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TO STUDY THE SCHOLASTIC PERFORMANCE IN IRON DEFICIENT SCHOOL AGE CHILDREN

M. Lakshmi Narayana Reddy*, Sudhakar Hegde, Ganesh

Department of Paediatrics, Vijayanagar Institute of Medical Sciences, Bellary, Karnataka

***Corresponding Author Email: drlnreddy999@gmail.com**

ABSTRACT

Introduction: *Iron deficiency is a major health problem worldwide affecting more than a quarter of the world's population. Iron deficiency anemia (IDA) is the most common form of anemia affecting 43% of the world's children. Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythrocytes, are noted. The more severe stages of iron deficiency are associated with anemia. When individual hemoglobin levels are below two standard deviations (-2SD) of the distribution mean for hemoglobin in an otherwise normal population of the same gender and age who are living at the same attitude, iron deficiency anaemia is considered to be present. In infants and children with iron deficiency, there is evidence of impaired motor development and coordination; impaired language development and scholastic achievements; psychological and behavioral effects (inattention, fatigue, insecurity, etc.). In addition, there is decreased physical activity in iron deficient children. The adverse effects on cognitive and educational test performance due to IDA in preschool and school-age children appear more transitory in nature than the effects on development in infants and imply that treatment of IDA in preschool and school-age children through iron supplementation programs may be beneficial and have immediate effects. This is in contrast to the effects of IDA on infants, for whom poorer performance on developmental tests may not be reversible with treatment and where programs aimed at the prevention of IDA may be the most appropriate action.* ***Aims and Objectives:*** *1.To assesses the scholastic performance in relation to iron deficiency in school going children. 2. To assess the impact of iron supplementation on scholastic performance in these children.* ***Materials and methods:*** *All children aged between 5 to 10 years at a government aided school in Bellary for a period of one academic year (2011-12) were included in the study. Consent was taken from the parents. History and clinical examination was done using a systematically designed proforma. CBC and Serum ferritin were done in all children. Those children who were found to be iron deficient as per WHO criteria were dewormed and supplemented with iron. Children were assessed for school performance, by reviewing the school records prior to and after iron supplementation.* ***Results:*** *A total of 186 children were screened, out of which 13.4% had iron deficiency anemia. 19.3% children had iron deficiency without anemia. Following iron supplementation, 48% of anemic children showed improvement the grades ($p<0.05$), 44.4% children in the iron deficiency without anemia group showed improvement in the grades ($p<0.05$), whereas 6.3% of the non anemia, non iron deficiency group showed improvement in grades. Iron deficiency is a cause of poor school performance, which improves with treatment.*

KEY WORDS

Iron deficiency, iron supplementation on scholastic performance.

INTRODUCTION

Iron deficiency is a major health problem worldwide affecting more than a quarter of the world's population. Iron deficiency anemia (IDA) is the most common form of anemia affecting 43% of the world's children.[2]

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, are noted. The more severe stages of iron deficiency are associated with anaemia. When individual haemoglobin levels are below two standard deviations (-2SD) of the distribution mean for haemoglobin in an otherwise normal population of the same gender and age who are living at the same altitude, iron deficiency anaemia is considered to be present.[3]

In infants and children with iron deficiency, there is evidence of impaired motor development and coordination; impaired language development and scholastic achievements; psychological and behavioral effects (inattention, fatigue, insecurity, etc.). In addition, there is decreased physical activity in iron deficient children.[4] Iron deficiency anemia leads to weakness, poor physical growth, and a compromised immune system and is also thought to impair cognitive performance and delay psychomotor development.

Recent macroeconomic estimates suggest that the impact of Iron Deficiency Anemia through both physical and cognitive channels could be as large as 4 percent of the GDP on average in less developed countries.[5] Through its impact on school participation and learning, anemia could also be central to understanding the intergenerational transmission of poverty.

There is increasing interest in strategies to improve education quality in poorly supported educational environments. Despite recent success in the expansion of educational access in low-income countries[6], concerns remain about levels of educational achievement and primary school completion in these countries. The reasons for this are multiple and complex, but it is increasingly recognized that poor health and nutrition affect children's cognitive functioning and therefore their ability to benefit from education.[7] Up to half of all school children in developing countries suffer from anaemia and there is good evidence that anaemia affects children's cognitive abilities.[5] Fortunately, iron supplementation and deworming have been showed to effectively improve cognitive performance and educational achievement.[8] These interventions can be cost-effectively delivered through school health and nutrition programmes which use the educational infrastructure to deliver interventions.[9]

Most research on the behavioral effects of iron deficiency and anemia has focused on the cognitive function of infants and pre schoolers and on the physical work capacity of adults. With some exceptions, little attention has been given to the effects of iron deficiency and anemia on the behavior and achievements of school aged children in formal educational settings. Hence, this study was conducted to assess school performance in relation to iron deficiency in school aged (5-10 yr) children and their response to iron supplementation with respect to school performance.

OBJECTIVES OF THE STUDY

1. To assess the scholastic performance in relation to iron deficiency in school going children.
2. To assess the impact of iron supplementation on scholastic performance in these children.

METHODOLOGY

1. STUDY TYPE: Prospective Cohort and Interventional Study.
2. DURATION OF THE STUDY: One year (2011- 2012)
3. STUDY SETTING: St Philomenas School, in Bellary.
4. STUDY SUBJECTS: 195 Children aged between *5* — 10 years, studying in classes 1st to 5th standard.
5. INCLUSION CRITERIA
    - All children in the age group of *5* to 10 years.

EXCLUSION CRITERIA

- Children less than 5 years and more than 10 years.
- Any child suffering from chronic systemic disease.
- Any behavioral problems.
- Any child where consent has not been given.

6. METHODS

• Consent for the study was taken from the parents.

• A detailed history including any chronic disorder, behavioral problems, perinatal history were taken in a systematically designed proforma. History of generalized weakness, anorexia, dyspnoea, and pica was asked for.

- A detailed clinical examination done.
- Complete Hemogram and Serum Ferritin were done in all children.
- Those children with low hemoglobin< 11.5gm,/dl, WHO criteria) were considered Anemic. Anemia was further classified as:

  Mild Anemia— *10—1l.5gm/dl*
  Moderate Anemia — *7* — 10 gm/dl
  Severe Anemia - < *7* gm/dl
- Those children with low serum ferritin (<l5mcg/l, WHO criteria) were considered Iron deficient.
- Total number of children were screened into 3 groups:
  GROUP A — Iron deficiency with Anemia.
  GROUP B — Iron deficiency without Anemia
  GROUP C — No Iron deficiency, No Anemia
- All children with iron deficiency were dewormed with 400mg single dose of albendazole.
- All children with iron deficiency were supplemented with ferrous sulphate tablets at a dose of 6 mg/kg/day for 3 months.
- School grades of all children were collected from school records prior to and after iron (ferrous sulphate) supplementation.
- These school grades were compared using appropriate statistical tests.
- Academic achievement was categorized into 3 groups for the study purpose.
  Low Achievers: Grade D (less than 40%)
  Grade C (40 — 60%)
  Moderate Achievers: Grade B (60- 80%)
  High Achievers: Grade A (above 80%)

PROCEDURE

2cc of blood was drawn in EDTA vial and hemoglobin, packed cell volume, total count, platelet count and red cell indices (MCV, MCH, MCHC) were estimated using automatic electronic counter.
2 cc of venous blood was collected in plain vial. Blood was allowed to clot and then centrifuged. Supernatant serum was collected and stored in deep freezer (temp <20° C) till the time it was used for assay of serum ferritin using Automated Chemiluminescence method. Care was taken to prevent hemolysis of the blood sample collected.

RESULTS

A total of 195 children were screened for the study purpose in a government aided primary school in Bellary urban district. Ethical committee permission was taken. Parental consent was obtained for all children after explaining the importance of the study.

Out of 195 children screened, 3 children had bronchial asthma, 2 children had experienced fever with jaundice in last one month, 1 child was operated for hernia in the past month, 1 child had pallor with fanconi's anemia phenotype, 1 child had aphakia, 1 child had icthyosis like skin condition. All these children were excluded from the study. Hence, total number of children studied was 186.
All children belonged to low socioeconomic status categorized according to Modified Kuppuswamy classification.

NUMBER OF CASES IN EACH GROUP

Groups	*No. of cases*	*Percentage of cases*
GROUP A(ID with Anemia)	*25*	*13.4%*
GROUP B (ID without Anemia)	*36*	*19.7%*
GROUP C (No ID, No Anemia)	*125*	*67.3%*
TOTAL	*186*	*100%*

Total Number of children in group A is 25(13:7%), Group B is 36(19.3%) and Group C is *125(67.3%).*
Prevalence of anemia was 13.7%.

Prevalence of iron deficiency was 32.7%.

HEMOGLOBIN LEVELS IN STUDY POPULATION

Hemoglobin levels	ID	Non ID
Severe Anemia Hb(< 7mg/dl)	-	-
Moderate Anemia Hb (7-10mg/dl)	4	-
MildAnemiaHb(10-11.5mg/dl)	21	-
No Anemia	36	125

The overall range of haemoglobin at screening was 8.3-14.3 g/dl with a mean of 11.7 g/dl for the 186 pupils enrolled. Females had a range of *8.6-12.5* g/dl with mean haemoglobin of 11.8 g/dl. Haemoglobin levels ranged from 8.3-14.3 g/dl in males with a mean of 11.7 g/dl. The mean haemoglobin did not differ between males and females (p >0.05).

FERRITIN LEVELS IN THE SAMPLE SCREENED

S. Ferritin levels	Group A	Group B	Group C
S. Ferritin <l0ng/ml	16(64%)	9(25%)	-
S. Ferritin 10- l5ng/ml	9(36%)	25(75%)	-
S. Ferritin>l5ng/ml	-	-	125(100%)
Total	25(100%)	36(100%)	125(100%)

SCHOOL PERFORMANCE AMONG THE CHILDREN SCREENED

School Achievement	Group A	Group B	Group C	Total
Low Achievers-Grade C and below (< 60%)	7	7	20	34(18.2%)
Moderate Achievers-Grade B (60- 80%)	15	26	83	124(66.6%)
High Achievers - Grade A (> 80%)	3	4	20	27(14.5%)
Total	25	36	125	100%

Prevalence of poor school performance was 18%, out of which 7% had iron deficiency.

CHANGE IN GRADES BEFORE AND AFTER IRON SUPPLEMENTATION

There was statistically significant change in the grades following iron supplementation in group A with a p value of 0.004 and in Group B with a p value of 0.03, as compared to group C where there was no statistically significant in the change in grades.

		GROUP A		GROUP B		GROUP C	
		PRE IRON	POST IRON	PRE IRON	POST IRON	PRE IRON	POST IRON
HIGH	Count	3	6	4	7	20	22
	%	12%	25%	11.1%	19.4%	16%	17.6%
MOD	Count	15	15	26	26	83	86
	%	**60%**	**60%**	72.2%	72.2%	66.4%	68.8%
LOW	Count	7	4	7	3	20	17
	%	28%	16%	19.4%	8.3%	16%	13.6%
Total	Count	25	25	36	36	125	125
	%	100.0%	100.0%	100.0%	100.0%	**100.0%**	100.0%

PRE AND POST IRON SUPPLEMENTATION CHANGE IN MARKS IN IRON DEFICIENT AND NON-IRON DEFICIENT CHILDREN

There was significant change in the marks before and after iron supplementation in Kannada, Science, Mathematics and Social Science in iron deficient school children, but the change was not significant in the non iron deficient children.

		IRON DEFICIENT CHILDREN			NON IRON DEFICIENT CHILDREN		
		Mean	N	p - value	Mean	N	p-value
KANNADA	**Pre iron**	31.39	61	0.0013	35.91	125	0.599
	Post iron	35,74	61		36.80	125	
ENGLISH	**Pre iron**	34.66	61	0.11	36.28	125	0.458
	Post iron	36.31	61		37.09	125	
HINDI	**Pre iron**	32.89	61	0.12	33.90	125	0.457
	Post iron	34.23	61		34.83	125	
SCIENCE	**Pre iron**	34.61	61	**0.0014**	35.63	125	0.743
	Post iron	37.56	61		36.11	125	
MATHS	**Pre iron**	36.39	61	**0.0015**	36.29	125	0.953
	Post iron	**39.66**	61		37.07	125	
SOCIAL SCIENCE	**Pre iron**	35.98	61	0.00 12	36.37	125	1.286
	Post iron	39.02	61		36.64	125	
TOTAL	**Pre iron**	207.92	61	0.0017	210.37	125	0.959
	Post iron	221.51	61		216.46	125	

CHANGE IN AVERAGE MARKS (SUBJECT WISE) FOLLOWING IRON SUPPLEMENTATION

Following iron supplementation, the change in marks was significant. The change in total marks was 13.59 following iron supplementation, whereas the change was 6 in non iron deficient group, where no supplementation was given. There was significant change in the marks in all subjects except Hindi and English.

	Iron deficient children	Non Iron deficient children	p-value
Kannada	4.35	0.89	0.03
English	1.65	0.81	0.46
Hindi	1.34	0.93	0.68
Science	2.95	0.48	0.037
Mathematics	2.68	0.7	0.04
Social science	3.04	0.27	0.01
Total	13.59	6.04	0.021

DISCUSSION

The study was a prospective and interventional study conducted during 2011 — 2012 at St. Philomenas School, Bellary. The study population was divided into three groups, depending on the hemoglobin and ferritin levels. Group A — ID with Anemia, Group B — ID without Anemia and Group C — No ID, No Anemia.

AGE AND SEXWISE DISTRIBUTION OF CASES

The study population is aged between 6 — 10 years. There were no statistically significant differences between groups in the mean age of children. There was no significant difference in sexes in the prevalence of anemia or iron deficiency in the study population.

COMPARISON BETWEEN DIFFERENT STUDIES IN SAMPLE SIZE AND AGE OF THE STUDY POPULATION

	n	Age in years
Pollitt et al(1982), USA	30	4 —7 yrs
Pollitt et al (1985), Egypt	68	7— 11 yrs
Soemantri et al (1987)	588	8 — 11 yrs
Seshadri et al(1989)	94	5 -8 yrs
Soewondo et al (1989)	139	3- 8 yrs
Present study	186	6 — 10 yrs

PREVALENCE OF ANEMIA AND IRON DEFICIENCY

Total Number of children in group A (ID with anemia) was 25(13.7%), Group B (ID without Anemia) 36(19.3%), Group C (No ID, No anemia) 125(67.3%). Prevalence of anemia was 13.7%. Prevalence of iron deficiency was 32.7%. The overall range of hemoglobin at screening was 8.3-14.3 g/dl with a mean of 11.7 g/dl for the 186 pupils enrolled. Females had a range of 8.6-12.5 g/dl with mean hemoglobin of 11.8 g/dl. Hemoglobin levels ranged from 8.3-14.3 g/dl in males with a mean of 11.7 g/dl. The mean hemoglobin did not differ between males and females ($p > 0.05$).

COMPARISON BETWEEN STUDY GROUPS IN PREVALENCE OF ANEMIA AND IRON DEFICIENCY

High prevalence of anemia in study conducted by Pollitt et al in 1985 could be due to the study population consisted mainly of children of low socio economic status in rural area. Seshadri et al also documented a higher prevalence. This could be due to the study population was mainly from rural Gujarat and during the study period, the mid day meal programme was not implemented.

	Anemia	Iron Deficiency
Pollitt et al (1985), Egypt	41%	60.8%
Soemantri et al (1987)	13.2%	30.6%
Soewondo et al (1989)	35.2%	66%
Seshadri et al(1989)	41.4%	-
WHO(2005),global	25.4%	70%
NFHS III	69.5%	-
Present study	13.7%	32.7%

The present study showed anemia prevalence of 13.7%, as compared to the national data of *69.5%* in 6 to 10 years age group. This low incidence of anemia and iron deficiency could be attributable to urban location of school, efficient implementation of midday meal programme and robust biannual school health checkups. The present study mostly correlated with the study done by Soemantri et al in Indonesia. Prevalence of poor school performance was 18%, of which 7% was constituted by iron deficient children. Sunil Kara de et al noticed that at least 20% of the children in the classroom are scholastically backward.

IMPACT OF IRON THERAPY ON SCHOOL PERFORMANCE

Halterman et al (2001) studied iron deficiency and cognitive achievement among school-aged children and adolescents in the United States (6-16 years); Average math scores (score approximately 87) lower for children with iron deficiency with and without anemia compared with children with normal iron status (score 94). Children with iron deficiency had more than twice risk of scoring below average in math than those with normal iron. Pollitt E et al (1989) studied Iron deficiency and educational deficiency. 41 children without anemia and 78 with iron-deficiency anemia (8.2-13 years of age) were given either iron supplements or placebo at school. IQ score of IDA group was 90.8±1.0 significant lower than Fe replew group (94.2+ 0.3, p - 0.001). Thai language score of Fe replete group *(59.0±0.5)* significantly higher than IDA group *(55.9±1.5,* p- 0.05) and Fe depleted (51.8 ± 2.2, p- 0.0 10).

Sheshadri et a! (1989) studied the impact of iron supplementation on cognitive functions in preschool and school-aged children. The study consisted of 94 children (age *5-8* yrs) of whom one third were randomly assigned to control. Anemic children had lower test scores at beginning of experiment. Nutrition therapy improved IQ/WISC scores for both anemic (11 points) and non anemic students (4 points) for children aged 7 and 8 years. Sungthong et al (2002) studied Effects of haemoglobin and serum ferritin on cognitive function in school children. Children were tested for cognitive function (Test of Nonverbal Intelligence), hemoglobin, iron, and height/weight. Those with iron-deficiency anemia consistently had poorest cognitive function (IQ *75)* and below-average math/language achievement. Those with iron deficiency but not anemia had higher cognitive function (IQ 86) and above average math/language achievement.

In the present study, following iron supplementation there was statistically significant improvement in the grades of pupils in iron and non iron deficient children. Total marks showed an increase of *13.59* marks compared to 6.01 in non iron deficient group. Subject wise marks also showed a significant improvement in Kannada *(4.35),* Mathematics (2.95), Science (2.68) and Social Science (3.04) except Hindi and English. This could be because, medium of instruction and majority of children's mother tongue was Kannada followed by Tamil; Hindi could be difficult to the children as it is not a local dialect.

CONCLUSION

Iron deficiency anemia is a preventable cause of cognitive impairment and other negative effects on the academic potential of children. Iron is needed continuously for brain growth in children and there is also evidence that IDA impairs growth. The developmental deficits related to IDA can to some extent be corrected with iron treatment; however,

there is evidence that some deficits are not reversible with iron treatment.

The purpose of the study was to explore the effects of IDA on school performance. We found a positive correlation between IDA and performance in life skills and languages. This finding is consistent with literature as most of the previous studies found that IDA negatively affects academic performance. Therefore, we were able to prove that IDA is associated with poor school performance and supplementation of iron in these children significantly improved the scholastic performance.

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***Corresponding Author:**
Dr. M.LAKSHMI NARAYANA REDDY
MBBS, MD,
Professor and Head of Department,
Department of Paediatrics,
Vijayanagar Institute of Medical Sciences,
Bellary, Karnataka.