Effect of Iron Deficiency Anemia on Academic Performance among Primary School Children

Manal Mohamed Ahmed Ayed 1*, Amel abd Elaziem Mohamed 2, Huwida Hamdy Abd El-Monem 3

1* Assistant Professor at Pediatric Nursing Department, Faculty of Nursing, Sohag University, Egypt
2 Lecture of Community Health Nursing Beni- Suef University, Egypt
3 Lecture of Pediatric Nursing Department, Faculty of Nursing, El-Fayoum University, Egypt.

Abstract

Introduction: anemia due to iron deficiency is considered a common global risk between primary school children that have a serious effect on their academic performance. The current study aim was to investigate the effect of iron deficiency anemia on academic performance among primary school children. **Design**: A descriptive cross-sectional correlational research design was used. **Materials and methods**: included 720 primary school children who selected randomly from two primary schools at Sohag city in October 2019 aged 6 to 12 years. Tools: A structured questionnaire filled in by the parents and the Raven Standards Progressive Matrices test was used to measure cognitive function and school academic performance. Iron level was determined by measuring hemoglobin and serum ferritin concentrations. **Results**: In this study most of primary school children 82.0% suffered from intellectual deficit. Academic performance on the Raven Standards Progressive Matrices test was associated significantly with anemia due to iron deficit (p=0.035). A positive significant relationship was found between ferritin values and academic performance between children (p=0.001). **Conclusion**: anemia due to iron deficiency anemia between children had effect on academic performance impairments. **Recommendation:** Encourage health educational program for parents about children's nutritional requirements specially iron requirement and frequent blood testing is required.

Keywords: Iron deficiency anemia, academic performance, primary school children

E-mail: Manal_ayed@yahoo.com.

Introduction:

Iron deficiency is considered a systemic condition and most prevalent hematologic disorder among childhood with many consequences. In recent studies about prevalence of iron deficiency anemia in the United States, up to 11% of children were iron-deficient. Iron deficiency anemia occurs when hemoglobin concentrations are reduced to below optimal levels. Iron deficiency anemia affected >45% of children aged <5 years in developing countries. Primary school children are susceptible to dietary iron deficiency

because of insufficient dietary requirements intake in relation with high requirements of iron related to rapid growth **(Camaschella, 2019).**

The signs and symptoms of Iron deficiency anemia include extreme fatigue, weakness, pale skin, chest pain, fast heartbeat or shortness of breath, headache, dizziness or lightheadedness, cold hands and feet, inflammation or soreness of the tongue, brittle nails, and poor appetite **(Disease and Injury Incidence and Prevalence Collaborators, 2016).**

Causes of iron deficiency anemia include blood loss, lack of iron in the diet, an inability to absorb iron. Children may have an increased risk of iron deficiency anemia are those need extra iron during growth spurts are not eating a healthy, varied diet or other iron-rich foods, and who routinely donate blood **(Belleza, 2020).**

Mild iron deficiency anemia usually doesn't cause complications. However, left untreated, it can become severe and lead to health problems, including heart problems and growth problems **(Kulnigg et al., 2018).**

Diagnosis of iron deficiency anemia by is confirmed by doing complete blood count (CBC), peripheral blood smear , hematocrit test, hemoglobin test, serum iron test, ferritin test, transferrin and total iron-binding capacity (TIBC), , and fecal occult blood test **(Belleza, 2020).**

Despite progress in medicine and science development, anemia continues to be common disorders. More than 25% has signs of anemia among world's population, and more than 50% of them, from children and women below 7 years of age suffer from iron deficiency anemia. Prevention and reducing risk of iron deficiency anemia is essential and it can be prevented by eating a diet containing sufficient amounts of iron or by iron supplementation and choosing iron-rich foods such as red meat, pork and poultry, seafood, beans, dark green leafy vegetables, such as spinach, dried fruit, such as raisins and apricots, iron-fortified cereals, breads and pastas, peas, choose foods containing vitamin C to enhance iron absorption which found in broccoli, grapefruit, kiwi, leafy greens, melons, oranges, peppers, strawberries, tangerines, and tomatoes **(Kiss and Vassallo, 2018).**

One of the common related consequences of iron deficiency anemia in primary school children is the alteration of cognitive performance. There were fewer published articles, about cognitive achievement in iron-deficient primary school children; thus, the relation between iron values, academic performance and cognitive functioning for children is not clear. Iron is very important for cognitive functions, which in many studies, reported that there was an association between cognitive functions and the deficiencies of iron. Many studies showed that iron-deficiency is causing cognitive impairment in humans, which causes brain mitochondrial damage that leads to decrease attention span and intelligence **(Kusumastuti et al., 2013).**

The daily iron intake in children aged 5–12 years improved cognitive assessment, Intelligence quotient for children with anemia, and the level of concentration and attention. Dietary iron intake reduced the risk to develop

anemia by 50% and the risk of iron deficiency by 79%. Data about the safeness of iron supplementation was limited (**Office of Dietary Supplements, 2018).**

Pediatric nurse plays an important role in the care of a child with iron deficiency anemia by the following interventions as assess dietary history and history of hemorrhage, perform Physical exam. Administer prescribed medications, as ordered; administer IM or IV iron when oral iron is poorly absorbed. Perform sensitivity testing of IM iron injection to avoid risk of anaphylaxis. Advise patient to take iron supplements an hour before meals for maximum absorption; if gastric distress occurs, suggest taking the supplement with meals resume to between-meals schedule if symptoms subside. Inform patient that iron salts change stool to dark green or black. Advise patient to take liquid forms of iron via a straw and rinse mouth with water. Reduce fatigue by assist the client/caregivers in developing a schedule for daily activity and rest, monitor hemoglobin, hematocrit, RBC count, and reticulocyte counts. Educate energy-conservation techniques **(Cappellini et al., 2019).**

Additionally, encourage the patient to continue iron therapy for a total therapy time (6 months to a year), even when fatigue is no longer present. Explain the importance of the diagnostic procedures (such as complete blood count), bone marrow aspiration and a possible referral to a hematologist. Explain the importance of iron replacement/ supplementation. Educate the client and the family regarding foods rich in iron (organ and other meats, leafy green vegetables, molasses, beans). Prevent infection by assessing for local or systemic signs of infection, such as fever, chills, swelling, pain, and body malaise. Monitor WBC count; anticipate the need for antibiotic, antiviral, and antifungal therapy, and instruct the client to avoid contact with people with existing infections. Community health nurses plays an important role in the care of a children with iron deficiency anemia by giving advice to their caregivers about sufficient daily requirements of iron and providing them health educational programs about the topic **(WHO, 2018).**

Significance of the Study

World Health Organization, (2007) reported that "Iron deficiency is considered one of the nutritional disorder all over the world that affects many children especially in developing countries; it is considered the only nutrient deficiency that causes behavioral and cognitive performance impairment are considered. One of the most worrying consequences of the anemia due to iron deficiency in children is behavioral changes such as decreased attention span and reduced the emotional responsiveness. Also, it causes decreasing in Intelligence IQ and learning abilities of the suffered children which affect their academic achievement.

Aim of the study:

The study was aimed to investigate the effect of iron deficiency anemia on academic performance among primary school children through:

1. Assessing the ferritin, iron and HB values between primary school children.
2. Identify academic performance level between primary school children.
3. Investigate effect of anemia due to iron deficiency on academic performance between primary school children.

Research questions:

1- What are the ferritin, iron and HB values between primary school children?
2- What is the academic performance level between primary school children?
3- What is the effect of anemia due to iron deficiency on academic performance between primary school children?

Operational definition:

Iron deficiency anemia: is a common type of anemia - a condition in which blood lacks adequate healthy red blood cells. Red blood cells carry oxygen to the body's tissues. As the name implies, iron deficiency anemia is due to insufficient iron.

Academic performance: is the measurement of student achievement across various academic subjects. Teachers and education officials typically measure achievement using classroom performance, graduation rates and results from standardized tests.

Primary school children: children in elementary school or grade school who are from about four to eleven years old, in which they receive primary or elementary education.

Subjects and Methods

Research design: A descriptive cross-sectional correlational research design was conducted in October 2019.

Research settings:

This study involved two primary schools in Sohag City. These included Sohag El-Ebtedia and El-Shimaa primary schools. Sohag City contained 10 primary schools. The researchers selected 20% of the total number of schools by stratified random sample which was two schools.

Subjects:

They included 720 primary school children who selected randomly from two primary schools at Sohag city in October 2019, after taking the consent from their parents. The researchers took 20% of students from the two schools by simple random sample (720 students). The inclusion criteria were: children enrolled in primary school from both sexes, free from cognitive disabilities and aged from 6 up to 12 years.

Tools of the study:

These tools were used in the present study to fulfill its aim which including:

Tool (I): A structured questionnaire filled in by the parents to gather information related to primary school children' demographic data, it was utilized to collect data pertinent to this study designed by the researchers based on reviewing the relevant literature**:** It was composed of two parts:

Part (1): It displayed the sociodemographic characteristics of parents; it included 4 items related to age, educational level, income, and working status.

Part (2): It presented the sociodemographic characteristics of children; it included 3 items related to students' age, gender, and residence.

Tool (II): Raven Standards Progressive Matrices test was used to measure cognitive function **(Raven, 1958).** The instrument consisted of 60

problems which contained 5 sets of 12 exercises. Testing was done in the classroom, and the scores were established in a percentile scale according to age: grade 1, superior intellectual ability (IA) (score ≥95th percentile); grade 2, above average IA (score ≥75th and 25th and 5th and ≤25th percentiles); and grade 5, intellectually defective (score ≤5th percentile). Many experts in World Health Organization recommended Raven's test for developing countries because its results are not affected by culture (**Pollitt et al., 1983)**.

Tool (III):- Children blood test assessment sheet; it was used to measure HB and serum ferritin concentration**.**

Tool (IV):- Modified Fahmy and ElSherbini scale: This scale was used to assess the socio-economic level of the family. The total score ranged from 5 to 19. Those with scores 15 or more (≥ 80% of total score) were considered of high socioeconomic class; scores 11-14 (60-< 11(< 60%) of low socioeconomic class (**Fahmy and EL-Sherbini, 1983).**

Validity and reliability: Content validity was determined through an extensive review of literature about the effect of iron deficiency anemia on academic performance among primary school children. Data collection tools content was submitted to a panel of five experts in pediatric nursing with more than ten years of experience in the field. The board ascertained the face and content validity of the tools. Modifications were done regarding the experts panel judgment about the clarity of sentences, appropriateness of its content, and recording of the items. Reliability was assessed through Cronbach's alpha reliability for tool 1 was =0.89 and the second tool was 0.92.

Administrative and Ethical consideration:

The official letters were obtained to conduct the study. Before starting this study, formal administrative approval was taken from authorities in the setting. Permission was obtained from the ministry of education in Sohag City, official permission from the managers of the two primary schools. After obtaining the written permission from the schools, a letter was sent to the parents of the participants to inform them about the research and to request their written consent to participate in the study. The researchers explained the aim of the study at the beginning for all participants, so they were reassured that all gathered information would be confidential. The study was conducted in the previously mentioned settings in October 2019.

Official permission was obtained from the directors of the selected schools. The researchers explained to the parents and their primary school children the aim and benefit of the study. The parents and their primary school children informed that their participation was voluntary and had the ethical right to participate or refuse participation in the study. It further emphasized that their responses were confidential, and had their right to withdraw from the study any time without giving further explanation. Privacy and confidentiality were resolutely kept in all data collection procedures. All ethical concerns were clarified in the letters sent to the children's parents.

Pilot study:

It was carried out on 10 % of the studied primary school children (72), for modification clarification and estimation of the time needed for filling the study tools, and testing the feasibility of the research process. The unclear items were clarified, unnecessary items were omitted and new items were added.

Modifications were carried out based on the results of the pilot study to develop the final form of the tools. Those who shared in the pilot study were excluded in the main study sample.

Field of the work:-

Data was collected in October 2019; it was performed by the researchers during the school day. The data collected according to every school policy. The actual work started by meeting the school managers throughout the morning school day, the researchers first introduced themselves to them and gave them a complete background about the study and the used tools which translated by the researchers in the Arabic language to collect the required data. Then the researchers went to the participants' classes and introduced themselves to primary school children, and explained the aim for their visits and the research aims, and invited them to participate in the study by filling out the data collection tools by their parents. A cover letter was given to primary school children including explanation about the research aims, and invited them to participate in the study by filling out the used tools which distributed to 720 students and collected on the second day and for illiterate parents were helped by the researchers to fill out the used tools. The researchers attended the setting of the study three times / a week from 9 am to 12 pm. The researchers visited each school three times every week to collect data.

The school performance was assessed by the students' score in mathematics (grade point average), cumulative grade point average, and rank. Blood samples were determined by measuring hemoglobin and serum ferritin concentrations. Blood was collected by venipuncture and drawn into a container. Blood samples were taken from all primary school children, during the school day by an expert laboratory technician. All of these tests were performed in a private laboratory of medical analysis. Anemia was defined when hemoglobin <11.5 g/dL. The degrees of iron deficiency anemia were determined by the following criteria: iron depletion was defined when a serum ferritin concentration <12 µg/L and iron deficiency anemia when serum ferritin <12 µg/L. Anemia, iron depletion, iron deficiency and iron deficiency anemia were defined according to the World Health Organization criteria **(WHO, 2001).**

Statistical analysis:

The data obtained were reviewed, prepared for computer entry, coded and scored, then analyzed and tabulated. Data entry and analysis were performed using the statistical package for social sciences SPSS (a software package) version 17.0. Data are expressed as the means, SD, and percentage distribution. Person's correlation is used for the numeric variables. $P > 0.05$ was considered not significant, while $P \leq 0.05$ was used as a

cutoff for significance and P ≤ 0.001 for highly significant differences.

Results:

A total of 720 primary school children participated in the study, table (1) revealed that the mean age of primary school children was 7.41 ± 2.71, the age group from 8 to 10 years was the most prevalent (40.3 %); it was found that males were more than females 60.0% compared to 40.0%. Regarding residence 90% of them lived in the urban area.

Table (2) reported that (60.0%) of fathers' age were from 20<30 years and 57.0% of mothers were 30 ≤ 40years. Concerning the educational level of fathers and mother were read and write (40.0%) respectively. As regard family income more than two thirds of fathers and mothers had low income (67%) and (68%) respectively. 64.0% of fathers and (34%) of mothers were working.

As shown in table (3) mean values of hemoglobin concentrations were 12.44 g/dL among boys and 12.3 g/dL among girls and the mean serum ferritin values were 26.4 µg/L in boys and 27.8 µg/L in girls.

Table (4) revealed the correlation between serum ferritin mean values and academic performance. It noticed a positive correlation was observed among primary school children between the values of serum ferritin and grade point average in mathematics (r295=0.5, p<0.05) and cumulative grade point average (r295=0.38, p<0.05)

Concerning table (5) There was a significant relation between cognitive Function and iron deficiency anemia; 82.0% of anemic primary school children suffered from intellectual deficit against 72.0% of primary school children who were not anemic (p=0.035).

Table (6) shows that grade point average in mathematics (p=0.046) and performance in the Raven test (p=0.001) were significantly correlated to hemoglobin values by using logistic regression analysis.

Considering the association between iron values, academic performance and socioeconomic characteristics of parents by using logistic regression to identify the factors influencing children's school academic performance, it revealed that iron values and the mother's income were significantly related to school academic performance. The overall F ratio for all variables was 6.45 (dF=6) and was highly significant (p=0.001) (Table 7).

Table (1): Frequency and Percentage Distribution of Studied Primary School Children Regarding their Demographic Characteristics (n=720)

Demographic data	No (720)	%
Age:		
- 6 to < 8	290	40.3
- 8 to < 10	221	30.7
- 10 -12	209	29.0
Mean± SD (7.41 ± 2.71)		
Gender :		
- Male	432	60.0
- Female	288	40.0
Residence		
- Rural	72	10.0
- Urban	648	90.0

Table (2): Frequency and Percentage Distribution of Parents of Studied Primary School Children Regarding their Demographic Characteristics (n=720)

Socio-demographic characteristics	Fathers (n=500)		Mothers (n=220)	
	No	%	No	%
1-Age in years				
- 20 <30 years	300	60.0	95	43.0
- 30 ≤ 40years	200	40.0	125	57.0
2- Education				
- Illiterate	45	9.0	11	5.0
-Read and write	200	40.0	88	40.0
-Primary education	50	10.0	31	14.0
-Secondary education	150	30.0	68	31.0
-University education	55	11.0	22	10.0
3-Parents' income:				
- Low	335	67.0	150	68.0
- High	165	33.0	70	32.0
4- Working status				
- Working	320	64.0	75	34.0
- Not working	180	36.0	145	66.0

Table (3): Distribution of Hematological Mean Values Regarding Sex of Primary School Children (n=720)

Variable	Boys		Girls	
	Mean	SD	Mean	SD
Hemoglobin (g/dL)	12.44	1.07	12.3	0.95
Hematocrit (%)	36	2.88	36.54	2.48
Serum ferritin (µg/L)	26.4	16.27	27.8	17.66
Serum iron (µg/dL)	2.54	10.66	2.2	9.11
Mean corpuscular volume (fl)	79.25	4.95	79.6	7.6
Mean corpuscular hemoglobin (pg)	27.35	2.22	27.4	2.2
Mean corpuscular hemoglobin Concentration (g/dL)	34.65	2.63	34.15	1.6

SD, standard deviation

Table (4): Correlation between Serum Ferritin Mean Values and Academic Performance among Primary School Children (n=720)

	Serum ferritin (µg/L)
Cumulative grade point average	r295= 0.38*
Rank	r295= -0.21
Grade point average in maths	r295= 0.5*

*significance at $p<0.05$

Table (5): Relation between Iron Deficiency Anemia and Cognitive Function among Primary School Children (n=720)

IA grades	Not anemic (n=200)		Anemic (n=70)	
	N	%	n	%
Grade 1	2	0.0	0	0
Grade 2	6	2.0	0	0
Grade 3	16	6.0	2	5.0
Grade 4	57	20.0	6	13.0
Grade 5	176	72.0	28	82.0

**** IA, intellectual ability as measured by Raven's Progressive Matrices test. Grade 1, superior IA; grade 2, above average IA; grade 3, average IA; grade 4, below average IA; grade 5, intellectually defective; *significant at p<0.05***

Table (6): Multivariate Logistic Regression Analysis Modeling Hemoglobin values among Primary School Children (n=720)

	B	SE	Wald	Exp (B)	Significance	95% CI	
	Lower	Upper					
CGPA	0.109	0.079	0.149	1.389	0.166	-.046*	0.264
GPA in maths	0.137	0.064	0.228	2.136	0.034	-.264	-0.011
Raven's test	0.021	0.006	0.205	3.273	0.001*	0.008	0.034

B, Ordinary least-squares regression coefficient; SE, standard error of B; CI, confidence interval; CGPA, cumulative grade point average; GPA, grade point average

Table (7): Association between iron values, academic performance and socioeconomic characteristics of parents (n=720)

	B	SE	β	t	Sign.	95% CI for B	
Age	3.8	0.053	0.025	0.71	0.047*	-0.067	0.143
Father's education level	1.91	0.057	0.12	0.336	0.737	-0.93	0.131
Mother's education level	0.063	0.59	-0.039	-1.077	0.282	-0.179	0.053
Father's income	1.878	0.032	0.021	0.59	0.555	-0.044	0.081
Mother's income	0.43	0.145	0.1	2.967	0.003*	0.144	0.715
Ferritin status	0.74	0.033	0.811	22.432	0.000*	0.677	0.807

B, ordinary least-squares regression: SE, standard error of B; β, standard beta coefficient: Sign, significance; CI, confidence interval Model summary: R=0.84; R2 =0.7; adjusted R2 =0.69; F ratio=6.45 (df=6)

Discussion:

Anemia occurred due to iron deficiency is wide-spread disease all over the world. Children in school age will come to experience this type of anemia. Primary school children' need to many foods, particularly iron, and the students with iron deficiency are at risk for infection with microbes due to decrease of their body strength. Iron deficiency anemia associated with a complex side effects and symptoms but, other symptoms respond to iron replacement therapy **(Camaschella, 2019).** Iron is considered an essential micronutrient that involved in many physiological processes such as oxygen transport and utilization, oxidative phosphorylation, mitochondrial function, DNA biosynthesis and ATP production (**Camaschella, 2017).** Hence**,** the study is aimed to evaluate the effect of iron deficiency anemia on academic performance among primary school children**.**

The current study reveals that prevalence of iron deficiency anemia in males were more than females children and the association with boys may be due to the faster growth of school boys compared to girls, which results in a high iron demand that cannot be met by diet alone.

The current study reveals that more than one third of the parents their educational levels were read and write, that may be the cause and meant that those parents had not enough

information about iron deficiency anemia and they not know about it and its complications so that they may be care of their children less than educated parents.

The current study reveals that family income more than two thirds of fathers and mothers had low income. This may be a result of decrease of parents' income that they unable to buy foods which rich with iron.

In a similar study, **Khan et al. (2016)**, who studied ferritin is a marker of inflammation rather than iron deficiency in overweight and obese people and reported that ferritin levels have got correlation with hemoglobin levels. Also, in a study conducted by **Kusumastuti et al. (2013)** who studied correlations between hemoglobin, serum ferritin, and soluble transferrin receptor levels in children and showed that children age and ferritin had relation with hemoglobin. Also **Kate et al. (1997),** who studied the Iron content of serum ferritin: physiological importance and diagnostic Value and found the same result.

These results were similar to those of **Habib et al. (2016)**, who studied prevalence and predictors of iron deficiency anemia in children under five years of age in Pakistan who found that about one third of children had iron deficiency anemia, as well, **Macher et al**. **(2012)**, showed high frequency of iron deficiency was noticed among school children.

The present study finding reported that there was a relation between iron-deficiency anemia and cognitive function and a positive correlation was observed among primary school children between the mean values of serum ferritin and grade point average in mathematics. This result was congruent with that of a study performed in Moroccan by **Mohamed et al. (2012),** who found the same result. Similarly, **Sarika et al. (2018)** reported that iron deficient in anemic students had scored less in mathematics. In contrast to the result study finding, **Zeeshan et al., (2017)** found that only 4% of the anemic children had low ferritin levels.

The current study result reflected the relationship between academic performance in Raven's Progressive Matrices and iron deficiency anemia and grade point average in mathematics and performance in the Raven test were significantly correlated to hemoglobin values. This means that iron concentration deficit lead to decrease the ability of cognitive function and concentration. This study result was in agreement with that of the study conducted by **Halterman et al., (2001),** who mentioned that there also was a relation between hemoglobin levels and both grade point average in mathematics and performance in the Raven Progressive Matrices test.

Similarly, **Mohamed et al., (2012)** reported that math scores were lower in children with iron deficiency anemia and those children had greater risk of scoring below average in math. These findings also were consistent with other research conducted by **Sungthong et al., (2002),** who mentioned in their study about effects of hemoglobin and serum ferritin on cognitive function in school children that children with iron deficiency anemia had poor cognitive function, and relation was found between hemoglobin and

cognitive function among children with iron deficiency anemia.

In a similar study **Hioui et al., (2008)**, who studied risk factors of anemia among rural school children in Kenitra and found that several previous studies proved that iron-deficiency anemia affects cognitive functions. Additionally, **Nader (2011)** reported similar findings.

These results were similar to those of **Nodoshan et al. (2016)**, who found that children who had iron deficiency anemia are liable to had psychomotor retardation, cognitive delays, lower cognitive scores and lower academic performance.

Similarly, **Nutrients, (2020)** reported the school performance in mathematics score were less in iron deficient children. Also, **Arcanjo et al., (2016)** detected and observed an association between iron deficiency anemia and deficits in cognitive performance in children.

This finding was also in line with that of **More et al., (2013),** in their study in American United States, which revealed that children with iron deficiency anemia had more than double the risk of scoring below average in the math test.

The current study result indicated that an association was found between iron values, academic performance and socioeconomic characteristics of parents as mother's income and education. This may be a result of decrease of parents' income and inability to buy foods rich with iron, concerning educational level of parents was also significantly correlated with iron values that meant educated parents had enough information about iron deficiency anemia and they know about it and its complications so that they may be care of their children more than non-educated parents. This result was similar to that of the study conducted in New Zealand by **Mohamed et al., (2012),** who clarified that iron status and the income of the child's mother were significantly related to their school achievement.

As highlighted by **Hioui et al., (2011),** and reported socioeconomic characterstics affect children's performance at school. Also, **Petranovic et al**., **(2008)** found that anemia can affect academic activities. However, this result was in disagreement with that of the study carried out by **Pratt and Khan, (2016)**, who detected that iron status did not affect educational performance and intelligence of school children.

Conclusion:

Based on the current study findings, it can be concluded that, anemia due to iron deficiency between children had effect on academic performance impairments.

Recommendations:

- Encourage health educational program for parents about children's nutritional requirements specially iron requirement and about the effects of iron deficiency on their children. .
- Encourage parents to do frequent blood testing for their children.
- Initiating program to encourage iron supplementation and folic acid

to primary school children to prevent hematological diseases and consequences of iron deficiency.

- Further studies could be conducted to explore the effects of iron deficiency on children.

References:

Arcanjo K., P. R. Santos J., and Nutr M.. (2016): Schoolchildren with Learning Difficulties Have Low Iron Status and High Anemia Prevalence, Published online 2016 Sep 15. doi: 10. 1155/ 2016/ 7357136

Belleza M. R. (2020): Iron Deficiency Anemia, Last Updated on June 29,

Benoist B, McLean E, Egli I, and Cogswell M, eds. (2008): Worldwide prevalence of anemia 1993-2005: WHO global database on anemia. Geneva: WHO Press 2008**.**

Camaschella C. (2017): New insights into iron deficiency and iron deficiency anemia. Blood Rev. 31: 225– 233. Doi: 10.1016/ j. blre. 2017. 02.004.

Camaschella C. (2019): Iron deficiency. Blood, 133:30–39. Doi: 10. 1182/ blood- 2018- 05-815944.

Cappellini M. D. , Musallam K. M. , Taher A. T. (2019): Iron deficiency anaemia revisited, First published: 30 October, https://doi. org/ 10. 1111/ joim. 13004, Citations: 14, journal of internal medicine, volume 287, Issue2, February 2020, Pages 153-170.

Disease and Injury Incidence and Prevalence Collaborators. (2016): Global, regional and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study; 390: 1211– 59.

Fahmy, S.I., and EL-Sherbini, A.F. (1983): Determining simple parameters for social classification for health. The Bulletin of HIPH. Alex. V111 (5) PP 95-100.

Habib K. Black, S. B. and Soofi et al. (2016): Prevalence and predictors of iron deficiency anemia in children under five years of age in Pakistan, a secondary analysis of national nutrition survey data 2011–2012," *PLoS ONE*, vol. 11, no. 5, Article ID 0155051,.View at: Publisher Site | Google Scholar

Halterman JS, Kaczorowski JM, Aligne CA, Auinger P, and Szilagry PG. (2001): Iron deficiency and cognitive achievement among school-aged children and adolescents in the United States. Pediatrics; 107: 1381-6.

Hioui M, Ahami AO, and Aboussaleh Y, et al. (2008): Risk factors of anemia among rural school children in Kenitra, Morocco. East Afr J Public Health; 5: 62-6.

Hioui M, Azzaoui FZ, Ahami AOT, and Aboussaleh Y. (2011): Nutritional status and school achievements in a rural area of Anti-Atlas, Morocco. Food and Nutrition Sciences; 2: 878-83.

Kate A, Wolthuis B, Westerhuis and van D. (1997): The Iron Content of Serum Ferritin: Physiological Importance and Diagnostic Value," *Clinical Chemistry and Laboratory Medicine*, vol. 35, no. 1, pp. 53–56,.View at: Publisher Site | Google Scholar

Khan, W. M. Khan, M. Ayub, M. Humayun, and M. Haroon. (2016): Ferritin Is a Marker of Inflammation rather than Iron Deficiency in Overweight and Obese People," *Journal of Obesity*, vol., Article ID 1937320, 7 pages, 2016.

Kiss JE, and Vassallo RR. (2018): How do we manage iron deficiency after blood donation? *Br J* Haematol: 181: 590– 603.Wiley Online Library CAS .

Kulnigg-Dabsch S, Resch M, Oberhuber G, Klinglmueller F, Gasche A, and Gasche C. (2018): Iron deficiency workup reveals high incidence of autoimmune gastritis with parietal cell antibody as reliable screening test. Semin Hematol; 55: 256– 61.

Kusumastuti, S. Sutaryo, and Mulatsih S. (2013): Correlations between hemoglobin, serum ferritin, and soluble transferrin receptor levels in children aged 6-59 months," *Paediatrica Indonesiana*, vol. 54, no. 2, pp. 122–126.

Macher S, Herster C, Holter M., Moritz M., Maria E. , Stojakovic T., Thomas R., Peter S., and Karin A. (2013): The Effect of Parenteral or Oral Iron Supplementation on Fatigue, Sleep, Quality of Life and Restless Legs Syndrome in Iron-Deficient Blood Donors: A Secondary Analysis of the Iron woman RCT

Mohamed E, Azzaoui Z. F., Ahmed O T A, Stéphane R, and Youssef Aboussaleh (2012): Iron deficiency and cognitive function among Moroccan school children.

More S., Shivkumar V. B., Gangane N., and Shende S. (2013): Effects of iron deficiency on cognitive function in school going adolescent females in rural area of central India. *Anemia*. ; 2013:5. doi: 10.1155/2013/819136.819136

Nader S. (2011): Relationship Between Anemia, Caused from the Iron Deficiency, and Academic Achievement Among Third Grade High School Female Students, Author links open overlay panel

Nodoshan A. Hashemi A. Golzar F. K and Akhondzaraini R. (2016): Hematological Indices in Children with Non-organic Failure to Thrive: a Case-Control Study," *Iranian Journal of Pediatric Hematology and Oncology*, vol. 6, no. 1, pp. 38–42,.

Nutrients. (2020) May; 12(5): 1313.Published online 2020 May, Volume 12, Issue 5.

Office of Dietary Supplements. (2018): Retrieved 11 December.

Petranovic D, Batinac T, Petranovic D, Ruzic A, and Ruzic T. (2008): Iron deficiency anemia influences cognitive functions. Med Hypotheses; 70: 70-2.

Pollitt et al., Evaluation de la conducts en los estudios sobre las consecuencias funcionales de la malnutrición. Description de métodos. In: Ambiente, nutrición y desarrollo mental. Publicación scientific No 450. Washington, DC: OPS/OMS; 1983; 58.

Pratt J.J. and Khan K.S. (2016): Non-anemic iron deficiency a disease looking for recognition of diagnosis: A systematic review. Eur. J. Haematol; 96:618–628. Doi: 10.1111/ejh.12645.

Radlowski E. C., and Johnson R. (2013): W. Perinatal iron deficiency and neurocognitive development. *Frontiers in Human Neuroscience.* ; 7, article 585 doi: 10.3389/fnhum.00585.

Raven J.C. (1958): Standard progressive matrices, General Introduction and Overview: The Raven Progressive Matrices Tests: Their Theoretical Basis and Measurement Model, London: Lewis.

Sarika More, V. B. Shivkumar, Nitin G, and Sumeet S .(2018): Effects of Iron Deficiency on Cognitive Function in School Going Adolescent Females in Rural Area of Central India, Anemia 2013(9, article a456):819136, Follow journal, DOI: 10. 1155/ 2013/ 819136.

Sungthong R, Mo-suwan L, and Chongsuvivatwong V. (2002): Effects of haemoglobin and serum ferritin on cognitive function in school children. Asia Pac J Clin Nutr; 11: 117-22.

World Health Organization (WHO). (2001): Iron deficiency anemia: assessment, prevention and control. A guide for program managers. Geneva: WHO.

World Health Organization (WHO). (2018): Iron Deficiency Anemia Assessment, Prevention, and Control A guide for programme managers WHO/ NHD/01.3 Distribution: General English only United

World Health Organization (WHO).. (2007): World Health Report. A safer future. Global public health security in the 21st century. Geneva: WHO 2007

Zeeshan, A., Bari, S., Farhan, U., and Rathore, A. W. (2017): Correlation between maternal and childhood VitB12, folic acid and ferritin levels," *Pakistan Journal Of Medical Sciences*, vol. 33, no. 1, pp. 162–166,.View at: Publisher Site | Google Scholar