Research Article

# Nutrition Intervention among Children under 24 months suffering from Iron Deficiency Anemia in rural Cameroon

**Marlyne Josephine Mananga[1,2*], Kana Sop Marie[2], Nolla Nicolas[2], Tetanye Ekoe[3] Gouado Inocent[2]**

[1]Department of Biochemistry, Faculty of Science, University of Yaoundé I, Cameroon

[2]Department of Biochemistry, Faculty of Science, University of Douala, Cameroon

[3]Faculty of Medicine and Biomedical Sciences, University of Yaoundé I, Cameroon

[*]**Corresponding Author:** Marlyne-Josephine Mananga Ph.D, Senior Lecturer, Faculty of Science University of Yaounde I, PO Box: 812, Yaoundé, Cameroon

**Received:** 30 January 2021; **Accepted:** 29 March 2021; **Published:** 30 March 2021

**Citation:** Marlyne-Josephine Mananga, Kana Sop Marie, Nolla Nicolas, Tetanye Ekoe and Gouado Inocent. Nutrition Intervention among Children under 24 months suffering from Iron Deficiency Anemia in rural Cameroon. Journal of Food Science and Nutrition Research 4 (2021): 037-049.

## Abstract

Almost 63% of young children living in Cameroon are anemic. However, young children in rural area are most affected. Current policy recommends the need to combine several strategies to reduce the burden of anemia in rural areas. A 20-week nutrition intervention program consisting of 4 weeks of nutrition education and 16 weeks of iron supplementation was carried out in 50 Cameroonian children aged 6-23 months in rural area, with mild iron deficiency anemia (IDA). Participants were distributed randomly by drawing lots into intervention and control groups with 25 participants in each group. A nutrition knowledge questionnaire, anthropometric measurements, hemoglobin (Hb) level, serum ferritin (SF), serum iron and iron status biomarkers were obtained in both groups before and after nutrition intervention. At the end of the study, the mothers of intervention group had greater knowledge on iron, IDA and dietary strategies to reduce IDA in children. Concerning anthropometric parameters, there were no significant differences in the weight/age, height/age and weight/height ($p>0.05$) before and after the intervention in both groups. At the end of nutrition intervention, a significant gain in Hb level was found in the both groups but significant difference was observed in the intervention group (10.63±0.18 and 11.46±0.19g/L; $p=0.0001$). However, the SF and serum iron were significantly lower in the control group compared to the intervention group (18.89±7.54 µg/L vs 28.93±5.81 µg/L; $p=0.03$) and (11.46±1.02 µg/L vs 19.65±0.78 µg/L; $p=0.01$) respectively. Iron status has improved in the both group. The incidence of anemia (28% and 76%; p=0.0007), iron deficiency (56% and 68%; p>0.05) and iron deficiency anemia (32% and 64%; p=0.02) was significantly lower in the intervention group compared to the control group. The study findings showed that, nutrition education combined with iron supplementation impact positively on the iron status of young children. It is therefore important to educate mothers or caregivers about good nutrition in addition to with others strategies.

**Key words:** Nutrition education; Iron supplementation; Iron status biomarkers; Children

## 1. Introduction

Childhood anemia is a condition where a child has an insufficient hemoglobin (Hb) level to provide adequate oxygen to the body tissues. For children between 6 and 59 months the threshold Hb level for being nonanemic is 11.0g/dL [1]. Moreover, absorbable iron intakes are highly and positively associated with hemoglobin concentrations. In children, anemia can negatively affect cognitive development, school performance, physical growth, and immunity. Some studies have found that the daily iron intake of children is generally poor, since most of their foods are of plant source whose nutrients are poorly bioavailable (cereals products and tubers) [2-11].

Iron is an essential micronutrient necessary for the transportation of respiratory gases via hemoglobin in the red blood cells. Iron also intervenes in the constitution of enzymatic systems such as catalases, peroxydases and cytochromes that play an essential role in cellular respiratory mechanisms in mitochondrial respiratory channel [6]. In addition, one major cause of anemia is iron deficiency (ID). The risk factors for anemia are multifaceted including malaria, renal disease, and nutritional deficiency. Studies also showed that schistosomiasis infection, hookworm infection, inherited disorders, diarrhea, and fever in 6-59-month old children are associated with risk of developing anemia [1,3]. ID is the most prevalent hematologic disorder in childhood which affects approximately two billion people worldwide; of these, about 500 million have anemia [3,9]. According to the World Health Organization (WHO) report in 2016, anemia remains the most common hematologic manifestation of iron deficiency [34]. Globally, around 1.62 billion people are affected by anemia, which accounts more than 24.8% of the world's population, of which 30 to 50% is caused by iron deficiency [4]. IDA resulted 273000 deaths in the world in which year and 97% of these deaths occurred in developing countries [4]. The demographic and Health Survey in Cameroon in which year? (EDS-MICS), reported that 60% of children aged 6 to 59 months were anemic. In the rural areas, 69% of children under 59 months are anemic [5].

The Sustainable Development Goals (SDGs) established by the United Nations has a major of improving community nutrition by 2030 by addressing malnutrition problems. Some indicators of the program are to reduce the prevalence of micronutrients deficiency among children under five years old [8]. In agreement with the SDGs and the initiatives taken by the Cameroonian government to reduce micronutrients deficiencies, a nutrition intervention is required urgently.

Although the diets of young children in Cameroon are typically low in iron, sources of bioavailable iron, fruits and vegetables, are available throughout the year [10]. Thus, dietary modifications to improve iron status using nutrition education of mothers and caregivers are possible. Nutrition education is an important component of strategies to reduce iron deficiency. It aims to generally improve nutritional status by adopting better eating habits, improving food hygiene and making efficient use of available food [12,13]. Improvement in nutritional knowledge has a positive impact on the behavior of individuals, and therefore their nutritional status [14]. In Iran, nutrition education has succeeded in increasing the production and consumption of protein-rich foods among the families and an entire village [15].

In Cameroon, many nutrition interventions are focused in the food diversification and food supplementation [16-18]. To the best of our knowledge, no research has been carried out to investigate the impact of a nutrition education program combined with supplementation of bioavailable iron to treat iron deficiency anemia in rural Cameroon. Therefore, this research was aimed at determining the effect of nutrition education program combined with iron supplementation in young children (6-23 months) in rural community in West Cameroon.

## 2. Materials and Methods

### 2.1 Study site

This study was conducted at Bangang community, in the West region of Cameroon. Bangang 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. It is one of the rural parts of Batcham council, Department of Bamboutos [5]. The purpose of choosing this rural community is that, the inhabitants are predominantly farmers and they primarily produce majority of the food (legumes, vegetables, animals products) consumed in the whole council.

### 2.2 Procedures

***2.2.1 Sampling procedure:*** A previous survey on iron deficiency epidemiology has been conducted among 177 children living in this rural community [5]. This first step of the nutrition intervention was to determine the nutritional and iron status of the children of this community. Following this screening, all children with anemia were listed and classified according to the different degrees of anemia [19-21]. Among these children, 50 (6-23 months old) were suffering from IDA and were selected to participate in our nutrition intervention program aimed at improving their iron status and consequently reducing the prevalence of anemia. The children were distributed by drawing lots in 2 lots. The distribution in the groups has been done in the following way. We had balls of two different colors black and white. The white color represented the control group and the black color the intervention group. Each mother therefore had to choose a color of ball inside the box which indicates to which group she should belong. After the selection, these children were divided in two groups: 25 children were in the control group and 25 others in the intervention group. For the study, all the children selected were treated initially with an anti-helminthic syrup (Vermox Mebendazole) and anti-malarial suspension.

### 2.3 Nutrition education program

Nutrition education took place at the Bangang District Medical Center over 4 weeks and 16 weeks of iron supplementation. Mothers of children of control and intervention group both groups received 4 weeks of nutrition education lessons. Before the nutrition education program, we had test the knowledge of mothers on anemia, iron rich foods, breastfeeding and dietary diversification practices. The educators were the principal investigators assisted by a nurse from the center for translation into Nguiembon (local language) when necessary. After this test, mothers of the selected children received approximatively 1 hour of lessons per week for 4 weeks. These lessons were developed using standards of food practices, product identification and determination of food that were inexpensive and rich in iron and other micronutrients [21] and data drawn from the literature on food composition locally available [19,20]. The nutrition education was structured into four lessons. Lesson 1: Anemia, definition, prevalence and symptoms and iron function; lesson 2: Main sources of iron, types and bioavailability in food; lesson 3: Dietary strategies to increase iron status; Lesson 4: Motivational session to encourage the mothers to adopt an appropriate iron-rich diet for their children. At the end of session the mothers of each group were divided in small groups of five participants, and were evaluated for their knowledge to verify if they understood the different nutrition lessons taught during all sessions.

### 2.4 Iron supplementation intervention

At the end of nutrition education session, children in the intervention group received 2mg/kg of body weight/week of iron supplement for 16 weeks. The iron supplement was made up of 65 mg of ferrous iron and 0.25mg of folic acid. The children of control group did not receive an iron supplement. Anthropometrics, biochemical and hematological assessment Following this nutritional intervention of 20 weeks, the anthropometrics parameters of both groups of children were taken: weight and height using an electronic balance (AEG PW4923, Germany) and measuring tape respectively, while nutritional indices (weight-for-height, weight-for-age) were calculated using Waterlow and Gomez formula for determination of malnutrition level. Then, blood samples were collected in order to determine iron status biomarkers. Hemoglobin concentrations were determined immediately in the field using a Hemocue Hemoglobinometer (URIT -12, Angelholm Sweden). Venous blood (3mL) was drawn from each child and centrifuged at 3000G for 15 minutes in the laboratory and serum aliquots were prepared and stored at -80°c until they were analyzed. Serum Ferritin (SF), transferrin and C-reactive protein (CRP) levels were measured using the Enzyme linked immunoturbidimetric assay, reagents from Biorex diagnostics, (United Kingdom), serum iron (colorimetric enzymatic ferene method), reagent from SGM italia, (Roma, Italia).

### 2.5 Data analysis

All data collected were analyzed with SPSS (version 17). Comparisons of differences in knowledge (percentage) and of iron status indicators (means) within groups over time were assessed by the McNemar and paired t tests respectively. Analyses of variance (ANOVA) were used to compare means of iron status indices between the 2 groups. Correlations between anemia and various parameters (age, anthropometrics parameters, ferritin levels, C-reactive protein concentrations) were determined using the Spearman's correlation test. Statistical significance was set at $p<0.05$ for all analyses.

### 2.6 Ethical consideration

Ethical approval was obtained from the National Ethics committee of Cameroon and Regional Health office (N°:177/CNE/SE/2012). Permission was obtained from the different local chiefs and elders. Written informed consent was also obtained from the mothers, caregivers/fathers.

## 3. Results and Discussion

### 3.1 Background characteristics for control and intervention groups before nutrition intervention

The study comprised of 17 females and 8 males aged 6-23 months in the control group and 10 females and 15 males aged 6-23 months in the intervention group. Participants' mean age was 13.09 ± 0.92 and 13.16 ± 0.79 months respectively for the control and intervention group. The mean weight and height were 9.46 ± 0.39 kg and 71.04 ± 1.12 cm respectively for control group and 9.17 ± 0.36 kg and 69.48 ± 1.25 cm for the intervention group (Table 1). No statistically significant difference was observed in the baseline anthropometrics parameters of children (p>0.05) between the both groups (table 1).

| | Control group | | | Intervention group | | | |
|---|---|---|---|---|---|---|---|
| | Females | Males | Sexes combined | Females | Males | Sexes Combined | p-value |
| Variables | n = 17 | n = 08 | n = 25 | n = 10 | n = 15 | n = 25 | |
| Age distribution | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | |
| 6-11 (months) | 16 | 8 | 24 | 12 | 16 | 28 | |
| 12 -23 (months) | 52 | 24 | 76 | 28 | 44 | 72 | |
| Age (months) | 13.54± 1.49 | 12.5± 0.90 | 13.09± 0.92 | 13.95± 0.82 | 10.67± 1.78 | 13.16± 0.79 | 0.58 (NS) |
| Length (cm) | 70.77± 1.70 | 71.4± 1.45 | 71.04± 1.12 | 70.84± 1.24 | 65.17± 2.95 | 69.48± 1.25 | 0.49 (NS) |
| Weight (kg) | 9.44± 0.40 | 09. 50± 0.51 | 9.46± 0.31 | 9.03± 0.34 | 9.61± 1.11 | 9.17± 0.36 | 0.38 (NS) |

NS: Not significant (p>0.05)

**Table 1:** Background characteristics for control and intervention groups before nutrition intervention.

### 3.2 Socio-economic and nutritional characteristics for the control and intervention groups before the nutrition intervention

It appeared that 40% and 32% of children were stunting in the control and intervention group respectively (table 2). However, 12% were underweight in the control and intervention group. No statistically significant difference was observed in the nutritional status of children (p>0.05) between the both groups. There was a significant difference (p<0.009) in mother's educational level between the two groups with 40% and 76% having primary education in the control and intervention group respectively. The findings showed that 52% and 44% of mothers were housewives, 40% and 48% were farmers in the control and intervention group respectively. Regarding the level of household size 64% and 68% of household had more than 3 children in the control and intervention group respectively (table 2).

| Variables | Control group n (%) | Intervention group n (%) | $\chi^2$ | p |
|---|---|---|---|---|
| **Age (months)** | | | | |
| 06-Nov | 06 (24) | 07 (28) | 0.1 | 0.75 (NS) |
| Dec-23 | 19 (76) | 18 (72) | | |
| **Nutritional status** | | | | |
| Stunting | 10 (40) | 08 (32) | | |
| Underweight | 03 (12) | 03 (12) | 0.35 | 0.55 (NS) |
| Wasting | 0 (0) | 0 (0) | | |
| **Mother's education** | | | | |
| Primary | 10 (40) | 19 (76) | 6.65 | 0.009** |
| Secondary | 15 (60) | 6 (24) | | |
| **Mother's occupation** | | | | |
| Housewives | 13 (52) | 11 (44) | 0.32 | 0.57 (NS) |
| Farmers or grower | 10 (40) | 12 (48) | | |
| Others activities | 02 (8) | 02 (8) | | |
| **Household size** | | | | |

| | | | | |
|---|---|---|---|---|
| ≤ 3 children | 09 (36) | 08 (32) | 0.09 | 0.76 (NS) |
| > 3 children | 16 (64) | 17 (68) | | |

Data are expressed as percentage n(%); NS: Not significant (p>0,05); **Significant at p<0,01; Comparison between group using Chi square test.

**Table 2:** Socio-economic and nutritional characteristics for the control and intervention groups before the nutrition intervention.

### 3.3 Nutrition knowledge scores of mothers before and after nutrition education program for the control and intervention groups

Before the nutrition education, there were no significant differences (p>0.05) between the nutrition knowledge of mothers of both groups. But at the end of education, mothers of intervention group had the better knowledge on anemia, iron deficiency, foods rich in bioavailable iron, risks groups on iron deficiency, exclusive breastfeeding and iron rich foods (table 3).

| | Control group n (%) | | | Intervention group n (%) | | |
|---|---|---|---|---|---|---|
| Nutrition knowledge | Before | After | p-value | Before | After | p-value |
| **Anemia** | | | | | | |
| Definition of anemia | 08 (32) | 10 (40) | 0.55 (NS) | 03 (12) | 25 (100) | < 0.0001** |
| Definition of iron deficiency | 08 (32) | 10 (40) | 0.55 (NS) | 03 (12) | 25 (100) | < 0.0001** |
| Risk groups of iron deficiency | 03 (12) | 07 (28) | 0.15 (NS) | 04 (16) | 25 (100) | < 0.0001** |
| Health consequences of iron deficiency anemia (IDA) | 01 (04) | 07 (28) | NS | 01 (04) | 24 (96) | < 0.0001** |
| **Iron** | | | | | | |
| Importance of iron in the body | 02 (08) | 04 (16) | NS | 02 (08) | 18 (72) | < 0.0001** |
| Iron rich foods | 02 (08) | 04 (16) | NS | 03 (12) | 23 (92) | < 0.0001** |
| Foods rich in bioavailable iron | 00 (00) | 02 (08) | NS | 00 (00) | 14 (56) | < 0.0001** |
| Dietary strategies to improve iron status | | | | | | |
| Exclusive breastfeeding (for the first 6 months) | 12 (48) | 16 (64) | NS | 06 (24) | 24 (96) | < 0.0001** |
| Good dietary diversification practices | 02 (08) | 07 (28) | NS | 03 (12) | 21 (84) | < 0.0001** |
| Regular consumption of fruits and animal products | 04 (16) | 08 (32) | NS | 03 (12) | 21 (84) | < 0.0001** |
| Decreasing the intake of inhibitors of iron absorption | 02 (08) | 02 (08) | NS | 03 (12) | 18 (72) | < 0.0001** |
| Impact of maternal iron nutrition on child growth | 00 (00) | 05 (20) | NS | 01 (04) | 20 (80) | < 0.0001** |

Data are expressed as percentage n (%). NS: Not significant (p > 0.05);

**Significant at p < 0.01; Comparison of nutrition education program between control and intervention groups using McNemar test.

**Table 3:** Nutrition knowledge scores of mothers before and after nutrition education program for the control and intervention groups

### 3.4 Iron status and hematological parameters before and after nutrition intervention in the both groups

The initial mean hemoglobin was 10.43 ± 0.05 and 10.41 ± 0.23 g/dL in the control and intervention group respectively. After supplementation, hemoglobin in intervention group, was higher 11.46 ± 0.19 g/dL compared to the control group 10.63 ± 0.18 g/dL ($p<0.0001$). Before nutrition intervention, serum ferritin, serum iron and others hematological parameters were similar in both groups. After supplementation, serum ferritin decreased in the control group (24.29 ± 2.14 to 18.89 ± 7.54 µg/dL) but increased in the intervention group (25.23 ± 1.11 to 28.93 ± 5.81 µg/dL). However, no statistically significant difference was observed in the serum ferritin level ($p>0.05$) between the both groups (table 4). The meanserum iron concentrations at baseline was 10.65 ± 2.53 and 10.85 ± 0.59 µg/dL) in the control and intervention group respectively ($p>0.05$). At the end of study, the mean serum iron concentration for intervention group (19.65 ± 0.78 µg/dL) was significantly ($p<0.05$) higher than that for the control group (11.46 ± 1.02 µg/dL). After 20 weeks of intervention, no statistically significant difference was observed in the transferrin saturation and TIBC level ($p>0.05$) between the both groups (table 4).

| Indicators | Control group (n = 25) | Intervention group (n = 25) | P |
|---|---|---|---|
| **Hemoglobin (g/dL)** | | | |
| Before intervention | 10.43 ± 0.05 | 10.41 ± 0.23 | 0.31 (NS) |
| After intervention | 10.63 ± 0.18 | 11.46 ± 0.19 | 0.0001** |
| Serum ferritin (µg/L) | | | |
| Before intervention | 24.29 ± 2.14 | 25.23 ± 1.11 | 0.11 (NS) |
| After intervention | 18.89 ± 7.54 | 28.93 ± 5.81 | 0.03* |
| Serum iron (µg/dL) | | | |
| Before intervention | 10.65 ± 2.53 | 10.85 ± 0.59 | 0.08 (NS) |
| After intervention | 11.46 ± 1.02 | 19.65 ± 0.78 | 0.01* |
| **Transferrin saturation (%)** | | | |
| Before intervention | 14.57 ± 0.99 | 14.88 ± 0.32 | 0.13 (NS) |
| After intervention | 21.32 ± 1.43 | 24.28 ± 1.45 | 0.28 (NS) |
| TIBC (µmol/l) | | | |
| Before intervention | 76.70 ± 0.68 | 75.40 ± 1.09 | 0.20 (NS) |
| After intervention | 71.20 ± 1.56 | 72.80 ± 0.98 | 0.07 (NS) |

Data are expressed as means ± standard deviation; NS: Not significant ($p > 0.05$); *Significant at $p< 0.05$; **Significant at $p< 0.01$; TIBC: Total iron binding capacity; Comparison between groups using Student's T test.

**Table 4:** Iron status indicators before and after nutrition intervention

### 3.5 Anthropometrics indices before and after nutrition intervention in the both groups

The findings revealed that there were no significant differences in anthropometric indices (weight for height, weight for age) between the control and intervention group (table 5) before and after the nutrition intervention ($p >0.05$).

| Indicators | Control group (n = 25) | Intervention group (n = 25) | P |
|---|---|---|---|
| Weight / age (z-score) | | | |
| Before intervention | -0.04 ± 0.25 | -0.26 ± 0.31 | 0.83 (NS) |
| After intervention | -0.03 ± 0.27 | -0.21 ± 0.11 | 0.31 (NS) |
| Length / age (z-score) | | | |
| Before intervention | -1.83 ± 0.24 | -2.37 ± 0.35 | 0.61 (NS) |
| After intervention | -1.78 ± 0.26 | -2.13 ± 0.42 | 0.71 (NS) |
| Weight /Length (z-score) | | | |
| Before intervention | 1.06 ± 0.30 | 1.12 ± 0.50 | 0.79 (NS) |
| After intervention | 1.20 ± 0.28 | 1.40 ± 0.53 | 0.66 (NS) |

Data are expressed as means ± standard deviation; NS: Not significant (p > 0.05); Comparison between groups using Student's T test.

**Table 5:** Anthropometrics indices before and after nutrition intervention

### 3.6 Prevalence of iron deficiency (ID), iron deficiency anemia (IDA) and anemia before and after nutrition intervention

Before the nutrition intervention, prevalence of ID, IDA and anemia were similar in the both group (p>0.05). After 20 weeks of nutrition intervention, the prevalence of anemia was lower in the intervention group 28% compared to 76% (p= 0.0007). The prevalence of ID was not statistically different (p>0.05) between the intervention group (56%) compared to the control group (68%) (table 6). IDA was lower in the intervention group (32%) compared to the control group (64%) (p<0.05). Generally, at the end of study, the findings showed that the iron status of children of both group had improved.

| Indicators | Control group (n = 25) n (%) | Intervention group (n = 25) n (%) | p |
|---|---|---|---|
| **ID** | | | |
| Before supplementation | 25 (100) | 25 (100) | NS |
| After supplementation | 17 (68) | 14 (56) | 0.38 (NS) |
| **IDA** | | | |
| Before supplementation | 25 (100) | 25 (100) | NS |
| After supplementation | 16 (64) | 08 (32) | 0.02* |
| **Anemia** | | | |
| Before supplementation | 25 (100) | 25 (100) | NS |
| After supplementation | 19 (76) | 07 (28) | 0.0007** |

Data are expressed as n (%); NS: Not significant (p > 0.05); *Significant at p< 0.05; **Significant at p< 0.01; Comparison between group using Chi square test.

**Table 6:** Prevalence iron deficiency (ID), iron deficiency anemia (IDA) and anemia before and after nutrition intervention.

## 4. Discussion

The aim of this study was to assess the effect of nutrition intervention among children aged 6-23 months suffering from IDA in the West region of Cameroon. An improvement of nutrition knowledge of mothers of intervention group was observed at the end of nutrition intervention. Some mothers had realized the importance of good dietary diversification practices for young children. Some eating practices were improved. This study showed that nutrition education of mothers of control group had positive impact but not significant on prevalence of anemia among these children. Indeed, the weekly follow up of children, the educational talks with the mothers during the iron supplementation period could explain the better score of nutrition knowledge of the mothers in the intervention group compared to that of the control group. These results are similar to those obtained by [22-29] with 1,8 % of reduction of prevalence of anemia among adolescent girls aged 12 to 17 years in the intervention group compared to those in the control group after a nutrition education campaign combined with identification and promotion of iron rich foods during 9 months. A study conducted in Morocco on assessment of nutritional knowledge of athletes in Kenitra revealed that the nutritional knowledge score (NKS) was relatively low (2.12/5 ± 1.08). The significant difference (NKS) between groups with nutritional education (3.75/5 ± 1.03) and without nutrition education (1.90/5 ± 1.09) ($p < 0.0001$). The authors concluded that the (NKS) can predict the level of nutrition education [30-35].

We have observed a positive but not significant improvement in the anthropometric parameters of the children of intervention group after nutrition intervention. The amount of iron intake and absorbed affected weight gain in supplemented children and the effect of iron supplementation on stunting was inconclusive. Others studies reported the same results in a similar population of children in Indonesia where a positive but not significant improvement ($p = 0.89$) in the height for age, weight for height ($p = 0.06$) and weight for age ($p = 0.77$) z-scores were observed after 4 months of iron supplementation [30]. In another similar study in Burkina Faso, the author reported that the height for age z-scores of children aged 6 to 23 months after 6 months of iron, folates and vitamin A supplementation did not significantly improve ($p = 0.33$) [31]. Improvement in the anthropometric parameters of children after iron supplementation remains inconclusive. Indeed, some authors think that iron supplementation does not directly influence weight gain in children [22,32]. However, other authors have shown that micronutrient (iron, zinc, multivitamins) supplementation could significantly improve the anthropometric parameters, mental and psychomotor development of supplemented children, provided that it is carried out over a long time [27,33,36].

Study findings revealed an increase of serum ferritin from 25, 23 to 28, 93 µg/dL (an increase of 3.7 µg/dL) and significant increase of hemoglobin level from 10.41 to 11.46 g/dL (an increase of 1.05 g/dL) in the intervention group. However, no improvement was observed in serum ferritin and hemoglobin levels in the control group. The results are similar to findings from studies conducted in Indonesia and Bangladesh [26,27] where six months of iron supplementation among children aged 6-12 months significantly improved iron status. The authors conclude that iron and folic acid supplementation increased hemoglobin, serum ferritin, and significantly improved the iron status of supplemented children. These findings corroborates earlier studies in Zanzibar [28] where 12 months of iron supplementation among children aged 6-59 months significantly improved ($p = 0.015$) hemoglobin level of children. In a study carried out on the health benefits and risks of iron supplementation, the findings revealed that iron supplementation in children under 59 months considerably improved the hemoglobin level and iron status of children [22].

At the end of nutrition intervention, an increase in iron status of the children in the control group, with a reduction of 36% of IDA, 32% of ID and 24 % of anemia was observed. An improvement in serum iron and transferrin saturation was observed among the children in control group. This could be explained by the beneficial effects of nutrition education. We observed a significant reduction in anemia and iron deficiency anemia in the intervention group compared to the control group. Iron supplementation is dependent on the renewal cycle of intestinal cells (5-6 days) and their capacity to absorb iron [23,24]. Also, an international study on iron supplementation among children showed that approximatively 23% of children remained anemic after 6 months of daily micronutrient supplementation comprising of 10 mg of iron, in 6 month old children, where the prevalence of anemia was 67.1% before the supplementation [25].

This is the first study conducted in Bangang village, West region of Cameroon. Iron supplementation combined with nutrition education is a good strategy to reduce significantly the prevalence of anemia. However, this strategy did not completely correct the disease probably because the duration of treatment, which was, 20 weeks and a state of chronic malnutrition already present among these children. This strategy would be gradually replaced by good dietary diversification practices in the household by encouraging the consumption of foods rich in micronutrients and vitamins which have a positive relation with iron metabolism such as fruits (oranges, papaya, lemons and eggs), vegetables, and animal products. For this reason, the findings obtained o ur pilot study could be used in others rural areas where we have the same nutritional problems.

## 5. Conclusion

The study findings demonstrate that 20 weeks of nutrition intervention can significantly reduce iron deficiency anemia among children in this community. However, this strategy to fight against anemia remains a short term solution. It would therefore be necessary to strengthen nutritional educational programs for mothers, particularly promotion of exclusive breastfeeding (the first 6 months) and good dietary diversification practices of children (6 to 24 months) based on local foods rich in animal and vegetable proteins. This would improve the long term nutritional status and iron status of children.

## Acknowledgement

The authors gratefully acknowledge local responsible of rural population in Bangang village, community workers, health workers, mothers, caretakers and children who participated to the study.

## Declaration

The authors declare no competing interests.

## References

1. Dyness K, Pammla MP, Haikel M, Martin EK, Theobald CE. Prevalence and predictors of anemia among children under 5 years of age in Arusha District, Tanzania. Pediatr. Health Med. Therap. 9 (2018): 9-15.
2. Chhabra S, Preetinder K, Chandan T and Prashant Z. Study of fetal blood with maternal vaginal bleeding. Asian J. Sci. Res. 5 (2012): 25-30.
3. Godfred E. Matilda SA, Faribu SK et al. Anemia among school children older than five

years in the Volta region of Ghana. Pan Afr. Med. J. 17 (2014): 1-4.

4. Robel T, Zekariyas S, Delelegn Y, Equilnet M and Ermiyas M. Prevalence of anemia among school-age children in Ethiopia: a systematic review and meta-analysis. Syst. Rev. 7 (2018): 1-7.
5. Kana SM, Mananga MJ, Tetanye E, Gouado I. Risk factors of anemia among young children in rural Cameroon. Int.J.Curr.Microbiol.App.Sci 4 (2015): 925-935.
6. Gouado I, Djuidje M, Pankoui J, Fotso H. Iron status of malaria patients in Douala-Cameroon. Pakistan J. Nutr. 7 (2008): 620-624.
7. Enquête de Démographie et de Santé au Cameroun. Rapport préliminaire. Institut national de la statistique. EDS-MICS (2011) : 1-66.
8. Dewi MDH, Siti NA, Siska W, Shellita M, Deni KS et al. Effects of supplementation of Anguilla biscuit on under five years old with underweight in Sumedang District, Indonesia: A randomized control trial. Health Sci. J. 12 (2018): 594.
9. Stoltzfus RJ, Mullany L, Black RE. Iron deficiency anaemia. In: Ezzati M, Lopez AD, Rodgers A, Murray CJL, editors. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva: World Health Organization (2004): 163-209.
10. Mananga MJ, Kana SM, Nolla N, Tetanye E, Gouado I. Influence of complementary food composition on prevalence of anemia among children aged 6-24 months in West Cameroon. IJFNR 3 (2019): 1-9.
11. Alaofè H, Zee J, Turgeon-O'Brien H. Apports alimentaires en fer et anémie ferriprive chez les adolescents au Benin. Rev. Epidemiol. Sante Publique 55 (2007): 187-196.
12. Hassan AB, Kamal MM, Fetohy EM, Turky GM. Health education program for mothers of children suffering from iron deficiency anemia in United Arab Emirates. J. Egypt Public Health Assoc. 80 (2005): 525-545.
13. Marquis M, Dubeau C, Thibault L. Canadian's level of confidence in their sources of nutrition information. Can. J. Diet Pract. Res. 66 (2005): 170-175.
14. Kafatos I, Manios Y, Moschandreas J, Kafatos A. Preventive medicine and nutrition clinic university of Crete research team. Health and nutrition education program in primary schools of Crete: changes in blood pressure over 10 years. Eur. J. Clin. Nutr. 61 (2007): 837-845.
15. Salehi M, Kimiagar SM, Shahbazi M, Mehrabi Y, Kolahi AA. Assessing the impact of nutrition education on growth indices of Iranian nomadic children: an application of modified beliefs, attitudes, subjective norms and enabling factors model. Br. J. Nutr. 91 (2004): 779-787.
16. Kana SMM, Namadi M, Tetanye E. and Gouado I. Effect of spirulina platensis supplementation on nutritional and biochemical parameters of under five years malnourished children from an orphanage in Douala, Cameroon. J. Phar. Nutr. Sci. 5 (2015): 5-13.
17. Mananga MJ, Kana SM, Nolla N, Tetanye E, Gouado I. Influence of complementary food composition on prevalence of anemia among children aged 6-24 months in West Cameroon. IJFNR 3 (2019): 1-9.
18. Reina ES, Martin N, Alex ON, Stephen AV and Kenneth HB. Estimating the effective coverage of programs to control vitamin A

deficiency and its consequences among women and young children in Cameroon. Food Nutr. Bul. 36 (2015): 149-171.

19. Kouebou CP, Achu M, Nzali S, Chelea M, Bonglaisin J, Kamda A, Djiele P, Yadang G, Ponka R, Ngoh Newilah G, Nkouam G, Teugwa C, Kana SMM. A review of composition studies of Cameroon traditional dishes: Macronutrients and minerals. Food Chem. 140 (2013): 483-494.
20. Kana SM, Gouado I, Teugwa MC et al. Mineral content in some Cameroonian household foods eaten in Douala. Afr. J. Biotech. 7 (2008): 3085-3091.
21. WHO. Global data base on child growth and malnutrition. World Health Organization (2012).
22. Iannotti LL, Tielsch JM4, Black MM, Black RE. Iron supplementation in early childhood: health benefits and risks. Am. J. Clin. Nutr. 84 (2006): 1261-1276.
23. Baqui AH, Black RE, El Arifeen. Weekly iron supplementation does not block increases in serum zinc due to weekly zinc supplementation in Bangladeshi infants. J. Nutr. 135 (2005): 2187-2191.
24. NIH (National Institutes of Health). Iron and Malaria Technical Working Group. Chapter 2: Mechanisms. In: Raiten Namaste DS, Brabin B, éd. Considerations for the safe and effective use of iron interventions.Bethesda, MD, Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) (2011) : 16-51.
25. Smuts CM, Lombard CJ, Benade AJ. Efficacy of a food let-based multiple micronutrient supplement for preventing growth faltering, anemia, and micronutrient deficiency of infants: the four country IRIS trial pooled data analysis. J. Nutr. 135 (2005): 631-638.
26. Lind T, Lonnerdal B, Stenlund H. A community-based randomized controlled trial of iron and zinc supplementation in Indonesian infants: effects on growth and development. Am. J. Clin. Nutr. 80 (2004): 729-736.
27. Black MM, Quigg AM, Hurley KM, Pepper MR. Iron deficiency and iron deficiency anemia in the first two years of life: strategies to prevent loss of developmental potential. Nutr. Rev. 69 (2011): 564-570.
28. Stoltzfus RJ, Kvalsvig JD, Chwaya HM, et al. Effects of iron supplementation and anthelmintic treatment on motor and language development of preschool children in Zanzibar: double blind, placebo controlled study. BMJ. 323 (2001): 1389-1393.
29. Creed-Kanashiro HM, Uribe TG, Bartolini RM, Fukumoto MN, Lopez TT, et al. Improving dietary intake to prevent anemia in adolescent girls through community kitchens in a periurban population of Lima, Peru. J. Nutr. 130 (2000): 459-461.
30. Dijkhuizen MA, Wieringa FT, West CE, Martuti S, Muhilal. Effects of iron and zinc supplementation in Indonesian infants on micronutrient status and growth. J. Nutr. 131 (2001): 2860-2865.
31. Ouedraogo HZ, Nikiema L, Some I, Sakande J, Dramaix M, et al. Home based practices of complementary foods improvement are associated with better height for age z-score in 12-23 months old children from a rural district of Burkina Faso. Afr. J. Food Agri. Nutr. Dev. 8 (2008): 204-218.
32. Pasricha SR, Vijaykumar V, Prashanth N. A community based field research project investigating anaemia amongst young children

living in rural Karnataka, India: a cross sectional study. Public Health. 9 (2009): 59.

33. Sachdev HPS, Gera T, Nestel P. Effect of iron supplementation on mental and motor development in children: systematic review of randomized controlled trials. Public Health Nutr. 8 (2007): 117-132.
34. http://www.int/gho/child-anemia/en/.
35. Lotfi Z, Youssef A, Rachid S. Assessment of nutritional knowledge of athletes in Kenitra city, Morocco. Am. J. Innov. Res. App. Sci. 1 (2015): 209-213.
36. Gian MP. Effects of iron in neonates and young infant: a review. Int. J. Pediatr. 4 (2016): 2256-71.