Archives of Hematology and Blood Diseases

ISSN: 2639-3581

Volume 3, Issue 1, 2020, PP: 26-43

Prevalence of Iron Deficiency Anaemia among School Children in Sabratha, Western Libya

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Abstract

***Background:** Anaemia is a silent but deteriorating health problem and Iron deficiency anaemia being very common in developed countries. It affects approximately 25% of school-aged children globally. 48% of the children aged between 5 and 14 years are anemic in developing countries. Iron deficiency anaemia adversely affects aerobic fitness, endurance capacity and efficiency of work. Childhood anaemia poses a major public health issue leading to an increased risk of child mortality as well as the negative consequences of iron deficiency anaemia on cognitive and physical development.*

***Objectives:** The present study aimed to assess the prevalence of iron deficiency anaemia among school children in Sabratha in Western Libya.*

***Methods:** Stratified random sampling technique covering the four geographical zones of Sabratha was used. Sabratha area is divided into four geographical zones: first, second, third, and fourth. From each zone number of schools were randomly selected then a sample of children from each school was randomly chosen (males and females from each age group). A total sample of 711 school children from the selected schools aged (6-14) years constituted the subjects of the study. Venous blood was collected in tubes containing EDTA. Fresh blood was used for the estimation of hematological parameters (RBCs indices, Serum iron, and ferritin).*

***Results:** Of the 711 screened school children 11.08% males and 12.90% females were anemic (Hb<12 g/dl). 9.67% females and 8.92% males were having Iron deficiency anaemia (Hb<12 g/dl & serum ferritin<15 ng/ml). A significant correlation was found between serum iron and serum ferritin in iron-deficient anaemic children (r-0.99).*

***Conclusion:** It can be concluded that anaemia occurs in all Sabratha area and though at significantly variable prevalence. The first zone population has the highest frequency of anemia and Iron deficiency followed by the second. In all zones, males in the age group (6-7) years and females in the age group (11-14) years were significantly more susceptible to develop anaemia and iron deficiency. Interventional health education programs should be conducted in schools to highlight the risk factors of anemia as well as to encourage the intake of miscellaneous diets which include iron-rich foods and fruits that contain vitamin C that enhances iron absorption.*

Keywords: *Iron deficiency, Iron deficiency anaemia, School children, Ferritin, Sabratha, Western Libya.*

Introduction

Anaemia is a silent but deteriorating health problem and Iron deficiency anaemia being very common in developed countries [1, 2]. It is a condition characterized by reduction in number of red blood cells or the haemoglobin (Hb) concentration in the blood is lower than normal or their oxygen-carrying capacity to meet physiologic needs [3,4]. Anaemia was defined according to World Health Organization (WHO) cut-offs as Hb level < 12.0 g/dL for girls and

boys under 15 years old or 13 g/dL for boys aged 15 years and over. Mild anaemia was defined as Hb levels between 9.0 g/dL and the cut-off points, moderate anaemia was Hb 7.0–8.9 g/dL and severe anaemia was Hb < 7.0 g/dL [5]. It is a global public health problem affecting both developing and developed countries and has major consequences for human health as well as social and economic development [6]. Because of health and socioeconomic problems, the prevalence of anemia is higher in developing countries [7]. It affects roughly one third of the world's population [8, 9, 10] and over 800 million women and children [10, 11].

Anaemia adversely affects the cognitive performance, behavioral characteristics and physical growth of infants, preschool and school-age children. It also affects the immune status and morbidity from infections of all age groups and the use of energy sources by muscles [12,13]. Anaemia in the adolescence causes reduced physical and mental capacity and diminished concentration in work and educational performance, and also poses a major threat to future safe motherhood in girls [6]. Anaemia has been shown to contribute to mortality; a recent meta-analysis of nearly 12,000 children from six African countries aged 28 days to 12 years indicates that for each 1 g/dL increase in Hb, the risk of death falls by 24% [14, 15].

Anaemia affects approximately 25% of school-aged children Globally [15, 16]. According to the 2001 World health Organization data, 48% of the children aged between 5 and 14 years are anemic in developing countries [17, 18]. According to the latest report of WHO (2011) estimated roughly 43% of children have anaemia globally which is corresponding to 273 million children [1, 2, 19, 20]). In developing countries it's not only poverty but social factors also play in poor nutrition, poor health management among girls in adolescence as they remain neglected for being a girl child [1, 2].

Iron is an important mineral for the body which uses it for the production of hemoglobin, a key pigment of red blood cells [10, 21, 22]. Iron is required in the final step of hemoglobin formation; ferrochelatase facilitates the incorporation of iron into protoporphyrin, thus forming hemoglobin [23, 24]. It is also a component of many essential enzymes in the development of cells, growth of the appropriate cells of the brain, muscle, and immune system [21, 22].

Iron deficiency is the most prevalent haematologic disorder during childhood, globally [25, 26]. Iron deficiency has also been linked to behavioural and learning problems among children and adolescents [27, 28]. Iron deficiency anaemia adversely affects aerobic fitness, endurance capacity and efficiency of work [28, 29]. It impacts cognition by decreasing the activity of iron-containing brain enzymes [28, 30].

Iron deficiency anaemia is a condition in which anaemia occurs due to lack of available iron to support normal red cell production [6, 31]. Iron deficiency develops when dietary iron intake cannot meet iron needs (e.g. owing to poor diet, or impaired absorption from high intake of phytates or phenolic compounds), especially during periods of life when iron requirements are especially high (i.e. during infancy and pregnancy), or iron losses exceed iron intake (e.g. from blood loss from parasites, childbirth or menstruation) over a period of time. In the late stages of iron deficiency, when the body's store of iron has been depleted, the supply of iron to support production of red blood cells is compromised and, as a result, haemoglobin concentration decreases. Iron-deficiency anaemia is characterized as a hypochromic, microcytic anaemia [10].

Iron deficiency is the most widespread and common nutritional disorder in the world. In spite of the efforts to decrease the frequency, the prevalence varies in different parts of the world with higher rates in the developing countries [32, 33]. Iron deficiency anemia is the commonest nutritional disorder in the world. Around 30% of the world's population are anemic, mainly due to iron deficiency [4]. The effects of IDA on children are the most dangerous one because their bodies are still developing, including the brain, which is the fastest developing organ in infancy and early childhood [4]. Childhood anaemia poses a major public health issue leading to an increased risk of child mortality as well as the negative consequences of iron deficiency anaemia on cognitive and physical development [20]. Causes of anaemia in developing countries are multi-factorial, which include nutritional (iron, folate, and vitamin B12) deficiencies, infections (such as malaria and intestinal parasitic infection, and chronic illness [6, 34]. Childhood anaemia is an ecological problem that does not occur alone. It consorts are poverty, ignorance, unhealthy cooking, disturbed family structure, poor eating and storing practices and of course poor knowledge. Socio

economic factors like neglect of girl child, large family size and lack of child spacing and poor adoption of family welfare measures and methods which have either a direct or indirect effect on childhood anaemia. Environmental factors like parental education, socio economic status, standards of living, parental attitudes and child bearing and rearing practices have a direct effect on the growth and development of children [20].

Objectives

Anaemia affects individuals of both gender and all ages, there is a need for localized and age- and context-specific studies to improve our knowledge of prevalence patterns and associated risk factors of Libyan population. The present study was done to determine the prevalence of iron deficiency anaemia among school children in Sabratha in Western Libya.

Materials and Methods

Study Population

Stratified random sampling technique covering the four geographical zones of Sabratha was used. Sabratha area is divided into four geographical zones: first (North East Sabratha zone), second (North West Sabratha zone), third (South West Sabratha zone), and fourth (South East Sabratha zone). From each zone number of schools were randomly selected then number of children from each school was randomly chosen (males and females from each age group).

Total sample of 711 children from the selected schools aged (6-14) years constituted the subjects of the study. Distribution of samples of school children in Sabratha area according to age groups, gender and geographical zones were shown in table 3.1.

Table 3.1. *Distribution of samples of school children in Sabratha area according to age groups, gender and geographical zones.*

Zones/ Age groups (years)	First		Second		Third		Fourth		**Total**					
	Males	Females	Males	Females	Males	Females	Males	Females	Males	%	Females	%	Total	%
(6-7)	42	28	-	-	5	3	2	3	49	6.9	34	4.8	83	11.7
(8-10)	43	18	9	13	12	16	35	37	99	13.9	84	11.8	183	25.7
(11-12)	26	25	32	29	8	12	26	45	92	12.9	111	15.6	203	28.6
(13-14)	25	23	42	40	34	26	29	23	130	18.3	112	15.7	242	34.0
Total	136	94	83	82	59	57	92	108	370	52.0	341	48	711	100

Blood Samples Collection

Blood sample of 5 ml was collected from each child by venepuncture and 2 ml were withdrawn into EDTA vacuutainer tube for complete blood count (CBC) estimation. The other 3 ml were collected in plain tube and blood was allowed to clot and serum separated and stored at ±20°C until used for the serum iron, ferritin, and TIBC estimation.

Haematological and Biochemical Analysis

Automatic blood analyzer (Sysmex KX-21N) used to analyze the blood samples for CBC according to the manufacture recommendation.

Further investigations were done for serum iron, serum ferritin, and TIBC. Manual Kit method and automatic measurement were used by (Siemens-Dimension P and plus).

Ethical Considerations

Ethical approvals were obtained from ethical committee of Sabratha Teaching Hospital, and from each school determined as a point for samples collection. Informed consent were taken from all the participants and their families prior to their inclusion in this study.

Statistical Analyses

The data were analyzed using GraphPad Prism software version 5. Chi-square statistical analysis was done to detect significant value.

Results

Data in table (1) and figure (1) shown the prevalence of anaemia (Hb<12g/dl) among school children in Sabratha according to geographical region and sex, the estimated prevalence of anaemia in males was 18.38%, 7.23%, 5.08%, 7.61%, and 11.08% in the first, second, third, fourth, and all regions respectively. But, the prevalence of anaemia in females school children was 17.02%, 14.63%, 7.02%, 11.11%, and 12.90% in the first, second, third, fourth, and all regions respectively.

Table 1. *Prevalence of anaemia (Hb<12g/dl) among school children in Sabratha according to geographical region and sex*

Sex / Regions	Males			Females		
	n	Number	%	n	Number	%
First	136	25	18.38	94	16	17.02
Second	83	6	7.23	82	12	14.63
Third	59	3		57	4	7.02
Fourth	92	7	7.61	108	12	11.11
All Regions	370	41	11.08	341	44	12.90

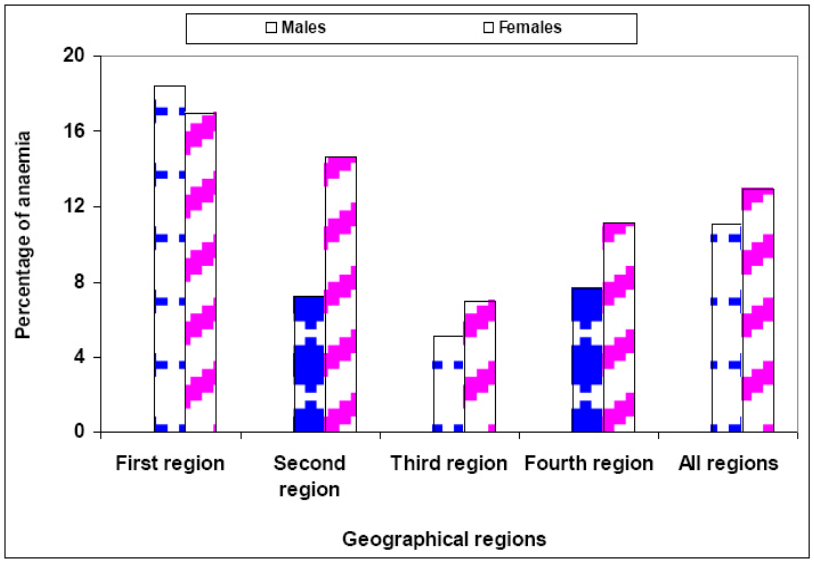

Figure 1. *Prevalence of anaemia (Hb<12g/dl) among school children in Sabratha according to geographical region and sex*

The prevalence of iron deficiency (serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex are shown in table (2) and figure (2). The estimated prevalence of iron deficiency in both males and females was 25.65%, 12.73%, 1.72%, 11.50%, and 14.77% in the first, second, third, fourth, and all regions respectively. But, in males, the prevalence of iron deficiency was 27.94%, 12.05%, 1.69%, 10.87%, and 15.95% in the first, second, third, fourth, and all regions respectively. In females, it was 22.34%, 13.41%, 1.75%, 12.04%, and 13.49% in the first, second, third, fourth, and all regions respectively.

Table 2. *Prevalence of iron deficiency (serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex*

Sex / Regions	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
First	136	38	27.94	94	21	22.34	230	59	25.65
Second	83	10	12.05	82	11	13.41	165	21	12.73
Third	59	1	1.69	57	1	1.75	116	2	1.72
Fourth	92	10	10.87	108	13	12.04	200	23	11.50
All Regions	370	59	15.95	341	46	13.49	711	105	14.77

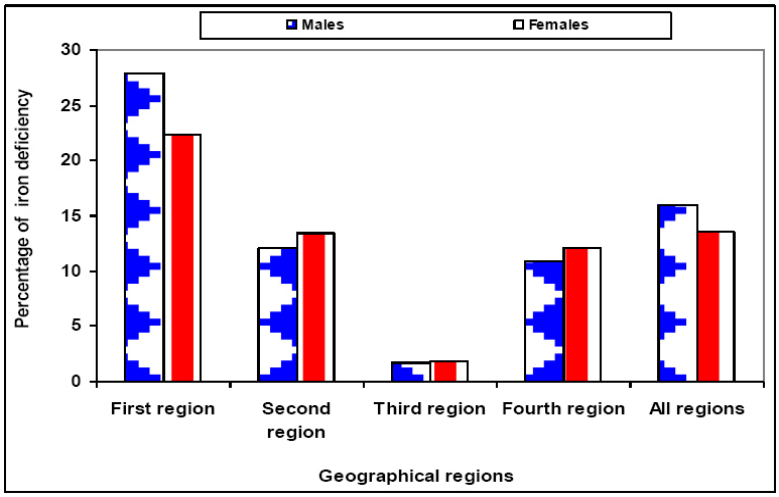

Figure 2. *Prevalence of iron deficiency (serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex*

The prevalence of ferritin deficiency (serum Ferritin <15 ng/ml) among school children in Sabratha according to geographical region and sex in both males and females was 52.61%, 30.30%, 21.55%, 20%, and 33.19% in the first, second, third, fourth, and all regions respectively. But, in males, the prevalence of ferritin deficiency was 55.88%, 27.71%, 23.73%, 15.22%, and 34.32% in the first, second, third, fourth, and all regions respectively. In females, it was 47.87%, 32.93%, 19.30%, 24.07%, and 31.96% in the first, second, third, fourth, and all regions respectively (Table.3 & Figure. 3).

Table 3. *Prevalence of Ferritin deficiency (serum Ferritin <15 ng/ml) among school children in Sabratha according to geographical region and sex*

Sex / Regions	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
First	136	76	55.88	94	45	47.87	230	121	52.61
Second	83	23	27.71	82	27	32.93	165	50	30.30
Third	59	14	23.73	57	11	19.30	116	25	21.55
Fourth	92	14	15.22	108	26	24.07	200	40	20.00
All Regions	370	127	34.32	341	109	31.96	711	236	33.19

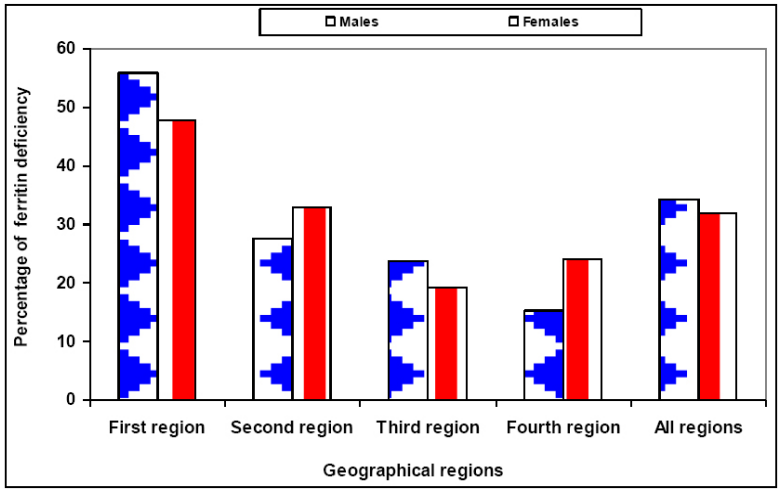

Figure 3. *Prevalence of Ferritin deficiency (serum Ferritin <15 ng/ml) among school children in Sabratha according to geographical region and sex*

The prevalence of iron deficiency anaemia (Hb <12g/dl - serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex in both males and females was 15.22%, 7.27%, 5.17%, 6.5%, and 9.28% in the first, second, third, fourth, and all regions respectively. But, in males, the prevalence of iron deficiency anaemia was 15.44%, 4.82%, 5.08%, 5.43%, and 8.92% in the first, second, third, fourth, and all regions respectively. In females, it was 14.89%, 9.76%, 5.26%, 7.41%, and 9.68% in the first, second, third, fourth, and all regions respectively as shown in table (4) and figure (4).

Table 4. *Prevalence of iron deficiency anaemia (Hb <12g/dl - serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex*

Sex / Regions	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
First	136	21	15.44	94	14	14.89	230	35	15.22
Second	83	4	4.82	82	8	9.76	165	12	7.27
Third	59	3	5.08	57	3	5.26	116	6	5.17
Fourth	92	5	5.43	108	8	7.41	200	13	6.50
All regions	370	33	8.92	341	33	9.68	711	66	9.28

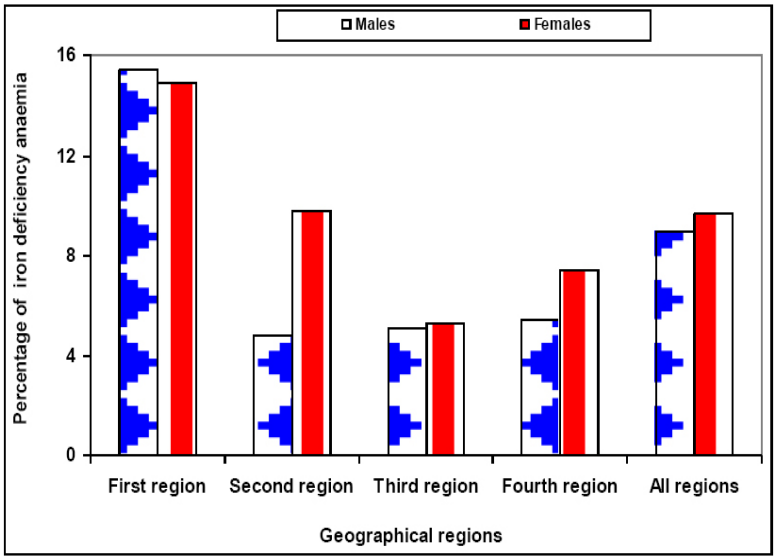

Figure 4. *Prevalence of iron deficiency anaemia (Hb <12g/dl – serum Iron <60 µg/dl) among school children in Sabratha according to geographical region and sex*

General Prevalence of iron deficiency anaemia (Hb <12g/dl - serum Iron <60 µg/dl - serum Ferritin <15 ng/ml - TIBC<10%) among school children in Sabratha are present in table (5) and figure (5). In males, anaemia, Iron deficiency, serum Ferritin <15 ng/ml, and Iron deficiency anaemia were 11.08%, 15.94%, 34.32, and 8.92% but in females were 12.9%, 13.48,%, 31.96%, and 9.67%, respectively.

Table 5. *General prevalence percentage of iron deficiency anaemia (Hb <12g/dl - serum Iron <60 µg/dl - serum Ferritin <15 ng/ml - TIBC<10%) among school children in Sabratha*

Sex	Prevalence percentage (%)			
	Anaemia	Iron deficiency	serum Ferritin <15 ng/ml	Iron deficiency anaemia
Males	11.08	15.94	34.32	8.92
Females	12.9	13.48	31.96	9.67

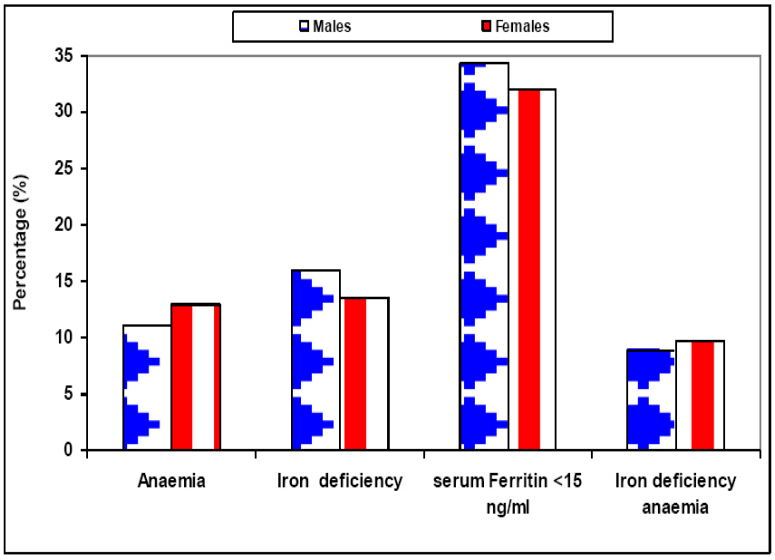

Figure 5. *General Prevalence percentage of iron deficiency anaemia (Hb <12g/dl - serum Iron <60 µg/dl - serum Ferritin <15 ng/ml - TIBC<10%) among school children in Sabratha*

The prevalence of anaemia among school children in Sabratha according to age group (years) in both males and females were 14.46%, 13.11%, 10.34%, and 11.98% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. But, the prevalence of anaemia in males was 18.37%, 11.11%, 9.78%, and 9.23%, and in females was 8.82%, 15.48%, 10.81%, and 15.18% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. These data are present in table (6) and figure (6).

Table 6. *Prevalence of anaemia among school children in Sabratha according to age group and sex*

Sex / Age groups (years)	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
(6-7)	49	9	18.37	34	3	8.82	83	12	14.46
(8-10)	99	11	11.11	84	13	15.48	183	24	13.11
(11-12)	92	9	9.78	111	12	10.81	203	21	10.34
(13-14)	130	12	9.23	112	17	15.18	242	29	11.98
Total	370	41	11.08	341	45	13.20	711	86	12.10

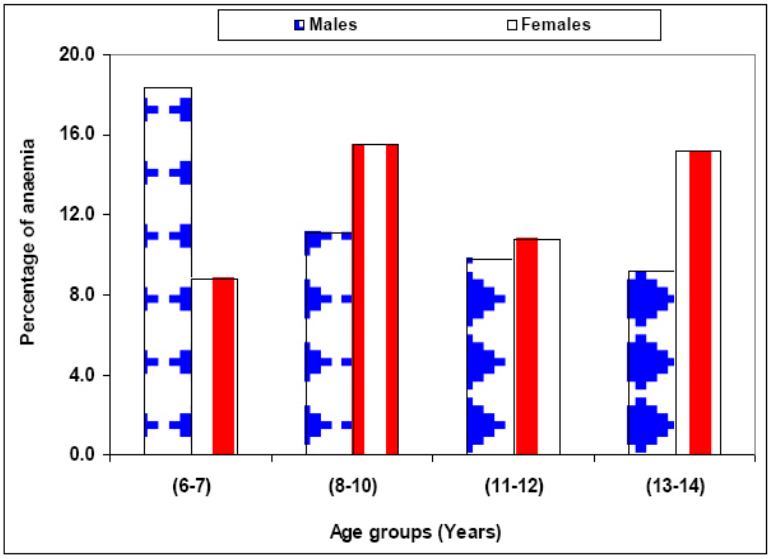

Figure 6. *Prevalence of anaemia among school children in Sabratha according to age group and sex*

Table (7) and figure (7) presented the prevalence of iron deficiency among school children in Sabratha according to age group and sex. In both males and females, the prevalence of Iron deficiency was 20.48%, 12.02%, 16.75%, and 13.22% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. But, the prevalence iron deficiency in males was 26.53%, 12.12%, 19.57%, and 12.31%, and in females was 11.76%, 11.9%, 14.41%, and 14.29% in age groups (6-7), (8-10), (11-12), and (13-14), respectively.

Table 7. *Prevalence of Iron deficiency among school children in Sabratha according to age group and sex*

Sex / Age groups (years)	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
(6-7)	49	13	26.53	34	4	11.76	83	17	20.48
(8-10)	99	12	12.12	84	10	11.90	183	22	12.02
(11-12)	92	18	19.57	111	16	14.41	203	34	16.75
(13-14)	130	16	12.31	112	16	14.29	242	32	13.22
Total	370	59	15.95	341	46	13.49	711	105	14.77

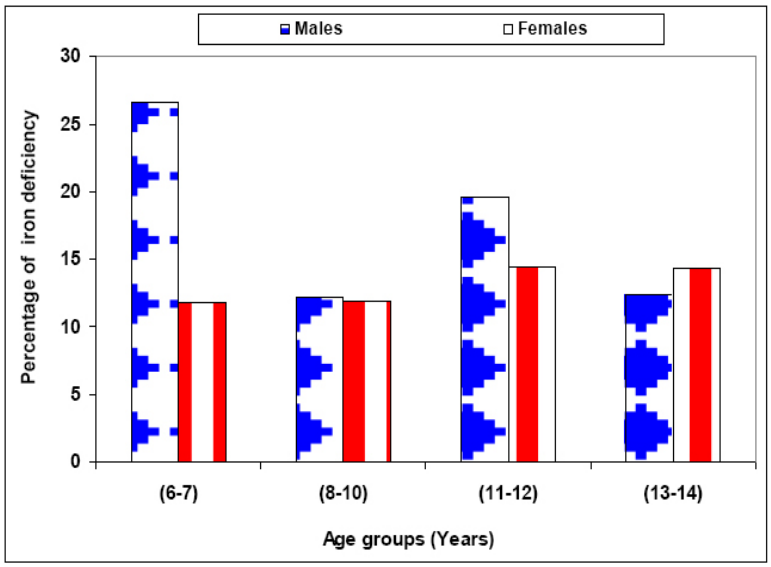

Figure 7. *Prevalence of Iron deficiency among school children in Sabratha according to age group and sex*

The prevalence of ferritin deficiency among school children in Sabratha according to age group in both males and females was 54.22%, 34.97%, 26.11%, and 30.58% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. But, the prevalence ferritin deficiency in males was 55.10%, 34.34%, 29.35%, and 30%, and in females was 52.94%, 35.71%, 23.42%, and 31.25% in age groups (6-7), (8-10), (11-12), and (13-14), respectively (Table. 8 & Figure. 8).

Table 8. *Prevalence of Ferritin deficiency among school children in Sabratha according to age group and sex*

Sex/ Age groups (years)	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
(6-7)	49	27	55.10	34	18	52.94	83	45	54.22
(8-10)	99	34	34.34	84	30	35.71	183	64	34.97
(11-12)	92	27	29.35	111	26	23.42	203	53	26.11
(13-14)	130	39	30.00	112	35	31.25	242	74	30.58
Total	370	127	34.32	341	109	31.96	711	236	33.19

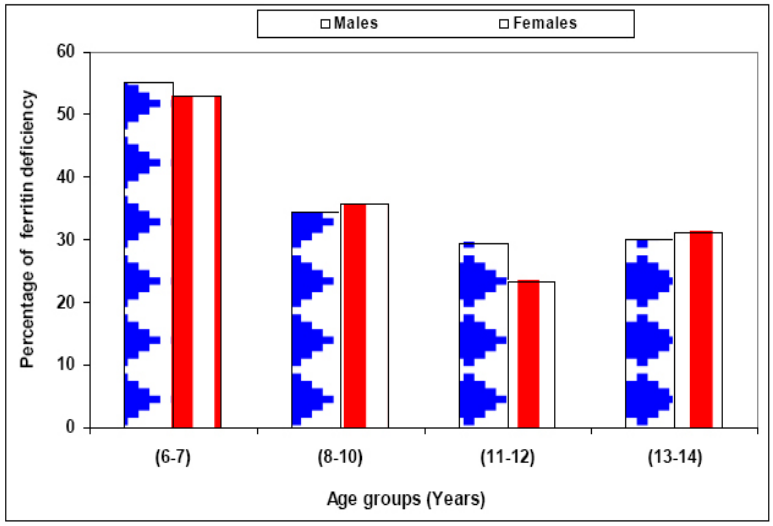

Figure 8. *Prevalence of Ferritin deficiency among school children in Sabratha according to age group and sex*

The data present in the table (9) and demonstrated by figures (9) shows the prevalence of iron deficiency anaemia among school children in Sabratha according to age group and sex. In both males and females, the prevalence of iron deficiency anaemia was 12.05%, 10.93%, 6.90%, and 9.09% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. But, the prevalence iron deficiency anaemia in males was 14.29%, 10.10%, 5.43%, and 8.46%, and in females was 8.82%, 11.90%, 8.11%, and 9.82% in age groups (6-7), (8-10), (11-12), and (13-14), respectively.

Table 9. *Prevalence of Iron deficiency anaemia among school children in Sabratha according to age group and sex*

Sex / Age groups (years)	Males			Females			Total		
	n	Number	%	n	Number	%	n	Number	%
(6-7)	49	7	14.29	34	3	8.82	83	10	12.05
(8-10)	99	10	10.10	84	10	11.90	183	20	10.93
(11-12)	92	5	5.43	111	9	8.11	203	14	6.90
(13-14)	130	11	8.46	112	11	9.82	242	22	9.09
Total	370	33	8.92	341	33	9.68	711	66	9.28

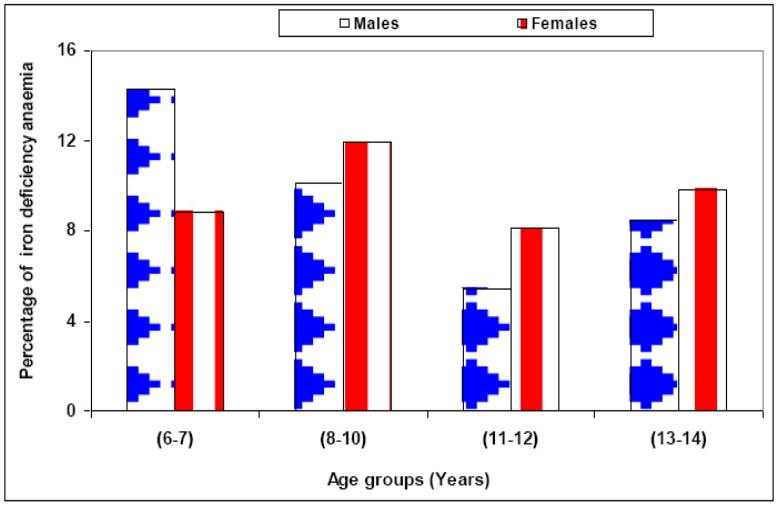

Figure 9. *Prevalence of Iron deficiency anaemia among school children in Sabratha according to age group and sex*

Haemoglobin concentrations (g/dl) among school children in Sabratha according to age group in males were (12.4±1.17), (12.7±1.17), (12.9±1.21), and (12.9±1.56) with coefficient of variance 9.39, 9.22, 9.40, and 12.00 in age groups (6-7), (8-10), (11-12), and (13-14), respectively. But, in females, Haemoglobin concentrations were (12.5±1.07), (12.6±1.17), (12.8±1.21), and (12.8±1.35) with coefficient of variance 8.58, 9.32, 9.80, and 10.50 in age groups (6-7), (8-10), (11-12), and (13-14), respectively as shown in table (10) and figure (10).

Table 10. *Haemoglobin concentrations (g/dl) among school children in Sabratha according to age group and sex*

Age groups (years)	Sex	Mean ± SD	Coefficient of Variance (CV%)
(6-7)	Males	12.4±1.17	9.39
	Females	12.5±1.07	8.58
(8-10)	Males	12.7±1.17	9.22
	Females	12.6±1.17	9.32
(11-12)	Males	12.9±1.21	9.40
	Females	12.8±1.21	9.80
(13-14)	Males	12.9±1.56	12.00
	Females	12.8±1.35	10.50
Total	Males	12.8±1.36	10.60
	Females	12.7±1.26	9.80

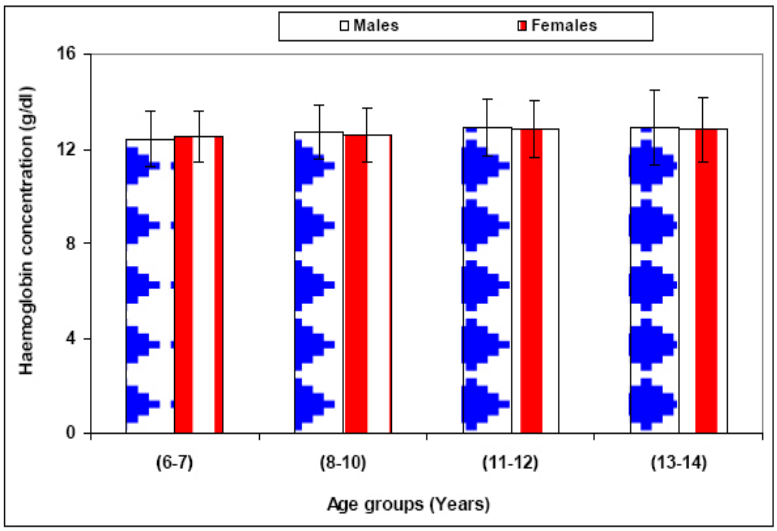

Figure 10. *Haemoglobin concentration among school children in Sabratha according to age group and sex*

The data recorded in table (11) and figure (11) shows the haemoglobin concentrations in iron deficiency anaemia cases among school children in Sabratha. In males iron deficiency anaemic school children, the haemoglobin concentration was (11.2±0.7) (g/dl) with 6.26% Coefficient of Variance but, in females was (10.9±0.85) (g/dl) with 7.80% Coefficient of Variance.

A significant correlation was found between serum iron and serum ferritin in iron-deficient anaemic children (r-0.99).

Table 11. *Haemoglobin concentration in iron deficiency anaemic cases among school children in Sabratha*

Sex	Mean ± SD	Coefficient of Variance (CV%)
Males	11.2±0.7	6.26
Females	10.9±0.85	7.80

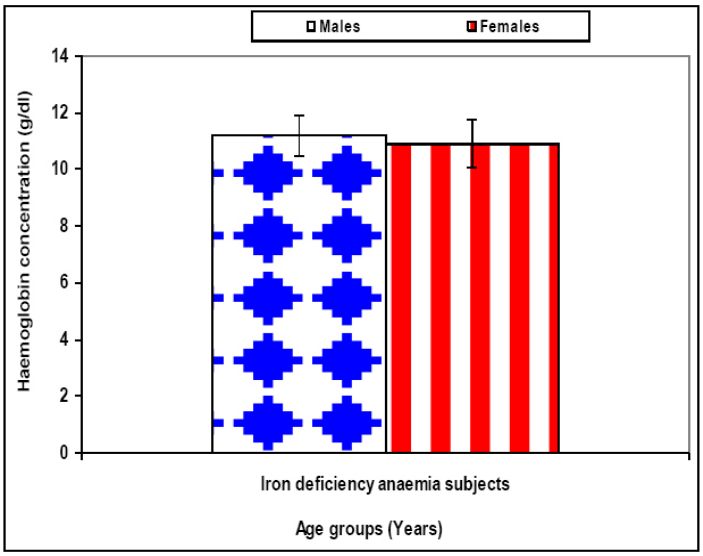

Figure 11. *Haemoglobin concentration in iron deficiency anaemia cases among school children in Sabratha*

Discussion

Measurement of hemoglobin level is a vital physiological parameter that helps diagnose the extent and severity of anemia, polycythemia as well as other diseases of red blood cells. The criteria for determining the presence of anemia, as recommended by the World Health Organization, are based on hemoglobin cut off values for age and sex [7].

Iron deficiency anemia (IDA) is the most common nutritional deficiency worldwide. It can cause reduced work capacity in adults [35] and impact motor and mental development in children and adolescents [36]. There is some evidence that iron deficiency without anemia affects cognition in adolescent girls [37], and causes fatigue in adult women. IDA may affect visual and auditory functioning and is weakly associated with poor cognitive development in children [38]. It is the commonest type of anemia in the developing countries, and has huge health and economic cost implications [39].

In the present study prevalence of anemia was 11.08% among 370 male children aged 6-14 years and 12.9% among 341 female children of the same age . The prevalence of anemia in the current study is in concordance with that concluded in Egypt (12%), Morocco (12.2%), and higher than in Turkey (5.4%) respectively [40, 41, 42]. Also, El-Hioui *et al.,* [42] reported that the overall prevalence of anaemia was 12 % in 295 Schoolchildren aged between 6 and 16 years old in a rural coastal region of Morocco. The mean haemoglobin concentration was 12.41 g/dl in boys and 12, 5 g/dl in girls. Furthermore, this result is not away from what was obtained from the done by Achouri *et al.,* [33] who found that the prevalence of anaemia (Hb<11.5g/dL) was 16.2% among a group of 271 school children age ranged between 6-15 years in Kenitra, Northwest of Morocco.

In contrast in many developing regions of the world, the prevalence of anaemia in 5-12 year's old is estimated with the highest rates from 20.5 % - 79% [5, 7, 43-51]. Anemia was more highly prevalence in many of the previous studies which showed that it was 24.8% of school going children (5-15 years) in Aligarh city in India [44], 35% In Northern Morocco [46], 36.4% among Vietnamese school age children [50], 36.9% in a group of 250 school-age children in Leyte, Philippines [49], 37.5% of school-age children-A scenario of urban slums in India [51], 37.6% in a group of 404 school-age children (6–14 years old) in Jimma Town, Southwest Ethiopia [7], 39.1% in a group of 271 school age children (age range: 7-14 years) in Asendabo Town, Southwest of Ethiopia [47], 39.4% of 531 school-age children in Cote Divoire [48], 40.5% among the age group of 6–11 years in Jimma Town, Southwest Ethiopia [7], 41.8%, in school children aged 5-10.9 years from urban slums in India [45], and 79% among school children up to 12 years of age in selected slum schools of Bhubaneswar, Odisha, India [5]. This difference in the prevalence of anemia in these regions may be due to difference in the study area, sample size, the food consumption and other factors.

In the present study, the mean hemoglobin concentration was 12.8 g/dl in male children and 12.7g/dl female children. This result is in concordance with that recorded by Achouri *et al.,* [33] who found that the mean hemoglobin concentration was 12.53 g/dL in boys and 12.52 g/dL in girls, and the mean hemoglobin level for both sexes among the age group of 6–11 years in Jimma Town, Southwest Ethiopia was 11.59 g/dl [7].

According to Herceberg *et al*., [52] and Kokore *et al.,* [22] three stage of iron deficiency, allow describing the deficit of iron in the body. First, the simple depletion of tissue iron stores without deficit of erythropoiesis that is characterized by an isolated decrease of serum ferritin below of 15 mg/l (in children). Then, the depletion of reserves, with deficiency of erythropoiesis is accompanied by a decrease in the coefficient saturation of transferrin, increased transferrin and total iron binding capacity, a decrease in serum iron and disruption of conventional erythrocyte parameters. The last stage is iron deficiency anaemia, where the fall in hemoglobin below the threshold limit, allows recognizing anaemia [22].

In the present study, the prevalence iron deficiency in males was 26.53%, 12.12%, 19.57%, and 12.31%, and in females was 11.76%, 11.9%, 14.41%, and 14.29% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. Iron deficiency is the most prevalent nutritional disease and the most common cause of anemia worldwide. Anemia resulting from ID affects approximately two billion people worldwide (34% of the world population), most of whom live in developing countries, where the incidence is about 40%. In developing countries, an iron deficient diet is commonly associated with IDA. The incidence of IDA in more developed countries, including the United States, is about 10% [52, 53]. In spite of all efforts to decrease this problem, its prevalence varies in various parts of the world.

The present study reported the prevalence iron deficiency anaemia in males was 14.29%, 10.10%, 5.43%, and 8.46%, and in females was 8.82%, 11.90%, 8.11%, and 9.82% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. The finding in the present study is in harmony with the results obtained by Kokore *et al.,* [22] who was carried out to evaluate iron status in children aged 5 to 11 years in good health in three canteens of three municipalities in of Abidjan (Côte d'Ivoire). A total of 103 students, including 42 girls and 61 boys were selected for this study. The mean values of various biological parameters of iron status were normal in accordance to physiological reference values from the literature with the exception of hemoglobin in boys which is below normal rate. All parameters did not indicate significant differences between girls and boys ($p > 0.05$). The results indicated that in children about two out of three have abnormal iron status. Abnormal iron status is composed respectively by 3.9% of iron deficiency, 8.7% iron deficiency anaemia. The anaemia by Iron deficiency in our study is lower than in the Kenyan students [55].

In Libya, Tabib *et al*. [56] found that Hb less than 7 g/dL in 22.5% of patients (11 male, 37 female), Hb between 7-10 gm/dL reported in 77.5% of patients (57 male, 108 female). The highest prevalence of IDA found between 22-39 years of age, Hb mean was 7.9 ± 0.08, this may be due differences in study population age groups. Iron deficiency without anemia in our study is below that obtained by El Hioui *et al*., [42] who realized their study in a rural province of Moroccan on school children aged of 6 to 16 years. Besides iron deficiency, inflammatory anaemia and inflammatory anaemia associated to iron deficiency coexist among school children. Inflammatory anaemia associated to iron deficiency is usually caused by infectious syndromes [22, 57]. In this sense, the prevalence of abnormal iron status could be explained by the existence of a number of factors such as infectious and inflammatory syndromes responsible for deviation and sequestration of iron circulating in the body [22, 58].

This result is much lower than what is shown in numerous similar studies that were conducted internationally, nationally as well as regionally. For instance, Aedh *et al.,* [59] assessed the prevalence of iron deficiency anemia among 240 subjects of teenagers that aged 13-19 years old in Najran, Saudi Arabia. The overall prevalence of anemia among teenagers in Najran was 22.5%, which indicates a moderate health problem. Also, WHO worldwide report that concluded a prevalence of 25.4% for IDA among school children globally [60]. El-Hazmi and Warsy, [61] reported the overall prevalence of anemia in Saudis was 24.8%.

Additionally, Al-Othaimeen, *et al.,* [62] found that the prevalence of anemia in Riyadh was 26.3%. Abedini *et al.,* [63] estimated the prevalence of iron deficiency anemia in Iran was 53.6%. While Stoltzfus and Rebecca, [64] reported that the prevalence of IDA in Africa was 60%, Latin America (46%), Eastern Mediterranean (63%), Southeast Asia I (49%), Southeast Asia II (66%). Additionally, a high prevalence of IDA was also reported in Tanzania (79.6%), Kenya (35.3%) and Nigeria (82.6%) [65-67].

Serum ferritin concentration has been identified as the most specific biochemical test that correlates with relative total body iron store, hence is a precondition for iron deficiency in the absence of infection [66, 68].

In the present study, the prevalence ferritin deficiency in males was 55.10%, 34.34%, 29.35%, and 30%, and in females was 52.94%, 35.71%, 23.42%, and 31.25% in age groups (6-7), (8-10), (11-12), and (13-14), respectively. This rate is comparable to the national prevalence reported by the Ministry of Health in 2000 [69].

El-Hioui *et al.,* [42] reported that the mean serum ferritin level was 26.7 µg/l in boys and 27.9 µg/l in girls. The overall prevalence of anaemia was 12.2 % and iron deficiency was in 20.4 %. Serum ferritin, serum iron concentrations and mean corpuscular volume (MCV) were significantly correlated with Hemoglobin. The results of Kokore *et al.,* [22] study showed that the ferritin and the saturation coefficient of transferrin, are lowered respectively of 12.6% and 55.3% in school children. More than half of populations (54%) are anaemic. Among these, about 18% are hypochromic.

Iron deficiency, results from an imbalance in the balance of iron in the body; in children, it is most often an insufficient of contributions to the needs more important deal with especially in infancy than in adults [22]. Low iron intake, iron mal-absorption and iron loss lead to IDA, and iron deficiency due to malnutrition is a most frequent affecting about of population 30% - health problem in the world. WHO reported recently, 1.62 billion of the world population is anemic. IDA main cause is a poor diet and/or certain intestinal diseases that affect adversely iron absorption or nutrient consumption by parasitic infestation. Iron fortified food is effective in improving and maintenance of Hb in general population especially during child bearing age [39]. There are two forms of dietary iron: Non-heme and heme iron. Non-heme iron takes the simplest form of free iron atoms such as ferric (Fe^{3+}) or ferrous (Fe^{2+}) iron. Non-heme iron is obtained from foods such as grains, legumes, fruits, and vegetables [70], so no easily absorbable [22, 57]. Numerous Africans have a diet that contains little or no animal protein. The diet of most Africans is based on plants [71, 72]. Gad *et al.,* [73] found that a significant association between iron deficiency anemia and frequent intake of soda drinks and milk/milk products which contain calcium that inhibits iron absorption. The differences in the prevalence of IDA in these regions could be due to differences in the study areas, cultural variations, sample sizes, lifestyles, socio-economic, dietary habits like frequent intake of soda drinks and milk/milk products, and other pathological or genetic factors.

There is a number of studies, which have shown an association between the socioeconomic status and the prevalence of anemia [4, 74]. Several studies also have shown that low parental education levels, low household incomes, and demographic factors including age, sex, and family size have been associated with development of anemia [4, 42, 75-77]. Preventive health care is supposed to be more effective those areas where accessibility of and affordability for health care services are much less [4, 78]. Hence, it is always important to understand the background characteristics of women and their children to increase the awareness on preventive health care practices [4].

Conclusion

It can be concluded that anemia in children is a common preventable health issue in schoolchildren in western Libya. Iron deficiency is the leading cause of anemia in the present study. Anaemia occurs in all Sabratha area and though at significantly variable prevalence. The first zone population has the highest frequency of anemia and Iron deficiency. Males in the age group (6-7) years and females in the age group (8-10) years were significantly more susceptible to develop iron deficiency anaemia. Correction of iron

deficiency at this age groups enhances their learning potential, increases their fitness and work capacity later. Therefore, health education to the community about balanced animal and plant food consumption are recommended strategies to reduce the burden of anemia. Moreover, health education programs and sustainable interventions should be implemented in schools to highlight the risk factors of anemia as well as to encourage the intake of diverse diets including iron-rich foods and fruits, which contain vitamin C that enhances iron absorption. Further longitudinal studies with long term follow-up are needed. Children with family history of anemia should be screened for anemia and treated if indicated. Additional studies are needed on micronutrients deficiency, parasite infections, hereditary disorders and environmental pollutants.

References

[1] Singh I, Singh H, Kaur D. Evaluation and comparison of knowledge, attitude and practice about iron deficiency anaemia amongst medical students of rural and urban background. Int J Res Med Sci 2015; 3:1342-1344.

[2] Chaluvaraj, T. S., and Satyanarayana, P. T.Change in knowledge, attitude and practice regarding anaemia among high school girls in rural Bangalore: An health educational interventional study. Natl J Community Med, 2018; 9: 358-362.

[3] WHO. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and Mineral Nutrition Information System. Geneva, World Health Organization, 2011 (WHO/NMH/NHD/MNM/11.1) http://www.who.int/vmnis/indicators/haemoglobin.

[4] Singh, S., and Parihar, S. Prevalence of anaemia in under five-year-old children: a hospital-based study. Int J Contemp Pediatr. 2019; 6(2): 842-847.

[5] Mohapatra, S., Maity, S., Behera, B. and Mohanty, S. Prevalence of anaemia among school going children (< 12 years of age) in selected slum schools of Bhubaneswar, Odisha. IOSR-J Nur Health Sci., 2014; 3(6 – III): 42-46.

[6] Tesfaye M, Yemane T, Adisu W, Asres Y. and Gedefaw L. Anaemia and iron deficiency among school adolescents: burden, severity, and determinant factors in southwest Ethiopia. Adolesc Health Med Ther., 2015; 6: 189–196.

[7] Assefa S, Mossie A, and Hamza L. Prevalence and severity of anemia among school children in Jimma Town, Southwest Ethiopia. BMC Hematol., 2014, 14:3. http://biomedcentral.com/2052-1839/14/3

[8] Kassebaum NJ. The global burden of anaemia. Hematol Oncol Clin North Am. 2016; 30(2): 247–308.

[9] FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world. Building resilience for peace and food security. Rome: Food and Agriculture Organization of the United Nations, 2017:1–109

[10] World Health Organization (WHO). Nutritional anaemias: tools for effective prevention and control. Geneva: WHO; 2017. Available at: www.who.

[11] Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F et al. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. Lancet Glob Health. 2013;1(1):e16–e25.

[12] Anuradha G., Rakesh K., Salhotra V. S., Mohan A. and Sheetal R. Guidelines for Control of Iron Deficiency anaemia. National Iron initiative, 2013.

[13] Shaka, M.F. and Wondimagegne, Y.A. Anaemia, a moderate public health concern among adolescents in South Ethiopia. PloS one, 2018; 13 (7): 0191467. https://doi.org/10.1371/journal.pone.0191467

[14] Scott, S. P., Chen-Edinboro, L. P., Caulfield, L. E., and Murray-Kolb, L. E. The impact of anemia on child mortality: an updated review. Nutrients, 2014; 6(12): 5915-5932.

[15] Syed, S., Addo, O. Y., la Cruz-Góngora, D., Ashour, F. A. S., Ziegler, T. R., & Suchdev, P. S. Determinants of anemia among school-aged children in Mexico,

the United States and Colombia. Nutrients, 2016; 8(7); 387. doi:10.3390/nu8070387.

[16] McLean, E., Cogswell, M., Egli, I., Wojdyla, D., de Benoist, B.Worldwide prevalence of anaemia, who vitamin and mineral nutrition information system, 1993–2005. Public Health Nutr. 2009; 12: 444–454.

[17] WHO. Iron Deficiency Anaemia Assessment Prevention and Control. A Guide for Programme Managers. World Health Organization, Geneva, Switzerland. 2001.

[18] Ozdemir, N. Iron deficiency anaemia from diagnosis to treatment in children. Turkish Archives of Pediatrics/Turk Pediatri Arşivi, 2015; 50(1): 11-19.

[19] WHO, The global prevalence of anaemia in 2011. Geneva: World Health Organization; 2015. http://apps.who.int/iris/bitstream/10665/177094/1/9 789241564960_eng.pdf.

[20] Ramesh S. Assess the Knowledge and Practice of Prevention and Management of Childhood Anaemia among Mothers of Preschool Children in Selected Anganwadi Centres of Thrissur, Kerala, South India. 5th Annual Worldwide Nursing Conference (WNC), 2017:231-236. doi: 10.5176/2315-4330_WNC17.83:

[21] Beard, J.L. Iron biology in immune function, muscle metabolism and neurological functioning, J Nutrition, 2001;131(2): 568-580.

[22] Kokore, B.A., Bleyere, M.N., Kamagate, S. and Yapo, P.A. 2016. Iron deficiency and iron deficiency anaemia in children of school canteens in Abidjan, Côte d'Ivoire. Age (year), Saudi J. Biomed. Res., 5(6): 64-71.

[23] Cornah J. E., Roper J. M., Pal Singh D., and Smith A. G. Measurement of ferrochelatase activity using a novel assay suggests that plastids are the major site of haem biosynthesis in both photosynthetic and non-photosynthetic cells of pea (Pisum sativum L.). Biochem J., 2002; 362(2): 423–432.

[24] Lo C and Jeng M. Dietary iron deficiency anaemia in children. Nutritional Anaemia, 2019; 8: 96–102. doi:10.1017/9781139023993.009

[25] Kriviene I, and Rageliene L. The prevalence of anaemia among school children in Siauliai region of Lithuania. Acta Medica Lituanica. 2006; 13(1): 56-59.

[26] Egbi, G., Steiner-Asiedu, M., Kwesi, F.S., Ayi, I., Ofosu, W., Setorglo, J., Klobodu, S.S. and Armar-Klemesu, M. Anaemia among school children older than five years in the Volta Region of Ghana. Pan African Med J, 2014; 17(1):10.

[27] Grantham-McGregor S, and Ani C. A review of studies on the effect of iron deficiency on cognitive development in children. J Nutr 2001;131 (2S-2): 649S–666S.

[28] Rakesh, P.S., Rajeswaran, T., Rakesh, R., Gigil, M., Sheeja, A.L. and Subhagan, S. Anaemia among schoolchildren from southern Kerala, India: A cross-sectional study. Natl Med. J. India, 2015; 28: 225-227.

[29] Brownlie TV, T., Utermohlen, V., Hinton, P.S., Giordano, C. and Haas, J.D., Marginal iron deficiency without anaemia impairs aerobic adaptation among previously untrained women. Am J Clin Nutr 2002; 75: 734–742.

[30] Oski FA. The non-hematologic manifestations of iron deficiency. Am J Dis Child, 1979; 133: 315–322.

[31] Ciesla B. Hematology in Practice. 2nd ed. Philadelphia, PA: FA Davis Company; 2011.

[32] Lerner, N.B. and R. Sills. Iron Deficiency Anemia. In: Nelson Textbook of Pediatrics, Kliegman, R. and W.E. Nelson (Eds.). 19th Edn., Elsevier/Saunders, Philadelphia, PA., ISBN-13: 9780808924203., 2011

[33] Achouri, I., Aboussaleh, Y., Sbaibi, R., Ahami, A. and El Hioui, M. 2015. Prevalence of iron deficiency anaemia among school children in Kenitra, Northwest of Morocco. Pakistan Journal of Biological Sciences, 18(4): 191-195.

[34] Cheesbrough M. District Laboratory Practice in Tropical Countries. 2nd ed. Cambridge: Cambridge University Press; 2005.

[35] Haas JD, and Brownlie T IV. Iron deficiency and reduced work capacity: acritical review of the

research to determine a causal relationship. J Nutr., 2001;131(2 suppl):676S-80S

[36] Halterman JS, Kaczorowski JM, Aligne CA, Auinger P, and Szilagyi PG. Iron deficiency and cognitive achievement among school-aged children and adolescents in the United States. Pediatrics 2001; 107: 1381-1386.

[37] Algarin C, Peirano P, Garrido M, Pizarro F, and Lozoff B. Iron deficiency anemia in infancy: long-lasting effects on auditory and visual system functioning. Pediatr Res 2003; 53:217-23.

[38] Verdon F, Burnand B, Stubi CL, Bonard C, Graff M, Michaud A, and Chapuis, C. Iron supplementation for unexplained fatigue in non-anaemic women: double blind randomised placebo controlled trial. BMJ 2003; 326(7399): 1124.

[39] United Nations Children's Fund/United Nations University/WHO: Iron deficiency anaemia. Assessment, prevention and control. A guide for programme managers (WHO/NHD/01.3). Geneva: World Health Organization; 2001: 15–31.

[40] Koc A., Kosecik, M., Vural, H., Erel, O., Ataş, A., and Tatli, M. M. The frequency and etiology of anemia among children 6-16 years of age in the southeast region of Turkey. Turkish J Ped., 2000; 42(2): 91-95.

[41] Barduagni, P., Ahmed, A. S., Curtale, F., Raafat, M., and Mansour, E. Anaemia among school children in Qena Governorate, Upper Egypt. East Mediter Health J., 2004; 10(6): 917-919.

[42] El-Hioui, M., Ahami, A. O. T., Aboussaleh, Y., Rusinek, S., Dik, K., and Soualem, A. Iron deficiency and anemia in rural school children in a coastal area of Morocco. Pakistani J Nutr., 2008; 7(1): 400-403.

[43] Abalkhail, B., and Shawky, S. Prevalence of daily breakfast intake, iron deficiency anemia and awareness of being anemic among Saudi school students. Inter J Food Sci Nutr., 2002; 53(6): 519-528.

[44] Hassan, M.A. and Khalique N. Health status and anthropometric profile of school going children (5-15 years) in Aligarh city. Proceedings of the 29th Annual Conference of IAPSM and 9th. Annual Conference of Maharashtra, 2002; 125: 10.

[45] Gomber, S., Madan N., Lal A., and Kela K. Prevalence and etiology of nutritional anaemia among school children of urban slums. Indian J. Med. Res.,2003; 118: 167-171.

[46] Zimmermann, M.B., Zeder C., Chaouki N., Saad A., Torresani T., and Hurrell R.F.. Dual fortification of salt with iodine and microencapsulated iron: A randomized, double-blind, controlled trial in Moroccan schoolchildren. Am. J. Clin. Nutr., 2003; 77: 425-432.

[47] Alemayehu N. Prevalence of hook worm infection and its association with anemia among students of Asendabo elementary school. Abstract, student research project, CBE program. 2nd edition. Jimma, Ethiopia: Jimma University, 2005. PP.209.

[48] Zimmermann MB, Molinari L, Staubli-Asobayire F, Hess SY, Chaouki N, Adou P, et al: Serum transferrin receptor and zinc protoporphyrin as indicators of iron status in African children. Am J Clin Nutr 2005; 81:615–623.

[49] Leenstra T, Acosta LP, Langdon GC, Manalo DL, Olveda RM, McGarvey ST, et al. Schistosomiasis japonica, anemia, and iron status in children, adolescents, and young adults in Leyte, Philippines. Am J Clin Nutr., 2006; 83: 371–379.

[50] Thi LH, Brouwer ID, Burema J, Nguyen KC, and Kok FJ. Efficacy of iron fortification compared to iron supplementation among Vietnamese schoolchildren. Nutr J., 2006; 5:32.

[51] Srivastava, A., S.E. Mahmood, P.M. Srivastava, V.P. Shrotriya and B. Kumar. Nutritional status of school-age children-A scenario of urban slums in India. Arch. Public Health, 2012; 70(1): 8. 10.1186/0778-7367-70-78.

[52] Hercberg, S., Galan P., Prual, A. and Preziosi, P. Epidemiology of iron deficiency and iron deficiency anemia in the French population. Annales de Biologie Clinique, 1998; 56(1), 49-52.

[53] Young NS, Gerson SL, and High KA. Clinical hematology. Philadelphia, PA: Mosby Elsevier, 2006. PP. 231–241.

[54] Akramipour, R., Rezaei, M., and Rahimi, Z. Prevalence of iron deficiency anemia among adolescent school girls from Kermanshah, Western Iran. Hematol, 2008; 13(6), 352-355.

[55] Andang'o, P.E.A., Saskia, J.M.O., Rosemary, A., Clive, E.W., David, L.M., Corine, A.D.W., Rob, K., Frans, J.K. and Hans, V. Efficacy of iron fortified whole maize flour on iron status of schoolchildren in Kenya: a randomised controlled trial, Lancet, 2007; 369(1): 1799-1806.

[56] Tabib M, Rayani A and Habas E. Diet habit and iron deficiency anemia in Libyan patients. LJMR., 2016; 10(1): 29-37.

[57] Dillon, J.C. Prevention of iron deficiency and iron deficiency anemia in a tropical environment. Médecine tropicale, 2000; 60(1): 83-91.

[58] Liao, Q. K. Prevalence of iron deficiency in pregnant and premenopausal women in China: a nationwide epidemiological survey, Zhonghua Xue Ye Xue Za Zhi., 2004; 25(11): 653-657.

[59] Aedh A, Elfaki NK, and Sounni EM. Iron deficiency anemia and associated risk factors among teenagers in Najran, Saudi Arabia. Inter J Med Res Health Sci., 2019; 8(5): 108-114.

[60] De Benoist, B., Cogswell, M., Egli, I., and McLean, E. Worldwide prevalence of anaemia 1993-2005; WHO Global Database of anaemia. 2008.

[61] El-Hazmi, M. A. F., and Warsy, A. S. The pattern for common anaemia among Saudi children. J Trop pediat., 1999; 45(4): 221-225.

[62] Al-Othaimeen A, Osman AK, and Al Orf SA. Prevalence of nutritional anaemia among primary school girls in Riyadh City, Saudi Arabia. Inter J Food Sci Nutr., 1999; 50(4): 237-243.

[63] Abedini, Z., Lotfi, M. M., and Parvizi, F. Prevalence of iron deficiency anemia and its related factors in school age children. Pajoohandeh J., 2010;15(5): 208-212.

[64] Stoltzfus, and Rebecca J. Iron deficiency: global prevalence and consequences. Food Nutr Bull., 2003; 24(4): 99-103.

[65] Tatala, S. R., Kihamia, C. M., Kyungu, L. H., and Svanbergrhaaa, U. Risk factors for anemia in school children in Tanga Region, Tanzania. Tanzania J Health Res., 2008; 10(4): 189-202.

[66] Onimawo, I. A., Ukegbu, P. O., Asumugha, V. U., Anyika, J. U., Okudu, H., Echendu, C. A., and Emebu, P. Assessment of anaemia and iron status of school age children (aged 7-12 years) in rural communities of Abia state, Nigeria. African J Food, Agric Nutr Develop., 2010. ; 10(5): 2570-2586.

[67] Pullan, R. L., Gitonga, C., Mwandawiro, C., Snow, R. W., and Brooker, S. J. Estimating the relative contribution of parasitic infections and nutrition for anaemia among school-aged children in Kenya: a subnational geostatistical analysis. BMJ open, 2013; 3(2): e001936.

[68] Shell-Duncan B and Mcdade T. Cultural and environmental barriers to adequate iron intake among Northern Kenyan school children. Food Nutr Bull.,2005; 26: 171-175.

[69] Ministry for the Public Health. Deficiencies in micronutriments: Extent of the Problem and strategies of fight Programs of fight against the disorders due to the deficiencies in micronutriments Morocco.2001

[70] Neumann, C. G., Bwibo, N. O., Murphy, S. P., Sigman, M., Whaley, S., Allen, L. H., and Demment, M. W. Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: Background, study design and baseline findings. J. Nutr., 2003; 133: 3941S-3949S.

[71] Van den Broek, N.R. and Letsky, E.A. Etiology of anemia in pregnancy in south Malawi. Amer J Clin Nutr, 2000; 72(1) 247s- 256s.

[72] Oguntona, C.R.B and Akinyele, I.O. Food and nutrient intakes by pregnant Nigerian adolescents during the third trimester, Nutr., 2002; 18(1): 673-679.

[73] Gad, A., Al-Quaiz, J., Khoja, T., As-Sharif, A., Al-Manea, H., Al-Edriss, A., and Shafi, S. Anemia among primary school children (5-12 years) in Riyadh Region, Saudi Arabia: a community-based study. Canadian J Clin Nutr., 1(1): 27-34. http://dx.doi.org/10.14206/canad.j.clin.nutr.2013.01.04

[74] Dey S, Gosawmi S, and Dey T. Identifying predictors of childhood anaemia in north-east India. J Health Populat Nutr., 2013; 31(4): 462-470.

[75] Hashizume M, Kunii O, Sasaki S, Shimoda T, Wakai S, Mazhitova Z, et al. Anemia and iron deficiency among schoolchildren in the Aral Sea region, Kazakhstan. J Trop Pediatr., 2003; 49:172-177.

[76] Foo LH, Khor GL, Tee ES, and Prabakaran D. Iron status and dietary iron intake of adolescents from a rural community in Sabah, Malaysia. Asia Pac J Clin Nutr., 2004; 13:48-55.

[77] Al-Mekhlafi MH, Surin J, Atiya AS, Ariffin WA, Mahdy AK, and Abdullah HC. Anaemia and iron deficiency anaemia among aboriginal school children in rural Peninsular Malaysia: an update on a continuing problem. Trans R Soc Trop Med Hyg., 2008; 102:1046-1052.

[78] Winichagoon P. Prevention and control of anemia: Thailand experiences. J Nutr., 2002; 132(4): 862S-866S.

Citation: **J. M. Jbireal, Azab Elsayed Azab.** *Prevalence of Iron Deficiency Anaemia among School Children in Sabratha, Western Libya. Archives of Hematology and Blood Diseases. 2020; 3(1): 26-43.*