Effectiveness of a School Nutrition Program for Preventing Iron Deficiency Anemia in School Children

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Abstract

Background: Iron deficiency Anemia (IDA) is one of the most common widespread nutritional disorders, affecting large number of children and women in developing countries

Objective: To determine the effectiveness of school nutrition program that offers an iron fortified food item

Methodology: The present study included 60 schoolchildren, first grade 3 primary schools from Nasr City- Cairo during academic year 2016. Males represented 43.3%, while female school children were 56.7%.

Results: The prevalence of IDA in studied school children is 40%. The mean weight of children after iron supplementation was significantly higher than before (23.87± 5.02, 24.96± 5.30 Kgm, t= 4.42, P< 0.000). There are no significant differences between the mean values of Hematological parameters before& after iron supplementation (P >0.05). The mean values of ferritin and Iron were significantly higher after iron supplementation. In anemic children (24), HT& S Iron were significantly higher after supplementation (t= - 2.158, P=.042, t= - 4.141, P=0.000, respectively). Gender Statistics among anemic children showed no significant differences (P>0.05).

Conclusion: Hematological and Iron biochemical parameters with significant values have been used in the diagnosis and follow up of iron deficiency anemia in children as they give accurate information about iron stores and response to iron therapy.

Keywords: Anemia, school children, Iron supplementation.

فاعلية برنامج التغذية المدرسية فى الوقاية من أنيميا نقص الحديد لدى أطفال المدارس

المقدمة: يعتبر الحديد أحد أهم العناصر الهامة لصحة الإنسان ويلعب دورا حيوياً فى حمايته من الإصابة بالأمراض.

الهدف: تقييم فاعلية برنامج التغذية المدرسية فى الوقاية من أنيميا نقص الحديد لدى أطفال المدارس.

المنهجية: أجريت هذه الدراسة على ستون طفلا مصريا من طلاب المداس الابتدائية بالقاهرة. وتم عمل: التاريخ الشخصى والعائلى والفحص الإكلينيكى الشامل. وصورة دم كاملة وقياس بروتين سى التفاعلى ومستوى الحديد ومخزون الحديد والسعة الكلية للحديد فى مصل الدم.

النتائج: أوضحت النتائج الإحصائية ارتفاع فى مستوى الحديد والفريتين فى دم الأطفال بعد برنامج التغذية المدرسية المدعم بالحديد عن مستوياته قبل التغذية المدرسية..

الخلاصة والتوصيات: الاهتمام بإمداد الأطفال بالكميات المناسبة من الأغذية التى تحتوى على الحديد وبعض الأدوية إذا لزم الأمر وذالك للوقاية وتحسين الحالة الصحية لأطفال المدارس من أنيميا نقص الحديد. وتوصى الدراسة بإجراء أبحاث على نطاق أوسع لأهمية الموضوع.

الكلمات المفتاحية: أنيميا نقص الحديد– الأطفال– المدارس– الحديد– تشبع الحديد .السعة الكلية للحديد.

Introduction:

Iron deficiency affects the health of two billion people worldwide, with a range of adverse health and social consequences, including anemia, reduced work capacity, impaired immune response, delayed development and increased maternal and infant mortality. Most affected populations are women and children living in developing countries, as their diets provide less available iron as well as malaria and other infections compound the problem by increasing loss (Trowbridge, 2002).

Iron deficiency is one of the most common widespread nutritional disorders, affecting large number of children and women in developing countries, it is the only nutrient deficiency which is also significantly prevalent in virtually all industrialized nations. About half of the pregnant women in the world are estimated to be anemic (52% in non-industrialized and 23% in industrialized countries) (WHO/ NHD, 2001).

Significant progress has been made in improving the health and nutrition status in the Eastern Mediterranean Region. In spite, iron deficiency anemia remained a public health problem. The prevalence of anemia in women of childbearing age ranged from around 20% in Jordan, parts of Egypt and parts of Oman to more than 60% in countries like Djibouti. Children were more affected than women, the prevalence was more than 60% in many countries (Bagchi, 2004).

In Egypt, about three in ten children suffer from some degree of anemia. This is similar to the level that was found among women. As was the situation among women, the anemia is mild in many cases. However, 11% of young children had a moderate level of anemia, and a small proportion (less than 1%) was classified as having severe anemia. Children less than 2 years were more likely to be anemic. Rural residence children were more likely to be anemic than urban ones (33% and 24%, respectively). Considering the variation by socioeconomic characteristics, the greatest variation in overall level of anemia (including mild as well as moderate and severe anemia) is observed by place of residence. The children (6- 59) months in rural Upper Egypt have the highest anemia levels (38%), and children in urban Lower Egypt have the lowest levels (23%). Looking at the mother's education level, children whose mothers never attended school have the highest anemia level and children whose mothers completed at least secondary school have the lowest level (25 and 33%, respectively) (El- Zanaty& Way, 2004).

Aim of The Study:

The aim of the study is to determine the effectiveness of school nutrition program that offers an iron fortified food item in preventing iron deficiency anemia in young school children.

Subjects& Methods

Study Design:

The study is a prospective study.

Subjects:

This study was implemented in 3 iron supplementation programs in primary school in Nasr City, Cairo. The selection of the schools participated in the study was random. The total number of schools participated in the study was 3, and the total number of school children was 60 (26 boys and 34 girls). The school children were in grade 1 during term 2016.

Inclusion Criteria:

All school children enrolled in first grade classes (males& females) who attend the selected schools for the duration of the first school term.

Exclusion Criteria:

- Participants with mental or physical disabilities.
- Participants With Chronic Diseases.
- Participants who are allergic to any of the ingredients of the school pie/ biscuit.
- Participants who suffers from other types of anemia (other than iron deficiency anemia).

Data Collection:

Parents/ guardians of the participants were interviewed at the first contact, in the schools selected, at the beginning of the school term.

A well structured Enrollment Form was used to conduct the interviews and to collect the necessary personal and socio- economic data for the study.

A weekly Child Feeding Pattern Questionnaire was used to collect the daily food intake pattern of the children of the study sample. The weekly food pattern questionnaire will be given to the parents/ guardians to be completed and brought back each week through the duration of the study.

An informed consent was signed by parents/ guardians who agree to enroll their children in the study.

Anthropometric measures (weight and height) of the children (enrolled in the study) were measured once at the beginning of the study and once more at the end of the study. This will be carried out at the school clinic in each of the selected schools.

A well structured health assessment form was used to record the anthropometric measures, health history, and blood tests results for each child enrolled in the study.

Meetings in each school were conducted with some parents of the school children, mainly the members of the parent council. Objectives of the meeting with the parents were to explain the objectives of the iron supplementation program and its impact on the health of their children. Also in that meeting it was aimed to get their consent for conducting the blood test to their children.

CBC, Serum Iron, Ferritin Level, TIBC and C Reactive Protein testing were done. Testing was conducted at the beginning and the end of the study at the nearest health center of the Ministry of Health and Population.

Statistical Analysis Method:

Clinical data forms will be completed, reviewed and collected at the selected schools. A data management and double data entry system will be designed for this study using standard software SPSS 12.0.

Ethical Issues:

An informed consent will be signed by parents/guardians who agree to

enroll their children in the study.

Limitations Of The Study:

Nevertheless the number of subjects recruited for the study will depend on the number of children enrolled in first grade and kindergarten 1classes in the selected school(s) at the beginning of the study. The number of children recruited for the study will also depend on their parents/ guardians willingness to participate in the study for its full duration.

Results:

Table (1) Children Distribution according to Family size

	No	Percent
More Than 3 Persons	57	95.0
Three Persons	1	1.7
Two Persons	1	1.7
One Person	1	1.7
Total	60	100.0

Table (1) shows Children Distribution according to Family size. More than 3 persons represented (57) 95.0%, three persons (1) 1.7%, two persons (1) 1.7% and one person (1) 1.7%.

Table (2) Gender Differences as regards Blood Parameters before supplementation.

	Gender	N	Mean	± Sd	SEM
Hb gm/dl	M	26	12.08	0.98	0.19
	F	34	12.04	0.73	0.12
RBCs	M	26	4.65	0.40	0.07
	F	34	4.64	0.43	0.07
RDW	M	26	13.78	0.97	0.19
	F	34	13.56	1.10	0.18
Ferritin ng/ml	M	26	32.05	14.94	2.93
	F	34	44.38*	20.57	3.52
Iron ng/dl	M	26	51.88	20.25	3.97
	F	34	55.41	22.98	3.94
TIBC ug/dl	M	26	338.73	38.15	7.48
	F	34	332.29	37.67	6.46

Significant P< 0.05

Table (2) shows Gender Differences as regards Blood Parameters before iron supplementation with no significant differences (P> 0.05).

Table (3) Gender Differences as regards Blood Parameters after supplementation.

	Gender	N	Mean	± Sd	SEM
Hb	M	26	11.99	0.85	0.166
	F	34	12.13	0.74	0.128
HT	M	26	35.89	2.30	0.452
	F	34	36.37	2.04	0.35
RBCs	M	26	4.63	0.32	0.064
	F	34	4.72	0.44	0.076
RDW	M	26	13.82	1.02	0.20
	F	34	13.74	1.11	0.19
S Ferritin	M	26	45.66	21.36	4.18
	F	34	47.69	19.05	3.26
S Iron	M	26	66.57	20.95	4.10
	F	34	72.82	20.72	3.55
TIBC	M	26	330.6	41.93	8.22
	F	34	405.05	460.40	78.95

Table (3) shows Gender Differences as regards Blood Parameters after supplementation.

Table (4) Mean& SD of Weight before& after supplementation.

	Mean	±Sd	SEM	T	P- Value
Before. Wt/ Kg	23.87	5.02	0.64	4.42	0.000*
After. WT. / kg	24.96	5.30	0.68		

Table (4) shows that the mean weight of children after supplementation was significantly higher than before (23.87± 5.02, 24.96± 5.30 Kgm, t= 4.42, P< 0.000).

Table (5) Mean& SD of Hematological Findings parameters before& after supplementation

		Mean	±Sd	SEM
Pair	BEF HG Gm/Dl	12.06	0.84	0.10
	Aft Hg	12.07	0.78	0.10
Pair	Bef Hematocrit	36.04	2.4	0.31
	Aft Hematocrit	36.15	2.15	0.27
Pair	Bef. Rbcs	4.64	0.419	0.05
	Aft. Rbcs	4.68	0.397	0.05
Pair	Bef. Rdw	13.66	1.04	0.13
	Aft. Rdw	13.77	1.07	0.13

Table (5) shows no significant differences between Mean& SD of Hematological Findings parameters before& after supplementation (P>0.05).

Table (6) Mean Values& SD of Iron Profile before& after supplementation

		Mean	±Sd	SEM
Pair	B. FERRITIN. ng/ml	39.04	19.21	2.48
	Aft. Ferritin	46.81	19.93	2.57
Pair	B. IRON ng/dl	53.88	21.73	2.8
	Aft. Iron	70.11	20.88	2.69
Pair	B. TIBC. ug/dl	335.08	37.69	4.86
	Aft. Tibc	372.81	347.40	44.84

Paired Analysis Test for Iron Profile

		Paired Differences					t	Sig. (P-Value)
		Mean	SD	SEM	95% Ci			
					Lower	Upper		
Pair	Ferrtin	- 7.76	21.83	2.81	- 13.40	- 2.12	- 2.75	0.008*
Pair	Iron	- 16.23	25.09	3.23	- 22.71	- 9.75	- 5.01	0.000*
Pair	TIBC	- 37.73	350.52	45.25	- 128.28	52.81	-.83	0.408

Significant P< 0.05

Table (6) shows the Mean Values& SD of Iron Profile before& after supplementation. Ferritin and Iron were significantly higher after supplementation.

Table (7) shows Paired Samples Statistics in anemic children (n= 24). HT& S Iron were significantly higher after supplementation (t= -2.158. P= 0.042, t= -4.141, P= 0.000, respectively).

Table (7) Paired Samples Statistics in anemic children (n= 24)

	Mean	±S D	SEM	
Pair 1	Hb Before	11.29	0.601	0.12
	Hb After	11.37	0.691	0.14
Pair 2	HT Before	33.96	1.45	0.29
	HT After	34.53*	1.97	0.40
Pair 3	RDW Before	14.09	1.38	0.28
	RDW After	14.17	1.33	0.27
Pair 4	Rbcs Before	4.575	0.48	0.09
	Rbcs After	4.642	0.49	0.10
Pair 5	S Ferritin Before	39.39	21.04	4.29
	S Ferritin After	40.15	16.62	3.39
Pair 6	S Iron Before	48.33	18.74	3.82
	S Iron After	68.20*	16.87	3.44
Pair 7	TIBC Before	339.7	41.17	8.40
	TIBC After	444.4	546.6	111.57

Significant P<0.05

Paired Samples Test

		Paired Differences					t	P- Value
		Mean	S D	SEM	95% Ci			
					Lower	Upper		
Pair 1	Hb Before- Hbter Af	-0.0833	0.3691	0.0753	-.2 392	0.0725	- 1.106	0.280
Pair 2	HT Before- HT After	-.5 708	1.2956	0.2645	- 1.1179	-0.0237	- 2.158	0.042*
Pair 3	RDW Before- RDW After	-0.0750	0.8263	0.1687	-0.4239	0.2739	-0.445	0.661
Pair 4	Rbcs Be- Rbcs Aft	-0.0667	0.1659	0.0339	-0.1367	0.0034	- 1.968	0.061
Pair 5	Ferritin Be- Ferritin Af	-76208	22.32477	4.55702	- 10.18901	8.66484	-0.167	0.869
Pair 6	Iron be- iron af	-19.8750	23.5119	4.7993	- 29.8032	- 9.9468	- 4.141	0.000*
Pair 7	TIBC Be- TIBC Af	-104.6250	554.0281	113.0905	- 338.5705	129.3205	-0.925	0.364

Table (8) Group Statistics gender among anemic children

	Gender	N	Mean	SD	Se Mean
Age Per Months	M	10	78.900	3.5730	1.1299
	F	14	78.357	3.5433	0.9470
Wt Before	M	10	22.940	2.7669	0.8750
	F	14	24.450	6.8713	1.8364
Hb Before	M	10	11.180	0.6052	0.1914
	F	14	11.379	0.6079	0.1625
Wt After	M	10	24.290	3.2719	1.0347
	F	14	25.250	7.1500	1.9109
Hb After	M	10	11.200	0.8165	0.2582
	F	14	11.507	0.5850	0.1564

Table (8) shows Group Statistics gender among anemic children all non significant (P> 0.05).

Discussion:

The present study included 60 schoolchildren, first grade 3 primary schools from Nasr City- Cairo during academic year 2016. Asmaa Fahmy School, (6)10.0%, Mohamed Farid School (10)16.7% and Omar Makram School, (44)73.3%. Females represented (34) 56.7% and males (26) 43.3%. Males represented 43.3%, while female school children were 56.7%. The prevalence of IDA among studied school children in 40%.

The prevalence of anemia among preparatory schoolchildren before implementing the supplementation and the nutrition education programs are (Hb < 12g/dl) before starting the supplementation program was 193, with an overall prevalence of anemia of 12.99% (Ibrahim Ismail, 2004).

In Giza governorate, the prevalence of anemia was 12.81% (NNI, 2000). In Alexandria, a study conducted by Ibrahim et.al. 1999, using the cyanmethaeglobin method, the overall prevalence of anemia in adolescent (11- 19) years old was 52.7%. Demographic Health Survey (DHS) 2000 reported the prevalence of anemia in (11- 19) years of age in Lower Egypt areas was 29% (DHS, 2000).

According to the WHO (2008), 66% of children in Southeast Asia, 63% of children in the eastern Mediterranean region, 60% of children in Africa, 46% of children in Latin America, and 7% of children in North America suffer from IDA.

According to the Egyptian Demographic and Health Survey for the year 2005, about half of the Egyptian children under 6 years of age were anemic (48.5%), and rural children are more likely to be anemic than urban children (51 vs. 44%, respectively).

The difference between studies may be due to the difference in age grouping and the difference in the method used for hemoglobin detection.

In the present study, gender statistics showed no significant differences in hematological and iron profile (P> 0.05%). The prevalence of IDA was higher in girls than in boys but did not reach significance. These results are in agreement with those of Abdel Rasoul et.al. (2014) and Mohamed et.al. (2008), who showed that there were no sex related differences in anemia. Illiteracy and low educational level of the mother was found to be a highly significant risk factor for IDA. These results are in agreement with those of Mamdooh (2008) and Mohamed et.al. (2008). However Mamdooh (2008) reported no significant difference.

The prevalence of anemia was higher in schoolgirls than in schoolboys (13.98& for girls Vs 12.05% for boys), the difference is not statistically significant (p= 0.26). The NNI 2000 found also that the anemia was higher in school girls more than in school boys (8.9% for school boys& 12% for girls) (Ibrahim Ismail, 2004).

In the current study, the mean weight of children after supplementation was significantly higher than before (23.87± 5.02, 24.96± 5.30 Kgm, t= 4.42, P< 0.000). There is no significant differences between the mean values of Hematological parameters before& after iron supplementation (P > 0.05).

The mean values of ferritin and Iron were significantly higher after iron supplementation. In anemic children (24), HT& S Iron were significantly higher after supplementation (t= -2.158. P= 0.042, t= - 4.141, P= 0.000, respectively). Gender Statistics among anemic children all non significant (P> 0.05).

Searching for factors that lead to iron deficiency anemia and it was found that parasitic infections such as giarsiasis, entamoeba histolytica were prevelant in anemic children more than in healthy children. In studied group it was about 75% (900) while in control group it was only 13% (35) which is highly significant (P= 0.0001) (Ibrahim Ismail, 2004).

There is a need to consider iron supplementation as part of a comprehensive strategy for the prevention of iron deficiency, and not just as treatment for anemia that is stopped as soon as clinical improvement is noted. Communication efforts must be expanded to increase understanding of the importance of taking supplement and to address any fears or misconceptions relating to supplement (Yip, 2002).

In the present study, the mean values of Hb showed no significant difference after iron supplementation (12.06± 0.84 gm/dl, 12.07± 0.78 gm/dl) (t= 0.12, P= 0.9).

The effect of ferric polymaltose complex in group II on hemoglobin

level showed that Hb level was 8.4 gm/dl± 1.1 before therapy and became 12.4 gm/dl± 1.1 with high statistical significant difference. The effect of ferrous sulfate used daily in group I (A) on MCV showed that MCV was 67.7 fl± 4.5 before therapy and became 78.8 fl± 2 with high statistical significant difference 0.0001 (Ibrahim Ismail, 2004).

In the present study, the mean values of Iron 53.88± 21.7 ug/ dl, 70.1± 20.8 ug/ dl (t= 5.01, P= 0.000). Serum iron showed that serum iron in group I (A) was 26.8 ug /dl± 13.4 before treatment and became 142 ug/dl± 30.4 with high statistical significant difference0.0001, while in group IB, serum iron was 31.7 ug/dl± 10.2 before treatment and became 70 ug /dl± 20.7 with statistical significant difference0.001 (Ibrahim Ismail, 2004).

In the present study, the mean values of TIBC 335± 38 ug/dl, 372± 34 ug/dl. TIBC was in group I (A) 512.4 ug/dl± 50.9 before treatment and became 271.4 ug/ dl± 46.3 with and high statistical significant difference0.0001, while in group I (B), using ferrous sulfate twice weekly, TIBC was 502.7 ug/dl± 50.9 before therapy, and became 403 ug/dl± 60.1 after treatment with statistical significant difference0.001 (Ibrahim Ismail, 2004).

In the present study, the mean values of S ferritin 39.04± 19.2 ng/ ml. 46.8± 19.9 ng/ml (t= 2.75, P= 0.008). Serum ferritin was 20.3 ng/ ml± 12.9 and became 14.2 ng/ml± 54.9 after treatment with statistical significant difference0.001 after treatment, while in group I (B) serum ferritin was 21.2 ng/ ml± 7.4 before treatment and became 49.4 ng/ml± 15.7 after treatment with ferrous sulfate twice weekly with statistical significant difference 0.001 (Ibrahim Ismail, 2004).

In the present study, the mean values of HT was 36.04% and became 36.15% after iron supplementation. HCT was 26.6%± 3 before treatment and became 29.9%± 1.9 after treatment with statistical significant difference (Ibrahim Ismail, 2004).

In the present study, the mean values of RDW was 13.66% and became 13.77% after supplementation. RDW was 19.2%± 3.3 before treatment and became 15.2%± 2.2 after iron salt therapy with statistical significant difference 0.001(Ibrahim Ismail, 2004).

In the current study, children distribution according to the birth order. The first birth order represented (27) 45.0%, the third (21) 35.0% and the second (12) 20.0%. Gafar et.al. (2017) studied some epidemiological factors and reported Birth order ≤ 2 36 (83.7%) in anemic children and 32 (68.1%) in controls ($\chi 2$=2.972 >0.05).

In the current study, Family size > 3 represented (57) 95.0%, 3 (1) 1.7%, 2 (1) 1.7% and 1 (1) 1.7%. Large family was found in 60% (721) in studied group where it was 15% (41) in control group with statistical significance (P= 0.0001). Low economic status was found in anemic children up to 80% (962) while it was only 30% (80) in normal children (P= 0.0001). Large family and low economic status are always associated with low bioavailable diet low in protein, low in minerals and low in energy, it was found in about 75% (900) in the studied group and only 30% (79) in control group with high statistical significant difference (P= 0.0001) (Ibrahim Ismail, 2004).

Gafar et.al. (2017) reported as regards Family size that ≤4 30 (69.8%) in anemic cases and 12 (25.6%) in controls (χ^2=3.27 <0.05), and family size> 4 represented 13 (30.2%) in anemic and 35 (74.4%) in controls.

In the current study, high school mothers represented (21) 35.0%, primary (16) 26.7%, illiterate (11) 18.3%, preparatory (9) 15.0% and university (3) 5.0%.

Mother's education in Gafar et.al. (2017) showed that Illiterate represented 12 (27.9%) in anemic cases and 21 (44.7%) in controls. (Z) = 7.31< 0.05. Read and write& basic education 28 (65.1%) in anemic cases and 18 (38.3%) in controls. (Z)= 8.20 <0.05. Secondary and above 3 (7.0%) in anemic cases and 7 (14.9%) in controls (Z)= 8.52 <0.05

In the current study, House wife mothers represented (51) 85.0%, worker (6) 10.0%, specialist (2) 3.3% and technician (1) 1.7%. Housewife represented 39 (90.7%) in anemic cases and 43 (91.5%) in controls. χ^2= 0.017 >0.05. Employed 4 (9.3%) in anemic cases and 4 (8.5%) in controls (Gafar et.al., 2017).

As regards food consumption among children in the present study, Meat 26.05% Chicken 30.16% Fish 14.09% Legume 33.49% Seeds 79.9%, green vegetable 37.01%, yellow vegetable 28.02%, Fruits 49.45%, Milk 62.43%, Tea 14.59% and Soda drink 22.9%.

Conclusion:

Hematological and Iron biochemical parameters with significant values have been used in the diagnosis and follow up of iron deficiency anemia in children as they give accurate information about iron stores and response to iron therapy.

Recommendations:

1. Use of routine micronutrient supplementation such as sprinkles in the community. Currently there is not enough evidence that the benefit is outweighed by the risk of infection.
2. Further oral iron formulations can be reviewed for efficacy and palatability when/ if they become available
3. Nutrition education should be implemented in schools to increase the awareness of the school children, teachers and parents about the impact of anemia on the health/ nutrition and the scholastic performance of the school children.
4. Iron supplementation is an effective technique in combating IDA especially if nutrition education strategy are used.
5. Educational materials (booklets, poster, flayers and brochures) about anemia should be prepared and distributed.
6. It is better to implement the supplementation program at the first school semester to ensure higher compliance rate.
7. More studies in different parts of Egypt should be implemented to study the prevalence of anemia in primary school children.

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