ORIGINAL ARTICLE

Iron Deficiency Anemia among Indonesian Children

by

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Abstract

Iron deficiency with or without anemia as the most common deficiency anemia and its problems in Indonesia has been presented.

The prevalence has been discussed and mention made about the etiology and several important factors contributing to iron deficiency; its deleterious effects on learning process, pregnancy, infection and others.

The intervention program for iron deficiency anemia conducted in short and long term by the Government of Republic of Indonesia has been presented.

It should be emphazised that international cooperation among research workers and supporting agencies should be encouraged to overcome the problems of nutritional anemia in Indonesia.

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Introduction

Nutritional anemia is widely prevalent in many parts of the world, particularly in developing countries. Although many nutrients and cofactors are involved for the maintenance of a normal hemoglobin concentration, the most common nutrient deficiency in nutritional anemia, from the public health viewpoint is iron deficiency (Kho, 1961; Hoo Swie Tjiong, 1962; Drajat, 1973; Darwin, 1974; Sutedjo and Samsudin 1976; Soemantri, 1978).

This communication is supposed to discuss briefly the problem and solving of iron deficiency with or without anemia among Indonesian children.

In iron deficiency with or without anemia, the basic problem is actually that of nutrition. As it is a nutritional problem, what facets are there to face?

First of all, how big is the problem? Second, what is the etiology and influencing factors leading to the problem? And third, granted there is a problem that is to be worried about, how to cope with it?

Problem I :

The total Indonesian population is approximately 140 million inhabitants; the population segment of those below 14 years of age is 43 %. Information from various studies in Indonesia about the prevalence of iron deficiency and iron deficiency anemia were as follows : The prevalence of iron deficiency anemia among children : between 6 months - 5 years, from low socio-economic groups but well-nourished were between 37,8 — 73,0 % (Oen Sien Djien, 1964; Kho, 1975; Untario, 1976; Sutedjo and Samsudin, 1976).

Children with mild protein-calorie malnutrition affected were 83,0 % and with severe malnutrition 85,0 — 100 % (Sutedjo and Samsudin, 1976) : in medium and high socio-economic groups and in well-nourished children the prevalence was 24,0 % (Soedigbia et al., 1979; Soenarto et al., 1979). Between 5.1 yrs. — 14 yrs. with low socio-economic level but good nutritional status the recorded prevalence was 46,6 — 63,7%, and with mild protein-calorie malnutrition 57,5 — 66,9 % (Sutedjo and Samsudin, 1976); in medium and high socio-economic segments it was 19,6 % (Soedigbia et al., 1979; Soenarto et al., 1979).

Severity of iron deficiency is divided into three stages.

Stage I : Iron depletion in its storage or pre-latent deficiency. In this the serum iron and hemoglobin are still normal but the ferritin decreases.

Stage II : In this stage a stadium appears after the iron storage is exhausted, serum iron, and ferritin decreases, but hemoglobin is still normal.

Stage III : In this stage anemic symptoms will appear. Serum iron, hemoglobin and ferritin decreases.

The result of iron deficiency study in Jakarta by Markum et al. (1980) was

53,7 % from 85 cases aged 0 — 14 yrs. It appears that this iron dificiency mostly prevails in the malnourished preschool group (72,0 %); where as from children of 6 — 14 years iron deficiency is discovered among those who are wellnourished (table 1 and 2).

Information from these studies indicates that iron deficinecy with or without anemia is prevalent in the most vulnerable segment of the population. This is a national public health problem and should be solved effectively.

TABLE 1 : *The prevalence of iron deficiency (Markum et al., 1980)*

Stages	Age			Total
	0 — 11,99 mos	11 — 5,99 yrs.	6 — 13,99 yrs.	
I	—	—	1	1
II	—	21	13	34
III	7	15	10	32
Total	7	36	24	67

TABLE 2 : *The relationship between the prevalence of iron deficiency and nutritional status (Markum et al., 1980)*

Age	Nutritional Status			Total
	Good	Mild	Severe	
0 — 11,99 mos	—	7	—	7
1 — 5,99 yrs.	12	17	7	36
6 — 13,99 yrs.	18	5	1	24
Total	30	29	8	67

Problem II

Etiology and influencing factors.

What is the etiology and influencing factors of nutritional iron deficiency?

Various studies on different aspects of the etiology of iron deficiency anemia have been done. The results are the interaction between many factors which predispose the development of iron deficiency anemia.

Factors contributing to the occurrence of iron deficiency anemia are shown in figure 1, illustrating the multifactoral interaction. Theoretically, alteration of any of these variables will increase the prevalence of iron deficiency anemia. On the other hand, the prevalence of iron deficiency anemia will decrease if any one of these variables is learned. For instance improvement of the socio-economic condition and environment result in correction of the nutritional status, feeding pattern and thus prevalence of iron deficiency anemia will decrease. Furthermore, the prevalence of intestinal worm infestation will also decrease with improvement of socio-economic conditions and environment; this is one of the public health approaches to control iron deficiency anemia.

The action of any of these variables could influence the incidence of iron deficiency anemia, e.g., nutritional status, pregnancy, menstrual blood loss, growth improvement, lack of health facilities etc.

According to many investigations in Indonesia, iron supplementation, improvement of health facilities and eradication of infectious diseases are all direct positive factors in decreasing the incidence of iron deficiency anemia. Therefore simultaneous improvement of all of these factors could produce optimal improvement.

Problem III

Deleterious effects of iron deficiency

There are many deleterious effects of iron deficiency anemia :

(1). learning disabilities, (2). pregnancy, (3). its impact in infection and others.

I. Learning disabilities

a). Learning ability

Soemantri (1978) observed that iron deficiency anemia is one of the influencing factor in decreasing learning ability and further studies showed that learning achievement was improved after iron treatment (see table 3 and 4).

TABLE 3 : *Statistical calculation of learning achievement score in anemic and non anemic group before treatment (Soemantri, 1978).*

Statistics	Anemic group	Non anemic group	Significant level
NA		77	
ÆXA	5.224,3900	3.244,4800	
ÆX²A	187.833,3625	146.209,4872	$p < 0,001$
161	32,4500	42,1361	

TABLE 4 : *Statistical calculation of learning achievement score in anemic and non-anemic group before and after placebo and iron treatment (Soemantri, 1978).*

G	S	Placebo		P	Iron		p
		B	A		B	A	
I	NA	77	77		79	79	
	ÆXA	2.498,46	2.509,16		2.564,91	2.903,43	>0.05
	Mean	90.320,65	90.702,71		92.640,39	15.283,89	
	ÆXA	32,45	32,59		32,47	36,75	
II	NA	40	40		35	35	
	ÆXA	1.697,85	1.692,74		1.477,63	1.413,73	>0.05
	Mean	76.311,55	75.734,64		67.887,72	62,134,50	
	ÆXA	42,45	42,32		42,22	40,39	

G = Group I = Anemic group S = Statistics

B = Before treatment II = Non anemic group A = After treatment

b). Learning concentration

Soemantri (1978) observed that learning concentration was also disturbed when hemoglobin value was below 10,5 % (see table 5 and 6).

TABLE 5 : *Statistical calculation of learning concentration score in anemic and non anemic group at Hb. ⩽ 10,5 g % level (Soemantri, 1978).*

Statistics	Anemic group	Non anemic group	Significant level
NA	68	77	
{ XA	22,161	29,835	p < 0.01
{X2A	7.962,807	12.742.967	
Mean	325,897	387,468	

TABLE 6 : *Statistical calculation of learning concentration score in anemic (HB ⩽ 10,5 g %) and non anemic group before and after placebo and iron treatment (Soemantri, 1978).*

G	S	Placebo		p	Iron		P
		B	A		B	A	
I	NA	26	26		42	42	
	XA	7,528	7,458	> 0.05	14,623	17,015	
	X2A	2.302,722	2.533,032		5.660,085	7.324,709	< 0.01
	Mean	289,92	286,85		348,17	405,12	
II	NA	40	40		35	35	
	XA	14,757	15,392		14,429	14,889	
	X2A	6.069,767	6.409,792	> 0.05	6.462,559	13.200,654	> 0.05
	Mean	368,93	384,80		412,26	425,40	

II = Non anemic group S = Statistics I = Anemic group

G = Group B = Before treatment A = After treatment

II. P r e g n a n c y

Severe anemia during pregnancy is associated with an increased risk of maternal and fetal morbidity and mortality. Even mild anemia has been shown to be associated with an increased risk of premature delivery, low birth weight, placental hypertrophy, and reduced estradiol excretion (Hoo Swie Tjiong, 1962).

III. Infection

A positive correlation between morbidity from infectious diseases and hemoglobin levels was observed by Darwin (1974) and Markum et al. (1980); there is no correlation between Hb level and prevalence of infection. Basta (1974) found that anemic laborers in Indonesia were significantly more prone to infection than non anemic laborers, and that supplementation with iron had a beneficial effect on the frequency of infections in anemic workers. Soemantri et al. (1977) and Soemantri (1978) stated that several biochemical and immunological effects of iron deficiency anemia may be relevant to infection and de-

creasing phagocytic effect of leucocytes due to impairment of myeloperoxydase activity.

Iron deficiency, both in man and animal, has been shown to produce a number of alteration in immunological systems such as impairment of lymphocyte transformation (Joynson, 1972; Srikantia et al., 1976; Macdougall, 1975; Chandra, 1975).

Neutrophil function may also be deranged (Srikantia et al., 1976; Macdougall, 1975), although studies by Kulapongs et al. (1974), showed normal leucocyte function. In iron deficient animals, there is a marked impairment of humoral antibody response; a reduction in leucocyte myeloperoxydase that may effect host resistance to bacterial diseases (Baggs, 1974), and a greatly increased sensitivity to Escherichia colientero-toxin (Osborne, 1968). On the other hand, a number of microbial organisms require iron for their growth (Weinberg, 1966) and hypoferraemia may inhibit the growth of bacteria in vitro (Masawe, 1973). From infectious aspects, Markum et al. (1980) discovered that pre-school children suffering from infection more than 3 times were suffering more from iron deficiency (61,2 %) than those suffering less than 3 times (only 38,8 %), see table 7. There was no difference between the prevalence of iron deficiency and infection in school age children. Although the complexity of the interaction between the infectious agent and the host makes such proof extremely difficult, there is likely evidence of an increased susceptibility to infection in subjects with iron deficiency anemia.

The precise relationship of all these findings to the incidence of morbidity in an iron deficient population has yet to be explored.

TABLE 7 : *The relationship between the prevalence of iron deficiency and infection.*

Age	Infection		Total
	less than 3x	more than 3x	
0 — 11,999 mos	2	5	7
1 — 5,999 yrs	12	24	36
6 — 13,999 yrs	12	12	24
Total	26	41	67

IV. Other Effects

It has been documented that iron deficiency may result in many abnormalities of the body's functions, such as decreased gastric juice secretion (Davidson and Markson, 1955), reduced activity of intestinal cell enzyme (Dallman et al., 1967) and subcellular structural abnormalities including mitochondrial enlargement (Jacob, 1969; Dallman and Goodman, 1970). After iron administration, improvement of subnormal mental performance in iron deficient infants and children has been reported (Garm and Smith, 1973; Webb and Oski, 1973a; Webb and Oski, 1973b; Webb and Oski, 1974).

Zinc deficiency, which may accompany iron deficiency, can lead to growth retardation in adolescents and may also contribute to the production of some of the "classical" signs of iron deficiency such as koilonychia and Plummer-Vinson syndrome.

Problem IV

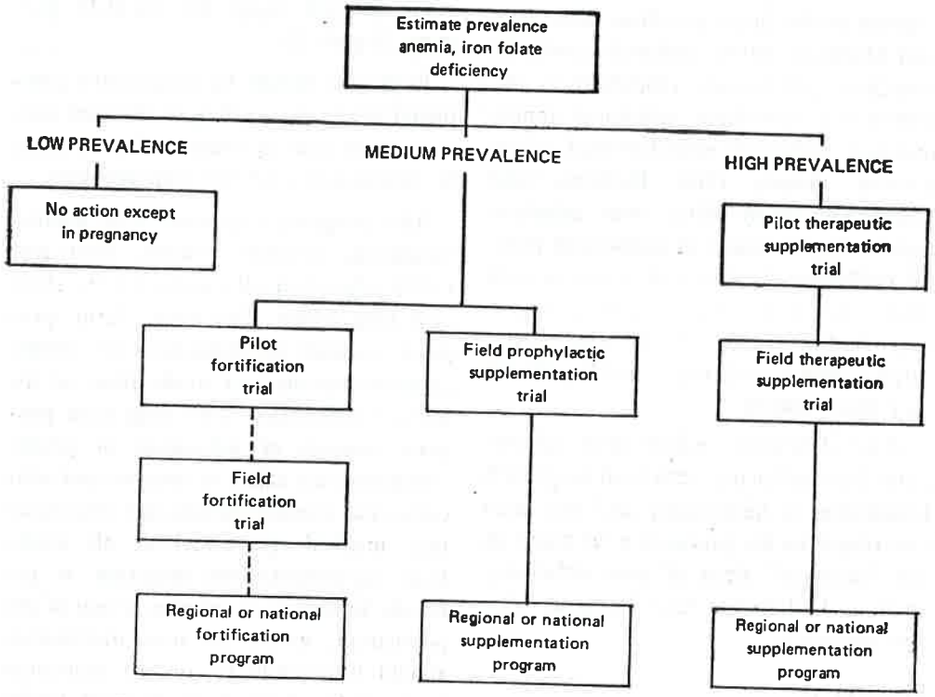
How to Solve the Problem?

The Government of the Republic of Indonesia is improving the health delivery system and eradication of diseases through the development of planning. Especially in relation to solving the problems of iron deficiency anemia, the government has decided on a program adopted from the INACG program (Figure 2).

Each step should be successfully completed before proceeding to the next one. If a given trial is unsuccessful, it must be redesigned and the step repeated.

The program comprise iron supplementation, parasite control, food and health education all conducted in short and long terms. The short term program consists of education of people supplementation and eradication of intestinal nematodes. The long term program consists of education of people concerning the effect of anemia and education for primary health care and training medical personnel at all levels. Iron supplementation program is generally limited to a selected group of the population, where as iron distribution should if possible be on an individual basis. It has been done in most health centres and representatives of all segments of the population e.g. : under five years group, pregnant women, laborers and factory workers.

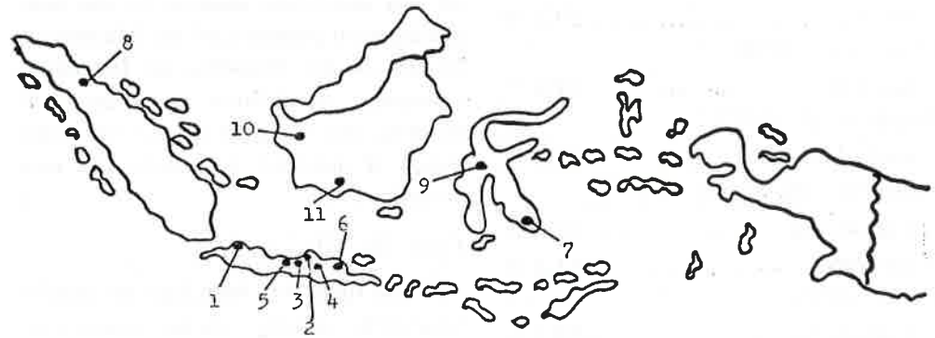
FIG. 2 : *Scheme for the control of nutritional anemia adapted from international nutritional anemia consultative group (INACG) (1977).*



Parasite Control

In many areas of our country, iron deficiency anemia is aggravated by increased blood loss due to intestinal parasitic infestation especially hookworms. The incidence (prevalence) of hookworm infestation is shown in fig. 3.

FIG. 3 : *The incidence (prevalence) of hookworm infestation in Indonesia. Soemantri et al. (1979).*



1.	Jakarta	89,4 % (1959)	4.	Surakarta	41,2 % (1973)
	West Java	58,0 % (1974)	5.	Central Java	52,1 % (1978)
		67,0 % (1978)	6.	Surabaya	23,7 % (1973)
2.	Boyolali	23,2 % (1968)	7.	South Sulawesi	73,0 % (1972)
		22,0 % (1970)	8.	Samosir Sumatera	43,0 % (1978)
3.	Yogyakarta	59,3 % (1973)	9.	Central Sulawesi	43,0 % (1977)
		52,1 % (1973)	10.	South Kalimantan	69,0 % (1978)
		93,0 % (1978)	11.	West Kalimantan	65,0 % (1978)

Lie Kian Joe and Tan Kok Siang (1959)

Jakarta ..... 89,4 %

Cross et al. (1968)

Boyolali ..... 23,2 %

Cross et al (1970)

Boyolali ..... 22,0 %

Pinardi et al. (1972)

South Sulawesi ..... 73,0 %

Nurhayati and Sunarno (1973)

Yogyakarta ..... 59,3 %

Surakarta ..... 41,2 %

Clarke (1973)

Yogyakarta ..... 52,1 %

Yuwono and Tantular (1973)

Dr. Sutomo Hospital

(Surabaya) ..... 23,7 %

Darwin (1974)

West Java ..... 58,0 %

Carney et al. (1977)

South Sulawesi ..... 68,0 %

Cross et al. (1977) ..... 59,0 %

Depary (1977)

Samosir Sumatra ..... 43,0 %

Putrali et al (1977) ..... 65,0 %

Bintari Rukmono (1978)

West Java ..... 67,0 %

Central Java ..... 52,1 %

Central Sulawesi ..... 69,6 %

South Kalimantan ..... 65,0 %

West Kalimantan ..... 66,0 %

Soemantri (1978)

Yogyakarta ..... 93,0 %

According to Scrimshaw et al. (1953) and Mayet and Powell (1966), the criteria for an hyperendemic area is 10 — 20 % of all cases with Ancylostomiasis with minimum worm load of 100. Most areas mentioned above are hyperendemic, and with high prevalence of iron deficiency anemia. In the next development planning of the Ministry of Health of the Republic of Indonesia, systematic eradication program will be done after the pilot project on eradication of intestinal nematodes has succeeded.

Food and Education

While stress has been laid on supplementation, dietary modifications can increase intake of available iron and folate and increasing of iron absorption from meat and fish and vitamin C-rich fruit and vegetable. Food that facilitates iron absorption such as meat, poultry and fish are not freely available by low socio-economic classes due to scarcity, poverty or local dietary practices. In medium socio-economic classes, iron-rich foods is frequently not consumed in adequate amounts. In either low and medium socio-economic strata, adequate educational programs can do much to alleviate iron deficiency. To be effective, such efforts must be addressed not only to the nutritional properties of foods and nutrient needs, but also to the cultural role of foods and attitudes. Simple principles of hygiene and health must be presented and basic understanding of cost values of foodstuffs given. Iron supplementation and parasitic control programs often serve as motivational stimuli for interest in nutritional and health education. Among low socio-economic classes, economic improvement should be a prerequisite to eradicate malnutrition. Changes in socio-economic strata do not occur in a short time; nevertheless, a national program to combat iron deficiency anemia must include such objectives.

Education effort concerning selection, production, and consumption of food have to be modified to include information on the relevant material such as environmental sanitation and personal hygiene. Education of parents on the benefits of spacing of births and the special needs of young mother can help in reducing the problems of anemia. These efforts should be included in the total education program administered by agencies responsible for health, agriculture or education. A well nourished and healthy individual is the ultimate aim of any nutritional program. The solution to iron deficiency anemia, or any nutritional problem, depends upon an adequate intake of affordable and acceptable nutritional food. Food must be available and the economic level of the population adequate to purchase them. Educational efforts must be broadly conceived, long term in nature, and must involve the total educational, health and agricultural organizations of the country. The solution depends upon an adequate food supply, either from domestic or foreign agriculture, apropriately processed, distributed, and consumed by the population. Education concerning food and nutrition must be an integral part of any program.

International Cooperation

Cooperation among research workers and supporting agencies should be encouraged.

(a). Close international cooperation in solving the global problems of nutritional anemia is highly desirable because it facilitates the exchange of ideas and experience and stimulates all concerned. In addition, institutions experienced in developing and applying the more complex laboratory methods should be encouraged to assist research groups with limited resources and capability.

(b). WHO and International Society of Hematology (ISH) should encourage close cooperation among supporting agencies by arranging meetings for the exchange of information and the identification of the more important areas for support.

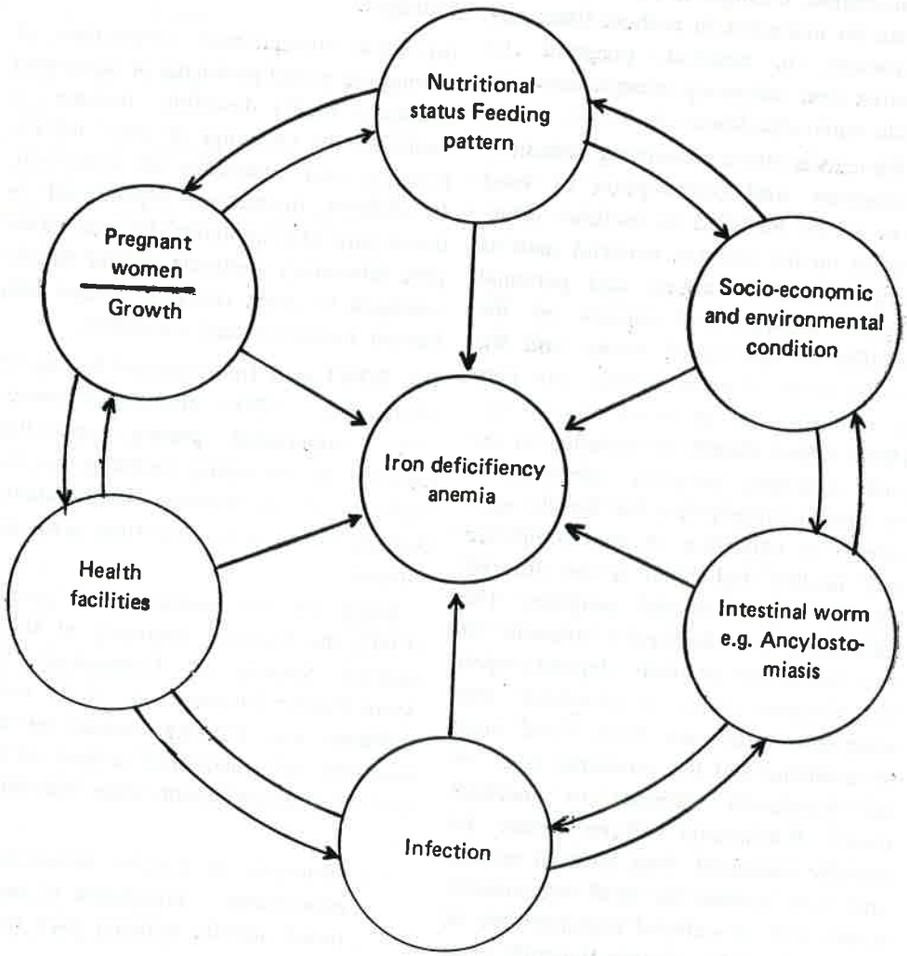
Based on the statement of Lovric, (1980) the General Secretary of International Society of Hematology for Asian Pasific Division, one of the main problems was training courses on the diagnosis of nutritional anemia at the level of primary health care, consisting of :

1). Principle of simple hematologic procedures : prevention of nutritional anemia is better than treatment.

2). Skill in operating the simple appropriate hematological instrument (both non-electrical and electrical equipment) :

* Calibration and standardization
* Proper staining method.

FIG. 1 : *Factors contributing to iron deficiency anemia.*



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