Original Articles

Iron status and prevalence of anaemia among school children in the Jaffna district

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Abstract

Introduction: The National Nutrition and Micronutrient Survey of 2012 reported that anaemia was seen in 15% of Sri Lankan children between 6 months and 5 years of age.

Objectives: To identify the prevalence of anaemia and the impact of the intervention programmes among 6-16 year old children in the Jaffna District.

Method: A community based cross sectional study was carried out using multistage stratified proportionate cluster sampling technique among children attending schools in the Jaffna district. A pre-tested questionnaire was used to collect data and a blood sample was obtained for serum ferritin and HS-CRP levels. Haemoglobin was checked using the Haemacue apparatus on the spot. WHO definitions and cut off values were used.

Results: A total of 1163 school students between 6-16 years were screened (male: female ratio 1:1.02). Mean age was 12.33 ±3.1 years. Mean haemoglobin was 12.31±1.51g/dl and mean serum ferritin was 21.31ng/ml 95%CI 18.99-23.63 respectively. The prevalence of anaemia was 27.9% (n=324), prevalence of iron deficiency anaemia was 16.8. Females had higher prevalence (30.6%) of anaemia when compared to males (25%) (p<0.01). Prevalence of iron deficiency was 52% adjusted after excluding population with high CRP. Haemoglobin level of study population significantly correlated with height (r-0.243, p<0.01), weight (r-0.256, p<0.01) and BMI (r-0.2, p<0.01). Prevalence of anaemia was significantly higher in children aged 12-16yrs (p<0.001) and among children from the Thenmaradchi zone (p<0.003)

Conclusions: Of the 6-16 year old school children in the Jaffna educational zones, more than a fourth has anaemia of which iron deficiency contributes to almost 60%. More than half of this population has iron deficiency with the highest prevalence in the Thenmaradchi zone.

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Introduction

Anaemia is defined as the reduction in haemoglobin levels below the norms for age and sex[1]. Haemoglobin levels vary with age, sex, physiological status and ethnicity[1]. In most developing countries the prevalence of anaemia is between 20-60%[2]. There are limited studies in Sri Lanka. The National Nutrition and Micronutrient Survey of 2012 reported that anaemia was seen in 15.1% of Sri Lankan children between 6 months and 5 years of age. Prevalence exceeded 20% in Moneragala (25.6%), Trincomalee (23.1%), Kilinochchi (26.9%), Puttalam (20.3%) and Polonnaruwa (21.5%). The prevalence rate in Jaffna was 18.6%[3].

Though anaemia is primarily due to iron deficiency, other conditions such as malaria, parasitic infections, nutritional deficiencies and haemoglobinopathies frequently co-exist[4]. In Sri Lanka, intervention is done through three main programmes. They are the multiple micronutrient supplementation (MMN), intermittent iron/folate supplementation and the routine use of anti-helminthic treatment. MMN supplementation schedule is to provide one sachet per day for two days for 60 consecutive days beginning at 6, 12 and 18 months. Despite the regular intervention programmes the prevalence remains high. Other causes like α and β thalassaemia have to be

considered before starting a national programme, as universal iron supplementation could be otherwise harmful[5]. Iron tablets given at school could lead to adverse effects which include nausea, abdominal discomfort, anaphylaxis and unintentional overdose that can be life-threatening[5]. The intervention programmes are costly and their effectiveness has never been studied in Sri Lanka.

Iron deficiency without anaemia is also a major health problem as it can hinder learning and growth but this has not been addressed[6]. The haemoglobin level is a more reliable indicator of anaemia at population level compared to clinical assessment[7]. There is an additional advantage as it is cheap and can be easily performed. Serum ferritin level, in the absence of an inflammatory response, is a reliable assay to check the body iron status[8]. Iron status could be assessed using the mean cell volume, transferring receptor concentration and serum ferritin levels. A level of serum ferritin below 15µg/l is considered as depleted iron stores[6,9]. Haemoglobin and serum ferritin levels have been used in resource poor settings to assess the status of iron deficiency[6,7]. Furthermore, a one month therapeutic trial of iron in suspected iron deficiency anaemia and observing a rise in haemoglobin level by 1g/dl is also an accepted mode of managing iron deficiency anaemia[9]. Research has suggested using the serum ferritin levels to determine the prevalence of iron deficiency in a population with a cut off level of >20% indicating that the population has iron deficiency. This needs validation in population surveys[6]. The lack of data regarding the iron deficiency and the practice of giving iron supplementation as an intervention, prompted us to do this survey.

Objectives

To identify the prevalence of anaemia and the impact of the intervention programmes among 6-16 year old children in the Jaffna District.

Method

A community based cross-sectional study was conducted at both Government and Private schools located in the Jaffna district from August 2015 to May 2016. Jaffna is a district in northern part of Sri Lanka which consists of five educational zones named Vadamaradchi, Thenmaradchi, Valikamam, Jaffna and the Islands. Considering the low school dropout rates among Sri Lankan children within the age group 6-16 years, this will represent the target population of apparently healthy children of 6-16 years in Sri Lanka.

Multistage stratified proportionate cluster sampling was used. Sample size was calculated using the Daniel (1999) formula and the *p* was 18.6% according to National Nutrition and Micronutrient survey (2012)[3]. Confidence level was 95%, z-score 1.96 and non-response rate 20%, giving a sample size of 383, sufficient for generalisation of the results to a wider population. Written informed consent was obtained from the parents and assent from the children. Students from selected schools in all five zones were included in this study. Children not of Sri Lankan origin or who have not been living in Sri Lanka during the last five years were excluded.

A structured interviewer-administered questionnaire was used to collect demographic and clinical data. The interview was done at the respective schools before school hours in the presence of teachers. Height and weight were measured from each study participant using standard protocol. Body mass index (BMI) was calculated using the formula weight in kg/height^2. The nutritional status of the children was classified according to international obesity task force (IOTF) classification[10]. Haemoglobin (Hb) was checked using the HemoCue® Hb 201* apparatus on the spot. WHO definitions and cut off values were used to detect anaemia and categorize its severity at sea level[7]. A serum sample of 2ml was obtained from each participant by an experienced nurse using aseptic procedures. Samples were analysed using ELISA technique to measure serum ferritin and HS-CRP. Serum ferritin levels of <15µg/dl were considered as iron deficiency[6]. Children with high CRP (>3mg/dl) were eliminated from the sample analysis[11].

Data were analysed using SPSS-Version 21. Descriptive analysis was used to summarize the socio-demographic, anthropometric and anaemic status. Independent t-test was used between sex and haemoglobin level. Haemoglobin levels among the zones was assessed by One way ANOVA test and Tukey's post Hoc multiple comparison was used to assess statistical difference among the zones related with haemoglobin level. Chi Square test was used to assess the correlation of demographic factors to anaemia and iron deficiency. The prevalence of anaemia was calculated with a confidence interval of 95%. The differences between the groups with and without anaemia were analysed using a bivariate form with the Chi-squared test. For all statistical tests, $p<0.05$ was taken to be statistically significant. Ethical Review Committee of the Faculty of Medicine, University of Jaffna approved the study. (J/ERC/14/50/NDR/0077)

Results

Socio demographic and anthropometric characteristics

A total of 1163 students from 16 schools from all 5 educational zones in Jaffna district were enrolled in our study. Male: female ratio was 1:1.02. Age of the students ranged between 6 to 16 years and mean age

was 12.3±3.1 years. Weight and height were measured and BMI was calculated. Mean weight was 38.1 ±16.71 kg. Mean height was 145.3 ±16.87 cm and mean BMI was 17.2 ±4.5 kg/m^2. Stunting was seen in 10.9 % (n=127) students according to the WHO criteria. Demographic details and BMI categorisation is given in Table 1.

Prevalence and severity of anaemia

The mean Hb concentration of the study participants was 12.3±1.51g/dl. Mean Hb values of males and females were 12.51±1.55g/dl and 12.11±1.46g/dl respectively and the difference in means is significant (p<0.05). The overall prevalence of anaemia was 27.9 % (n=324) based on age specific cutoff values by WHO at sea level[7]. Table 2 shows the distribution of severity of anaemia in the different age groups.

Iron deficiency

Mean ferritin level for the study population was 25.0±3.5µg/l. Serum ferritin of less than 15.0µg/l was seen in 51.5% (n=599). Among children with anaemia 60.5 % (n=196) had low serum ferritin suggesting iron deficiency anaemia (Table 3).

Table 1: ***Sociodemographic and anthropometric distribution of study population***

Socio demographic and anthropometric details	Number of students (%)
Gender	
Males	579 (49.8)
Females	584 (50.2)
Age (in years)	
06-08	137 (11.8)
09-10	178 (15.3)
11-12	309 (26.6)
13-14	257 (22.1)
>14	282 (24.2)
BMI category	
Underweight	347 (29.8)
Normal	615 (52.9)
Overweight	128 (11.0)
Obese	073 (06.3)
Educational zones	
Jaffna	368 (31.6)
Vadamaradchi	269 (23.1)
Thenmaradchi	235 (20.2)
Valikamam	118 (10.1)
Islands	173 (14.9)

Table 2: ***Severity of anaemia***

Severity of anaemia	6-11 years Number (%)	12-16 years Number (%)	Total Number (%)
Mild	63 (05.4)	201 (17.3)	264 (22.7)
Moderate	09 (0.8)	39 (03.3)	48 (04.1)
Severe	02 (0.2)	10 (0.8)	12 (01.0)
Not anaemic	315 (27.0)	474 (40.8)	789 (67.8)

p<0.001

Table 3: ***Prevalence of anaemia and iron deficiency***

		Ferritin		
		> 15 µg/l	≤15µg/l	Total
Anaemia*	No	413 (35.5%)	379 (32.6%)	792 (68.1%)
	Yes	128 (11.0%)	196 (16.9%)	324 (27.9%)
	Total	564 (48.5%)	599 (51.5%)	1163 (100%)

p<0.001

Sociodemographic and anthropometric distribution of anaemia and prevalence of iron deficiency

Among 324 anaemic students, 145 (44.2%) were boys, and 179 (55.2%) were girls. The prevalence of anaemia in relation to the sociodemographic data was significantly dependent on age and educational zones. As the age of the students increases, there was also an increase in the prevalence of anaemia (p-0.001). The prevalence of anaemia was high in the Thenmaradchi zone compared to other zones (p-0.001). Mean haemoglobin was significantly high in Vadamaradchi zone than other zones using Tukey's post Hoc multiple comparison (p=0.001). (Table 4)

The prevalence of iron deficiency had significant correlation with gender, age and educational zones ($p<0.05$). Girls had high prevalence of iron deficiency compared to boys (p=0.024). Children aged 13-14 years had the highest prevalence of iron deficiency (60.3%). Children from Vadamaradchi zone had the lowest prevalence of anaemia (20.07%) and iron deficiency was lowest in Valikamam (32.2%) when compared to the other zones p=0.001). (Table 4)

Table 4: ***Sociodemographic factors and anthropometric distribution of anaemia and iron deficiency***

Socio demographic and anthropometric details	Prevalence of iron deficiency (%), CI (95%)	P value	Prevalence of Anaemia (%), CI (95%)	P value
Gender				
Boys	48.19 (44.12-52.26)	0.024	25.04 (21.51-28.57)	0.112
Girls	54.79 (50.76-58.83)		30.65 (26.91-34.39)	
Age category (in years)				
06-08	42.34 (34.06-50.61)	0.001	23.36(16.27-30.44)	0.001
09-10	48.88 (41.53-56.22)		12.36 (7.52-17.19)	
11-12	44.66 (39.12-50.20)		23.95 (19.19-28.71)	
13-14	60.31 (54.33-66.29)		39.69 (33.71-45.67)	
>14	56.74 (50.95-62.52)		32.98 (27.49-38.47)	
BMI category				
Underweight	51.01 (45.75-56.27)	0.140	30.55 (25.70-35.39)	0.734
Normal	54.15 (50.21-58.08)		27.80 (24.26-31.35)	
Overweight	46.09 (37.46-54.73)		17.97 (11.32- 24.62)	
Obese	41.10 (29.81-52.38)		32.88 (22.10- 43.65)	
Educational zones				
Jaffna	52.17 (47.07-57.28)	0.003	26.09 (21.60 -30.57)	0.001
Vadamaradchi	51.06 (44.67-57.46)		20.07 (15.29- 24.86)	
Thenmaradchi	63.94 (58.20-69.68)		42.98 (36.65- 49.31)	
Valikamam	32.20 (23.77-40.63)		26.27 (18.33 -34.21)	
Islands	44.51 (37.10-51.91)		24.28 (17.89-30.67)	

Discussion

This is the largest study done in 6-16 year old school children in the Jaffna district on assessing the prevalence of anaemia. A study done by Allen A *et al* in 2017 among secondary school children of Sri Lanka state that iron deficiency and iron deficiency anaemia were commoner in Tamils than in other ethnic groups[12]. Based on WHO cut off values, anaemia prevalence in this study indicates a public health problem. Globally, anaemia affects 1.62 billion people, the highest prevalence being in preschool children[4]. Overall prevalence of anaemia in this study was 27.9% and Thenmaradchi zone had a significantly higher prevalence than other zones. A similar study in the North Central Province among 4460 primary school children showed an overall prevalence of anaemia of 17.3%[13]. This shows that there is a difference in the prevalence of anaemia between northern and north central province indicating that the demographic factor has a role in the prevalence. Demographical inequity and disparities in nutrition among the zones could have been a reason for this difference in prevalence. Religious reasons which make them strictly adhere to a vegetarian diet may also be a cause for this difference. The difference in easy access to iron rich foods, presence of worm infestation, and breast feeding and weaning practices may also play a role. Iron chelating agents like calcium in the water may also contribute to this.

Prevalence of anaemia in this study in males and females is 25.04% and 30.65% respectively. There was a significant difference in the iron deficient status between males (48.2%) and females (54.8%) in this study (p=0.024), A survey done in the Galle district in 2003 among school children of 12–16 years old also showed a significantly increased prevalence of anaemia in females compared with males (p=0.004). The same study found iron deficiency in 30.2% males and 47.8% females[14]. Nutrition and Food Security Assessment in Sri Lanka, 2009 showed 33.9% of females aged less than 20 were anaemic[15]. The difference in the

prevalence of anaemia with gender could be due to the physiological differences in gender, like loss of iron in females due to menstruation, disparities in sharing food among family members with preference towards male gender and adherence to religious practices. When factors associated with anaemia were studied among the rural primary school children in North Central province, BMI significantly contributed to the changes in haemoglobin level ($p=0.002$)[11]. Our study also showed haemoglobin significantly correlated with height (r-0.243, $p<0.01$), weight (r-0.256, $p<0.01$) and BMI (r-0.2, $p<0.01$). Even though the changes in haemoglobin correlated with BMI, presence of anaemia and iron deficiency did not significantly correlate with the BMI. (Table 4)

Mild anaemia was seen in 22.7% and moderate anaemia in 4.1% of the study population. The cross sectional study done in North Central Province found mild and moderate anaemia in 9.4% and 7.6% of children respectively[13]. Prevalence of anaemia among school children aged 5-19 years in Ethiopia in 2017 was 23% and among them 61%, 21% and 11% had mild, moderate, and severe anaemia respectively[16]. The WHO considers anaemia to be a public health problem only when the prevalence exceeds 5% of the population. WHO classification for mild, moderate, and severe prevalence is when the rates exceed 5, 20, or 40%, respectively[2]. Thus, mild anaemia which is 22.7% in our study should be considered as a public health problem.

Iron deficiency anaemia in this study population was 16.9%. A population-based, cross-sectional study in 7980 adults residing in mainland Portugal in 2015 found 29% had iron deficiency anaemia[17]. Iron deficiency is a global nutritional problem, 30-60% of women and children in developing countries being iron deficient[18]. In developing countries, the chief cause of iron deficiency is low iron bioavailability in diet and poor absorption of iron from diets high in phytate or phenolic compounds[7]. Iron deficiency in the study population was 51.5%. Iron deficiency is more prevalent than iron deficiency anaemia which is consistent with the study by Odeh MMM in 2006 among school children in Salfeet District[19]. Adolescent girls are more susceptible to iron deficiency because of high iron requirements related to rapid growth and menstrual blood loss[20].

Even though the main cause of the anaemia in the study population is iron deficiency, in almost 40% of the time the cause for the anaemia is not clear. This is anticipated to be due to other causes of non-iron deficiency like haemoglobinopathy. Further studies are needed to look into this aetiology in this region as there are no reported studies in the literature. As iron deficiency is a public health problem in the study area, health strategies to prevent and control anaemia must be implemented. This includes improvements in dietary diversity, food fortification with iron and distribution of iron-containing supplements. Advice on diet containing adequate amounts of bioavailable iron should be given. Poor hygienic practices and worm infection can contribute to the iron deficiency and hence sanitation and worm treatment have to be considered to prevent anaemia due to iron deficiency[21]. Public health programmes delivering iron supplementation must be reviewed to assess their effectiveness.

Conclusions

Of the 6-16 year old school children in the Jaffna educational zones, more than a fourth have anaemia of which iron deficiency contributes to almost 60%. More than half of this population has iron deficiency with the highest prevalence in the Thenmaradchi zone.

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