Etiology of Anemia, Iron Deficiency among Young Children and Strategies to Overcome

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Abstract

Background: Anemia, iron deficiency, worm infestation and *Helicobacter pylori* infection is highly prevalent among young children population in India.

Objectives: To understand the aetiology of anaemia, iron deficiency, role of worm infestation and presence of *Helicobacter pylori* among young children population and to assess the impact of intervention

Method: 484 children of age 5-12 years from rural schools were enrolled for the study. Blood haemoglobin and serum ferritin were measured. *H.pylori* status was investigated with the 13C- Urea Breath Test. Stool specimen was assessed for the presence of parasites. 140 anemic children were selected for the intervention. They were randomly divided into seven groups of 20 children in each and named as group 1 to 7. 1 as control, 2 iron supplementation, 3 treated for *H. pylori* alone, 4 treated for worms, 5 treated for *H. pylori* infection along with iron supplementation, 6 treated for worms along with iron supplementation & 7 supplemented with iron along with treatment for *H. pylori* and deworming (for duration and dose refer Methodology in the text).

Results: Of the 484 children, 30.4% were anemic. 18.8% children were iron deficient, of which, 50.3% were anemic. 13.2% children were positive for *H.pylori* and 50.0% children are infested with potentially pathogenic parasites. Intervention studies showed that the Group 7 children showed significant rise in hemoglobin and serum ferritin in comparison.

Conclusion: Childhood anemia continues to be a significant public health problem in school children and targeted intervention to iron deficiency either alone or in combination (Iron deficiency, worm infestation and H. pylori infection) can reduce the burden.

Keywords: *Anemia, iron deficiency, H.pylori, Worm infestation, Intervention.*

Introduction

Anemia is a leading public health issue in developing countries. An estimated 30% of the world's population is anemic[1]. The global prevalence of anemia among 6-12y old children in developing countries ranges from 36-77%[2-4]. In India the prevalence of anemia among 5-14y old urban and rural is found to be in the range of 66.7 to 77%[5].

Iron Deficiency Anemia (IDA) can range from mild to severe health issues such as delayed growth and development and behavior problems among young children[6-8]. Infection with *H. pylori* infection has an effect on iron absorption [9]. It is reported that *H. pylori*

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infection is observed in over 50-70% people in the world [9,10]. Moreover, IDA affects two billion people in the world. When two diseases have such a high prevalence in the population, definitely they may appear to be associated with each other. However, knowledge regarding any relation between *H.pylori* infection and IDA is limited[10,11]. Parasitic infestations caused by protozoa and helminthes continue to take their toll on mankind. The misery these parasites inflict on humans remains a major health problem worldwide[9,12]. Anemia, which can be mild to severe, acute or chronic, is commonly associated with parasitic infestations [13,14]. In view of the deleterious effects of iron deficiency anemia on overall development of children, present study was designed to assess the prevalence of anemia and iron deficiency among apparently healthy children of rural background and also to establish the impact of worm infestation on anemia and to evaluate the association between H. pylori infection and IDA. The study also aimed to investigate the related changes before and after the treatment for *H. pylori* and deworming along with and without iron supplementation and the relationship of these changes among iron deficiency anemia in children.

Methodology

Three rural schools from Uddaghatta, Baramasamundra and Horkeravillages were selected from Jagalur taluk, Davangere district, Karnataka. Each school was named as Group A, B and C.

Body mass index of boys and girls were measured. Prevalence of anemia, iron deficiency, *H. pylori* infection and parasitic infestation were determined among study populations by standard tests[6,9,10,13,14]. Based on the prevalence of anemia, iron deficiency, *H. pylori* infection and parasitic infestation, a well-designed interventional program was executed.

Intervention Study: A total of 140 anemic children out of 147 anemia were selected for the intervention study and were randomly divided into seven groups. Each group comprised of 20 children.

Group 1 (20 numbers): Children were kept as a control group with no iron supplementation, no treatment for H. pylori and with no deworming, for up to 3 months.

Group 2 (20 numbers): Iron supplementation by giving iron tablet to all the 20 children for three months (3mg/kg/day – not to exceed 60mg daily).

Group 3 (20 numbers): Treatment for H. pylori was given for 2 weeks with no iron supplementation for 3 months. A triple drug therapy: lansoprazole (0.6mg/kg per day, once daily), clarithromycin (15mg/kg per day, divided into 2 doses) and metronidazole (20mg/kg per day, divided into 2 doses) was administered for the period of 2 weeks.

Group 4 (20 numbers): Deworming was done by a single dose of albendazole 400mg was for the worms that are transmitted through contaminated soil.

Group 5 (20 numbers): Children were treated for H. pylori infection for 2 weeks (Treatment same as Group 3) along with iron supplementation for 3 months (Iron supplementation same as Group 2).

Group 6 (20 numbers): Deworming (Same as Group 4) along with iron supplementation for 3 months (Iron supplementation same as Group 2).

Group 7 (20 numbers): Children were supplemented with iron for 3 months (Iron supplementation same as Group 2) along with both the treatment for H.pylori up to 2 weeks (Treatment same as Group 3) and deworming by a single dose (Same as Group 4).

The investigation for hemoglobin, serum ferritin levels, worm infestation and breath test for *H.pylori* was done before the intervention study and after the intervention period to assess the impact of intervention.

Results

Screening: A total of 484 children were enrolled for the study from three different schools from rural area of Davangere district. Age wise distribution of the children is given in the table-1. 26.0% of the children were of the age group 11-12 years and 25.8% were of the age 9-10 years. Preponderance of girl child (51.2%) was seen when compared with boys (48.8%)

Anthropometric Measurements: Among 236 boys, 15 (6.4%) were underweight, 3 (1.3%) obese and 218 (92.4%) were normal.

Out of 248 girls, 34 (13.7%) were underweight, 11 (4.4%) obese and 203 (81.9%) girls were normal (Table 2).

Prevalence of Anemia: WHO criteria was used to categorize anemia among children of 5-12 year age group. Of the 484 children, 147 (30.4%) were found to

be anemic and 337 (69.6%) were non-anemic. Among anemic children, mild anemia was found in 62 (42.2%), moderate anemia in 53 (36.1%) and 32(21.8%) were severely anemic. The prevalence of anemia was found to be highest in 5-6y age group (36.7%). Among 7-8y age group 43 (29.2%) were anemic and 29 (19.7%) among 9-10y. The anemia was more prevalent among girls (57.8%) when compared to boys (42.2%) (Table-3).

Prevalence of Iron-Deficiency: Not all anemic children were iron deficient and iron deficiency may occur without anemia. Out of 484 children studied 91 (18.8%) were iron deficient. Among these 17 (5.0%) were non-anemic and 74 (50.3%) were found to be anemic (Table-4).

Prevalence of H. pylori infection: Out of 484 children studied, 64 (13.2%) children were found positive for H. pylori infection by breath test. Among these 19 (17.0%) were positive in 5-6y age group, 16 (13.0%) in 7-8y, 17 (14.0%) in 9-10y and 12 (10.0%) in11-12y age group were found positive for H. pylori infection (Table-5).

Association between Anemia, Iron Deficiency (ID), Iron Deficiency Anemia (IDA) and H. pylori: The prevalence of H. pylori among non-anemic children was 36 (10.7%), of which 17 were positive for both Iron Deficiency and H. pylori infection, whereas other 19 were positive only for *H.pylori* infection.

In mild anemic children, 6 of them were positive for H.pylori. Similarly among mild anemic children, 8 were positive for H.pylori and in severely anemic children, 14 were positive for H.pylori. The relationship among anemia, IDA and H. pylori infection is depicted in the Table 5.

Prevalence of Parasitic Infestation: Parasitic infestation was examined in 474 children. 237 (50.0%) were found infested with potentially pathogenic parasites. The most common parasitic seen are; *Ascaris lumbricoides* excreted by 44 (18.6%) children, followed by *Enterobius vermicular* by 41 (17.3), *Ancylostoma duodenale* by 39 (16.5), *Trichuris trichiura* by 37 (15.6%), *Hymenolepis nana* by 35 (14.8%), *Giardia lamblia* by 33 (13.9%) and *Entamoeba histolytica* excreted by 8 (3.4%) children. The parasitic infestation was found more in girls (53.2%) compared to boys (46.8%). The prevalence of parasitic infestation was found highest among 5-6y age group (35.0%), followed by 31.2% in 7-8y children, 21.1% in 9-10y and 12.7% was infested among 11-12y age group.

Comparison of hemoglobin and serum ferritin levels before and after the intervention program

After the intervention program 73 (52.1%) children showed increase in the hemoglobin and serum ferritin levels which was highly significant.

Group 1: Increase in hemoglobin and serum ferritin level was seen in only one child (5.0%) who was not supplemented with iron nor treated for H. pylori and deworming. They were kept as control.

Group 2: Increase in hemoglobin concentration and serum ferritin was seen in 6 (30.0%) children who were supplemented only with iron tablets.

Group 3: Rise in hemoglobin concentration and serum ferritin was seen in 13 (65.0%) children who were treated only for H. pylori infection.

Group 4: Hemoglobin and serum ferritin level was increased in 9 (45.0%) children for whom only deworming was done.

Group 5: Hemoglobin and serum ferritin concentration was raised in 15 (75.0%) children who were treated for H. pylori infection along with iron supplementation.

Group 6: Increase in hemoglobin and serum ferritin level was observed in 11 (55.0%) children who were supplemented with iron tablets along with deworming.

Group 7: Hemoglobin and serum ferritin concentration was well improved in 18 (90.0%) children of this group who were treated for H. pylori and deworming along with iron supplementation.

Table 1: Age wise distribution of children among different schools

Age (Years)	Group			Total Number (%)
	A Number (%)	B Number (%)	C Number (%)	
5-6	41(23.7)	33 (22.4)	38 (23.2)	112 (23.1)
7-8	45(26.0)	35(23.8)	41(25.0)	121(25.0)
9-10	42(24.3)	40(27.2)	43(26.2)	125(25.8)
11-12	45(26.0)	39(26.5)	42(25.6)	126(26.0)
Total	173	147	164	484

Table 2: Body mass index of the boys and girls among different schools

Age (Years)	Group						Total Number (%)
	Underweight		Normal		Obese		
	Boys	Girls	Boys	Girls	Boys	Girls	
	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	
5-6	8(15.4)	12(23.7)	44 (84.6)	48(23.7)	-	-	112 (23.1)
7-8	5(9.3)	9(26.0)	49(23.8)	57(26.0)	-	1(26.0)	121(25.0)
9-10	2(3.0)	8(24.3)	62(27.2)	47(24.3)	2(26.2)	4(24.3)	125(25.8)
11-12	-	5(26.0)	63(26.5)	51(26.0)	1(25.6)	6(26.0)	126(26.0)
Total	**15**	**34**	**218**	**203**	**3**	**11**	**484**

Table 3: Prevalence of anemia among children of different schools

Age (Years)	Anemia						Total Number (%)
	Mild		Moderate		Severe		
	Boys	Girls	Boys	Girls	Boys	Girls	
	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	
5-6	10(35.7)	14(41.2)	6 (84.6)	12(37.5)	5(38.5)	7(36.8)	54 (36.7)
7-8	12(42.9)	8(23.5)	5(23.8)	9(28.1)	4(30.8)	5(26.3)	43(29.2)
9-10	3(10.7)	7(20.6)	6(27.2)	5(15.6)	3(23.1)	5(26.3)	29(19.7)
11-12	3(10.7)	5(14.7)	4(26.5)	6(18.8)	1(7.7)	2(10.5)	21(14.3)
Total	**15**	**34**	**218**	**203**	**3**	**11**	**147**

Table 4: Prevalence of Iron deficiency among children of different schools

Group	Serum ferritin (SF) levels among different age group				Total
	5-6 years Number (%)	7-8 years Number (%)	9-10 years Number (%)	11-12 years Number (%)	
Non-Anemic	2 (11.8)	3 (11.8)	5 (11.8)	7 (11.8)	17
Mild anemic	4 (11.8)	2 (11.8)	7 (11.8)	6 (11.8)	19
Moderate anemic	8 (11.8)	11 (11.8)	7 (11.8)	7 (11.8)	33
Severe Anemic	10 (11.8)	5(11.8)	5 (11.8)	2 (11.8)	22
Total	24(11.8)	21(11.8)	24 (11.8)	22 (11.8)	91

Table 5: Association among anemia, iron deficiency, iron deficiency anemia and Helicobacter pylori infection

Anaemic Status	Iron Deficiency	Helicobacter Pylori Positivity
Non Anaemic (n=337)	17 (5.0)	36(10.7)
Anaemic (n=147)	74 (50.3)	28(19)
Mild (n=62)	19 (30.6)	6(9.7)
Moderate (53)	33 (62.2)	8(15.1)
Severe (n=32)	22 (68.8)	14(43.8)
Total	**91(18.8%)**	**64(13.2%)**

Discussion

In view of the above findings, it is highly recommended that measures to reduce worm infestation including mass chemotherapy; should deserve high priority because of the known harmful effects of these worms. Worm infestation may also influence anemia to a large extent & calls for a deworming campaign along with IFA distribution in control program for anemia in children. It was found to be a strong predictor of anemia in the present study too. Stoltzfus et al [4] found that 25% of all anemia, 35% of iron deficiency anemia and 73% of severe anemia was attributable to hookworm infection.

Emerging evidence seems to place *H. pylori* infection next to helminthiasis as a communicable cause of anemia[17] . Therefore, new initiatives designed to further decrease prevalence of iron deficiency and IDA in high-risk groups may need to address the eradication of *H. pylori* infection. Different epidemiological studies conducted all over the world have demonstrated an association between *H. pylori* infection and IDA[17-18]. In the present study the prevalence of *H. pylori* infection in IDA was 28 (19%) this is in concurrence to the other studies[16-18]. The prevalence of *H. pylori* was 13.2% in the present study. The rate of *H. pylori* infection was significantly higher in IDA (19%) when compared to non IDA group (10.7%). A significant association between *H. pylori* and IDA was found in children. Treatment for *H. pylori* infection showed increase in hemoglobin level in 13 (65%) children without iron supplementation. *H. pylori* eradication therapy combined with iron administration showed increase in hemoglobin level in 15 (75%) children which is more effective than iron administration alone for the treatment of IDA where only 6 (30%) children showed the improvement. *H. pylori* infection may lead to IDA by impairing iron uptake or increasing the demand for iron[18]. These findings and those from the current study suggest that eradication of *H. pylori* infection is a promising approach for achieving long term recovery from IDA in certain children.

After deworming, 9 (45%) children showed increase in hemoglobin level whereas deworming combined with iron supplementation showed increase in 11 (55%) children. Children who were treated for *H. pylroi* and deworming along with iron supplementation showed a very good improvement where 18 (90%) children showed rise in hemoglobin and serum ferritin concentration.

In the present study, age, education status, socio-economic status and BMI was not significantly related with anemia. Mehta M and Kotecha et al., also reported that age is not a significant correlation of anemia[18]. Educational and socioeconomic status alone may not have any significant effect on anemia.

To conclude, childhood anemia continues to be a significant public health problem in school children and iron deficiency either alone or in combination (Iron deficiency, worm infestation and H.pylori infection) is the commonest nutritional cause of anemia in school children aged 5-12y in the community. Improvement in knowledge regarding anemia and factors associated with it and life style management can be taught through educational programs and through the media.

Acknowledgment: Authors would like to thank Block education officers and the Principal of the schools for the permission and logistic support, SSIM & RC for the facilities, Bharathiyar University for the permission for the study.

Ethical Clearance: The research proposal was reviewed and cleared by the committee of Bharathiar University, Coimbatore.

Source of Funding: Self funding

Conflict of Interest: Nil

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