IRON DEFICIENCY AND IRON DEFICIENCY ANAEMIA IN CHILDREN AGED 5-10 YEARS IN GAMPAHA DISTRICT

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Sponsorship: Micronutrient Initiatives, India

ABSTRACT

Background: World Health Organisation estimates that approximately 50% of all anaemia can be attributed to iron deficiency. Iron deficiency data are very limited.

Objective: To assess the extent of iron deficiency among children aged 5 – 10 years in Gampaha district.

Subjects and Design setting: A cross sectional study carried out on a representative sample of children aged 5-10 years resident in Gampaha district using a multi-stage sampling method.

Method: A pretested interviewer administered questionnaire was used to collect information of socio demographic and economic characteristics and dietary practices from the relevant households. Venous blood sample were taken from all children to assess the haemoglobin (Hb) level to detect anaemia, levels of Serum Ferritin and C-Reactive Protein.

Results: Prevalence of anaemia, iron deficiency and iron deficiency anaemia was 22.7%, 21.9% and 14.0%. Iron deficiency was significantly higher among non anaemic children (24.3%) than anaemic children (14.0%) and in mildly anaemic children (16.5%) than moderately anaemic children (10.9%). Among the varied socio demographic and socio economic variables studied, the only significant differences were seen in the source of water to the household and living in the urban areas. The prevalence of stunting and thinness were higher in iron deficient children though not significant. Presence of acute infections were low (2.1%) in this population.

Conclusions: Iron deficiency is a public health problem in this population. It is recommended to implement appropriate interventions to prevent the multiple health problems.

Key words:

Iron deficiency, Anaemia, Nutrition status of Children 5-10 years, Iron deficiency anaemia,

INTRODUCTION

Iron deficiency is the most widespread micronutrient and overall nutritional deficiency. As stated by the World Health Organisation (WHO), 2 billion people – over 30% of the world's population – are anaemic with about 1 billion suffering from iron deficiency anaemia [1]. WHO estimates that some 800,000 deaths worldwide are attributed to iron deficiency anaemia and it remains among 15 leading contributors to the global burden of disease [2]. As measured in disability adjusted life years (DALYs), iron deficiency anaemia accounts for 25 million, or 2.4%, of the total. Anaemia is commonly used as an indicator of iron deficiency in population-based surveys [3].

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 erythron, are noted. The more severe stages of iron deficiency are associated with anaemia [4].

Iron deficiency (ID) can affect all populations and age groups, but the most vulnerable groups are women and children. It can impair cognitive performance at all stages of life [3].

In Sri Lanka, anaemia has continued to be important public health problems as shown in many studies [5,6]. The prevalence of anaemia among primary schoolchildren was reported in year 1996 as 58%, 21% in year 2001 and 16.7% in 2004 at national level [6,7,8]. No studies on iron deficiency among children between 5-10 years are available.

To plan effective interventions to combat both ID and iron deficiency anaemia (IDA) there is an urgent need to have better information on the iron status of populations. This will enable the appropriate interventions to be chosen and once programmes are in place, to have the relevant indicators to monitor their impact. Hence this study was conducted to assess the iron deficiency and associated factors in children aged 5-10 years in a community setting representing a district.

SUBJECTS AND METHODS

This is a cross sectional community based study among children 5-10 years of age representing Gampaha district. The calculated sample size was 704 considering the prevalence estimates of anaemia among children as 20% with the 95% of confidence interval and 5% error. Design factor was taken as 2.5 and non respondent rate was considered at 5%. It was decided to include 32 clusters and 22 participants from each cluster.

A multi-stage sampling technique was used to identify the sample. During the first stage all public health midwife areas (PHM) in Gampaha district was listed out by urban and rural sectors and 16 PHM areas (identified as clusters) from each sector were randomly selected. As the second stage, twenty two children were identified randomly from each PHM area. Five teams each comprising of 2 health personnel who had previous experience of participating in nutritional surveys was responsible for data collection. A pre tested interviewer administered questionnaire was administered to obtain date of birth, sex of children, dietary information and socioeconomic characteristics.

Anthropometric data were collected by specially trained health personnel one in each team. Heights and weights were measured using standard techniques described by the World Health Organization (WHO) [9]. Height was measured by using a stadiometer with the child without footwear and the head held in the Frankfurt horizontal plane. An electronic Seca weighing scale was used to weigh the children with a minimum of clothing without footwear. Accuracy of the weighing scales were checked every morning using standard weights. The weights and heights were recorded to the nearest 0.1kg and 0.1cm respectively. The measurer variation was assessed by duplicating the 10% of measurements by the same measurer and repeating the 10% by the Nutrition Assistant.

Venous blood samples were taken from all children to assess the levels of haemoglobin (Hb) using cyanmethaemoglobin method, serum ferritin (SF) using ELISA and C-reactive protein (CRP) using test kits. When the Hb level is below 10g/dl, presence or absence of thalassaemia was assessed using High Performance Liquid Chromatography (HPLC) method. WHO defined cut-off levels were used to assess the anaemia (Hb<11.5g/dl), iron deficiency (SF<15μg/l) and acute phase of infections (CRP>6.0mg/L) [10,11].

All fieldwork was completed during the period, May to June 2011. Ethical approval was obtained from the institutional ethical committee. Permission was obtained from the Provincial and district health authorities. Written informed consent was obtained from parents.

Age was calculated from the subject's date of birth. Height-for-age and BMI-for-age-sex Z scores were calculated by using Anthro 2010 (WHO) software. The WHO cut-off levels were used to estimate prevalence of stunting (height-for-age <-2SD) and prevalence of thinness (BMI-for-age-sex <-2SD) [12]. Chi square test and odds ratio was calculated and the level of significance was taken at 0.05.

RESULTS

A total of 688 children aged 5-10 years were enrolled in the study. Non response rate was 2.3%. Gender distribution in the sample was 47.5% of boys and 52.5% of girls. Figure 1 shows median serum ferritin value was 26.2µg/l and ranged from 1.1 to 170.2µg/dl. Majority of children had serum ferritin levels <100µg/l.

Comparison of prevalence figures of iron deficiency by selected variables was carried out to enable identification of factors associated with iron deficiency.

Figure 1: Frequency distribution of serum ferritin levels

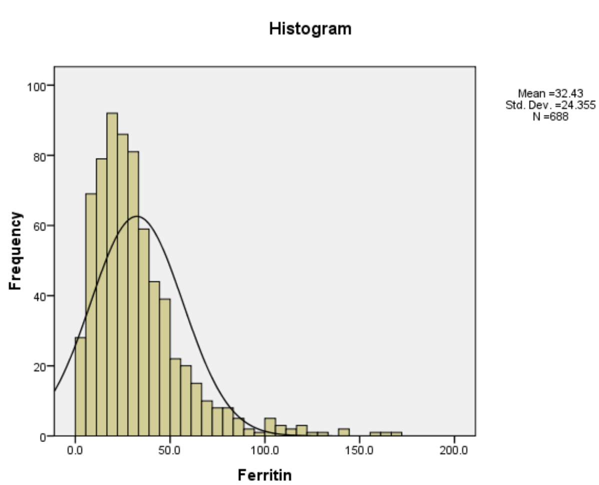

Table 1.Prevalence of iron deficiency among children aged 5-10 years, by socio demographic and socio economic characteristics

Background characteristic	% of Children with iron deficiency (SF<15µg/dl)	% of Children with iron deficiency (SF≥15µg/dl)	Total number of children	Statistical significance
Sector				
Urban	91 (26.5%)	253 (73.5%)	344 (50.0%)	**X^2=8.2 P=0.006**
Rural	60 (17.4%)	284 (82.6%)	344 (50.0%)	
Mother's education in years				
1-5	9 (27.3%)	24 (72.7%)	33 (4.8%)	X^2=3.22 P=0.359
6-10	106 (21.6%)	384 (78.4%)	490 (71.2%)	
11-12	36 (23.1%)	120 (76.9%)	156 (22.7%)	
Higher	0 (0.0%)	9 (100.0%)	9 (1.3%)	
No. of household members				
1-3	19 (19.2%)	80 (80.8%)	99 (14.4%)	X^2=0.75 P=0.69
4-6	129 (22.6%)	443 (77.4%)	572 (83.1%)	
≥7	3 (17.6%)	14 (82.4%)	17 (2.5%)	
Source of drinking water				
Piped water	49 (31.0%)	109 (69.0%)	158 (23.0%)	**X^2=38.9**

Public tap	7 (18.4%)	31 (81.6%)	38 (5.5%)	**P=0.000**
Tube well	24 (42.1%)	33 (57.9%)	57 (8.3%)	
Protected well	47 (16.8%)	233 (83.2%)	280 (40.7%)	
Unprotected well	21 (14.3%)	126 (85.7%)	147 (21.4%)	
Other (canal, rain water etc)	3 (37.5%)	5 (62.5%)	8 (1.1%)	
Toilet facilities				
Sanitary	141 (21.3%)	520 (78.7%)	661 (96.1%)	X^2=5.6 P=0.06
Not sanitary (pit latrine)	10 (37.0%)	17 (63.0%)	27 (3.9%)	
Monthly household income (Rs.)				
<9,000	9 (17.6%)	42 (82.4%)	51 (7.4%)	X^2=3.0 P=0.55
9,000-13,999	29 (23.8%)	93 (76.2%)	122 (17.7%)	
14,000-19,999	40 (22.2%)	140 (77.8%)	180 (26.2%0	
20,000-31,999	59 (23.8%)	189 (76.2%)	248 (36.0%)	
≥ 32,000	14 (16.1%)	73 (83.9%)	87 (12.6%)	
Overall	151 (21.9%)	537 (78.1%)	688 (100.0%)	

As shown in table 1, prevalence of iron deficinecy among children living in urban areas were significantly higher than among their rural counterparts. All other basic socio demographic and socio economic characteristics relevant to the children were not statistically significant with the exception of sources of drinking water.

Table 2 : Prevalence of iron deficiency in relation to the age, sex and dietary practices of children

Background characteristic	% of Children with iron deficiency (SF<15µg/dl)	% of Children with iron deficiency (SF≥15µg/dl)	Total number of children	Statistical significance
Age of the child (years)				
5.0 – 6.9	57 (19.6%)	234 (80.4%)	291 (42.3%)	X^2=1.8 P=0.4
7.0 – 8.9	66 (24.2%)	207 (75.8%)	273 (39.7%)	
9.0 – 10.9	28 (22.6%)	96 (77.4%)	124 (18.0%)	
Sex of the child				
Male	64 (19.6%)	263 (80.4%)	327 (47.5%)	X^2=2.1 P=0.17
Female	87 (24.1%)	274 (75.9%)	361 (52.5%)	
Knowledge on anaemia				
Yes	117 (23.1%)	394 (77.1%)	511 (74.3%)	X^2=1.04 P=0.34
No	34 (19.2%)	143 (80.8%)	177 (25.7%)	
Taking iron tablets during last 6 months				
Yes	12 (29.3%)	29 (70.7%)	41 (6.0%)	X^2=1.36 P=0.25
No	139 (21.5%)	508 (78.5%)	647 (94.0%)	
Drink tea within 2 hours of the main meals				
Yes	50 (25.0%)	147 (75.0%)	197 (28.6%)	X^2=1.9

No	101 (20.6%)	390 (79.4%)	491 (70.9%)	P=0.19
Eating fruits after main meals				
Yes	71 (26.0%)	202 (74.0%)	273 (28.6%)	X^2=4.35
No	80 (19.3%)	335 (80.7%)	415 (71.4%)	P=0.05
Drinking milk after main meals				
Yes	7 (20.6%)	27 (79.4%)	34 (4.9%)	X^2=0.04
No	144 (22.2%)	510 (78.0%)	654 (95.1%)	P=1.00
Consume iron rich foods daily				
Meat Yes	2 (12.5%)	14 (87.5%)	16 (3.3%)	X^2=0.85
No	149 (22.2%)	523 (77.8%)	672 (96.7%)	P=0.54
Chicken Yes	1 (7.1%)	13 (92.9%)	14 (10.2%)	X^2=1.8
No	150 (22.3%)	524 (77.7%)	674 (89.8%)	P=0.32
Fish Yes	29 (29.9%)	68 (70.1%)	97 (54.7%)	X^2=4.17
No	122 (20.6%)	469 (79.4%)	591 (45.3%)	P=0.05
DGLV * Yes	20 (16.7%)	100 (83.3%)	120 (70.2%)	X^2=2.4
No	131 (23.1%)	437 (76.9%)	568 (29.8%)	P=0.15
Egg Yes	6 (27.3%)	16 (72.7%)	22 (32.6%)	X^2=0.38
No	145 (21.8%)	521 (78.2%)	666 (67.4%)	P=0.6
Nuts Yes	12 (17.9%)	55 (82.1%)	67 (47.1%)	X^2=0.71
No	139 (22.4%)	482 (77.6%)	621 (52.9%)	P=0.44
Overall	151 (21.9%)	537 (78.1%)	688 (100.0%)	

(*DGLV = Dark Green Leafy Vegetables)

A higher percentage of children in the older age groups were iron deficient compared to the younger children. However, this difference was not statistically significant. All the other variables studied; knowledge on anaemia, taking iron during the previous 6 months, practices related to diet, consumption of iron rich food were not significantly different between the two groups (Table 2).

Table 3. Prevalence of anaemia, by other nutritional status indicators and related variables

Variable	% of Children with iron deficiency* (SF<15µg/dl)	% of Children with iron deficiency (SF≥15µg/dl)	Total number of children	Statistical significance
Nutritional status				
Thinness (n=684)				
Yes	43 (22.3%)	150 (77.7%)	193 (28.2%)	OR=1.2 (0.7-1.6) P=0.88
No	107 (21.8%)	384 (78.2%)	491 (71.8%)	
Stunting (n=685)				
Yes	11 (25.6%)	32 (74.4%)	43 (6.3%)	OR=1.2 (0.6-2.5) P=0.57
No	139 (21.7%)	503 (78.3%)	642 (94.0%)	
Acute infections (CRP >6mg/l)				

Yes	2 (12.5%)	14 (87.5%)	16 (2.3%)	OR=0.4 (1.2-0.23) P=0.54
No	149 (22.2%)	523 (77.8%)	672 (97.7%)	
Anaemia (Hb<11.5g/dl)				
Yes	22 (14.0%)	135 (86.0%)	157 (22.7%)	**OR=0.48 (0.3-0.8) P=0.006**
No	129 (24.3%)	402 (75.7%)	531 (77.3%)	
Grade of Anaemia				
Moderate (8.0-10.9mg/dl)	7 (10.9%)	57 (89.1%)	64 (9.3%)	**X^2=7.7 P=0.02**
Mild (11.0-11.4g/dl)	15 (16.5%)	76 (83.5%)	91 (13.2%)	
Not anaemic (≥11.5g/dl)	129 (24.2%)	404 (75.8%)	533 (77.4%)	
Thalassaemia				
Yes	0 (0.0%)	6 (100.0%)	6 (0.9%)	P=0.35
No	151 (22.1%)	531 (77.9%)	682 (99.1%)	
Overall	151 (21.9%)	537 (78.1%)	688 (100.0%)	

As shown in table 3, prevalence of anaemia, iron deficiency , and iron deficiency anaemia was 22.7%, 21.9%, and 14.0% respectively. There were 6 (0.9%) thalassaemic children. Iron deficiency was significantly higher among non anaemic children (24.3%) than anaemic children (14.0%) and in mildly anaemic children (16.5%) than moderately anaemic children (10.9%). Out of all children, 13.2% were mildly anaemic with 9.3% were moderately anaemic and none were severely anaemic (<8.0g/dl). The prevalence of stunting was 6.3% and thinness was 28.2%. The prevalence of iron deficiency was higher among children who were thin (22.8%) or were stunted (25.6%), among children who did not show evidence of acute infections (22.2%) and among children who did not have thalassaemia (22.1%). None of these differences were statistically significant.

DISCUSSION

The unmet need for iron in times of rapid growth, during infancy, early childhood, adolescence and pregnancy, results in iron-deficiency and iron deficiency anaemia. In addition, poor dietary iron intake, especially of bioavailable iron, and helminth infections such as hookworms result in iron deficiency [13]. The prevalence of iron deficiency within this sample of children living in Gampaha district was 21.9% and out of that 81.5% were not anaemic indicating that they will be missed during routine investigations. Serum ferritin levels are tested in practice only when anaemia is present.

The high prevalence of iron deficiency and iron deficiency anaemia in this population might lead to multiple health problems, such as impaired cognitive function, reduced school performance and poor reproductive health. These in turn would impact the future quality of human resources.

With regards to the study findings iron deficiency is not the major cause of anaemia in this population compared to the published studies [14,15]. It may be due to no severely anaemic children in this sample. By considering the low infection rates (elevated CRP of 2.1%) and high level of thinness (22.8%) in this population, it is necessary to investigate for other causal factors for anaemia such as worm infestations and other micronutrient deficiencies as leading to anaemia.

In this population, majority had serum ferritin <100 μg/l as shown in figure 1. When a ferritin concentration of <15 μg/l indicates the depletion of storage iron while concentrations >100 μg/l indicate the presence of storage iron [13]. Out of iron deficient only 14.6% had anaemia. The prevalence of anaemia is an important health indicator to provide information about the severity of iron deficiency [10]. Concentrations above 200 μg/l serum ferritin are considered as iron overload and none was found in the study sample [3]. Considering the low levels of acute infections (2.1%), serum ferritin can be taken as a useful indicator to assess the iron status of this population [11].

In this study, there was no relationship between iron deficiency and BMI, family income, number of family members, mother's education, consuming iron rich food, food practices and knowledge except with the source of drinking water. However, some studies have shown a high prevalence of iron deficiency anaemia in families with lower education levels and a high number of family members [16]. Present study assessed only the frequency of iron rich food consumption and not the quantity consumed, this may be the reason for not showing any relationship. Prevalence of iron deficiency in this study was higher in children living in urban areas indicating that they had a higher chance of developing iron deficiency than their rural counterparts. The reasons behind these differences may be multi factorial including differences in dietary practices. Though the present study did not have data on hook worm infestation, other studies indicated that Sri Lanka has a very low prevalence [17].

Around 95% of children between 5-10 years attend schooling in Sri Lanka. Hence implementation of a programme to improve the iron status as well as improving the nutritional status of children aged 5-10 years could be a key strategy to be incorporated into the school health programme. With regards to the iron deficiency, considering the relatively low level of iron deficiency anemia in this population, fortification of a common food item should be considered as a priority.

CONCLUSIONS

The results suggest that iron deficiency is an important public health problem in this population affecting nearly one fifth of the children aged 5-10 years. Only one seventh of anaemic children were iron deficient and one fourth of non anaemic children were iron deficient. Anaemia cannot be solely explained by iron deficiency. It is recommended to formulate and implement a programme for the prevention of iron deficiency based on a combination of dietary improvements, food fortification and iron supplementation integrated into school health programmes. It is important to further study the aetiology of anaemia in this population.

ACKNOWLEDGEMENTS

This study was supported by the Micronutrient Initiatives India and coordinated by ICCIDD Sri Lanka. The authors thank Dr. Upul Senarath and Indika Siriwardana for statistical support and Dr. Mala Tudawa for analysis of samples for thalassaemia. Thanks for RDHS and health staff of Gampaha district and all the staff of Department of Nutrition for supporting the data collection.

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