WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 10, Issue 10, 1456-1467. Research Article ISSN 2277– 7105

EFFECT OF WEEKLY IRON SUPPLEMENTATION ON HEMOGLOBIN STATUS IN PRESCHOOL CHILDREN IN DONGOLA CITY

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Article Received on 28 May 2021,
Revised on 18 June 2021,
Accepted on 08 July 2021
DOI: 10.20959/wjpr202110-21239

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ABSTRACT

Introduction: Iron deficiency anemia is an important public health problem in Sudan. Between 1994 and 1995, the survey observed a high prevalence (84.6%) of hemoglobin concentrations below 110.0g/l in the population of children between 6 month and 5 years. Objective: Study the effect of weekly iron supplementation on hemoglobin status in preschool children in Dongola city. **Materials and Methods:** A weekly medication scheme, in kindergartens was evaluated in order to make it feasible for routine use. The study was conducted in three kindergartens in Dongola town - Sudan. The iron supplement (6 mg/kg) was provided on a weekly basis to all children (n=72) 3 to 5 years old during three months at the institution by the researcher to control hemoglobin levels. This is an intervention study whose individuals were examined at two different periods: at the beginning of treatment (T1); and after three months of iron supplementation (T2). Hemoglobin measurements were obtained using a portable digital colorimeter–(lab- tech, made in India, SR.NO.15605/05/08) Cyanmethemoglobin. **Results:** The prevalence of anemia in study group was 60%. A significant improvement was observed in the hemoglobin levels of the children after controlling for age and initial hemoglobin. The hemoglobin concentration of these children improved an average of 0.067 g/l after each dose of iron sulfate. At the end of three months there was an average gain of 0.8 g/l, and prevalence of anemia reduced by 50%. **Conclusion:** The intervention proved to be feasible for child-care centers and pre-school population.

INTRODUCTION AND LITRITURE REVIEW

Anemia is defined as a pathological process in which hemoglobin (Hb) concentration is abnormally low, considering variations to age, gender, sea-level attitude, as a result of several situations such as chronic infections, hereditary blood conditions, deficiency of one or more essential nutrients that are necessary for the formation of hemoglobin e.g. folic acid, B12, B6. C vitamins, and proteins.[1]

Iron deficiency anemia IDA in children ages one month-5years can result in behavioral,[2] cognitive, psychometric[3,4] deficits and decreased growth rate[5,6] as well as impaired immune system thus increasing the susceptibility of infection even in mild cases.[7] These impairments can lead to decreased motor activity, social interaction, and attention to tasks, just to mention a few. The danger of irreversible developmental delays due to a temporary nutritional deficiency emphasizes the importance of prevention, especially since the risk of IDA during this period depends largely on diet.

Iron deficiency occurs at three stages. The first stage -iron depletion - occurs when iron content is not enough to meet body requirements. At the beginning, there is a reduction in iron deposition, characterized by serum ferritin below .012 mg/l, without functional changes. If the negative balance persists, the second stage begins- iron-deficient erythropoiesis - characterized by a reduction in serum iron, transferrin saturation below 16% and an increase in the free erythrocyte protoporphyrin level. At this stage, work capacity may be reduced.

At the third stage - iron deficiency anemia – hemoglobin is below the standards for age and gender. This stage is characterized by the development of microcytosis and hypochromia.

Iron depletion at the initial stages is substantially higher than anemia itself. The Pan-American Health Organization /World Health Organization estimates that for each person with anemia there is at least another one with iron deficiency.[8]

The operational definition of anemia, in terms of hemoglobin levels, was established by the World Health Organization, adopting the level of 11.0 g/dl for children under the age of six and pregnant women. For children aged between 6 and 14 years and non pregnant adult women, the level was 12 g/dl, and 13 g/dl for adult men.[1]

The clinical signs of anemia are not easily recognizable and many times go unnoticed. These signs include paleness anorexia, apathy, irritability, reduced attention and psychomotor deficiencies.[9]

Usually, anemia originates from blood loss and/or prolonged iron deficient diet, especially in periods in which requirements are high, as in the case of children and adolescents who have accelerated growth rate. In addition, pregnancy and lactation are periods in which there is a lot of iron requirement.

The causes of iron deficiency anemia and iron deficiency may have their onset in the intrauterine life. Physiological reserves of iron (0.5g/kg in full-term new-born) are formed during the last three months of pregnancy, and together with the iron found in breastmilk, meet the demands of breast-fed infants until their sixth month of life. Therefore, prematurity, low weight at birth, early interruption of exclusive breast-feeding, are the most common causes that contribute to iron depletion in breast fed infants.[10,11]

Acute or chronic blood loss depletes body iron reserves and may cause pathologies such as gastro esophageal reflux,[10] or parasites such as Ancylostoma duodenal or Necatoramericanus, Ascaris lumbricoides and Giardia lamblia cause bleeding as they compete for food.

Iron deficiency anemia is a the most common nutritional deficiency,[12] the population groups which are most affected are infants aged between 4 and 24 months, school age children, female adolescents, pregnant women and nurturing mothers.[13] About 43% of preschool children all over the world, especially in developing countries, which present prevalence rates four times higher than those found in industrialized countries. This high prevalence is associated with poor sanitation conditions, low socioeconomic conditions and high morbidity among infants.[14]

In Sudan, the prevalence of anemia in preschool children can be extremely high. Between 1994 and 1995 a survey observed a high prevalence (84.6%) of hemoglobin concentrations below 110.0g/l in the universe of children between 6 month and 5 years.[15]

International reports suggested that, in populations with a high prevalence of anemia (>40%), direct supplementation was likely to be the preferred initial approach to control existing anemia, then to be complemented, and perhaps replaced, by supplementation or nutritional guidance for the prevention of anemia.[12,16]

Unfortunately, supplementation using medication, although efficient for the control of iron deficiency, presents several practical problems, because the obligation of ingesting the medication every day leads to saturation of the intestinal mucosa[16] which, in turn, causes gastrointestinal problems and non-compliance before hemoglobin levels are normal. In addition, as anemia generally does not present apparent clinical symptoms, patients forget to continue treatment for a prolonged period.

An attempt to solve this deficiency resulted in the proposal of an intermittent medical treatment (weekly or twice weekly)could have as similar an effect on the hemoglobin status as daily iron supplementation, reducing the side effects[17] and the interaction of a daily iron dose with the absorption of other nutrients.[18]

Several studies conducted in many countries demonstrated benefit from twice a week doses of iron supplementation to control anemia[19,20,21] in preschool and young children. However the benefit was not as large n older children[22,23]

The goal of this study was to evaluate the efficacy of a weekly iron supplementation on the hematological status of Sudanese preschool children (3 to 5 years) in Dongola city.

MATERIALS AND METHODS

Materials

The Iron preparation which was used in the study was Saferon syrup 50mg/5ml - is a trade name of ferrous sulphate–made in India by Glenmark company and imported to Sudan by Raheeg company.

Vitamin C in form of tablet (Remedeca company, Cyprus), imported to Sudan by Siho trading company.

Instruments: A beam balance detecto scale and stadiometer. This an instrument was used to measure body weight of children. Sterile lancet and digital colorimeter (lab-tech, made in India, RS. NO.15605/05/08) cynometha hemoglobin)

Methods

This was a prospective and interventional study to assess the effect of weekly iron supplementation on hemoglobin level of preschool children carried out in Dongola city, which is about 500 km north of Khartoum, and is the capital of Northern state of Sudan. Three ntergardens were selected randomly for the study.

The parents of the children between 3 and 5 years were invited to participate in the study signing the consent form, parents of only 72 children agreed to participate from the three kindergartens, 44 of children were males (61%) and 28 females (39%).

None of these children showed clinical signs of chronic diseases on medical examination by the pediatrian. Each individual has baseline as internal control.

Measurement

First day demographic variables, sex, age, school, and class were extracted directly from the school record.

Second day the body weight of children wearing school uniforms without belt and shoes and with empty pockets was measured using a beam balance detecto scale and stadiometer.

Every child in the samples underwent a physical examination by the pediatrian before (T1). Clinical abnormalities such as skin infections upper respiratory infections, or ear infections were treated and recorded, but the children with such minor medical problems were included.

It was decided to only measure hemoglobin as an indicator of iron status because previous studies in similar population groups had shown that iron deficiency was the main cause for low hemoglobin concentrations(6, 20), and because the primary aim was to decrease the prevalence of low hemoglobin concentrations rather than to build iron stores.

Hemoglobin concentration(Hb) was determined in finger-prick blood in all children in the morning and the samples of blood were kept in micro-containers containing EDTA and hemoglobin concentration was measured by well trained laboratory Technician using sterile lancet and digital colorimeter before starting the intervention (T1) and after three months of intervention. (T2).

The cut-off point used to define anemia was a hemoglobin concentration of < 110.0g/l (1).

Intervention

After the initial hemoglobin and body weight of the children were measured, every child received the iron supplementation (6mg/kg/week) with vitamin C (50mg) to increase the absorption of iron every week for three months.

The specific dose of iron (ml) and vitamin C was given to the child after breakfast to minimize the gastrointestinal side effects of iron.

The kindergartens were visited on the next day of delivering the supplement to the children to ask the individuals responsible for kindergartens about their observations – side effects of the drug, increase or decrease appetite and activity of children, and on the remaining days of the week parent were instructed to report any side effects.

Statistical analysis

The statistical analysis of quantitative data was performed using statistical package for science (SPSS) software (t. test).

RESULTS

The greatest difficulty in carrying out this intervention study was following up the children investigated. Despite the best efforts, some of them were lost because they had either moved or had become ill. A total of 72 children were enrolled aged 3-5 years, of which male were 61% and female 39%. By the end of intervention only 56 children completed the study.

Table 1: Number of children lost to follow up.

Initial Age(years)	No at T1	No at T2	Lost	%
3	27	18	9	33.3%
4	25	21	4	16%
5	20	17	3	15%
Total	72	56	16	22%

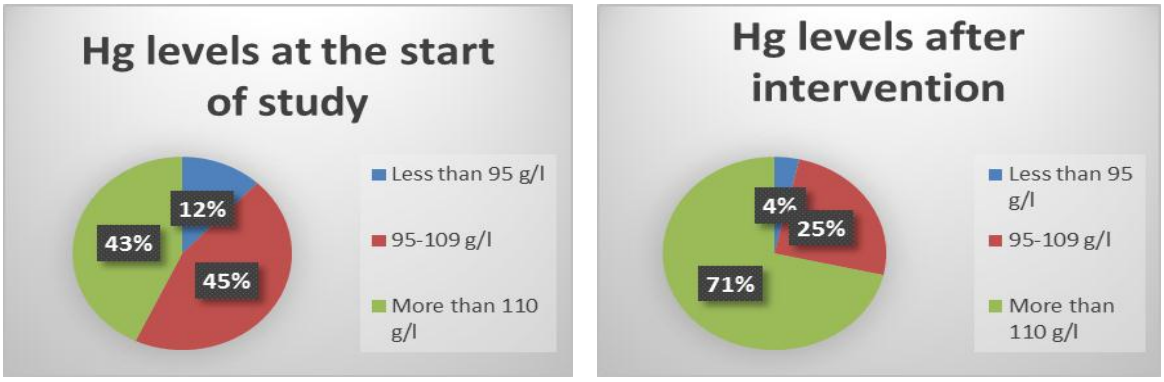

Figure 1: Hemoglobin values of preschool children in Dongola city who completed the study.

Anemia prevalence (hemoglobin <110 g/L) among all children at the start of the study was high, (43 out of 72), they represent about 60%. At baseline the selection of the study population that classified into three groups: normal (Hb equal or more than110g/dl), moderate (Hb = 95-109 g/dl) and severe anemic (Hb< 95g/dl), represented 24(42.9%), 25 (44.6%) and 7 (12.5%) respectively as shown in figure 1.

Table (2 a and b): represented the distribution of males and females according to initial hemoglobin level. Also the study showed that the prevalence of anemia in female of the study group was about 60% and in male of that group was 55% as describe. And represents the percentage of anemic children among the children who completed the study was 57.1% (32 out of 56) in table 2 (a), table (b) below.

Table 2(a): Hemoglobin distribution of Males and Females in the studied group.

Hb1		**Gender**		
		Male	**Female**	**Total**
Less than 95	Count	7	2	9
	% within Hb1	77.8%	22.2%	100.0%
	% within gender	19.4%	10.0%	16.1%
	% of Total(56)	12.5%	3.6%	16.1%
95-109	Count	13	10	23
	% within Hb1	56.5%	43.5%	100.0%
	% within gender	36.1%	50.0%	41.1%
	% of Total(56)	23.2%	17.9%	41.1%
More than 110	Count	16	8	24
	% within Hb1	66.7%	33.3%	100.0%
	% within gender	44.4%	40.0%	42.9%
	% of Total(56)	28.6%	14.3%	42.9%
Total	Count	36	20	56
	% within Hb1	64.3%	35.7%	100.0%
	% within gender	100.0%	100.0%	100.0%
	% of Total(56)	64.3%	35.7%	100.0%

Table 2(b): Hemoglobin distribution of Males and Females in the studied group.

Gender/	**Male /36**	**Female /20**	**Total**
Less than 110	20	12	32 out of 56
%	55%	60%	57%

The mean body weight of the study group was less than the ideal body weight for each age. The ideal body weight for 3 years is 14 kg (mean = 13.3 kg), for 4 years is 16 kg (mean = 15 kg) and for 5 years is 18 kg (mean =17.7 kg).

There was a clear and significant reduction in the prevalence of anemia in study population after the weekly iron supplementation period (%Hb<110.0g/l), the prevalence reduced by half, since the beginning of the weekly treatment the prevalence of anemia was 57.1% and at the end of study it reduced to 28.6%), as described in figure 4.

Table 3: Hemoglobin concentration (mean ±SD g/l) at the beginning of study (Hb1), and After three month of intervention.

Age	No	Hb1 mean ± SD	Hb2 mean ± SD	Hb2-Hb1
5 years	17	110.64 ± 12.00	120.60 ±7.99	9.95
4 years	21	104.45 ± 11.1	111.47 ±12.60	7.01
3 years	18	106.14 ± 9.41	113.3 ±11.17	7.17

Table 4: Hemoglobin concentration (mean ±SD) g/l) at the beginning of study (Hb1), and After three month of intervention.

Initial Hb g/l	No	Hb1 mean(SD)	Hb2mean(SD)	Hb2-Hb1
Less than 95	7	89.4	106.4	17
95 to < 110	25	101.8	111.09	9.29
110 and more	24	112.375	120.77	8.4
Total	56	106.87(11.0)	114.84(11.4)	7.96

* P. value = 0.005

Table 3 & 4 represent that the average hemoglobin concentrations for the two readings taken during the study. A comparison of hemoglobin means from the beginning of the study (Hb1) and after the three months intervention (Hb2) showed a significant increase (p. value is 0.005) of 8.0 g/l, regardless of the child initial age and hemoglobin.

5 years old Children had higher initial hemoglobin values- approximately 5g/l more- than the two others age groups.

Comparing hemoglobin means, before and after three months intervention with medication, there was a significant increase by 8 g/l ($p = .005$). The mean hemoglobin concentration increased from 106.9 g/l to 114.8 at the end of study.

Also, the study showed that there was a significant variation between the anemic children and non-anemic ones in the effect of medication on hemoglobin levels. This variation was doubled in children who were anemic to begin with (17 g/l), compared to non-anemic children (8.4 g/l). Those with Hb< 110 g/l at baseline achieved a mean increase of (9.29 g/l) at the end of weekly treatment with medication. Severely anemic children (Hb< 95 g/l) achieved a gain of (17 g/l) at the end of iron supplementation. By the end of the study, they obtained a mean of 106.4 g/l, that is, lower than the cutoff point for anemia by only 3.6 g/l.

Children with a hemoglobin concentration higher than or equal to 95 g/l had average increase of 8.8 g/l, equal to half the increment (17 g/l) in severe anemia.

As table 5 shows there was a variation in responsiveness of female and male to weekly iron supplementation, the prevalence of anemia in female was dropped from 60% to 25% and from 55% to 31% in male.

The study also showed that the number of children with hemoglobin concentration less than 95 g/l before the intervention was 7 children (12.5 %), and this was reduced by1/4 became 2 children(3.6%) at the end of study. And the number of children with hemoglobin concentration 95 g/l and less than 110 g/l at the baseline was 25 (44.6 g/l) and at the end of intervention they were 14 (25%), reduced by the half.

On opposite hand there was an increase in the number of children with hemoglobin concentration more than 110 g/l from 24 children (42.8%) to 40 children (71.4%).

Table 5: Presents Male and Female still anemic after the intervention.

Hb2		Gender		
		Male	**Female**	**Total**
Less than 95	Count	2	0	2
	% within Hb2	100.0%	.0%	100.0%
	% within gender	5.6%	.0%	3.6%
	% of Total	3.6%	.0%	3.6%
95-109	Count	9	5	14
	% within Hb2	64.3%	35.7%	100.0%
	% within gender	25.0%	25.0%	25.0%
	% of Total	16.1%	8.9%	25.0%
More than 110	Count	25	15	40
	% within Hb2	62.5%	37.5%	100.0%
	% within gender	69.4%	75.0%	71.4%
	% of Total	44.6%	26.8%	71.4%
Total	Count	36	20	56
	% within Hb2	64.3%	35.7%	100.0%
	% within gender	100.0%	100.0%	100.0%
	% of Total	64.3%	35.7%	100.0%

At the beginning of the intervention, some children complained about stomachache after ingestion of the iron. The frequency of gastrointestinal side effects is known to relate to the iron dose, but also symptoms were most common in pupils who came to school without breakfast.

CONCLUSION

The results of this study showed that the weekly iron supplementation has significant effect on hemoglobin status especially in severe anemic children (Hb less than 95 g/l) and reduced the prevalence of anemia by 50% in pre-school children of Dongola city.

Once the iron status of these children is restored, chances are favorable that it will remain adequate for a prolonged period of time.[32]

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