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Original Article

Effects of Supplementary Feeding on the Nutritional Status of Internally Displaced School Children in the West Region of Cameroon

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ABSTRACT

Background and Objectives: Supplementary feeding has been verified as highly cost-effective in improving nutritional and health statuses, especially in vulnerable children such as those affected by a crisis. The objective of this study was to assess effects of supplementary feeding with an enriched corn-soy mixture on the nutritional status of internally displaced schoolchildren in the West Region of Cameroon.

Materials and Methods: In this study, pretest-posttest randomized experimental design was used. Sixty internally displaced schoolchildren were recruited from four primary schools in the West Region of Cameroon. They were subdivided into two groups of 30 children each (intervention and control groups). Children in the intervention group were fed with an enriched corn-soy mixture three times a week for 13 w, while those in the control group did not receive the formulated food. Anthropometric, biochemical and morbidity statuses and clinical signs of the malnutrition in the children were assessed at the beginning and at the end of the supplementation using standard anthropometric and biochemical equipment and pretested questionnaires.

Results: Children who received the enriched corn-soy mixture gained averagely a further 0.41 kg of weight and an average of further 0.46 cm of height, compared to the control group. There were statistically significant improvements in the mean weight-for-age ($p = 0.032$), BMI-for-age ($p = 0.000$) and MUAC-for-age Z-scores ($p = 0.001$), clinical signs of malnutrition [xerosis ($p = 0.048$), Bitot's spot ($p = 0.047$) and pallor ($p = 0.025$)] and hematological indicators such as serum albumin ($p = 0.026$) and hemoglobin ($p = 0.043$) levels.

Conclusions: This study highlights that supplementary feeding with enriched corn-soy mixture is one of the effective ways of decreasing prevalence of malnutrition in vulnerable children.

Keywords: Supplementary feeding, Nutritional status, Internally displaced school children, Western Cameroon

Introduction

Adequate dietary intake is needed for appropriate growth, development and good nutritional statuses (1). Under-nutrition in childhood is one of the reasons behind the high child mortality rates reported in developing countries. Under-nutrition is highly prevalent in children in Cameroon as 31% are stunted, 16% are underweight and 5.2% are wasted (2). Undernourished children are emotionally and intellectually less productive and suffer further from disabilities, compared to well-nourished children (3) and are exposed to a large range of harmful, parasitic and infectious diseases, which result in deterioration of nutritional statuses. Under-nutrition is part of a vicious cycle that comprises poverty and diseases, causing significant growth and cognitive delays (4). Diets of displaced schoolchildren in the West Region of Cameroon is dominated by foods of plant origins with limited intakes of proteins, vitamin A and iron, resulting in poor-quality diets (5).

Micronutrient malnutrition adversely affects health and motor development (6). In micronutrients, iron and vitamin

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A are greatly important for appropriate development of children. Iron deficiency includes critical consequences for cognitive, physical and mental developments of children (7). If left untreated, iron deficiency leads to anemia, decreased work capacity, diminished learning ability, impaired growth and greater risks of maternal and childhood mortalities (8). Vitamin A is the leading cause of preventable blindness and visual impairment in children, manifesting in a milder form of night blindness. It results in decreased growth, diarrheal diseases and increased risks of measles and mortality (9). Armed conflicts have increased steadily in number, duration and complexity over the past two decades (1). Protracted conflicts are a major cause of the increases in forced migration. Its consequences such as food insecurity, infectious diseases, poor water supply and marginal sanitation, inaccessibility to health services and other socioeconomic disadvantages can contribute to worsening of the malnutrition (10).

Efforts to fight under-nutrition and make progress towards the second Sustainable Development Goal, which aims to eradicate hunger and improve nutrition, have achieved a limited success as the number of undernourished children is continuing increasing. Hence, implementation of further interventions is necessary to ensure sufficient caloric and micronutrient intakes in children since they are further vulnerable to the consequences of inadequate nutrition (4). There are increasing evidence that improving nutrient intakes of schoolchildren can include measurable optimistic effects on cognition, linear growth and other health outcomes. Since schoolchildren are at a decisive stage in intellectual development, optimization of their cognitive performance can include long-lasting individual and population benefits (11, 12). Thus, there are needs to improve micronutrient intakes in this group of children.

Despite the efforts made by the Cameroon government to alleviate malnutrition and micronutrient deficiency, including vitamin A supplementation with capsules, deworming of children and fortification of commonly consumed foods, prevalence of malnutrition is still high (13). Therefore, it is critical to find other alternatives to complement these strategies. Hence, option of supplementation with food is an important option. Food supplementation has been verified as a highly cost-effective option in achieving its nutritional goals and health effects, especially in disadvantaged children such as those affected by a crisis (14, 15, 16, 17). Although various studies have verified that supplementary feeding is effective in preventing and treating under nutrition in populations, there are insufficient studies on supplementary feeding interventions in older children (e.g., schoolchildren) in Cameroon (14). The purpose of this study was to assess effects of supplementary feeding on the nutritional status of internally displaced schoolchildren in the West Region of Cameroon.

Materials and Methods

Study location

The study was carried out in the West Region of Cameroon. The West Region borders the Northwest Region to the Northwest, the Adamawa Region to the Northeast, the Centre Region to the Southeast, the Littoral Region to the Southwest and the Southwest Region to the West. Total area of the West Region includes 13,892 km^2 with a population of 2,770,400 people in 2019. The population density includes 200 inhabitants per km^2. The West Region consists of eight divisions, but Mifi, Bamboutos, Menoua and Noun Divisions are the most populated with internally displaced children (18).

Study design

The study used a pretest-posttest randomized experimental design in two schools from the West Region of Cameroon.

Study population

The study population included pairs of internally displaced schoolchildren aged 5–15 y, schooling in primary schools of the West Region of Cameroon as well as their mothers/caregivers.

Sample size

Sample size was assessed using formula for sample size calculation for epidemiological studies (19).

$$n1=\frac{(Z_{\alpha/2}+Z_{\beta})^2(P_1Q_1+P_2Q_2)^2}{(P_1-P_2)^2}$$

Where,

$Z_{\alpha/2}$ = critical value, a positive value that was at the vertical boundary for the area in the right tail of the standard normal distribution, which was 1.96

Z_{β}= referred from the tables of normal distribution at the power of 1-β, where value of Zβ at 5% 2-sided test with 80% power included 0.842

Q_1= 1- P_1 expected non-prevalence at the baseline of 76%

Q_2= 1- P_2 expected non-prevalence after the interventions at 90%

Prevalence of underweight in children of 5–19 years old in Cameroon (P_1 was 24% (2) and P_2 was 10%) was assumed based on an expected 14% decrease rate in the prevalence of underweight in children. This was substituted in equation n1 to calculate the number of participants in the intervention. After allowing an attrition rate of 10% (four participants), the calculated sample size (40) increased to 60 participants.

Eligibility criteria

Inclusion criteria for the trial included internally displaced schoolchildren of 5–15 years old, who were resident in the West Region, did not have a chronic illness and had an informed consent signed by at least one authorized guardian. Exclusion criteria included not meeting the inclusion criteria, being overweight or obese, having history of grave allergic reactions to cereals or milk demanding urgent medical cares, simultaneous participating in other clinical trials that made interventions in the child and having serious illnesses requiring referrals to hospitals. Children whose serum albumin, iron or hemoglobin levels were greater than the reference ranges or those who had a history of blood diseases were excluded from the study.

Sampling techniques

The West Region was purposely selected because it was one of the regions, which hosted the majority of internally displaced persons (IDPs), compared to other regions in the country. Schools, which hosted large numbers of displaced children, were identified by the Regional Delegation of Basic Education. Four study schools were randomly selected from this list. In these schools, internally displaced children were randomly recruited for the study into the supplementation group and the control group.

Group allocation and intervention

Before the intervention, 60 internally displaced school-aged children were recruited from four primary schools in the West Region of Cameroon. On the enrolment, children were randomized into the intervention and the control groups of 30 children each. Children in the intervention group were fed with the supplementary food, while those in the control group did not receive interventions during the study. Intervention included supplementary feeding of randomly selected internally displaced schoolchildren in the West Region, Cameroon. Food supplementation included an intervention designed to prevent or treat nutritional problems in children during the baseline study, including protein, energy, vitamin A and iron deficiencies, and hence improved nutritional statuses of the children.

Supplementary food

Corn-soy mixture was selected as a supplementary food for this study since maize and soybeans were completely unprocessed grains. This was better than several other processed foods, which were used for supplementation because processed foods partially lost their nutrients in processing. Furthermore, maize that was used included yellow maize, which was rich in energy and carotenoids. Soybeans were good sources of dietary proteins and Nido milk was a good source of vitamin A and iron since it was fortified with these nutrients.

Sources of the materials

Yellow maize, soybeans (*Glycine max*), refined sugar (sucrose) and powdered milk were purchased from a local market in Bafoussam (Marche A), Cameroon.

Processing of the supplementary food

Maize and soybeans were cleaned manually to remove husks, damaged grains, stones, dusts, light materials, stalks, undersized and immature grains and other extraneous materials and separately washed with tap water. Maize was air-dried at room temperature (RT) (25 °C ±2) for 48 h. maize was ground using electric grinder (Thomas Willy, Model ED-5, Germany) to make fine flour and then sieved using 500-µm sieve to remove bran from the flour. Soybeans were soaked in tap water at RT (25 °C ±2) for 12 h. Soybean seeds were boiled in a ratio of 1:3 for 30 min and dehulled manually by rubbing between the palms and then rewashed several times with tap water to wash out the test. This was drained and air-dried at RT (25 °C ±2) for 48 h and mildly roasted at approximately 80 °C for 15 min. Soaking and roasting were carried out to remove the beany flavor. Processed soybeans were milled to fine flour in a disc attrition mill (Thomas Willy, Model ED-5, Germany) and sieved using 500-µm mesh screen sieve. The steps are described in Figure 1.

Formulation of the supplementary flour mixture

Food supplement was developed based on the technical specifications for the formulation of corn-soy mixture by the World Food Program (20), stating that a corn-soy mixture used as supplementary food must be fortified in such a way that the vitamin A content of the finished product ranges 2770–4160 IU/100 g and its iron content ranges 9.4–14.1 mg/100 g of the flour. Moreover, protein content should be at least 14.0 g/100 g. Technically, WFP (20) specifies that the corn-soy mixture should be mixed in the proportion of 78 and 22% of maize and soybeans per 100 g, respectively. Corn-soy mixture was mixed thoroughly in the proportion of 78% of maize and 22% of soybeans. Flour was packed and sealed in plastic bags and stored at RT until used. Soybeans and maize flours were produced in absence of sunlight to avoid the oxidation of carotenoids.

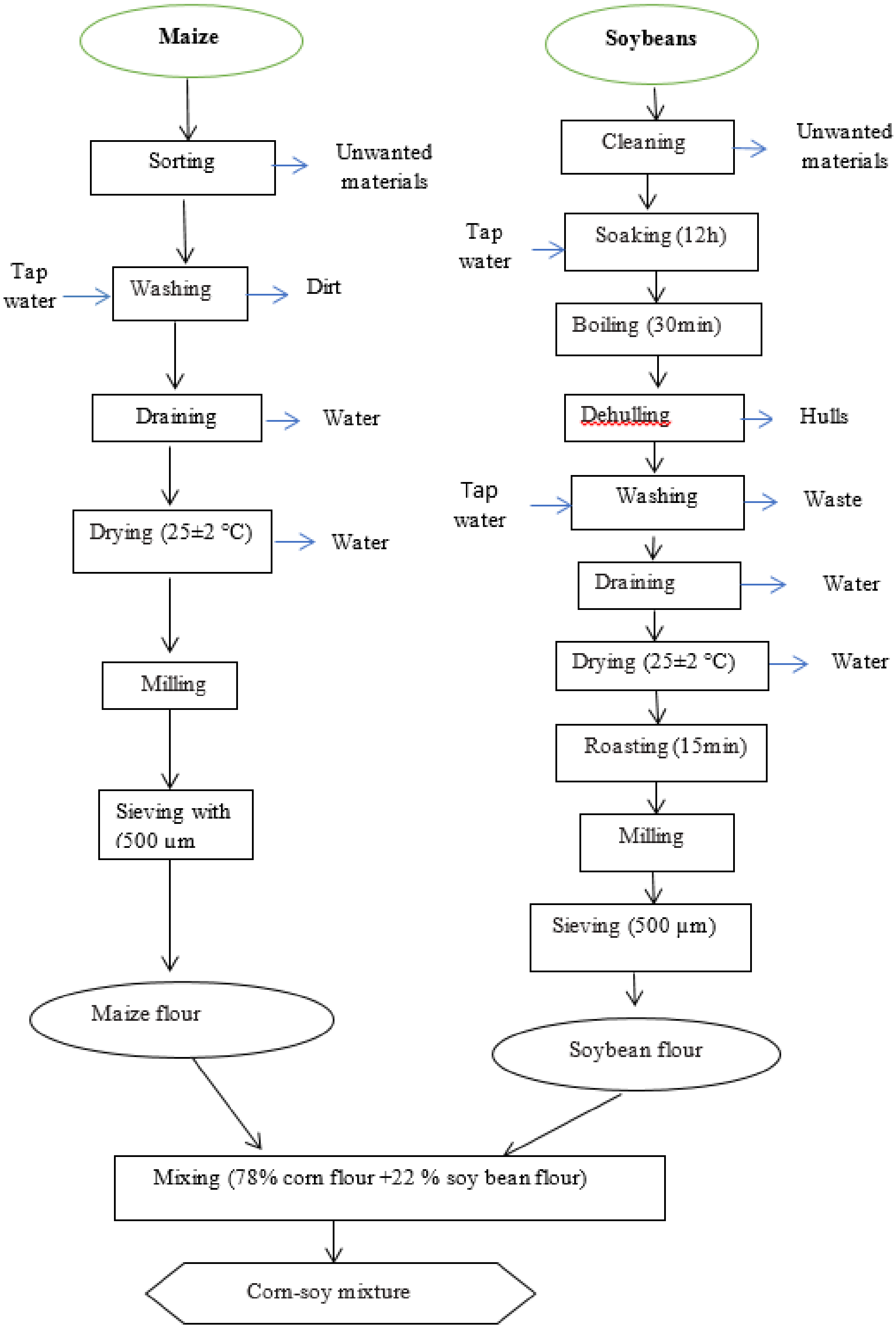

Figure 1. Production process of the corn-soy flour mixture

Cooking the corn-soy mixture

Cooking trials were carried out to quantify proportions of water and flour composite that yielded the quantity of porridge (450 ml) served to each child during the feeding intervention. Cooking test was carried out using a ratio of 100 g of flour and 500 ml of water. Flour was mixed in 250 ml of water at RT until it was smooth and free from all lumps. Nearly 250 ml of water were boiled over the gas range using cooking pot and the mixture was added while stirring continuously using spoon to prevent lump formation. Five cubes of sugar were added to the mixture during the cooking. Mixture was boiled for nearly 15 min while adjusting its consistency with the rest of 250 ml of water to achieve a thick porridge. The ratio of flour to water that yielded nearly 450 ml of porridge was then used to estimate higher quantities of the composite flour to water that was used in large-scale cooking during the supplementation to feed all 30 children in the intervention group. Food preparation, cooking, serving and cleaning activities were carried out by data collection team.

Assessment of the nutrient composition of the supplementary food

Nutrient composition of the supplementary food formulation was assessed using the following methods. Energy and protein contents were analyzed using the AOAC method (21). Iron was assessed based on a method of Pauwels *et al* (21). Carotenoids were assessed using the UHPLC method (21). The recommended daily dietary intake included the recommended daily dietary intake of children of 10–13 years old (22) since the mean age of the children was in this age range (10.12 y ±1.6).

Food Supplementation

In this study, enriched corn-soy mixture was used because the maize and soybeans were whole grains, in contrast to several supplementary foods that were made from refined grains that lost most of their nutrients during refinement. The supplementary feeding program was plotted to correct or prevent protein-energy malnutrition and vitamin A and iron deficiency. Each child in the intervention group received 450 ml of the corn-soy mixture enriched with 30 g of commercial fortified milk (Nestle-fortified Nido milk, Nestle, Switzerland) three times a week (Mondays, Wednesdays and Fridays) for 13 w (from 10 September, 2021, to 13 December, 2021) during break time on the school campus. The milk was added to the cooked food before serving. This was carried out without modification of their usual diets. Children in the control group did not receive supplementary food throughout the study.

Supplementary food intake

Food was served to children by the investigators. There was one refusal of the food by a child on the second day of supplementation based on the taste of the corn-soy mixture. Child was replaced on the second day of supplementation. None of the 60 children was lost to follow-up. Generally, food was detected as palatable to almost all the children with no negative side effects during or after the supplementation.

Data collection procedure

Data were collected at the beginning and the end of the intervention. Study was designed to investigate differences between the baseline and the end-line data. Mother of each child was interviewed during a meeting with the mothers on the school campus. Structured interviewer questionnaire was used to collect sociodemographic information of the children and their mothers/caregivers, morbidity, anthropometry and information on the children biochemical samples. The children were later examined for clinical signs of malnutrition on campus. All the children in the intervention and control groups were administrated with a single dose of 500 mg of mebendazole to prevent parasitic infestations from compromising effects of supplementation.

Anthropometric measures

Anthropometric parameters of the children were assessed before and after the nutritional intervention using standard anthropometric equipment following the procedure described by (23). Weight of the children, wearing minimal clothing, was measured to the nearest 0.01 kg using digital scale (Seca 750 1017009, China). The scale was checked for accuracy using a known weight during every visit and calibrated before weighing when necessary. Height was measured to the nearest 0.1 cm using locally made wooden height board. A measuring tape was attached to the woodwork that served as a stadiometer. Mid upper arm circumference (MUAC) measurements were carried out using non-stretchable arm circumference tape to the nearest 1 mm. Anthropometric outcomes included mean changes in the anthropometric indices of weight-for-age z-scores (WAZ), height-for-age z-scores (HAZ), MUAC-for-age z-score, body mass index-for-age Z-scores (BMI-for-age z-scores) and changes in children's weight and height.

Biochemical assessment of the proteins, iron and anemia

Blood samples were collected before and after the intervention by two laboratory technicians through venipuncture. All blood samples were collected in the morning between 8:00 and 10:00 AM to minimalize effects of diurnal and postprandial variations on plasma nutrient levels. Blood sample for each participant was collected into two various test tubes, a dry test tube and a test tube with anticoagulant of K-EDTA (potassium ethylene diamine tetracetic acid). Nearly 2 ml of blood were transferred into the dry test tube and nearly 5 ml of blood were added to the tube that contained the anti-coagulant. The K-EDTA was necessary to avoid interfere with the hemoglobin (Hb) estimation. Blood samples were collected before and after the feeding time (supplementation). Blood samples were transported to the laboratory of Bafoussam Regional Hospital using flasks filled with ice cubes to preserve the low temperature (nearly 4 °C) within 2 h of collection to prevent changes in the blood samples. Protein statuses of the children were assessed by assessing serum albumin concentrations using a method by the Collaborative

Laboratory Services (24). The reference range for albumin in children between 1–18 years old was 3.1–4.8 g/dl that was used to indicate protein adequacy (24). Iron statuses of the children were assessed by measuring their serum iron concentrations (22). The reference range for serum iron was 60–170 µg/dl. Anemia statuses of the children were assessed by investigating their hemoglobin concentration using HemoCue photometer, Sweden, with a reference range of 11.9–15.0 g/dl for children of 5–18 years old (22). All laboratory experiments were carried out in the laboratory of the Bafoussam Regional Hospital, Cameroon.

Clinical indicators

Children were examined for clinical signs of malnutrition in their hair, eyes, lips, face skin, nails and legs. This was carried out to diagnose children with signs of protein deficiency (e.g., depigmentation, bilateral pitting edema, thin, dry, or sparse hair, distended abdomen and moon face), vitamin A (e.g., night blindness, Bitot's spots and xerosis of the skin and conjunctiva) and iron (e.g., angular cheilitis, pallor of the skin, conjunctiva and tongue, easy fatigue, shortness of breath, dizziness and spoon-shape nails) (25, 26).

Morbidity data

Data on morbidity were collected from children in the intervention and control groups at the baseline and at the end line. Information was collected from the children mothers or primary caretakers about the presence or absence of symptoms of illnesses within the previous month of the study. Illnesses included symptoms of diarrhea (defined as more than three watery stools in a day), malaria, measles, anemia, dental caries, vomiting, stomachache, skin infections (e.g., rashes, ringworm and eczema) and respiratory infections (e.g., runny nose, cough, wheezing, sneezing and difficult breathing). Malaria, anemia and measles were diagnosed by the physicians.

Data analysis

All 60 questionnaires from the two groups were analyzed as no child was lost to follow-up. Data were edited, coded and entered using Microsoft Excel 2016 (Microsoft, USA) with the assistance of a statistician and then analyzed using SPSS software v.21 (IBM, USA). Descriptive statistics, including frequencies, proportions, mean, median, confidence interval (CI) and standard deviation (SD) were calculated and presented using tables and figures. Continuous data were presented as median with range or mean ±SD, while categorical data were presented as frequencies, proportions and means. Nutritional indices, including height-for-age, BMI-for-age and weight-for-age were assessed using World Health Organization (WHO) AnthroPlus software, which included growth reference standards for the children and adolescents of 5–19 years old and compared with relative WHO standards (27). The MUAC-for-age z-scores were analyzed using the growth reference for MUAC-for-age for school-aged children (28). Children with HAZ, MUAC-for-age z-scores and WAZ between -3 and -2SD from the median of the WHO reference population were defined as moderately stunted, moderately wasted and moderately underweight children, respectively. Children whose HAZ, MUAC-for-age, BMI-for-age and WA Z-scores were less than -3 were recognized as severely stunted, severely wasted and severely underweight children. Children whose BMI-for-age z-scores were between less than -2.0 and -3.0 SD were reported as thin children. Children who had HAZ, MUAC-for-age and WA Z-scores between -2.0 to +2.0 SD and BMI-for-age z-scores between -2.0 to +1.0 SD were reported as normal children. Overweight and obesity were defined by BMI-for-age z-scores of greater than +1.0 to +2.0 SD and BMI-for-age z-scores of greater than +2.0 SD, respectively. Frequencies were used to describe categorical variables such as sex, age and clinical signs of malnutrition. For continuous variables, student t-test was used to assess significant differences between the characteristics of two groups, while differences in prevalence were tested using Pearson's chi-square test. Statistical significances were set at $p < 0.05$.

Ethical approval

All the study protocols were carried out based on the ethical standards of Helsinki Declaration. Protocols were reviewed and approved by the Institutional Ethics Committee of the University of Bamenda, Cameroon (2021/006H/UBa/IRB). The Regional Delegate of Basic Education for the West Region gave the authorization to carry out the study in this region. Additional administrative approvals were achieved from the divisional delegates, inspectorates of basic education and head teachers of the selected schools. Written informed consents were signed by the mothers/caregivers of the children who participated in the study.

Results

Nutrient content of the supplementary food

Food consumed by each child (450 ml of the corn-soy mixture) included approximately 78 g of corn powder, 22 g of soybean powder, 30 g of Nestle Nido fortified milk and 20 g of sugar. Protein and energy contents of the food formulation were 25.7 ±1.8 g/100 g and 744.5 ±4.3 kcal/100 g of the corn-soy mixture, respectively. Carotenoid content of the supplementary food ranged 984.9 ±7.2 µg/100 g and iron content was 11.8 ±1.4 mg/100 g of the corn-soy mixture (Table 1). This contributed, as a proportion of the reference dietary intakes (RDI) for children aged 10–13 years old, 37% of energy, 92% of protein, 118% of iron and 140% of vitamin A.

Table 1. Nutrient contents of the supplementary food per 450 ml of the corn-soy mixture

Nutrient	Supplementary food	RDI for 10-13yrs	% RDI (10-13 years)
Carotenoids (μg)	984.9±7.2	700	140
Iron (mg)	11.8±1.4	10	118
Protein (g)	25.7±1.8	28	92
Calories (Kcal)	744.5±4.3	2000	37

Baseline socioeconomic characteristics of the children and their parents/caregivers in the control and intervention groups

Baseline sociodemographic characteristics of the children: Table 2 shows socioeconomic characteristics of the children at the baseline. Study included 56.7% males and 43.3% females in the control group and 60% males and 40% females in the intervention group. The mean age of the children was 8.6 y ±1.44 in the control group and 10.24 y ±2.62 in the intervention group. At the baseline, children in the supplementary group were mildly older and heavier than that those in the control group were. The mean MUAC values were respectively 173.13 ±7.31 and 183.2 ±8.69 for the control and intervention groups. The mean weight and height were respectively 28.79 kg ±2.41 and 125.53 cm ±7.02 for the control group and 29.19 kg ±2.56 and 125.6 cm ±6.63 for the intervention group (Table 2). The greatest proportion of children in the intervention (33.3%) and the control (33.3%) groups were shown in 2018, while the minimum proportion of displacement (0 and 10%, respectively) occurred in 2021. A large proportion of children in the control (43.3%) and intervention (50%) groups lived in crowded houses, with a household size of more than eight people. The majority of the children in the intervention (80%) and the control (86.7%) groups had good drinking water sources such as tap, bottled and spring water, while the rest of them drank water from bad sources such as the well and stream water. The most common type of toilet used by the children in the two groups was the pit toilet (≥ 80%). No significant differences ($p > 0.05$) were seen in the baseline sociodemographic data between the two groups.

Table 2. Demographic characteristics of the children at the baseline

Child's characteristics	Category	Intervention Frequency (%)	Control Frequency (%)	P-values
Sex of child	Male	18(60)	17(56.7)	0.797
	Female	12(40)	13(43.3)	0.788
Age range of children	5-9years	11(36.7)	17(56.7)	0.123
	10-15years	19(63.3)	13(43.3)	0.152
Height(0.01cm)	Mean	125.6±6.63	125.53±7.02	0.708
Weight(0.01Kg)	Mean	29.19±2.56	28.79±2.41	0.816
MUAC(0.1mm)	Mean	183.2±7.31	173.13±8.69	0.077
Where the child lived before the crisis	Northwest	22(73.3)	23(76.7)	0.763
	Southwest	8(26.7)	7(23.3)	0.763
Main drinking water source	Good water source	24(80)	26(86.7)	0.489
	Bad water source	6(20)	4(13.3)	0.512
Toilet type	Pit Toilet	26(86.7)	24(80)	0.396
	Flushing Toilet	4(13.3)	5(16.7)	0.714
	No Toilet	0(0)	1(3.3)	0.319
The year of child displacement	2017	7(23.3)	6(20)	0.758
	2018	10(33.3)	10(33.3)	0.828
	2019	10(33.3)	7(23.3)	0.384
	2020	3(10)	4(13.3)	0.692
	2021	0(0)	3(10)	0.078
Household size				
	Below 5	3(10)	1(3.3)	0.301
	5-8	12(40)	16(53.3)	0.405
	More than 8	15(50)	13(43.3)	0.606

Sociodemographic characteristics of the mothers/ caregivers at the baseline

The baseline sociodemographic characteristics of the mothers/caregivers in each age group are shown in Table 3. No significant differences were demonstrated between the supplementary and control groups for all the variables at the baseline. Mothers were predominantly unemployed as 60 and 40% of the mothers in the intervention and control groups respectively were unemployed. The proportion of mothers in the intervention and control groups who were self-employed was 36.7 and 46.7% respectively, while the minimum proportion (3.3 and 13.3%) of the mothers were formally employed. In all the groups, large numbers of families were disadvantaged by family income as most of the families (66.7%) had a monthly income of less than 50.000 Francs CFA, whereas the rest families (36.7%) had an income range of 50.000–150.000 Francs. None of the families had an income more than 300.000 Francs. The mean ages of the caregivers are summarized in Table 3 and the results disclosed that the majority of caregivers in the intervention group were insignificantly older than those in the control group as 76.7 and 60% of the mother/caregivers in the intervention and control groups respectively aged at least 25 years. Most of the mothers/caregivers in the intervention (76.7%) and the control (53.3%) groups were Christians followed by Muslims (23.3%) of the intervention group and 33.3% of the control group and pagans, which included 13.3% of the control group and none of the intervention group. Secondary education was the most common highest level of education for mothers in the two groups as the highest level of education of the greatest proportion of mothers in the intervention (46.7%) and control (70%) groups was secondary education.

Table 3. Sociodemographic data of the mothers/caregivers at the baseline

Mother's /caregivers' characteristics	Category	Intervention Frequency (%)	Control Frequency (%)	P-values
The highest academic level of the mother or caregiver	No formal education	0(0)	1(3.3)	0.371
	Primary	12(40)	7(23.3)	0.168
	Secondary	14(46.7)	21(70)	0.0695
	Higher	4 (13.3)	1(3.3)	0.164
Employment status of the mother/caregiver	Formally employed	1(3.3)	4(13.3)	0.142
	Self-employed	11(36.7)	14(46.7)	0.436
	Unemployed	18(60)	12(40)	0.125
Marital status of mother/caregiver	Married	20(66.7)	21(70)	0.785
	Divorced	1(3.3)	1(3.3)	0.914
	Never married	5(16.7)	7(23.3)	0.526
	Widow	4(13.3)	0(0)	0.040
Household income	Below 50,000	20(66.7)	17(56.7)	0.429
	50-150,000	5(16.7)	11(36.7)	0.082
	151-300,000	5(16.7)	2(6.7)	0.232
	Above 300,000	0(0)	0(0)	0.951
Relationship of the mother or caregiver to child	Mother	20(66.7)	18(60)	0.593
	Family relation	10(33.3)	12(40)	0.585
	Parent's friend	0(0))	0(0)	1
	Others	0(0)	0(0)	1
Age of the mother/caregiver	Below 25	6(20)	10(33.3)	0.248
	25-50	23(76.7)	18(60)	0.167
	Above 50	1(3.3)	2(6.7)	0.549
Housing condition	Renting	12(40)	21(70)	0.02
	Living under another family	18(60)	7(23.3)	0.004
	House owner	0(0)	2(6.7)	0.152
Religion	Christian	23 (76.7)	16(53.3)	0.059
	Muslim	7(23.3)	10(33.3)	0.393
	Pagan	0(0)	4(13.3)	0.04
	Others	0(0)	0(0)	1

Effects of supplementation on the anthropometric statuses of displaced schoolchildren

After 3 m of the intervention, general increases in the mean weight and height were reported in the two study groups (Table 4). This might be due to the normal growth process in the children during the intervention. However, the mean increases in weight and height observed in the intervention group (0.98 kg and 2.86 cm, respectively) were higher than the mean increases of those observed in the control group (0.67 kg and 2.33 cm, respectively). Values of the mean BMI-for-age, WAZ, HAZ and MUAC-for-age Z-scores of the two groups between the baseline and the end line are shown in Table 4. Results revealed that the mean WAZ, HAZ, BMI-for-age and MUAC-for-age Z-scores of most children were more than -2SD in the two groups, suggesting that most of the study children had normal nutritional statuses. No significant differences were reported in the mean z-scores between the two groups. The mean baseline Z-scores of BMI-for-age, WAZ, HAZ and MUAC-for-age were -1.56 (±0.11), -1.68 (±04), -1.71 (±0.31) and -1.53 (±0.41) respectively for the intervention group and -1.50 (±0.36), -1.62 (±0.12), -1.73 (±0.40) and -1.57 (±0.37) respectively for the control group. At the end of the intervention, the mean Z-scores of BMI-for-age, WAZ, HAZ and MUAC-for-age groups respectively shifted to -1.58 (±0.25), -1.57 (±0.13), -1.75 (±0.51) and -1.63 (±0.39) for the control and respectively to -1.31 (±0.07), -1.57 (±0.17), -1.60 (±0.38) and -1.03 (±0.35) for the intervention group.

At the end of the supplementary feeding intervention in the intervention group, general improvements were reported in all the anthropometric parameters. The mean Z-scores of BMI-for-age Z-score, MUAC-for-age and WAZ of the children improved significantly as well ($p < 0.05$). The highest improvement was reported in BMI for age Z-score ($p = 0.000$), followed by MUAC-for-age ($p = 0.001$) in the intervention group. Only the HAZ of the displaced children increased insignificantly ($p = 0.185$). No statistically significant improvements were seen in all the anthropometric indices of the control group ($p > 0.05$). Although a little improvement was registered in the WAZ and MUAC-for-age Z-score of children in the control group, it was less evident compared to the intervention group. The mean WAZ and BMI-for-age of the children in the control group decreased mildly after the intervention, indicating that the nutritional statuses of the children were deteriorated.

Prevalence of underweight, wasting and stunting in displaced children before and after the intervention

Results summarized in Table 5 show that no children were overweight or obese either at the beginning or at the end of the intervention in the two groups. In the control group, the baseline prevalence of severe and moderate stunting in the children were 10 and 23.3% respectively. No changes were observed in the control group at the end line. In the control group, 20% of the children were wasted at baseline based on the MUAC-for-age. Proportion of the wasted children increased marginally from 20 to 23.4% at the end of the intervention. The baseline prevalence of underweight in children of the control was 30%. Although decreases were seen in the prevalence of moderate underweight in the control group (from 30 to 26.7%) at the end of Week 12, improvements in the intervention group (23.4 and 13.3%) nearly tripled those of the control group. Marginal increases were recorded in the prevalence of wasting based on the BMI-for-age in the control group (from 16.7 to 20%). In the intervention group, respectively 6.7 and 10% of the children were severely and moderately wasted at the baseline based on their MUAC-for-age. After the intervention, only 3.3% were severely wasted while the proportion of children that were moderately wasted decreased to 3.3%.

Based on their BMI-for-age, respectively 3.3 and 13.3% of the children were severely and moderately wasted at the baseline in the intervention group. At the end of the intervention, no children were severely wasted while the proportion of moderately wasted children decreased by 3.3%. At the enrolment, 6.7% of the children were severely underweight and 16.7% were moderately underweight in the intervention group. At the end line, no child in the intervention group were severely underweight and the proportion of moderately underweight children decreased to 13.3%. Stunting was the minimum anthropometric parameter that was affected by the intervention. The baseline prevalence of severe and moderate stunting were 6.7 and 20% respectively for the intervention group. At the end line, no changes were seen in the prevalence of severe stunting and moderate stunting mildly decreased to 16.7%, indicating that supplementation included negligible effects on stunting.

Table 4. Nutritional statuses of the children using the mean Z-scores before and after supplementation

	Control group			Supplementary group		
	Baseline	End-line		Baseline	End-line	
Variable	Mean (SD)	Mean (SD)	P-value	Mean (SD)	Mean (SD)	P-value
Weight (kg)	27.82±2.41	28.39±2.74	0.395	28.57±2.56	29.55±3.01	0.179
Height (cm)	124.1±7.02	126.4±6.35	0.182	126.4±6.63	129.2±6.91	0.116
BMI-for-age	-1.50(±0.36)	-1.58(±0.25)	0.321	-1.56(±0.11)	-1.31(±0.07)	0.000
WAZ	-1.62(±0.12)	-1.57(±0.13)	0.127	-1.68(±0.4)	-1.57(±0.17)	0.032
HAZ	-1.73(±0.40)	-1.75(±0.51)	0.866	-1.71(±0.31)	-1.60(±0.38)	0.185
MUAC-for-age z-score	-1.57(±0.37)	-1.63(±0.39)	0.543	-1.53(±0.41)	-1.03(±0.35)	0.001

Values are presented as Mean± SD

Table 5. Prevalence of underweight, wasting and stunting in displaced children before and after supplementation

Z-score	Weight –for-age (WAZ)		BMI-for-age (BMIZ)		Height-for-age (HAZ)		MUAC-for-age Z-score	
	Before n(%)	After n(%)	Before n(%)	After n(%)	Before n(%)	After n(%)	Before n(%)	After n(%)
Control								
> +2.0 SD	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
-2.0 SD to +2.0 SD (Normal)	21(70)	23(73.3)	25(83.3)	24(80)	20(66.7)	20(66.7)	24(80)	23(76.7)
<-2.0 SD (Moderately malnourished)	7(23.3)	6(20)	3(10)	4(13.3)	7(23.3)	7(23.3)	5(16.7)	5(16.7)
<-3.0 SD (Severely malnourished)	2(6.7)	2(6.7)	2(6.7)	2(6.7)	3(10)	3(10)	1(3.3)	2(6.7)
Intervention								
> +2.0 SD	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
-2.0 SD to +2.0 SD (Normal)	23(76.7)	25(83.3)	25(83.3)	29(96.7)	22(73.3)	23(76.7)	25(83.3)	27(90)
<-2.0 SD (Moderately malnourished)	5(16.7)	4(13.3)	4(13.3)	1(3.3)	6(20)	5(16.7)	3(10)	1(3.3))
<-3.0 SD (Severely malnourished)	2(6.7)	0(0)	1(3.3)	0(0)	2(6.7)	2(6.7)	2(6.7)	1(3.3)

Effects of supplementation on the biochemical statuses of displaced schoolchildren

The mean biochemical profile values of the children before and after the supplementation are displayed in Table 6. The mean baseline levels of blood albumin, serum iron and
hemoglobin were reported as 38.5 ±3 g/l, 91.3 ±11 mcg/dl and 12.2 ±3 g/dl in the control group and 37.4 ±9 g/l, 92.4 ±13 mcg/dl and 11.9 ±3 g/dl in the intervention group, respectively. Statistical analysis showed no significant differences in the baseline biochemical values between the two groups for all the nutrients. Significant (p = 0.026) increases in the serum levels of albumin and hemoglobin (p = 0.043) were reported in the participants of the intervention group after supplementation. Although the mean serum iron increased in the intervention group at the end of the intervention, increases were not significant (p = 0.093). However, complete eradication of the severe form of anemia was seen in the intervention group after supplementation. At the end of the intervention, non-significant changes were seen for all the biochemical parameters of the children in the control group.

Effects of supplementation on the clinical signs of malnutrition

Effects of supplementation on clinical signs of malnutrition in the study children are present in Table 7. At the baseline, only four children (13.3%) in the intervention group included clinical signs of malnutrition. This number decreased significantly to one (3.3%) at the end of supplementation. At the baseline, thin, dry or sparse hair, pallor and xerosis were present in 4, 12 and 4% of the children, respectively. After the intervention, nearly all the children in the control group still had all signs of protein and vitamin A deficiencies. Two out of three children with pallor had the signs after the intervention. Before the intervention, depigmentation, thin, dry or sparse hair, moon face, pallor and xerosis were respectively present in 4, 4, 4, 13.3 and 10% of the children in the intervention group. After supplementation, most of the clinical indicators of deficiencies (depigmentation, thin, dry, or sparse hair, moon face, xerosis and pallor) were normal.

Effects of supplementation on the health statuses of the children

Table 8 shows effects of supplementation on the health statuses of the children in the two groups. At the baseline, 26.7% of the children in the control group were sick in the month prior to the study. At the end line, proportion of children who were sick in the month prior to the study increased to 40% with the most common illness of respiratory tract infections (RTIs) (40%). At the baseline, morbidity in the intervention children was as high as 40% of the children suffered from a particular illness in the month prior to the study. The illnesses that were reported in the children included dental caries (10%), diarrhea (6.7%), stomachache (10%), malaria (3.3%) and skin infections (10%) with the most common illness of RTIs (23.3%). After the intervention, proportion of children who were ill during the month prior to the study decreased insignificantly (p = 0.748) from 40 to 36.7%.

Table 6. Effects of supplementary feeding on biochemical parameters of displaced schoolchildren

	Control group			Intervention group		
Variable	Baseline	End-line	P-value	Baseline	End-line	P-value
Serum albumin	38.5±3g/L	38.1±6g/L	0.745	37.4±9g/L	42.4±8g/L	0.026
Hb (g/dL)	12.2g±3/dL	12.0g±4/dL	0.827	11.9g±3/dL	13.5g±3/dL	0.043
Serum iron	91.3±11 μg/dL	92.7±9 μg/dL	0.591	92.4 ± 13 μg/dL	97.5±10 μg/dL	0.093

Table 7. Effects of supplementation on the clinical signs of malnutrition

		Intervention group			Control group		
Type of deficiency	Clinical sign	Baseline results	End-line results	P-value	Baseline results	End-line results	P-value
		n(%)	n(%)		n(%)	n(%)	
Protein deficiency	Depigmentation	1(3.3)	0(0)	0.317	1(3.3)	1(3.3)	1
	Thin, dry or sparse hair	2(6.7)	1(3.3)	0.548	2(6.7)	3(10)	1
	Moon face	1(3.3)	0(0)	0.317	0(0)	0(0)	1
Iron deficiency	Pallor	4(13.3)	0(0)	0.025	3(10)	2(6.7)	0.645
Vitamin A deficiency	Xerosis	3(10)	0(0)	0.048	1(3.3)	1(3.3)	1
	Bitot's spot	1(3.3)	0(0)	0.047	0(0)	0(0)	1

Table 8. Effects of supplementation on the health statuses of the children

Morbidity	Intervention group			Control group		
	Before n(%)	After n(%)	P-value	Before n(%)	After n(%)	P-value
Dental caries	3(10)	3(10)	1	2(6.7)	2(6.7)	1
Diarrhea	2(6.7)	1(3.3)	0.548	1(3.3)	1(3.3)	1
Stomachache	3(10)	1(3.3)	0.14	3(10)	4(13.3)	0.877
Respiratory infections	7(23.3)	10(33.3)	0.389	8(26.7)	12(40)	0.275
Malaria	1(3.3)	0(0)	0.32	1(3.3)	1(3.3)	1
Skin infections	3(10)	2(6.7)	0.462	2(6.7)	2(6.7)	1

Discussion

Intervention strategy of the present study was selected based on several parameters. The fortified corn-soy mixture is energy and protein-dense, rich in vitamin A and iron. During the baseline survey and from a study carried on children in orphanages in Bamenda, Cameroon (29), it was reported that many children were deficient in these nutrients. Hence, the supplementary food was selected to meet the nutrient requirements of the children, which were identified during the baseline survey. This was because nutritious supplementary feeding was highly recommended for vulnerable populations and particularly those who were displaced since they were generally food insecure (14). In this study, diets of the children were dominated by foods of plant origin with a limited intake of protein, vitamin A and iron, resulting in poor-quality diets (5). At the end of the intervention, the mean MUAC-for-age z-scores of the children in the intervention groups increased significantly from -1.33 (±0.41) to -0.16 (±0.35) (p = 0.02). These results were in contrast to those of several previous studies on young children of 0–5 years old (16, 30, 31). They documented insignificant increases in the MUAC of children after supplementary feeding for 3 m. These differences could be attributed to the fact that the MUAC of children of 1–5 years old was much unchanged, even though growth within this age stage was rapid. Mild increases in MUAC possibly showed either increases in muscle mass, dermal fat or both. However, studies on other age groups are similar to the current study. For example, a study in pregnant women in Guinea-Bissau demonstrated significant improvements in the MUAC of pregnant women after they were supplemented with ready-to-use supplementary foods for 3 m (30).

In this study, significant decreases were observed in wasting between the baseline and the end line in the supplement group. This finding was similar favorably to an earlier supplementary feeding trial by Thakwalakwa *et al.* (16), who reported a comparable finding of significant decreases in wasting in children who consumed supplementary foods, compared with children who did not receive supplementations. They reported that after a nutritional rehabilitation of 12 w (feeding under-nourished children with lipid-based nutrients), proportion of the wasted children decreased from 59 to 6%. A similar finding of significant decreases in wasting was reported in children of Guinea-Bissau, who were supplemented with ready-to-use supplementary foods for 3 m (30). This rapid recovery from wasting documented in several studies has verified established evidence from other studies in nutritional sciences that although wasting usually develops within a short time because of discrepancies in tissue and fat mass, it can be reversed rapidly with appropriate nutritional interventions. Significant constructive effects of the supplementary feeding on the BMI-for-age registered in the children who were wasted at the baseline present additional evidence for the roles of supplementary feeding with fortified foods in the recovery of initially wasted people. Similar results have been described in refugee children in South Africa after the children were fed with fortified supplementary foods (32). However, a lengthier supplementation time may be needed to preserve improvements in wasting. Trehan *et al.* (33) observed sustained improvements in nutritional statuses only when supplementary feeding of the children continued.

The BMI-for-age Z-score of the children, who were supplemented, increased significantly (p = 0.000). This has verified the fact that food supplementation is a highly effective method of increasing nutritional statuses of the children who are vulnerable to wasting. This was possibly because wasting was more sensitive to seasonal or temporal variations in food supplies and effects of infectious diseases and could therefore change rapidly in response to such factors. The BMI-for-age Z-score of those children in the non-supplement group rather decreased from -1.50 (±0.36) to -1.58 (±0.25) (p = 0.321). This indicated that the rate of wasting in the children continued to increase as time passed by if interventions were not implemented to improve nutritional statuses of the children. Hence, supplementary feeding in the form of school feeding programs should be implemented in the schools, where these children are improved for their nutritional statuses.

Results of this study were in contrast to those reported by (33), who observed no significant effects of supplementary feeding with unfortified cereals on wasting during a targeted supplementary feeding program on pre-school children from Busia County, Kenya. Differences could be linked to the low quantity of proteins in cereals. The fact that significant improvements in wasting were reported in other groups of children fed with soy-fortified porridges in the same study further verified suggestions that insignificant improvements were resulted from lacks of essential nutrients in unfortified cereal foods (34). It has been verified that cereals generally used as food for children in developing countries are not rich in total protein, particularly limiting essential amino acids such as lysine and tryptophan (35). Amino acids are essential for the linear growth, repair and sustenance of body tissues in other functions (36). Insignificant decreases in levels of stunting (p = 0.185) recorded in this study were similar to those reported by Thakwalakwa *et al.* (16) in a rehabilitation study of rural Malawian under-nourished children. This was similar to another study in Northern India, which established complexity of preventing under-nutrition in stunted children using specialized foods (37).

Insignificant effects of the intervention on stunting occurred possibly because stunting has been verified as irreversible, especially at a later stage in life de Onis and Branca (14). Therefore, interventions to reverse stunting in children should be implemented during infancy. It could be attributed to the fact that most of the children were not initially malnourished, since previous studies have shown that nutritional interventions, particularly supplementation, are further effective when children are initially malnourished (14). Another reason for the insignificant decreases in stunting in this study could be because of the study time (3 m) was too short to assess significant changes in stunting. However, a study on the supplementation of refugee children in Saharawi, Southwest Algeria, compared 3-m with 6-m supplementary feedings and concluded that a 3-m time was adequate to accomplish the best possible improvement in nutritional status and growth (38). In contrast, Schlossman *et al.* (30) recorded significant decreases in the prevalence of stunting in malnourished children of Guinea-Bissau after supplementation. Substantial increases could be seen because all the children of Guinea-Bissau were malnourished and under 5 years old which provided opportunities for improvements in their nutritional statuses unlike the children in the present study who were 5 years old and older; most of whom were not malnourished. Kristjansson *et al.* (14) concluded that supplementary feeding improved stunting in young children but questioned possibility of inducing catch-up growth in older children. This might be an important issue in this study population because no significant effects were seen on the stunted children after supplementary feeding. Unlike results of this study, Lopriore *et al.* (38) and Schlossman *et al* (30) reported significant increases in the HAZ of stunted young refugee children, who were supplemented with fortified supplementary foods. Significant increases recorded by Lopriore *et al.* (38) and Schlossman *et al* (30) possibly occurred because children were younger (0–6 years old) and hence were able to grow up further. The rate of catch-up growth response in the children was deleteriously linked to the children's age; hence, the younger the children, the greater the growth rate and the higher the possibility of inducing catch-up growth. In contrast, age range of the children in the current study was 5–15 y and it has been verified that recovery from stunting within this age range is difficult (11). After 3 m of intervention, significant increases were observed in WAZ (p = 0.032) of the children who were fed with fortified supplementary foods. Similar to this study, several previous studies reported associations between the supplementary feedings and decreased risks of child under-weight (30, 34, 38).

In this study, supplementation resulted in significant increases in WAZ (p = 0.032). This was unlike what was reported by Thakwalakwa *et al.* (16) after a 12-w supplementary feeding of underweight children with corn-soya mixture (0.51±0.39) in rural Malawi. Although children in the later study were underweight, changes in their mean WAZ were not significant. There are numerous potential explanations for the differences in WAZ summarized previously. Possibly, it could be because the foods fed to the displaced children were provided during lunch breaks. Hence, their usual meal times were not interrupted. Investigators provided foods directly to the study children and supervised its consumption and time when foods were served (break times) corresponded to the time when the children were hungry. Children did not have chance to share the foods with friends or household members. This is in contrast to the method used by Thakwalakwa *et al.* (16), who distributed foods to the caregivers of the study children and the children were fed at home with the opportunity to share the foods provided to the intended beneficiaries with family members, decreasing the rations and hence efficacy of the intervention. Moreover, the supplementary foods possibly replaced the usual meals of the children. Another possible explanation for the enormous increases in WAZ of the displaced children in this study could be addressed because some children were around the age of puberty, which was characterized by high/weight gain, whereas Malawian children were far under the age of puberty. The fact that no children were overweight or obese in the supplement group at the end of the intervention suggested that supplementary feeding did not result in overweight or obesity.

In this study, insignificant increases in height were seen in the control and intervention groups. Follow-up was likely carried out too early (after 90 d) to perceive significant gains in height in the children. One of the reasons for the success of this study included use of a fortified corn-soy mixture, which was far more attractive to children than the pharmaceutical formulations habitually shared during most supplementation trials. The palatability of the food was demonstrated by its high acceptability as almost all the selected children ate the food with passion, resulting in high compliance rates. Moreover, increased nutrient density made the food further efficient. In the intervention group, general increases were seen in the mean of all hematologic indicators. Similarly, several preceding studies reported these findings. For example, hematologic indicators of the supplemented refugee children in Saharawi increased by an average of two times of those in the control group (38). Lopriore *et al.* (38) reported that supplementation with a fortified supplementary food included exceedingly significant effects on hemoglobin, as well as anemia statuses of the refugee children in Saharawi, Southwest Algeria. Another intervention study on refugee children in South Africa documented significant increases in blood micronutrients at the end of a supplementary feeding (32). Hemoglobin of the schoolchildren of Northern India increased significantly after they were fed with 100 g/d of cauliflower-leaf powder supplements (37).

Insignificant increases were recorded in serum iron levels in the two groups. However, higher increases might be expected in the intervention group due to the high iron contents of the supplementary diet. A reason for the insignificant increases could be due to poor absorption of iron in the intestines. Factors that could limit iron absorption include fibers from the diets, phytates, oxalates, polyphenols (tannins) and vitamin D deficiency. These anti-nutrients are rich in plant-based foods such as the food that was used in this study (34). Further improvements in iron statuses could be delayed by infections, lack of access to foods, new locations and other environmental factors and partially physiological stages of the children. Significant improvements in vitamin A statuses from the baseline to the end line were prominent, as similar improvements have not been achieved in children after one year of fortification of oil and other foods in major cities of Cameroon (13). This shows that supplementary feeding is a further effective method of eradicating micronutrient deficiency in children. Effective eradication of severe and moderate types of anemia in this study via use of fortified supplementary food is an essential result from a public health perspective.

At the end of the intervention, significant changes were seen in the hemoglobin levels of children in the supplement group. These results were in contrast of those by Thakwalakwa *et al* (16), who reported insignificant increases in levels of hemoglobin after a supplementary feeding study on children in rural Malawi. Significant changes were reported in the prevalence of clinical signs of malnutrition such as xerosis, Bitot's spot and pallor ($p < 0.05$). Results of this study were similar to those of a study by Rudolph *et al.* (32). They reported that supplementary feeding with fortified supplementary foods included significant effects on clinical signs of malnutrition in the eyes and nails of children in South Africa. Another study by Jood *et al.* (37) on the nutritional statuses of schoolchildren in Northern India recorded significant decreases in the clinical signs of protein-energy malnutrition (PEM), vitamin A and iron after daily supplementary feeding with cauliflower-leaf powder supplements.

Incidence of morbidity in children, who ate the enriched supplementary food, was slightly less than that of the children in the control group, without any significant differences between groups. These findings were supported by findings from Lopriore *et al.* (38). They reported that supplementary feeding with a spread fortified with vitamins and minerals insignificantly improved the health status of refugee children in Algeria. In contrast to the findings of this study, Rudolph *et al.* (32) observed a significant improvement in the health status of refugee children in South Africa who were supplemented with fortified supplementary food. Although it has been verified that supplementation significantly decreases morbidity in children (14), supplementation included no significant effects on the morbidity status of the children. However, results of this study were similar to those of other previous studies, which reported that supplementation did not affect morbidity in children in the US, SA and rural Malawi (16, 32, 40).

In the current study, prevalence of diarrhea decreased after supplementary feeding. This was in contrast to that of a supplementary feeding trial in children in rural Malawi, which reported increased prevalence of diarrhea at the end line of the study (16). This was likely because the investigators of the present study prepared the food and provided it to the children under optimal hygienic conditions while in the later study, food was prepared and shared by the parents, who might not practice the necessary sanitary demands of food preparation. This could contribute to the increased prevalence of diarrhea observed in the study and eventually the modest weight gain observed in children even though they were underweight at the baseline. At the end of the intervention, proportion of the children who suffered from RTIs within the month prior to the study increased insignificantly in the two groups ($p = 0.748$). Although increases in the prevalence of RTIs were in contrast to the expectations, it could be attributed to the prevailing weather during the end-line data collection. The baseline data were collected in September, which was included in the rainy season of Cameroon. The end line data were collected in December, which was included in the dry season of Cameroon characterized by dust and increased cold. These conditions positively affected prevalence of RTIs and might contribute to the increased prevalence of RTIs in the study children.

Conclusion

Results of this study have shown beneficial effects of the corn-soy supplementation on the children. Children who received the enriched corn-soy mixture gained an average weight of 0.41 kg as well as an average height of 0.46 cm, compared to those in the control group. Statistical significant improvements ($p < 0.05$) were seen in WAZ, BMI-for-age and MUAC-for-age Z-scores, clinical signs of malnutrition (xerosis, Bitot's spot and pallor) and hematological indicators such as serum albumin and hemoglobin. Supplementary feeding included favorable but insignificant effects on clinical signs of malnutrition such as depigmentation, Bitot's spot, pallor and moon face. Supplementation resulted in decreases in the prevalence of illnesses such as stomachache, diarrhea, skin infections and malaria even though these were statistically insignificant ($p > 0.05$). Therefore, supplementary feeding with enriched corn-soy mixture is one of the effective ways of decreasing prevalence of malnutrition in vulnerable children in developing countries. This supplementary food can be used in the school feeding programs of displaced children. However, this strategy to combat malnutrition is a short-term solution. Therefore, it is necessary to develop sustainable strategies such as nutrition educational programs for mothers as they can improve long-term nutritional statuses of the children.

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