Iron deficiency in inner city pre-school children: development of a general practice screening programme

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SUMMARY. Iron deficiency in children has been associated with behavioural disorder and developmental delay. Screening for iron deficiency was offered to all 527 children aged between one and four years in an inner city practice. Half the children belong to an ethnic minority group, and there is widespread social deprivation in the area. Capillary haemoglobin concentration and mean corpuscular volume were estimated in 365 children (69%). Dietary history, birth weight and current weight were also recorded. Fifty-eight (16%) of the children were iron deficient as defined by a mean corpuscular volume of less than 75 fl and/or a haemoglobin concentration of less than 10.5 g dl^{-1}. All were hypochromic and among 23 tested all had serum ferritin levels below 10 $\mu g\ l^{-1}$. Twenty-one children (5.8%) were anaemic (haemoglobin concentration less than 10.5 g dl^{-1}). Anaemia was significantly more common among children who were currently underweight but was not related to weight at birth. Iron deficiency was significantly more prevalent in non-Caucasian children — 25.0% compared with 7.8% of Caucasian children. There was also a significant linear decrease in iron deficiency with increasing age. Sex, weight at birth, current weight, whether breast fed, age weaned or whether on a vegetarian diet were not significant factors in iron deficiency. Iron supplements were given to all the children with iron deficiency.

In view of the high prevalence of iron deficiency, all children in the practice are now routinely offered screening for iron deficiency at the age of 14 months. The programme has been welcomed by all parents. It is suggested that screening for iron deficiency should be part of routine child surveillance.

Introduction

IRON deficiency is associated with developmental delay and behavioural disorder in children,[1-5] but recent work[5] has demonstrated that development rapidly improves when iron deficiency is corrected. Studies have reported the incidence of iron deficiency in children to be between 4% and 28%[6-10] but none involved unselected groups of children or a single practice.

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It was decided to carry out a study of iron deficiency in a practice in an area of Bristol with widespread social deprivation — over a third of the registered children are members of a single parent family and half are members of an ethnic minority group, principally West Indian. It is important, therefore, to identify those pre-school children whose development may be further handicapped by iron deficiency and if possible to identify predisposing factors. The doctors and health visitors work together closely and have built up good relationships with the families attending the practice. Previous experience with screening for nutritional rickets[11] and the improved uptake of immunizations in the practice[12] suggested there would be a good response to a screening programme. It was decided to limit the study to pre-school children aged between one and four years and to develop a practice policy for the diagnosis of iron deficiency if the results indicated a need.

Method

The five-doctor practice, run from a health centre, has 11 100 patients. Using the practice age–sex register 527 children aged between one and four years were identified and a letter outlining the importance of identifying and treating iron deficiency was sent to their parents. Over a six month period, the children were invited to attend the weekly 'iron clinic' held at the health centre. Those who did not attend were sent two further appointments or offered the chance of making an appointment in surgery time.

The clinic was staffed by a health visitor, a doctor and a medical laboratory scientific officer in haematology. A careful dietary history was taken, detailing duration of breastfeeding, time of weaning, duration of vitamin supplementation and whether the child was on a vegetarian diet. Birth weight and current weight were recorded, as well as the ethnic group of each child. Haemoglobin concentration and mean corpuscular volume were obtained from a 0.5 ml capillary blood sample. In addition, a haemoglobin S solubility test was carried out in children of Afro-Caribbean origin.

Children whose haemoglobin concentration was less than 10.5 g dl^{-1} or whose mean corpuscular volume was less than 75 fl and who had a hypochromic film were considered to be iron deficient and were invited back to the clinic. They were examined, and venesection for haemoglobin concentration and mean corpuscular volume as well as serum ferritin assay were offered. At the same time, haemoglobin electrophoresis was carried out for iron deficient children from ethnic minorities. All of these children were commenced on ferrous fumarate syrup (0.5–7.5 ml daily) irrespective of whether a further blood sample was obtained. Haemoglobin concentration, mean corpuscular volume and reticulocyte count were determined, where possible, two weeks after starting therapy.

In order to assess whether the children screened were representative of the children registered with the practice, the notes of those children who did not attend were scrutinized for age, sex, ethnic group and social class.

All of the results were analysed using Pearson's chi-square test statistic, with Yate's correction where necessary. At the end of the study a letter was sent to all the parents outlining the results,

thanking them for their cooperation and enclosing a diet sheet listing food rich in iron.

Results

Over the six month period, 365 of the 527 eligible children (69.3%) were screened. The screened and unscreened children did not differ in age, sex, ethnic group or social background.

Of the 365 screened children 58 (15.9%) were iron deficient and 21 (5.8%) anaemic (Table 1) — all 58 had hypochromic films. The only factor which was significantly associated with anaemia was the child's current weight ($P<0.05$); the incidence of anaemia was 14.7% in children whose weight was less than the tenth percentile and 4.8% in those whose weight was on or above the tenth percentile. Caucasian children had a significantly lower incidence of iron deficiency than non-Caucasian children ($P<0.01$) and there was also a significant negative linear trend with increasing age ($P<0.01$).

Follow up

All 58 iron deficient children were examined and given iron supplements. Of these, 23 children had further venesection and the haemoglobin concentration and mean corpuscular volume confirmed iron deficiency in all cases. In addition, the serum ferritin levels were all below 10 $\mu g\ l^{-1}$. At the same time, haemoglobin electrophoresis was carried out in 13 Afro-Caribbean children and, apart from one child who was found to have sickle cell trait, the results were all normal. Two Vietnamese children and one Indian child also had normal haemoglobin electrophoresis.

Ten of the 58 children with iron deficiency had follow up blood tests after two weeks of iron therapy; all had an increased haemoglobin concentration, mean corpuscular volume and reticulocyte count.

Discussion

Routine screening for iron deficiency in children has been suggested[5,10,13-15] and this paper is the first to report the outcome of such screening in an inner city general practice. The prevalence of iron deficiency among the children studied was high (16%) but was significantly higher among children from ethnic minority groups than for Caucasians. Afro-Caribbeans formed the largest ethnic minority group and 24% were iron deficient. Haemoglobin electrophoresis was performed on a sample of this group and, with the exception of one child with sickle cell trait, was normal in all cases. Although this does not rule out alpha-thalassaemia trait, all the children who had repeated full blood counts showed a response to iron supplements.

Anaemia was most common in children who were currently underweight, but was not related to weight at birth. Small babies often receive vitamin and iron supplements and may, therefore, be less at risk. Iron deficiency was also less common in older children, perhaps reflecting a diet that is supplemented by good food at nursery and primary school.

In spite of these associations, blood sampling is necessary if iron deficiency is not to be underdiagnosed. We identified iron deficiency in one in six children and screening must, therefore, be considered worthwhile.

Perhaps the most important finding of this study was that our patients were most cooperative. Throughout the study period emphasis was placed on the reasons for carrying out the study and appropriate health education was given. Thus, if proper explanations are given, a good response to screening for iron deficiency involving blood sampling can be expected. In this practice, the baby clinic is well attended and there is a high uptake of immunization. In view of this, we have now adopted a policy of screening all children for iron deficiency at 14 months when they attend for measles immunization. Where appropriate, screening for sickle cell disease and haemoglobinopathies are carried out at the same time. A blood sample is taken by a doctor or a treatment room nurse and this provides an opportunity to discuss diet and supply a diet sheet. The programme has been welcomed by all parents.

Iron deficiency is an important, preventable and treatable condition and every effort should be made to eliminate it. We would encourage routine screening of all children.

Table 1. Prevalence of anaemia and iron deficiency by sex, ethnic group, age, weight at birth, current weight and diet.

	Number (%) of children		
	Total	Iron deficient[a]	Anaemic[b]
All	365 (*100.0*)	58 (*15.9*)	21[c] (*5.8*)
Sex			
Male	186 (*51.0*)	32 (*17.2*)	12 (*6.5*)
Female	179 (*49.0*)	26 (*14.5*)	9 (*5.0*)
Ethnic group			
Caucasian	193 (*52.9*)	15 (*7.8*)	8 (*4.1*)
Non-Caucasian	172 (*47.1*)	43 (*25.0*)	13 (*7.6*)
Afro-Caribbean	98 (*26.8*)	23 (*23.5*)	8 (*8.2*)
Mixed	58 (*15.9*)	14 (*24.1*)	2 (*3.4*)
Vietnamese	10 (*2.7*)	4 (*40.0*)	2 (*20.0*)
Indian	6 (*1.6*)	2 (*33.3*)	1 (*16.7*)
		$P<0.01$[d]	
Age (years)			
1	102 (*27.9*)	24 (*23.5*)	9 (*8.8*)
2	101 (*27.7*)	20 (*19.8*)	7 (*6.9*)
3	67 (*18.4*)	5 (*7.5*)	2 (*3.0*)
4	95 (*26.0*)	9 (*9.5*)	3 (*3.2*)
		$P<0.01$	
Birth weight			
On or above 10th percentile	267 (*73.2*)	40 (*15.0*)	14 (*5.2*)
Below 10th percentile	98 (*26.8*)	18 (*18.4*)	7 (*7.1*)
Current weight			
On or above 10th percentile	331 (*90.7*)	50 (*15.1*)	16 (*4.8*)
Below 10th percentile	34 (*9.3*)	8 (*23.5*)	5 (*14.7*)
			$P<0.05$
Breast fed			
Yes	302 (*82.7*)	47 (*15.6*)	18 (*6.0*)
No	63 (*17.3*)	11 (*17.5*)	3 (*4.8*)
Diet			
Vegetarian	44 (*12.1*)	5 (*11.4*)	2 (*4.5*)
Meat eating	321 (*87.9*)	53 (*16.5*)	19 (*5.9*)
Vitamin drops			
Given for more than 3 months	218 (*59.7*)	32 (*14.7*)	11 (*5.0*)
Given for less than 3 months	147 (*40.3*)	26 (*17.7*)	10 (*6.8*)
Weaned			
Before three months	141 (*38.6*)	17 (*12.1*)	7 (*5.0*)
After three months	224 (*61.4*)	40 (*17.9*)	13 (*5.8*)

[a]Mean corpuscular volume less than 75 fl and/or haemoglobin concentration less than 10.5 g dl^{-1}. [b]Haemoglobin concentration less than 10.5 g dl^{-1}. [c]Range of haemoglobin concentration 7.8–10.4 g dl^{-1}, mean 9.7 g dl^{-1}. [d]Caucasian versus non-Caucasian.

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