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THE EFFECTIVENESS OF A SCHOOL-BASED INTERVENTION FOR THE TREATMENT OF IRON DEFICIENCY ANEMIA

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ABSTRACT

Background: In Brazil, iron deficiency anemia is considered a public health problem, which has a direct impact on the process of child growth and development. To assess the impact of a powdered supplement added to food preparations, on hemoglobin (Hb) levels and other hematimetric parameters in children.

Method: This study is a double-blind, community-controlled clinical trial conducted in education centers in the northeast of Brazil. In this trial, food preparations were offered with a powdered supplement, enriched with iron (intervention) and control (no supplementation), Monday through Friday, for 60 days. Two biochemical evaluations were performed to determine Hb, hematocrit (Ht), mean corpuscular volume and ferritin levels before and after the intervention.

Results: For participants in the 6- to 59-month age range, we identified an increase in mean Hb concentrations and other hematimetric parameters. In the 5- to 11-year age group, there was a significant increase in both groups for Hb and Ht values, and mean Hb concentration was significantly greater in the intervention group (12.25±0.76 vs. 11.93±0.94, p<.0035). In the 12- to 14-year-olds, all variables analyzed presented an increase.

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Conclusions: This school-based intervention effectively increased Hb concentrations other hematimetric parameters and reduced the prevalence of anemia in children and adolescents.

Keywords: Anemia, Iron Deficiency, Child Nutrition, Iron Supplements, Hemoglobins

1. INTRODUCTION

Worldwide, it is estimated that almost two billion people have anemia, and 27% to 50% of the population has iron deficiency (ID) Brazil (2019); Kassebaum and Gbd (2013); Pediatria (2018); WHO (2017). In Brazil, iron deficiency anemia (IDA) is considered a public health problem, and in some regions, it is the most prevalent nutritional deficiency among children under the age of five years, which has a direct impact on the process of child growth and development, both physical, cognitive, and behavioral Brazil (2019); Pediatria (2018). However, statistical data vary widely, with results indicating that 40 to 50% of the children studied are affected by this condition Pediatria (2018), with the highest prevalence being in the northern and northeastern regions of the country Kassebaum and Gbd (2013); Pediatria (2018).

Although IDA is a condition that affects different socioeconomic classes, it ends up affecting more frequently populations with lower household income per capita, with less schooling, with greater difficulty in accessing basic services such as sanitation and electricity, and in situations of food and nutrition insecurity de Castro Morais et al. (2014); Kassebaum and Gbd (2013); Oliveira et al. (2010); Pediatria (2018); WHO (2017).

Faced with the problem of IDA in Brazil, there are some programs and policies in progress in the country that aim to control and prevent it, among them are the fortification of wheat and corn flours, as outlined in the National Iron Supplementation Program and the NutriSUS Strategy Brazil (2019).

Considering the relevance of further investigations on the issue, this study aims to assess the impact of a powdered supplement, enriched with iron, added to food preparations, on hemoglobin (Hb) levels and other hematimetric parameters in children and adolescents enrolled in early childhood centers and schools, compared with a control group (CG).

2. MATERIALS AND METHODS

2.1 STUDY DESIGN, PARTICIPANTS, AND LOCATION

This is a double-blind, community-controlled study that enrolled 2368 participants to evaluate the impact of a powdered supplement, enriched with iron, added to food preparations, on Hb levels and other hematimetric parameters, in the municipality of Cabo de Santo Agostinho, State of Pernambuco, in the northeast of Brazil.

The protocol for the parent study was approved by the Research Ethics Committee of the Universidade Federal de São Paulo - Escola Paulista de Medicina (UNIFESP / EPM), protocol number 1040/07. All students aged 6 months to 14 years from the early education centers and schools were invited to participate in our study. The children and parents or legal guardians were consented / assented prior to participation in the study. Exclusion criteria were schoolchildren with chronic diseases; history of blood transfusion in the previous three months; those with Hb <9.5 g/dL at the initial evaluation (who were referred to specific outpatient treatment), students already using iron supplementation and parents' refusal to participate. Medical support was available upon request. After intervention, anemic children were referred for treatment.

The study was conducted in 10 municipal early education centers and schools which were randomized into 2 groups: the IG and the CG, each with 5 municipal early education centers and schools. For this study, we only considered infants and children aged six months to 14 years with IDA, defined according to World Health Organization (WHO) criteria. WHO (2011)

2.2 INTERVENTION

In this study, for the IG, single-dose sachets of the powdered supplement, enriched with iron (according to each age range) were mixed into the child's individual portion of food immediately before consumption (Table 1). The intervention was administered Monday through Friday and lasted for 60 days, beginning, and ending on the same date for all participants.

Table 1 Food preparations in the intervention group.

Type of education center	Age range	Number of supplemented meals offered / day	Daily per capita consumption (g) by age group	Daily iron supplementation (mg) for every 100g of food offered
Early education centers	6≥59 months	1	100 to 150	3.0
Schools	5≥11 years	1	180 to 230	4.0
	12≥14 years	1	250 to 300	4.0

2.3 DATA COLLECTION

Two biochemical evaluations were performed to determine Hb, hematocrit (Ht), mean corpuscular volume (MCV) and ferritin levels before and at the end of the intervention. In addition, anthropometric measurements (weight and height) were taken, according to standard techniques as proposed by Lohman et al (1988),[8] to calculate the Body Mass Index (BMI). Members of the study team who collected outcome data were blinded to the different interventions.

2.4 STATISTICAL ANALYSIS

Statistical procedures were performed based on the intention to treat. Excel 2010 programs and SPSS software version 23.0 for Windows (SPSS Inc.; Chicago, IL, USA) were used to tabulate and analyze the data.

According to the initial characteristics, the means and standard deviations of the continuous variables and the absolute and relative frequencies of the categorical variables were calculated. All variables were subjected to the Kolmogorov-Smirnov test to verify the normal distribution of data. Participants were stratified by age (according to the criteria established by the WHO for the identification of IDA) WHO (2011) to facilitate the analysis of the results: 6≥59 months, 5≥11 years, 12≥14 years. During the intervention, the change in age of the participants was taken into consideration, and they were reallocated accordingly.

A comparative analysis of the biochemical parameters, age, weight, height and BMI was performed between the groups before the intervention, using the t test for independent samples; within and between groups after the intervention using the t-test for independent samples (by intention to treat); the differences between the initial and final means (Δ) of the study variables were calculated; and the comparative analysis of these means was performed using the t test for independent samples. A comparative analysis for the presence / absence of IDA according to the Hb values before and after the intervention was performed using Fisher's exact test (two-tailed). The number needed to treat (NNT) was calculated to verify the impact of the intervention on Hb levels. The level of significance was adjusted to 5% ($p<0.05$) in all tests.

3. RESULTS

In this subgroup analysis, a total of 461 infants and children aged six months to 14 years presented IDA, with 216 children in the IG and 245 children in the CG.

Table 2 Comparative analysis of study variables according to age group before the intervention.

Age range	Variables	n	Intervention group	n	Controle group	95%CI
			Mean±SD		Mean±SD	
6-59 months	Age (years)	5	4.32±0.74	18	4.53±0.25	-0.63, 0.21
	Hemoglobin (g/dL)	5	10.32±0.80	18	10.13±0.73	-0.59, 0.96
	Hematocrit (%)	5	28.40±7.27	18	31.64±1.53	-6.88, 0.39
	MCV (fL)	5	75.20±6.94	18	75.83±6.49	-7.55, 6.28
	Ferritin (ng/mL)	5	54.88±27.96	17	26.61±11.66	10.99, 45.55
	Weight (kg)	4	18.33±5.67	15	19.31±5.12	-7.18, 5.21
	Height (m)	5	1.07±0.16	15	1.11±0.13	-0.21, 0.12
	BMI	5	15.79±2.62	15	15.44±1.42	-1.65, 2.36
5≥11 years	Age (years)	179	7.98±1.96	214	7.52±1.99	0.06, 0.85
	Hemoglobin (g/dL)	179	10.79±0.54	214	10.77±0.62	-0.10, 0.13
	Hematocrit (%)	179	32.80±2.69	214	32.79±2.32	-0.49, 0.51

Continued on next page

Table 2 continued

	MCV (fL)	179	78.96±5.60	214	78.50±6.17	-0.72, 1.63
	Ferritin (ng/mL)	176	44.14±30.65	209	42.22±24.37	-3.59, 7.44
	Weight (kg)	171	27.81±9.68	202	26.20±9.03	-0.30, 3.52
	Height (m)	171	1.27±0.14	202	1.25±0.14	-0.00, 0.05
	BMI	171	16.68±3.02	202	16.31±2.53	-0.19, 0.94
12≥14 years	Age (years)	32	12.53±0.32	13	12.44±0.39	-0.13, 0.32
	Hemoglobin (g/dL)	32	11.35±0.48	13	11.33±0.72	-0.35, 0.39
	Hematocrit (%)	32	34.48±1.79	13	34.97±1.52	-1.63, 0.65
	MCV (fL)	32	80.63±5.51	13	80.00±7.94	-3.54. 4.79
	Ferritin (ng/mL)	32	37.71±23.31	13	39.20±36.05	-19.71. 16.72
	Weight (kg)	32	38.69±11.78	13	35.66±7.55	-4.11. 10.17
	Height (m)	32	1.44±0.11	13	1.43±0.12	-0.06. 0.09
	BMI	32	18.31±3.70	13	17.40±2.75	-1.39. 3.20

All numbers are absolute. MCV = mean corpuscular volume. BMI = Body mass index. SD =- Standard deviation. Confidence interval for the mean difference. ‡Calculated using the t test for independent samples.

Table 2 Presents the initial characteristics of the participants, with a significant difference observed for ferritin in the 6≥59-month age range (IG 54.88±27.96 vs. CG 26.61±11.66 ng/mL, p=.003); and in the age group of 5≥11 years, the participants in the IG were older (IG 7.98±1.96 vs. CG 7.52±1.99 years, p=.023). At baseline, the distribution of participants according to age group shows a predominance in the 5≥11-year age range, with 179 students in the IG and 214 in the CG. There were no significant differences for other variables analyzed (Table 2).

During the study it must be acknowledged that the children aged, and consequently, the number of children in each age group also changed; at the end of the intervention, distribution was as follows: in the 6≥59-month age range there were 3 participants in the IG and 16 in the CG; in the 5≥11-year age range – 164 participants in the IG and 197 in the CG; and in the in the 12≥14-year age range – 49 participants in the IG and 32 in the CG.

In the comparative analysis of the biochemical parameters and BMI before and after the intervention, in the 6≥59-month age range, an increase in Hb and Ht was observed in both groups, however these increases were only significant in the CG, p =.002 and <.0001, respectively. In this same age group, a significant difference in the final values was detected between the groups for ferritin, IG 63.47±34.53 vs. CG 32.23±14.58 ng / mL, p=.0247.

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In the 5≥11-year age group, there was a significant increase in both groups for Hb and Ht values (p<.0001), and mean Hb concentration was significantly greater in the IG compared with the CG in the analysis between the groups. (IG 12.25±0.76 vs. GC 11.93±0.94, p=.0035). Still in this same age group, the IG showed a significant increase for the MCV at the end of the intervention, from 78.96±5.60 to 80.68±6.04 fL, p=.0107. In the 12- to 14-year age range, there was a significant increase in Hb and Ht in the IG and in the CG, MCV value showed a significant increase in the IG, from 80.63±5.51 to 83.74±5.50 fL, p =.0282 (Table 3).

To better visualize the results, an analysis of the differences between the means (Δ) of the biochemical parameters and BMI was performed after the intervention according to age group. Only in the 5- to 11-year age range, a significant result was identified, there was a greater absolute increase in mean Hb concentrations in the IG when compared to the CG, 1.41±0.81 vs. 1.19±0.97 g/dL, p=.0485. No statistical significance was identified for any other variable in the comparison between groups (Table 4).

The presence / absence of IDA before and after the intervention was determined using Hb concentrations according to the WHO cutoff points. WHO (2011) At the beginning of the study, anemia was present in 100% of the participants, and there was a reduction in both groups in all age ranges. For preschoolers between 6 and 59 months, the reduction was not significant, in the IG 5 children were anemic at the beginning of the study, and only 1 at the end of the intervention, in CG 18 participants were anemic at the beginning of the study, falling to 3 at the end. For the schoolchildren aged five to 11 years, there was a significant reduction in the prevalence of IDA in both groups (IG = 9.52% vs. CG = 26.40%, p<.0001); and the reduction in the IG was significantly greater than in the CG (p=.0005). For the adolescents, aged 12-14 years, a significant reduction in the prevalence of anemia was noted only in the IG (19.35%, p=.0108) (Table 5).

In this study, the IG was compared with the CG to identify a favorable or adverse outcome (absence or presence of anemia). In the six to 59-month age range, the adverse result was present in 33.33% of the children in the IG and 25.00% in the CG, showing that the participants were not benefited by the intervention (NNH=12). However, for the schoolchildren aged 5 to 11 years, the adverse outcome was present in 9.52% of participants in the IG and 26.40% in the CG, the difference, the reduction in absolute risk (RAR) was 16.88% (95% CI 7.60, 26.15), and the NNT was 6. The intervention was also beneficial for adolescents (12 to 14 years old), the adverse result was present in 19.35% of the students in the IG, and 28.00% in the CG, RAR = 8,65% (95% CI 13.79, 31.08), and the NNT was 12 (Table 6).

Although acceptance was not studied directly, there was no direct or indirect evidence of a detectable difference in acceptability of the food in the IG compared with

Table 3 Comparative analysis of biochemical parameters and BMI according to age group before and after the intervention, and between groups, by intention to treat.

Age range	Variable	Intervention group			Control group			Between groups at the end of the intervention
		Before Mean±S (95%CI)	After Mean±S	p-value‡	Before Mean±SD (95%CI)	After Mean±S	p-va	p-value‡
6≥59 months	Hb (g/dL)	10.32±0	11.30±0	.11	10.13±	11.33±0	**.0**	.95
		(-2.26, 0.30)			(-1.78, -0.62)			
	Ht (%)	28.40±7	34.13±0	.24	31.64±	35.63±2	**<.**	.31
		(-16.37, 4.90)			(-5.42, -2.54)			
	MCV (fL)	75.20±6	75.67±7	.93	75.83±	76.83±4	.65	.73
		(-13.26, 12.33)			(-5.43, 3.43)			
	Ferritin (ng/mL)	54.88±2	63.47±3	.71	26.61±11.	32.23±1	.26	**.0247**
		(-62.75, 45.58)			(-15.62, 4.39)			
	BMI	15.79±2	14.56±0	.57	15.44±	15.37±1	.92	.51
		9-4.30, 6.77)			(-1.33, 1.47)			
5≥11 years	Hb (g/dL)	10.79±0	12.25±0	**<.0001**	10.77±	11.93±0	**<.**	**.0035**
		(-1.60, -1.31)			(-1.32, -0.99)			
	Ht (%)	32.80±2	37.55±2	**<.0001**	32.79±	37.44±2	**<.**	.73
		(-5.34, -4.16)			(-5.18, -4.12)			
	MCV (fL)	78.96±5	80.68±6	**.0107**	78.50±	79.53±6	.14	.14
		(-3.05, -0.40)			(-2.40, 0.35)			
	Ferritin (ng/mL)	44.14±3	47.33±2	.35	42.22±24.	43.42±2	.66	.22
		(-9.88, 3.50)			(-6.56, 4.15)			
	BMI	16.68±3	16.82±3	.71	16.31±	16.70±2	.19	.76
		(-0.89, 0.61)			(-0.98, 0.19)			
12≥14 years	Hb (g/dL)	11.35±0	12.58±1	**<.0001**	11.33±	12.29±0	**.0**	.23
		(-1.65, -0.84)			(-1.48, -0.45)			
	Ht (%)	34.48±1	38.34±2	**<.0001**	34.97±	38.47±2	**<.**	.85
		(-5.08, -2.63)			-4.94, -2.06			
	MCV (fL)	80.63±5	83.74±5	**.0282**	80.00±	84.04±6	.11	.86
		(-5.89, -0.34)			(-9.04, 0.96)			
	Ferritin (ng/mL)	37.71±2	40.05±1	.65	39.20±36.	40.72±2	.89	.91
		-12.65, 7.96			(-22.76, 19.73)			
	BMI	18.31±3	18.43±3	.89	17.40±	18.73±3	.20	.74
		(-1.93, 1.68)			(-3.40, 0.73)			

All numbers are absolute. Hemoglobin = Hb. Hematocrit = Ht. MCV = mean corpuscular volume. BMI = Body mass index. SD =- Standard deviation. 95%CI = 95% Confidence interval for the mean difference. ‡Calculated using the t test for independent samples.

Table 4 Comparative analysis of the differences between the means (Δ) of the biochemical parameters and BMI after the intervention according to age group.

Age range	Variable	Intervention group		Control group		95%CI	p-value‡
		n	Δ±SD	n	Δ±SD		
6≥59 months	Hemoglobin (g/dL)	3	0.90±0.66	12	1.14±1.01	-1.58, 1.10	.70
	Hematocrit (%)	3	2.83±1.88	12	4.12±2.12	-4.19, 1.62	.36
	MCV (fL)	3	4.00±3.46	12	2.67±3.52	-3.57, 6.24	.57
	Ferritin (ng/mL)	3	4.77±39.74	12	5.98±15.56	-30.73, 28.30	.93
	BMI	2	0.05±0.43	6	-0.52±1.01	-1.32, 2.44	.49
5≥11 years	Hemoglobin (g/dL)	126	1.41±0.81	125	1.19±0.97	0.00, 0.45	.0485
	Hematocrit (%)	126	5.06±3.64	125	4.66±3.03	-0.43, 1.23	.35
	MCV (fL)	126	2.13±2.34	125	1.78±2.82	-0.29, 0.99	.28
	Ferritin (ng/mL)	125	3.33±28.46	116	3.40±22.33	-6.59, 6.46	.98
	BMI	105	0.34±1.22	105	0.68±2.38	-0.85, 0.18	.20
	Hemoglobin (g/dL)	31	1.41±1.08	25	1.31±1.13	-0.50, 0.69	.75
	Hematocrit (%)	31	3.98±2.35	25	5.35±5.00	-3.40, 0.67	.18
	MCV (fL)	31	2.19±3.05	25	2.76±0.93	-1.84, 0.70	.37
	Ferritin (ng/mL)	31	-1.25±18.57	25	-7.33±25.11	-5.62, 17.79	.30
	BMI	36	0.72±1.18	25	0.38±2.48	-0.61, 1.29	.47

All numbers are absolute. Δ = differences between the means. MCV = mean corpuscular volume. BMI = Body mass index. SD =- Standard deviation. 95%CI = 95% Confidence interval for the mean difference. ‡Calculated using the t test for independent samples.

Table 5 Comparative analysis of the presence of anemia according to hemoglobin values according to age group before and after the intervention, and between groups.

Age range	Intervention group			Control group			p-value‡
	Before Cases/-Total	After Cases/-Total	p-value	Before Cases/-Total	After Cases/-Total	p-value	between the groups (at the end of the intervention)
6-59 months	5/5 (100.0)	1/3 (33.33)	.38	18/18 (100.0)	3/12 (25.00)	.05	> .99
5≥11 years	179/179 (100.0)	12/126 (9.52)	**<.00**	214/214 (100.0)	33/125 (26.40)	**<.00**	**.0005**
12≥14 years	32/32 (100.0)	6/31 (19.35)	**.0108**	13/13 (100.0)	7/25 (28.00)	.07	.53

All numbers are absolute, with respective frequencies given in parentheses. ‡Calculated using Fisher's exact test (two-tailed).

Table 6 Comparative analysis of the number needed to treat (NNT) according to age group.

Age range	Adverse outcome (%)		ARR	ARI	IC 95%	NNT	NNH
	Intervention group	Control group	(%)	(%)			
6-59 months	33.33	25.00		8.33	-50.37, 67.03		12
5≥11 years	9.52	26.40	16.88		7.60, 26.15	6	
12≥14 years	19.35	28.00	8.65		-13.79, 31.08	12	

Adverse outcome = participants remained anemic at the end of the study. ARR = Absolute risk reduction. ARI = Absolute risk increase. 95%CI = 95% confidence interval. NNT = Number needed to treat. NNH = Number needed to harm.

the CG. The powdered supplement enriched with iron did not alter the color or taste of the food to be consumed. No complaints were received from participants or parents / guardians in either group; there were no dropouts after the intervention had begun.

4. DISCUSSION

The objective of this study to assess the impact of a powdered supplement, enriched with iron, added to food preparations, on Hb levels and other hematimetric parameters in children and adolescents enrolled in early childhood centers and schools, compared with a CG. For participants in the 6 to 59 months age range, there was an increase in mean Hb concentrations in both groups, with a greater increase in the CG. The small number of children analyzed in this age range (n=3) may have contributed to the non-significant increase in the IG. Among participants aged 5 to 11 years, there was an increase in Hb and Ht in both groups, however, the rise in mean Hb concentration (Δ) was significantly greater in the IG (1.41±0.81 g/dL vs. 1.19±0.97, p=.0485). The NNT for the treatment of anemia in this age group was 6. In the older age range (12-14 years), all variables analyzed in both groups presented an increase; this increase was considered significant for Hb, Ht and MCV in the IG, and Hb and Ht in the CG. However, there were no significant differences between the groups. The NNT for the treatment of anemia in this age group was 12.

Pre- and school-age children are at greater risk for IDA, the global prevalence of anemia in this age range is 47.4 and 25.4%, respectively WHO (2008). In Brazil, researchers have reported that approximately one-fifth of children under the age of five years were anemic Brazil (2009). The consequences of IDA vary greatly, which has been associated with inhibited growth, low birth weight, poor psychomotor and cognitive development, compromised immunity, and increased infant morbidity and mortality Beard (2001); Domellöf et al. (2013); WHO (2001). At the United Nations summit in 2000, the Millennium Development Goals made a call to improve child

nutrition UN (2015). Treatment for IDA usually involves iron fortification or supplementation and making dietary changes Man et al. (2021). In this context, several studies have been conducted to verify the effectiveness of different fortification and supplementation programs.

Arcanjo et al. (2019) evaluated the impact of NutriSUS micronutrient fortification for the prophylaxis and treatment of IDA. This cluster-randomized clinical trial was conducted with 130 infants aged 12-36 months during a period of 12 weeks. At the end of the intervention, the authors reported a significant increase in mean Hb concentrations (0.5 g/dL), and a significant decrease in anemia prevalence (from 29.9% to 7.5%). Another randomized, double-blind controlled trial was performed in Western Europe to investigate the effect of a micronutrient fortified young-child formula compared to cow's milk on iron and vitamin D status, in 318 children aged 1-3 years. After a 20-week intervention, there was a significant reduction in the number of anemic children in the young-child formula group. However, there was no significant difference between the groups for mean change in Hb Akkermans et al. (2017). For this age range, these findings are in line with those presented in the current study – an increase in mean Hb concentrations and a decrease in the prevalence of anemia.

Duque et al. (2014) conducted a randomized, double-blind clinical trial in 200 children, aged 5 to 13 years, who showed low iron stores without anemia, in Mexico City. In this study, the authors had as aim to compare the effect of ferrous sulfate and iron bis-glycinate chelate on serum ferritin concentration. Both interventions lasted 12 weeks and provided a significant increase in serum ferritin levels; this effect persisted for 6 months after the intervention. A community-based randomized controlled trial, conducted in the Kirti Nagar slums of West Delhi with 446 mildly and moderately anemic volunteer adolescent girls (aged 11-18 years), had as objective to assess and compare the impact of weekly iron folic acid supplementation with or without vitamin B12 on the prevalence of anemia, Hb concentration, serum ferritin, folic acid, and vitamin B12. Results from this study showed that weekly iron folic acid supplementation (with or without vitamin B12) significantly improved iron status and reduced anemia prevalence Bansal et al. (2016).

In Sri Lanka, a trial was conducted with 821 schoolchildren aged 12-16 years. This study had as objective to evaluate the effectiveness of combined iron and zinc over the iron or zinc-only supplementation. At the end of the intervention, in the iron-only supplementation group there was a mean Hb increase of 18.2 g/l, and in the iron+zinc group a mean Hb increase of 11.0 g/l. Furthermore, for the prevalence of anemia there was a significant reduction in the iron-only and iron+zinc groups, from 70.3 to 14.5% and 64.8 to 19.3%, respectively Hettiarachchi et al. (2008). In the present study, we identified a 1.41 g/dL increase in mean Hb concentrations for participants aged 5 to 11 years and 12 to 14 years; and a significant reduction in the prevalence of anemia, for participants aged 5 to 11 years in the IG, from 100 to 9.52%, and for those aged 12 to 14 years, from 100 to 19.35% after the intervention.

Our intervention was insufficient to bring about changes in BMI, probably due to the short duration of the study (60 days). To date, few studies have addressed the effects of micronutrient fortification on BMI. One such study conducted by Goyle (2012), in India with 107 adolescent girls aged 10 to 16 years, assessed the effect of supplementation of biscuits with and without micronutrients on weight and height. This controlled clinical trial resulted in significant weight gains of 1.85 and 2.00 kg in the control and experimental groups, respectively. In summary, the intervention with biscuits with and without micronutrients resulted in significant improvements in weight gain and BMI.

Supplementation with multiple micronutrient powders has also been the focus of systematic reviews. De-Regil et al. (2011) performed a review to assess the effects and safety multiple micronutrient powders for the fortification of foods in children under two years of age. Eight trials were included in the review with a total of 3748 participants in low-income countries with high prevalence rates of anemia. Multiple micronutrient powders reduced anemia by 31% and ID by 51% when compared to control or placebo. Suchdev et al. (2020) conducted a meta-analysis to assess the effects and safety of multiple micronutrient powders. Twenty-nine studies conducted in low- and middle-income countries with 33,147 children aged 6 to 23 months were included. The authors concluded that the home fortification of foods with multiple micronutrient powders was an effective intervention for the reduction of IDA and ID in children under the age of 2 years.

Currently, the WHO defends the use of multiple micronutrient powders for the fortification of foods. These powders are intended to increase the mineral and vitamin intakes of infants and schoolchildren. For this, a guideline was published to help Member States and their partners achieve the Sustainable Development Goals, which establishes global targets for maternal, infant and young child nutrition WHO (2016).

Regarding the present study, some limitations need to be acknowledged and addressed. Many confounding factors may affect the outcome of Hb concentrations and the prevalence of anemia, such as illness, inadequate dietary habits, periods of rapid growth, etc. Secondly, the period of intervention was short (60 days), a longer period may have presented more significant results. In the 6≥59-month age range, one major limitation of our findings is the statistical insignificance of the results due to the small number of participants, 5 at baseline, and 3 at the end of the intervention. In addition, the iron dosage in the powdered supplement refers to the value offered to the participants and not necessarily to the amount ingested. Finally, the intervention was conducted only on school days (excluding weekends and holidays) and food intake was not recorded on weekends. Nevertheless, this is one of the few studies to tackle IDA with multiple micronutrient powders for the fortification of foods in such a wide age range (from six months to 14 years).

5. CONCLUSIONS

In conclusion, this powdered supplement, enriched with iron, added to food preparations effectively increased Hb concentrations and other hematimetric parameters, and reduced the prevalence of anemia in children and adolescents enrolled in childhood centers and schools. In populations where anemia is considered a public health problem, we recommend the fortification of food with iron-containing micronutrient powders to improve iron status and reduce anemia prevalence. Furthermore, future studies should be conducted to identify the long-term effects of this kind of intervention on other parameters such as growth, cognitive and motor development, attention span, and resistance to infection.

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