, are also important factors in determining childhood anemia [17-25].

However, the relationship between child's sex and anemia is less consistent, with some studies indicating associations between these variables [1] and others not [25].The results of our survey revealed an association but no significant between sex and anemia in rural young children with greater risk among girls, although the difference was small.

Hemoglobin level of infants is strongly linked to the maternal hemoglobin [17-26]. For instance, antenatal anemia contributes to low birth weight and prematurity, both of which increase the risk of childhood anemia. Severe maternal anemia may also reduce breast milk iron content [17-27]. The results of our study highlight important associations of children less than 12 months with anemia. In this population, exclusive breastfeeding is very rare. Mothers and children most often share a home environment, which involves mutual exposure to a common set of physical, socioeconomic and dietary conditions [1-11]. Maternal iron deficiency is associated with low birth weight and prematurity [26-28] and there is evidence that even children born with adequate weight have diminished iron reserves when their mothers are anemic. Anemic children tend to start school later progress less rapidly, have lower attainments, and perform less well on cognitive achievement tests, even into adulthood [5-12].

With regard to socioeconomic characteristics, the findings reveals that both maternal schooling and number of children which are often considered linked to family income, were shown to be protective factors for the occurrence of anemia in young children. Lack of knowledge of mothers can explain the high rate of anemia observed in this community among young children with primary education level of mothers [19].

High prevalence of stunting and anemia was observed in young children in this rural community. It is reported that malnutrition [29,30] is very harmful the first 1000 days of life and most of the consequences are irreversible and will negatively influence cognitive, psychomotor and brain growth of children until their adulthood. This age indicates nutrition transition [12] and probably inappropriate breastfeeding and complementary feeding practices. Nutritional status of young children is affected by a common set of factors, including socioeconomic status, sanitation, infectious and parasitic diseases, and diet. With regard to diet, protein energy malnutrition favors the development of anemia through a synergistic relationship. Moreover, low hemoglobin levels have been implicated in compromising linear growth [28]. The association between these anthropometric index and anemia has also been observed in several other studies [30].

Concerning the mean value of hemoglobin obtained in the case of this study is similar to that indicated in a rural population of preschool children in Ebolowa in southern Cameroon (10.76 g/dl) [31], and in preschool children in the region of Kenitra, Morocco (10.00 g/dl) [19] where the mean of haemoglobin is lower than established standards. We observed a highly significant association between hemoglobin level and other biological parameters suggesting that iron status was likely to be an important determinant of hemoglobin and hence anemia. The risk of iron deficiency anemia may thus depend on complex interactions between dietary iron content (type of diet), iron bioavailability (duration of breastfeeding and appropriate complementary feeding practices), increased iron use (growth velocity and erythroid mass expansion), and inappropriate iron losses (infection and infestation) [17].

Approximately anemia appeared related to a nutrient deficiency, with more than half the subjects in this category deficient in iron, either alone or in combination with vitamins deficiency [32]. The data revealed that mean daily intake above 50 % for all slices age (months). Surprisingly, the prevalence iron deficiency was 51.41 % among these children. Iron deficiency is due to inadequate intake or malabsorption of dietary iron. The adequacy of dietary iron depends on the intake and the bioavailability, which in turn are contingent to the nature of the food and the composition of the overall diet. In developing countries, the amount of iron in the diet is usually enough to cover body needs, because it is mainly provided by plant (cereals, tubers) based food in the form of non heme iron, its bioavailability is very low [33]. The low iron content of breast milk, the lack of other iron rich food, and the age related increase in iron requirements predispose young children to the depletion of iron stores that occurs at approximately one year of age. In addition, the major components of the diet in young children in Bangang are maize, irish potatoes, red and black beans, leafy vegetables, red palm oil and groundnuts which are not favorable for iron absorption and which contain inhibitors of iron absorption as compared with meat or fish [31].

This result is not surprising since iron deficiency is common in African children in the second year of life, and this has been related to inappropriate complementary feeding practices [31]. Iron deficiency is generally assumed to be the major cause of anemia globally [1]. However, besides iron deficiency, others factors that may cause or be associated with anemia include nutritional deficiencies involving other micronutrients (folate, vitamin A, and vitamin B12), infectious and parasitic diseases (diarrhea, malaria, and geohelminthosis), glucose-6-phosphate dehydrogenase deficiency, and genetically derived hemoglobinopathies [24-32].

In conclusion, anemia an important problem worldwide is increasing among young children in Bangang and requires urgent attention. Our findings suggest that current public health strategies such as combining iron supplementation and the development of a nutrition program based on locally available foods in this locality are necessary to reduce childhood anemia and improvement of children's hemoglobin levels.

Table.1 Prevalence of anemia by socio-economic and demographic characteristics and others determinants

Parameters	Overall n (%)	Anemic n (%)	χ^2	p
Sex				
Girls	97 (54.80)	65 (67.01)	0.01	NS
Boys	80 (45.20)	53 (66.25)		
Age (months)				
< 12 months	85 (48.02)	74 (87.05)	30.6	< 0.0001**
≥ 12 months	92 (51.97)	44 (47.82)		
Mother's education				
Primary	86 (48.59)	64 (74.42)	4.52	0.03*
Secondary	91 (51.41)	54 (59.34)		
Mother's working status				
Yes	40 (22.59)	29 (72.50)	0.79	NS
Non	137 (77.40)	89 (64.96)		
N° of children				
≤ 5	125 (70.62)	82 (65,60)	0.22	NS
> 5	52 (29.37)	36 (69.23)		
Still breastfeeding				
Non	85 (48.02)	63 (74.11)	4.09	0.04*
Yes	92 (51.97)	55 (59.78)		
Underweight				
Yes	27 (15.25)	17 (62.96)	0.20	NS
Non	150 (84.74)	101 (67.33)		
Stunting				
Yes	81 (45.76)	49 (60.49)	2.56	NS
Non	96 (54.23)	69 (71.88)		
Wasting				
Yes	09 (5.08)	03 (33.33)	-	NS
Non	168 (94.92)	115 (68.45)		

* P < 0.05 significance level; ** P<0.01 high significance level; NS: Non-significant difference.

Table.2 Mean values of iron status parameters in young children

Parameters	Overall	Girls	Boys	p value	References values
Hemoglobin (g/dl)	10.52 ± 2.21	10.46 ± 2,18	10.59 ± 2.25	(NS)	11-14.5; 14.5-22
Serum iron (µmol/l)	11.06 ± 0.59	11.70 ± 0.92	10.33 ± 0.69	(NS)	11-23
Ferritin (µg/l)	28.62 ± 2.51	25.87 ± 3.14	32.61 ± 4.09	(NS)	12-140
Total iron binding capacity (µmol/L)	55,66 ± 3,08	54,05 ± 4,51	57,08 ± 4,25	(NS)	45-72
Transferrin saturation (%)	21,08 ± 1,34	21,26 ± 1,92	20,92 ± 1,89	(NS)	16-40

Table.3 Mean nutrient intake from non-breast milk sources during the previous 24 hours

Nutrients/Age	Age (months)	Iron mg/24h	Zinc mg/24h	Energy Kcal/24h
Mean daily intake		0.17	0.27	185.64
RDI	3-4	0.27	5	700
Mean intake % RDI		62.96	5.40	26.52
Mean daily intake		0.43	1.31	344.40
RDI	5-6	0.27	5	700
Mean intake % RDI		159.25	26.20	49.20
Mean daily intake		2.40	1.43	381.58
RDI	7-8	11	5	810
Mean intake % RDI		21.82	28.60	47.11
Mean daily intake		2.61	1.88	427.48
RDI	9-10	11	5	950
Mean intake % RDI		23.73	37.60	45.00
Mean daily intake		3.29	1.93	496.84
RDI	11-24	11	5	1150
Mean intake % RDI		29,91	38.6	43.20

RDI: Recommended daily intake

Table.4 Anemia, iron deficiency and iron deficiency anemia

Indicators	Overall	Girls	Boys	p value
% of anemia	118 (66.67)	65 (36.72)	53 (29.94)	NS
% of severe anemia	09 (5.08)	05 (2.82)	04 (2.26)	NS
% of moderate anemia	54 (30.51)	29 (16.38)	25 (14.12)	NS
% of mild anemia	20 (11.29)	19 (10.73)	39 (22.02)	NS
% of iron deficiency	91 (51.41)	45 (25.42)	46 (25.99)	NS
% of iron deficiency anemia	69 (38.98)	36 (20.34)	33 (18.64)	NS

NS: Non-significant, ($p > 0.05$).

Table.5 Regression coefficients between hemoglobin level and conditions in the child

Factors	Coefficient (95% CI)	p
Serum iron	-0.18 (1.06 to 1.35)	< 0.01
Ferritin	-0,38 (-0.62 to -0.13)	< 0.01
Total iron binding capacity	0.16 (0.08 to 0.23)	< 0.01
Transferrin Saturation	-0.05 (-2.01 to 0.093)	< 0.01
C reactive protein	0.113 (0.12 to 0.25)	< 0.01
Length for age, z-score	0.099 (-0.050 to 0.244)	0.19
Weight for age, z-score	0.104 (-0.045 to 0.248)	0.17
Weight for length, z-score	0.050 (-0.096 to 0.202)	0.48
Maternal education	0.06 (0.02 to 0.09)	0.03
Child still breastfeeding	0.186 (0.05 to 0.27)	0.01
Number of children	0.173 (0.026 to 0.313)	0.02
Age of children	0.086 (-0.062 to 0.231)	0.25
Gender	0.029 (-0.119 to 0.176)	0.70
Iron intake	0.454 (0.178 to 0.732)	0.01
Zinc intake	-0.223 (-0.157 to 0.067)	0.02
Energy intake	-0.239 (-0.195 to 0.045)	0.02

* P < 0.05 significance level; ** P<0.01 high significance level

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