NUTRITIONAL Vs HEREDITARY ANAEMIAS APPROPRIATE SCREENING PROCEDURES FOR BAHRAIN

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ABSTRACT

Blood samples from 109 Bahraini schoolgirls and 92 boys and girls from the Salman Centre of the General Organisation for Youth and Sport were examined to differentiate between dietary anaemias and hereditary haemoglobinopathies. Previous studies of the nutritional status of Bahrainis have concluded that iron deficiency was the prevalent cause of the observed anaemias. Haemoglobins, blood cell indices, serum iron and total iron binding capacity (TIBC) were analysed in the pathology laboratory at the Bahrain Defence Force Hospital. Iron deficiency and microcytic hypochromic anaemia account for approximately 50% respectively of the 27.5% of low haemoglobin values among the schoolgirls. Indices of serum iron revealed that many children are iron deficient without frank anaemia in Bahrain, it is necessary to perform blood smears routinely along with multiple indices of iron status, preferably serum ferritin and haemoglobin electrophoresis when applicable.

Studies of the nutritional status of the Bahraini population have shown that anaemia is a public health problem. In 1980 Mobayed et al.[1] reported low haemoglobin values among 39.5% of rural pre-school childern and 19.7% of urban childern. The same year Amine[2] reported that 49.6% of adult females in his sample had haemoglobin values less than 12g/dl.

Mobayed et al.[1] and Amine[2] concluded that iron deficiency was the likely cause of the observed anaemias. More recent research does not completely support their hypothesis and shows that more extensive haematological analyses are required to differentiate between the dietary anaemias and hereditary haemoglobinopathies which are prevalent in Bahrain.

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METHODS

In 1984, the blood of 109 Bahraini girls, ages 7 to 18, was examined[3]. The sample was drawn from 12 schools around the island, mainly from urban and suburban areas. Similar blood work was performed on 92 privileged Bahraini children attending the Salman Centre after school programmes. Haemoglobins and red blood cell indices were analysed by Coulter Counter. In addition, serum iron and total iron binding capacity were analysed by the combination colourmetric method, iron without deproteinisation[4]. All analyses were performed at the pathology laboratory of the Bahrain Defence Force hospital.

Standards for the determination of abnormal values were taken from the recommendations of the International Anaemia Consultative Group[5], the Federation of the American Societies for Experimental Biologists[6], and Wintrobe[7]. Haematological findings below the following values were used to determine anaemia and iron deficiency: Haemoglobin <11.5 g/dl — age 7, <12 g/dl ages 8-11 for males and ages 8-18 for females, <12.5 g/dl for males ages 12-14, <13.0 g/dl for males ages 15-17 and <14.0 g/dl for males age 18 years; Mean corpuscular volume <75 fl ages 7-10, and <78 fl ages 11-18; Transferrin saturation <15% ages 7-10, and <16% ages 11-18.

RESULTS

The haematological findings on these two samples of Bahraini children are presented in Tables 1 and 2. When red blood cell and iron indices are examined along with haemoglobin, a more complicated picture of the causes of anaemia in Bahrain is revealed. Iron deficiency accounts for less than half of the 27.5% observed low haemoglobin values among the schoolgirl sample (Table 2).

TABLE 1: Abnormal haematological findings in Bahraini school girls ages 7-18, N=109: by total sample and age group

	Total Sample N=109 %	7-10 N=35 %	11-13 N=33 %	15-18 N=41 %
Anaemic				
Iron Deficiency [a]	12.8	8.6	6.1	22.0
Microcytic, Hypochromic [b]	13.8	14.3	6.1	19.5
Normocytic, Normochromic with Sickle Cell Trait	0.9	0	3.0	0
Non Anaemic				
Sickle Cell Trait	7.3	11.4	6.1	4.9
Microcytic [c]	7.3	5.7	6.1	9.8
Iron Deficiency [d]	14.7	5.7	15.2	22.0
Total Anaemic	27.5	22.9		41.5
Total Iron Deficiency	27.5	14.4		43.9

[a] *Low Haemoglobin, MCV, MCH and Transferrin Saturation.*

[b] *Low Haemoglobin, MCV, MCH, Normal Serum Iron and Transferrin Saturation.*

[c] *Normal Haemoglobin, MCV<72; Normal Transferrin Saturation.*

[d] *Transferrin Saturation low for age.*

TABLE 2: Abnormal haematological findings in privileged Bahraini children by sex, ages 6-13, N = 95

	Male N=47 %	Female N=45 %
Anaemia		
Iron Deficiency [a]	4.3	2.2
Microcytic Hypochromic [b]	12.8	2.2
Microcytic, Normochromic with Sickle Cell Trait	0.0	2.2
Normochromic, Normocytic	0.0	4.4
Non Anaemic		
Microcytic	6.4	2.2
Sickle Cell Trait	8.5	4.3
Iron Deficiency	6.4	6.7
Total Anaemia	17.1	11.0
Total Iron Deficiency	10.7	8.9

[a] *Low Haemoglobin, MCV, MCH and Transferrin Saturation.*

[b] *Low Haemoglobin, MCV, MCH, Normal Serum Iron and Transferrin Saturation.*

[c] *Normal Haemoglobin, MCV<72; Normal Transferrin Saturation.*

[d] *Transferrin Saturation low for age.*

Microcytic hypochromic anaemia without low transferrin saturation and with mean corpuscular volumes <72 accounts for half of the observed anaemia. The incidences of both iron deficiency anaemia and also microcytic hypochromic anaemia without signs of iron deficiency are lower among the Salman Centre children (Table 3), but the trend for the existence of both types of anaemias is still evident.

TABLE 3: Values used for the determination of iron deficiency [a]

Age (YR)	Serum Ferritin (ng/ml)	Transferrin Saturation (%)	Erythrocyte Protoporphyrin (ug/dl RBC)	Mean Corpuscular Volume (MCV) (fl)
1-2	-	*<12*	*>80*	*<73*
3-4	*<10*	*<14*	*>75*	*<75*
5-10	*<10*	*<15*	*>70*	*<76*
11-14	*<10*	*<16*	*>70*	*<78*
15-74	*<12*	*<16*	*>70*	*<80*

[a] *From: Pilch and Senti. Assessment of the iron Nutritional Status of the U.S. Population based on data collected in the second National Health and Nutrition Examination Survey, 1976-1980, August 1984.*

Sickle cell trait has an incidence of about 7% in both samples, but the incidence of normochromic normocytic anaemia which accompanies sickle cell disease is low.

The indices of serum iron reveal that many children are iron deficient without frank anaemia. An observable decrease in haemoglobin is the last stage of iron deficiency. The cytochromes and other iron containing enzymes are affected along with haemopoiesis. Even slight iron deficiency anaemia may lead to a reduction in work capacity associated with increased lactate formation[8]. Children with severe iron deficiency are restless and irritable due to an increased level of catecholamines[9]. Nearly 15% of the schoolgirls and 6.5% of the Salman Centre children had low transferrin saturations without low haemoglobin values. The prevalence of iron deficiency was 27.5% among the schoolgirl sample and was particularly high among the older girls (43.9%). The prevalence of iron deficiency was 8.7% among the younger, privileged children at the Salman Centre.

DISCUSSION

Microcytic hypchromic anaemia with abnormally low mean corpuscular volumes and without signs of iron deficiency is indicative of thalassaemia. The mild anaemia observed in these samples (haemoglobin >9.0 and <12 g/dl) indicates thalassaemia minor. However, due to insufficient data, our conclusions can only be tentative. Blood smears and haemoglobin electrophoresis are required for a definitive diagnosis. Though thalassaemia minor is not currently treatable, such a diagnosis is desirable for genetic counselling.

Blood smears are desirable for other reasons, especially when red blood cell indices are mechanically derived. The Coulter Counter averages the volumes of cells so that a normal mean corpuscular volume may be observed even when two populations of large and small cells exist. Microcytosis indicative of folic acid or Vitamin B12 deficiency was observed in neither group. However, without blood smears we cannot be assured that vitamin related anaemias do not exist in the Bahraini population.

Serum iron and total iron binding capacity are not completely satisfactory indices for determining iron deficiency. Transferrin saturation is increased in inflammatory disease due to a drop in TIBC. Also, young children have an indeterminate range of transferrin saturation (7-16%) which overlaps normal and deficient values[8].

Multiple indices of iron deficiency are required for a definitive diagnosis. Serum ferritin, a measure of the size of iron stores is an alternative to transferrin saturation. Erythrocyte protoporphyrin is elevated in iron deficiency due to its reduced utilisation when heme synthesis is slowed. Neither serum ferritin or erythrocyte protoporphyrin is a specific measure of iron deficiency. Erythrocyte protoporphyrin does not distinguish between iron deficiency and infection and is also elevated in lead poisoning. Serum ferritin values tend to increase in response to infection, malignancy and liver disease. Serum ferritin is the more sensitive indicator, able to detect mild depletion in iron stores, but false negatives are possible. The lower limits for the determination of iron deficiency as currently used in the U.S.A. are described in Table 3.

CONCLUSION

It is clear that the multiple haemoglobinopathies, sickle cell trait, and iron deficiency prevalent among the Bahraini population complicate the diagnosis of anaemia. Coulter Counter analysis of whole blood is appropriate but not sufficient for correct diagnosis. Blood smears should be performed routinely along with multiple indices of iron status, preferably including serum ferritin. Haemoglobin electrophoresis should be performed if the mean corpuscular volume is exceptionally low or if the anaemia is unexplained by iron indices.

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