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Iron Deficiency Anemia in School Children of Dera Ismail Khan, Pakistan

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Abstract: The prevalence of obesity has increased at an epidemic rate and obesity has become one of the most common health concerns in both developed and developing countries. Very few studies in Pakistan have noted a possible association between iron deficiency anemia and obesity. The objective of this study was to investigate the frequency of iron deficiency anemia in obese school children of Dera Ismail Khan (N.W.F.P), Pakistan. This study involved a total of 103 children (6-11 years) with 76 (73.79%) obese and 27 (26.21%) as healthy/normal weights, comprising 58 (56.31%) as the boys and 45 (43.69%) as the girls. Concentration of hemoglobin was used as the sole criteria for iron deficiency anemia. Children were considered iron deficient anemic if their hemoglobin concentration was found below 11.5g/dl. With the use of Centers of Disease Control and Prevention (CDC)'s age and gender specific Growth charts, obese were defined as having BMI of more than 95^{th} percentile. In the present study none of the obese boys or girls was suffering from iron deficiency anemia. However, 58.82% healthy/normal weight boys were anemic, with maximum number at the age of 06 years. Similarly 70% healthy/normal weight girls were anemic, with maximum number at the age of 6 (100%), followed by 10 years (66.66%). Both are the ages of physical activity and growth spurt. Given the increasing number of obese children and known morbidities of iron deficiency anemia, screening for iron deficiency anemia may be included in children with elevated BMI for age percentiles.

Key words: School children, iron deficiency anemia, obesity

Introduction

Anemia is defined as a decreased concentration of hemoglobin and red blood cell mass compared with that in age matched controls. It is a frequent laboratory abnormality in children. As many as 20% children in the United States and 80% children in the developing countries will be anemic at some point by the age of 18 years. Erythropoietin is the primary hormone regulator of red blood cell (RBC) production. In the fetus, erythropoietin comes from the monocyte/macrophage system of the liver. Postnatal erythropoietin is produced in the peritubular cells of the kidneys.

Key steps in Red Cell differentiation include condensation of red cell nuclear material, production of hemoglobin until it amounts to 90% of the total red cell mass and the extrusion of nucleus that causes loss of RBC synthetic ability. Normal RBCs survive an average of 120 days, while abnormal RBCs can survive as little as 15 days (Joseph *et al*., 2001).

Harbans (2004) revealed that the total quantity of iron (Fe) in 70kgs human adult is 4g. Most of it is present as a component of haemoglobin and myoglobin, either bonds to various proteins; haem containing proteins include hemoglobin and myoglobin and non-haem proteins include ferretin, transferrin iron-sulfur proteins and several cytochromes for electron transport chain and oxidative phosphorylation. Certain enzymes such as catalases and peroxidases also contain iron. It is also an important component of Lysozymal enzymes-Myeloperoxidases. Iron is required in phagocytosis by neutrophils.

According to Dreyfuss *et al*. (2000) two billion children are affected with iron deficiency anemia worldwide. There are multiple causes of iron deficiency anemia, including inadequate iron intake, respiratory infections, helminthes' infestation, malaria, diarrhoea, vitamin A and vitamin C deficiencies.

Raju and Bindu (2005) reported that deficiency of iron is also produced by bleeding and sloughing of cells (menstrual flow) and transfer to developing fetus. Since iron is in bound form it does not get excreted.

Iron deficiency causes reduction in hemoglobin content of red blood corpuscles, the Iron containing pigment that carries oxygen from the lungs to all tissues in the body. Iron deficiency also impairs the growth and learning ability of children, lower resistance to infectionous diseases and reduces the physical work capacity/exercise ability of children. It reduces the productivity in adults. Economic losses due to iron deficiency in South Asia have been estimated at 5 billion$ (U.S.) annually. This deficiency also increases fatigue, shortens attention span and impairs intellectual performance (Ross and Hostons, 1998).

There are multiple sources of dietary iron including haem and non-haem iron, contamination iron and fortification iron. Haem iron is usually of animal origin with high bioavailability including meat, fish and blood products. Dietary intake of haem iron is negligible in developing countries. It is an important component of haemoglobin and myoglobin. Non-haem iron is present in plants i.e. tubers, vegetables, cereals and pulses. It is of low bioavailability and important source of dietary iron in developing countries. Ascorbic acid, presence of food items of animal origin and low pH enhance while milk, coffee and tea inhibits the iron absorption. Iron status and health status (infection, malabsorption) are the host factors influencing iron absorption (WHO, 1971). Likewise, deficiency of Vitamin A limits the body ability to use stored iron, resulting in an apparent iron deficiency because Hb levels are low even though the body stores are normal. This is commonly seen in developing countries (Sturjvon *et al.,* 1997). Dietary intake of iron is needed to replace iron lost in stools, urine and through skin. Daily iron requirement of iron of children (6-11 years) is 40ug/kg/day (DeMaeyer *et al.,* 1989).

Physical examination is important but will be unremarkable in most children with anemia. Findings that suggest chronic anemia include irritability, pallor, (usually not seen until hemoglobin levels are less than (7g/dl), glossitis, a systolic murmur, growth delay and nail bed changes. Children with acute anemia often present more dramatically with clinical findings including jaundice, tachypnoea, tachycardia, splenomegaly, haematuria and congestive heart failure (Joseph *et al.* 2001).

Materials and Methods

Eight primary schools of Dera Ismail Khan City (N.W.F.P) were involved in this study having mixed population except some wards belonged to the high socio-economic group. A total of 1336 students of both the sexes were examined including 865 (64.75%) boys and 471 (35.25%) as girls. All the children were subjected to thorough clinical examination excluding those complaining of chronic diseases. The children were classified into six age groups according to their gender. Weight and height of each one was measured. Body Mass Index (BMI) was computed by Quatelet's index while BMI for age percentile was calculated according to National Center for Health Statistics (NCHS) and Centers for Disease Control and Prevention (CDC)'s gender specific growth charts 2-20 years. Obese were identified as having BMI for age percentile $\geq$ 95th percentile compared to children of the same gender and age in the (CDC)'s reference population. Obese children were subjected to further investigation through the consent of their parents. Random venous blood samples of each one was collected in the laboratory and hemoglobin concentration was determined instantly by photoelectric colorimeter/spectra-photometer through Cynamet hemoglobin (HBCN) method by measuring absorption at 540mm (WHO, 1995).

For the diagnosis of iron deficiency/nutritional anemia, it is essential to measure HB in blood. HB in the blood was determined by taking 20ul venous blood and diluted to 250 times of its volume (5ml) with Drab kin's solution at the spot (in the laboratory) by automatic pipette. Blood was mixed with diluent's solution to convert HB into Cynamet haemoglobin. The absorbance of the said Cynamet haemoglobin was measured at 540nm by photoelectric calorimeter. Cynamethemoglobin method is most popular as it measures practically all hemoglobins except sulphur hemoglobin. The standard used is stable for a long time (Thomas and Collins, 1982; Young *et al.,* 1986).

Results

Poor dietary habits combined with decreased physical activity have lead to increase in overweight and obesity among adults and children. Overweight and obese children are not only at risk for infection, insulin resistance syndrome, hypertension, dyslipidemia and hypertriglyceridemia but also for poor micronutrients status. Report from countries such as United States, Israel and Canada have shown that overweight and obese children have a higher prevalence of iron deficiency than normal weight children (Pinhas *et al.,* 2003).

Gender wise distribution of 103 school children (6-11 years) including 58 (56.31%) boys and 45 (43.18%) girls are shown in Table 1. Amongst the examined 76 (73.79%) children were obese and 27 (26.21%) were of normal weight.

The age and gender wise distribution of the obese children with 41 (53.94%) boys and 35 (46.05%) girls are presented in Table 2. The maximum number of obese boys was recorded at the age of 11 and 7 years and the number of obese girls is highest at the age of 10 and 7 years. It also represents the greater tendency of obesity in girls. This age is characterized by relative increase in fatness (William and Dietz, 2004).

The age wise distribution of the BMI, BMI-for-age percentile and HB concentration with means and SD of obese boys is presented in Table 3. All obese children (Boys) have normal concentration of hemoglobin and no one is anemic.

The age wise distribution of BMI, BMI-for-age percentile and hemoglobin concentration with mean and SD for obese girls is shown in Table 4. All obese girls have normal concentration of hemoglobin except at the age of 11 years (11.383%). Slight decrease in HB percentage at this age is usual due to loss of blood through early menstruation. The cutoff value for diagnosing anemia as recommended by UNICEF and WHO/CDC for children of 05-11 years age is 11.5g/dl (De-Maeyer *et al.,* 1989).

The age and gender wise distribution of the normal/healthy weight school children with 17 (62.96%)

Table 1: Gender wise distribution of children (06-11 years) on the basis of body weight

	Obese		Normal/Healthy		Total		
Body Weight Status	Boys	Girls	Boys	Girls	Boys	Girls	Total
No. of Children	41	35	17	10	58	45	103
% Gender	39.81	33.98	16.50	9.71	56.31	43.69	

Table 2: Age and gender wise distribution of obese children

Age Group (Years)	Boys	Girls	Total
11	19	5	24
10	6	12	18
9	6	6	12
8	3	4	7
7	7	8	15
6	0	0	0
Total	41	35	76
%	53.95	46.05	-

Table 3: Age wise distribution of BMI, BMI-for-age percentile and Haemoglobine (HB) Concentration in obese boys

Parameter	BMI		BMI For Age Percentile		HB%	
Age Group	Mean	S.D	Mean	S.D	Mean	S.D
11 years	26.153	± 3.372	> 95	0	11.806	± 0.718
10 years	27.352	± 8.232	> 95	0	11.925	± 0.639
9 years	23.615	± 3.41	> 95	0	12.083	± 0.972
8 years	25.333	± 3.300	> 95	0	12.833	± 0.387
7 years	23.922	± 2.811	> 95	0	12.186	± 0.682
6 years	0	0	> 95	0	0	0

Table 4: Age wise distribution of BMI, BMI-for-age percentile and haemoglobine concentration in obese girls

Parameter	BMI		BMI For Age Percentile		HB%	
Age Group	Mean	S.D	Mean	S.D	Mean	S.D
11 years	27.452	± 4.023	> 95	0	11.383	± 1.656
10 years	22.006	± 9.893	> 95	0	11.691	± 0.911
9 years	22.630	± 1.410	> 95	0	11.720	± 0.655
8 years	21.963	± 1.811	> 95	0	11.825	± 1.114
7 years	21.689	± 0.785	> 95	0	11.944	± 1.462
6 years	0	0	> 95	0	0	0

boys and 10 (37.03%) girls are exhibited in Table 5. The maximum healthy weight children were found at the age of 6 years.

The concentration of haemoglobine by anthropometric data of normal / healthy weight boys (6-11 years) are shown in Table 6.

There is linear increase of hemoglobin concentration with the increase of BMI and BMI-for-age percentile. The hemoglobin concentration is low at the age of 6 years. It represents the age of growth spurt and increase in physical activity with iron deficiency.

The haemoglobine concentration increases with the increase in BMI and BMI-for-age percentile. This is comparable to the haemoglobine concentration of healthy/normal school children in United States of America (1.18%).

The hemoglobin concentration by anthropometric data of normal/healthy weight girls (6-11 years) are represented in Table 7. The relationship of haemoglobine concentration with both the anthropometric indexes is variable. It is inversely proportional to the increase in both the indices (at 6 and 9 years). It represents the period of increase in height, weight and physical activity. Dietary intake deficient in iron will produce the iron deficiency anemia. Early maturing girls begin their growth spurt as early as 7-8 years and early maturing boys may begin growing by the age of 9-10 years.

Discussion

The objective of this study was to investigate the frequency of iron deficiency in school children (6-11 years) at Dera Ismail Khan and its association with anthropometric parameters (BMI). None of the obese children were found to be iron deficient anemic. This is comparable to the iron deficient anemia in obese/overweight children of USA where it is reported to be 2.4% (Karen *et al.*, 2004). It is most likely to be due to in appropriate of food choices and practices (Darnton *et al.*, 2004). Non existence of iron deficiency anemia in the study area is due to usual consumption of animal food

Table 5: Age and gender wise distribution of normal weight/healthy weight children

Age Group (Years)	Boys	Girls	Total
6	6	3	9
7	0	1	1
8	2	2	4
9	1	1	2
10	3	3	6
11	5	0	5
Total	17	10	27
%	62.96	37.03	-

Table 6: Age wise distribution of BMI, BMI-for-age percentile and haemoglobine concentration in normal / healthy weight boys

Parameter	BMI		BMI-For-Age Percentile		HB%	
Age Group	Mean	S.D	Mean	S.D	Mean	S.D
6 years	14.212	± 0.551	14.000	± 7.303	11.100	± 1.344
7 years	-	-	-	-	-	-
8 years	14.78	± 1.186	19.000	± 1.186	12.133	± 0.411
9 years	13.90	-	27.500	± 18.875	8.7	-
10 years	14.87	± 0.723	21.667	± 9.428	11.667	± 1.109
11 years	19.115	± 1.124	70.500	± 14.580	12.182	± 0.782

Table 7: Age wise distribution of BMI, BMI-for-age percentile and haemoglobine concentration of normal / healthy weight girls

Parameter	BMI		BMI-For-Age Percentile		HB%	
Age Group	Mean	S.D	Mean	S.D	Mean	S.D
6 years	15.48	± 0.562	45.233	22.422	9.667	± 1.190
7 years	13.850	± 0.150	13.500	3.500	12.100	± 1.100
8 years	15.935	± 1.065	42.500	32.500	11.700	± 1.200
9 years	14.830	± 1.170	27.500	22.500	9.550	± 0.250
10 years	14.000	± 4.717	16.500	11.369	12.150	± 0.953
11 years	0	0	0	0	0	0

(lean meat, poultry and fish) and fruits in families of high socio-economic status (to which they belong). Most of the affluent families in this part of the country prefer to take animal food as a routine with less variety of vegetables. Consumption of lean meat and poultry is considered as status symbol. Frequency of iron deficiency anemia in normal/healthy weight children in study area is 10.67% (overall). It is 6.7% in boys and 3.88% in girls. Girls had performed better reflecting no gender discrimination. This is comparable to the reported prevalence of iron deficiency anemia as 1.2% in United States normal weight children of 6-11 years with 2.1% overall (Karen *et al.,* 2004). Similar studies have reported 12.2% as prevalence of anemia in rural school children in a coastal area of Morocco (Mohamed El Hioui *et al.,* 2008). Zimmermann *et al.,* 2003, reported prevalence of anemia as 35% in Northern Morocco. These results are comparable to a 7.4% prevalence reported by WHO and MDI, 2005 in Tunisia among children 6-10 years with WHO cutoff points (HB < 11.5g/dl). The frequency of iron deficiency anemia is not uniform in the same country (Morocco) as well as in different global regions. Global prevalence of anemia among school age children is 37%. It is 46% in developing regions with highest in South Asia and Africa (DeMaeyer *et al.,* 1989).

Conclusion: Iron deficiency anemia is a serious health problem affecting mostly infants, children and women of reproductive age. In children, it impairs physical and psychological development, reduces immunity to infections, poor academic performance and limits physical activity and exercise. It is the most prevalent nutritional problem in the world. Diagnosis of iron deficiency anemia is simple and treatment bears less cost. The four basic approaches to the prevention of iron deficiency anemia are supplementation with medicinal iron, education and associated measures to increase dietary intake, the control of infection and the fortification of the staple food with iron. Signs and symptoms of anemia are non specific and difficult to detect .Simple laboratory tests should therefore be used to diagnose and determine its severity.

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