Control of Iron and Other Micronutrient Deficiencies in the English-speaking Caribbean

W. K. SIMMONS[1]

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Most micronutrient deficiencies affect relatively few people in the Caribbean; however, many Caribbean residents are affected by anemia that appears due primarily to a lack of dietary iron. While generally substantial, the prevalences of such anemia have differed a good deal from place to place and study to study, observed rates ranging from 27% to 75% in pregnant women, 19% to 55% in lactating women, and 15% to 80% in young children. Severe anemia, defined by a blood hemoglobin concentration below 8 g/dl, has been found in approximately 6% of the pregnant women and 11% of the preschool children in some Caribbean countries.

The principal ways of controlling iron deficiency anemia are through food fortification, control of intestinal parasites, direct oral supplementation, and dietary modification. Progress has been made in iron fortification of wheat flour and wheat products (the principal foodstuffs consumed by the general public in most of the English-speaking Caribbean). Data on control of relevant parasites in the Caribbean (primarily hookworm and to a lesser extent whipworm) are limited. Health services throughout the English-speaking Caribbean have been providing direct iron supplementation for pregnant women, but high levels of anemia during pregnancy still exist because of coverage, monitoring, and compliance problems. All the Caribbean countries also have education programs, which mainly advise pregnant women about iron-rich foods and iron absorption inhibitors and enhancers.

In addition to their humanitarian benefits, programs to remedy micronutrient deficiencies in the populations of Third World countries are proving to be valuable economic investments—because such deficiencies commonly lead to higher health costs, lower educational attainments, reduced school attendance, and reduced labor productivity. Within the area of the English-speaking Caribbean, however, deficiencies of micronutrients other than iron are relatively rare. Therefore, this report will touch briefly on other deficiencies that have occasionally been noted and will then focus on problems relating to shortages of dietary iron and methods currently employed for their control.

[1]Public Health Nutritionist, Caribbean Food and Nutrition Institute, Kingston 7, Jamaica.

DEFICIENT MICRONUTRIENTS OTHER THAN IRON

Regarding vitamins, vitamin A deficiency severe enough to cause eye lesions is extremely rare (*1*). Among the B vitamins, only riboflavin shows evidence of clinical and biochemical deficiency, which has been found to occur in children with severe protein-calorie malnutrition (2). Scurvy (from vitamin C deficiency) and rickets (from vitamin D deficiency) are virtually unknown. Nonfat milk is often fortified with vitamins A and D. Most milk and milk products in the Caribbean, including butter (and also margarine), are likewise fortified with vitamins A and D (*3*). In addition, of course, the Caribbean has an abundant supply of sunshine.

Regarding fluoride, there is a high prevalence of dental caries in some Caribbean countries. A survey conducted in 1984 showed a very high prevalence of caries among Jamaican children in terms of the classification established by the World Health Organization (WHO) (*4*). In September 1987 the Government of Jamaica started adding fluoride to all salt in the country at a level of 250 mg of fluoride per kilogram of salt. (Approximately 60 countries around the world add fluoride to either drinking water or salt in order to reduce the prevalence of dental caries.) This action increased the cost of salt to the consumer by four Jamaican cents[2] per kilogram; iodine was already being added to the salt. The action was taken at Jamaica's one salt factory, which has been exporting some of its fortified salt to Barbados, Belize, Grenada, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago.

ANEMIA AND IRON DEFICIENCY

A large share of the Caribbean population in all age groups suffers from varying degrees of anemia, which available evidence suggests is caused primarily by a deficiency of iron. Folate and vitamin B_{12} deficiencies have been noted occasionally in Trinidad and Tobago and Guyana among nationals of East Indian origin, but these deficiencies are far less prevalent than iron deficiency.

The prevalence of anemia varies widely in the countries of the region, the prevalences found by different studies ranging from 27% to 75% in pregnant women, 19% to 55% in lactating women, and 15% to 80% in young children. Severe anemia, as defined by a blood hemoglobin concentration below 8 g/dl, has been found in approximately 6% of the pregnant and lactating women and 11% of the preschool children in some Caribbean countries (*5–16*).

As Figure 1 shows, a recent island-wide survey in Grenada found noteworthy anemia in all age groups (*17*). Defining anemia in terms of a hemoglobin level below established WHO cutoff points,[3] the survey found anemia in 62.9% of the pregnant women, 47.0% of the lactating women, and 43.7% of the children 6 months through 5 years old in the study population. The lowest percentage of anemic subjects was found among males 15–44 years old.

As Figure 2 indicates, this Grenada survey also found striking prevalences of iron deficiency when this was defined in terms of plasma ferritin levels below 12 μg/l. Here again the data pointed to iron deficiency among some members of all age groups, but in this case the percentages of lactating women and preschool children affected were even higher than those indicated by hemoglobin levels. Specifically, 53.6% of the pregnant women, 61.7% of the lactating women, and 59.7% of the preschool children had ferritin levels below 12 μg/l, indicating no iron reserves.

In 1987 an island-wide survey on anemia in Jamaica collected information on 5 509 participants (*18*). It was found that the prevalence of anemia, as determined by a hemoglobin level below the WHO recommended cutoff points, ranged from 12% among male children 5–9 years old to 78% among preschoolers 6 months to 2 years old. A little over half (52%) of the pregnant women surveyed were also anemic according to this criterion (Figures 3 and 4).

[2]At the time, J$ 5.5 was equivalent to US $1.0.

[3]These cutoff points for the indicated age groups were as follows: 6 months through 5 years, 11.0 g/dl; 6 through 14 years, 12.0 g/dl; adult pregnant females, 11.0 g/dl; adult nonpregnant females, 12.0 g/dl; adult males, 13.0 g/dl.

Figure 1. Hemoglobin levels in Grenada's population, showing the percentage of each survey group listed with hemoglobin levels below the World Health Organization's suggested cutoff points (see footnote 3). Source: Caribbean Food and Nutrition Institute (*17*).

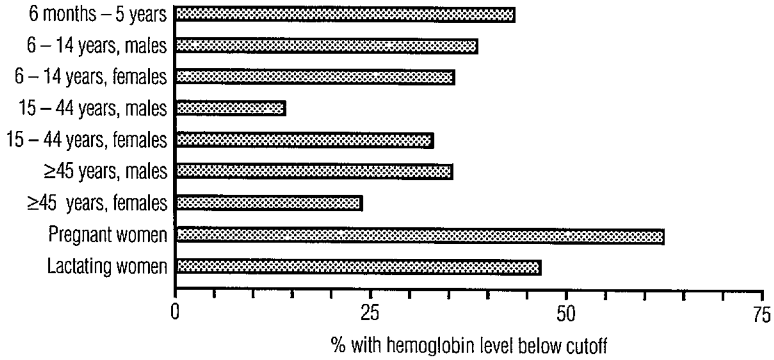


Figure 2. Plasma ferritin levels in Grenada's population, showing the percentage of each survey group listed with plasma ferritin levels below 12 μg/l, by age and sex. Source: Caribbean Food and Nutrition Institute (*17*).

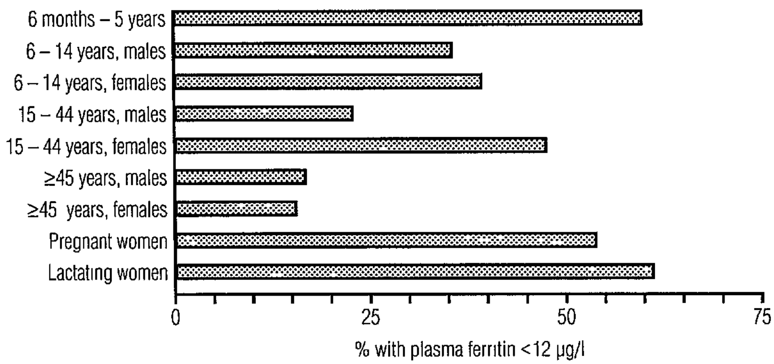


Figure 3. Hemoglobin levels in Jamaican males 0–19 years old, showing the percentage of each age group surveyed with hemoglobin levels below the World Health Organization's suggested cutoff points (see footnote 3). Source: University of the West Indies and Ministry of Health of Jamaica (*18*).

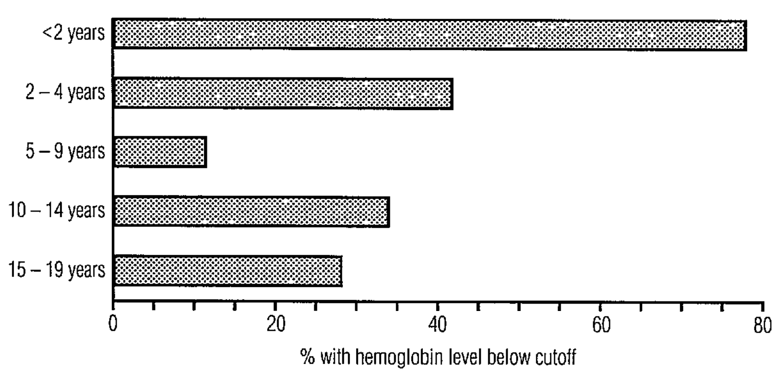
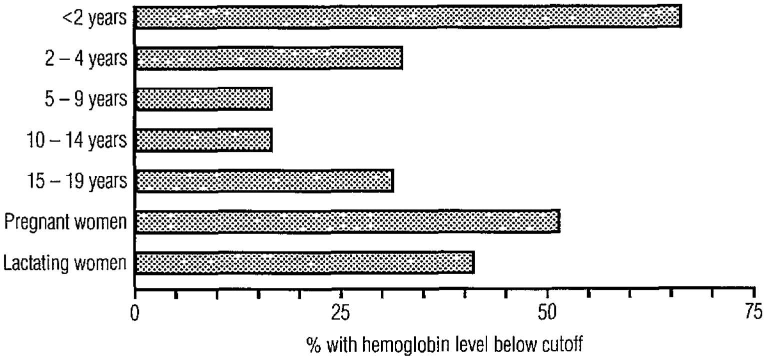


Figure 4. Hemoglobin levels in Jamaican females 0–19 years old, pregnant women, and lactating women, showing the percentage of each group surveyed with hemoglobin levels below the World Health Organization's suggested cutoff points (see footnote 3). Source: University of the West Indies and Ministry of Health of Jamaica (*18*).



Iron stores were calculated by using hemoglobin, ferritin, the saturation index, and the three erythrocyte protoporphyrin levels (*19*). (Body iron is divided into storage and functional categories and is expressed in relation to the storage component. Negative values indicate iron deficiency and the amount of iron which must be returned to the body before stores can accumulate.) In the Jamaica survey, 65% and 56% of the males and females less than 2 years old, 37% and 34% of the boys and girls 2–4 years old, and 25% of the 15–19 year old nonpregnant nonlactating females (as well as substantial percentages of the pregnant and lactating groups) were found to be iron deficient (iron stores 0 mg or less, Figures 5 and 6).

In another study, conducted in 1989 on Saint Vincent and the Grenadines, 48% of the pregnant women surveyed were found to have plasma ferritin levels below 12 μg/l (*20*), which again pointed to iron deficiency as a public health problem.

Figure 5. Negative iron stores in Jamaican males 0–19 years old, showing the percentage of each group surveyed with iron stores below 0 mg. Source: University of the West Indies and Ministry of Health of Jamaica (*18*).

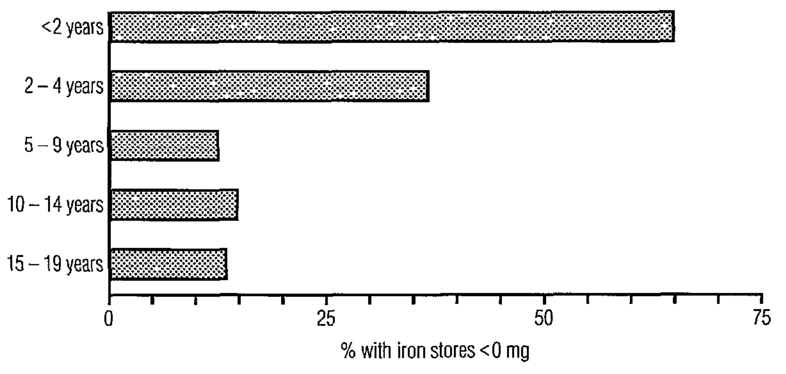


Figure 6. Negative iron stores in Jamaican females 0–19 years old, pregnant women, and lactating women, showing the percentage of each group surveyed with iron stores below 0 mg. Source: University of the West Indies and Ministry of Health of Jamaica (*18*).

CONTROL OF IRON DEFICIENCY

WHO and the International Nutrition Anemia Consultative Group (INACG) recommend four approaches for control of anemia (*21–22*). These are as follows:

(1) Direct oral supplementation with the missing nutrients.
(2) Dietary modification to improve intake and absorption of hematinic elements.
(3) Fortification of one or more food vehicles.
(4) Control of intestinal parasites.

Direct supplementation, which should be aimed mainly at special target groups, is a therapeutic method for correcting the deficiency where ordinary dietary intake is unable to do this in a short time. Dietary modification and fortification are methods that should be used to ensure adequate iron stores in the general population. Parasite control, which involves public health measures directed against environmental problems, reduces iron loss from the body. Because no one of these approaches by itself is likely to be entirely successful, the countries of the English-speaking Caribbean have tended to use them in combination, developing their own programs based on the availability of necessary resources and the extent of the problem. However, for purposes of analysis it is appropriate to consider each of these approaches individually.

Supplementation

All of the English-speaking Caribbean countries have been carrying out supplementation programs through their health services that are directed at pregnant women. These programs have never been completely satisfactory in terms of realizing their key aims—achieving or maintaining adequate iron reserves at delivery and preventing anemia in infancy.

Examination of recommended dietary allowances in the Caribbean clearly indicates that in this region iron needs cannot generally be met in pregnancy by diet alone. Research also indicates that supplementation started early in pregnancy can maintain or (rarely) improve a woman's iron nutrition status satisfactorily by the time of delivery. However, preliminary findings suggest that noncompliance by iron supplement recipients is high, due largely to side effects (usually nausea and vomiting) (*12*).

Numerous iron preparations that differ in iron content, type of iron provided, disintegration and dissolution times, and cost are available. Most have been reported to produce side effects when administered in high doses. Available iron supplement tablets, which vary in terms of dosage, may contain ferrous sulfate, ferrous fumarate, or ferrous gluconate, and may also provide folate. Combined ferrous sulfate/folate tablets are often administered. Liquid supplements containing iron in the form of ferrous sulfate or ferrous ammonium citrate, with or without folate, are used by child health clinics in most English-speaking Caribbean countries.

In the past, monitoring and evaluation of iron supplementation programs have been poor. Although exact figures are not available, compliance is known to be low. Only some of the Caribbean countries are currently monitoring hemoglobin levels of preschool-age children attending child health clinics (*12*).

Despite wide availability and distribution of iron tablets, high prevalences of anemia during pregnancy still exist. This could be due to low clinic coverage in some countries, inadequate monitoring of anemia at prenatal clinics, and low patient compliance due to side effects from multiple daily doses. In order to deal with these and other potential difficulties and achieve an adequate level of success, a number of circumstances must be considered and appropriate measures taken. These circumstances are as follows:

(1) The organization and coverage of the existing primary health care system.
(2) The regularity and appropriateness of the supply of materials.
(3) Efficacy of the supplement tablets and/or liquids used.
(4) Recipient compliance.
(5) Recipient folate status.
(6) Recipient parasite prevalences and loads (especially of hookworm).
(7) Program monitoring and evaluation.

Diet Modification

In the English-speaking Caribbean most diets contain more nonheme iron than heme iron. Heme iron is found in fish and meat, which are expensive foods, and it is unreasonable to expect a major increase in their intake among those with anemia or at risk of it. Consequently, diet modification efforts should concentrate on enhancing the consumption and bioavailability of nonheme iron.

Within this context, effective diet modification will depend on availability and affordability of the needed foods, and upon the awareness of what is needed by those procuring and preparing food for the family as well as their willingness to select and serve those foods. Fortunately, the dietary changes involved need not be great in order to have a considerable beneficial effect. All this implies that what is needed is mainly education, although food prices and availability are also important motivational components.

This need for education has not been lost upon Caribbean health authorities. Indeed, at present anemia education programs are operating in all the Caribbean countries. The education provided by these programs consists mainly of counseling for pregnant women by nurses and nutrition officers regarding iron-rich foods and iron absorption inhibitors and enhancers. These programs should continue and should be supported by training courses designed to update health personnel on the latest aspects of controlling anemia.

Control of Intestinal Parasites

Hookworm infections can aggravate anemia. In subjects with hookworm egg counts exceeding 2 000/g of feces, a significant correlation has been found between the severity of the infection and the degree of anemia. The blood loss produced by hookworm ranges from about 2 ml/day in lightly infected subjects to about 100 ml/day in those heavily infected (*23*).

Whipworm (*Trichuris trichiura*) is less generally recognized than hookworm as a cause of human anemia. However, some Caribbean populations (especially children) exhibit high prevalences of whipworm infection. Each worm is responsible for an average loss of about 0.005 ml of blood per day; and since whipworms live in the large intestine, there is no reabsorption of hemoglobin iron. When high worm densities exist, such as those capable of causing *Trichuris* dysentery syndrome (TDS), significant iron loss may result (*18*).

Hookworm and whipworm infections are controlled by removing the parasites from the intestine. The simplest treatment, administration of broad-spectrum anthelmintics, has been used for treating individuals in the English-speaking Caribbean and also in a community helminthiasis control program (*24*).

Data on improvement of iron deficiency anemia through control of parasitic infections in the Caribbean are limited. However, a study that dealt with the nutritional status of Jamaican children with TDS and the effects of treatment was recently carried out (*21*). Specifically, a group of very anemic children with TDS were treated every three months and given iron supplementation in the first month of the study. When this group was compared to matched controls over the one-year study period, it was found that their hemoglobin levels improved significantly within six months of enrollment in the study and that this improvement was maintained throughout the study.

Fortification

Food fortification, in the context of preventing and controlling iron deficiency anemia, means addition of iron and/or folate to foods. Such fortification can be directed at the general public by fortifying a widely consumed product such as wheat flour or sugar; or it can be directed at a particular high-risk group such as infants who are not breast-fed.

There are three options for increasing bodily iron absorption through fortification. The first and most obvious is to add an absorbable iron salt or particles of reduced iron to some item in the diet; the second is to add something that facilitates iron absorption, such as ascorbic acid; and the third is to do both. Radioisotope studies have shown all three to be feasible (*26*).

Iron has been added to fish sauce, sugar, salt, pasta, cornmeal, infant foods, breakfast cereals, and MSG; but it is most widely used to fortify wheat flour (*22, 25, 26*). The technology for adding iron to cereal foods (generally as a component of a vitamin-mineral blend) has been well developed over the past 40 years and has been greatly facilitated by the fact that these foods are centrally processed in a manner that readily lends itself to control of the addition of nutrients. Questions still remain regarding which form of iron can and should be used by manufacturers in various applications. Today food processors use mainly reduced iron or ferrous sulfate, though in some parts of the world insoluble phosphates such as ferric orthophosphate or ferric pyrophosphate are also used (*25*).

Reduced iron can be produced by either hydrogen reduction or electrolytic reduction of iron oxide. The bioavailability and chemical reactivity of this reduced iron depends on particle size, smaller particles being absorbed better. Electrolytically reduced iron, one of the least expensive forms of iron available, is commonly used to fortify foodstuffs (*27*).

Ferrous sulfate is widely used—both for food fortification when soluble iron is considered necessary and therapeutically for treatment of acute iron deficiency anemia. Iron sulfate tends to make flour discolor and go rancid when it is used at high levels or when the treated flour is stored for a long time at high humidity. However, this product (commonly used to fortify wheat flour) is inexpensive and has excellent bioavailability (*26*).

Except in Guyana, where rice consumption exceeds wheat consumption, wheat flour and wheat products are the principal foodstuffs of the English-speaking Caribbean. Both wheat and wheat flour are imported—mainly from the United States, Canada, and Europe. Some of the preground wheat flour imported by the Caribbean is fortified with vitamins and iron, but some is not. Within the area, wheat flour mills are located in Barbados, Belize, Grenada, Guyana, Jamaica, Saint Vincent and the Grenadines, and Trinidad and Tobago.

The iron added to both preground and locally ground wheat is in the form of ferrous sulfate or reduced iron, the latter usually as particles with an average diameter of 44 microns. Ferrous sulfate has better bioavailability than does reduced iron with this relatively large particle size. However, one of the flour mills is using reduced iron with a smaller average particle size, which should make it more bioavailable (*12*).

Except for "counter flour" (see next paragraph) ground in Grenada, all flour ground locally in the Caribbean from imported wheat is fortified with vitamins and iron. By law, wheat flour must be fortified with iron and the B complex vitamins in Guyana, Jamaica, and Trinidad and Tobago. This fortification is usually at the following levels: thiamine, 4.4–5.5 mg/kg; riboflavin, 2.6–3.3 mg/kg; niacin, 35.0–46.0 mg/kg; and iron, 26.0–28.0 mg/kg. Calcium fortification (typically at the level of 1.1–1.4 mg/kg) is optional and is usually not done (*12*).

An important distinction is made between "baking" and "counter" flour. Counter flour has a different protein level from baking flour, is used more for home (as opposed to commercial) baking, and is the main type consumed by those with lower socioeconomic status.

In the specific case of Jamaica, wheat for baking flour is imported into Jamaica and ground at the Jamaica Flour Mills. This baking flour accounts for about 40% of all the wheat flour consumed in the country; the type of iron used to fortify it is usually reduced iron of large particle size. Up to 1984, counter flour, which makes up about 60% of the total flour consumed in Jamaica, was imported directly; this flour was sometimes fortified with iron and B vitamins but usually not.

Since July 1984 all baking flour and counter flour have been milled in Jamaica by the Jamaica Flour Mills. Both types of flour are fortified at the following levels: thiamine, 6.3 mg/kg; riboflavin, 3.9 mg/kg; niacin, 52.8 mg/kg; and iron, 44.0 mg/kg (*3*). Iron, which is added in the reduced form (large particle size), increases the flour's natural iron content by 70%. Use of electrolytically reduced iron was being considered (*13*).

At the present time, wheat flour is being fortified with iron at the level of 44.0 mg/kg in Grenada, Jamaica, and Saint Vincent and the Grenadines. Discussions are also taking place in the other Caribbean countries where flour mills are located with regard to increasing the amount of iron added to 44 mg/kg.

CONCLUDING REMARKS

Since iron deficiency anemia is a major public health problem, programs for changing the iron status of West Indians should receive attention. One step that would have wide usefulness would be to change the type and level of iron added to wheat flour. In Grenada, Jamaica, and Saint Vincent and the Grenadines the level of iron has been increased from 26 to 44 mg/kg. Careful consideration should be given to changing the level of iron at other flour mills in the Caribbean. Given the high level of iron deficiency in the Caribbean countries and the fact that wheat flour is the staple food of the population, this matter merits high priority.

The Caribbean Food and Nutrition Institute (CFNI) has been working with its member governments for about a decade to develop a program for the control of anemia. Background information on anemia's prevalence and etiology was collected, and a workshop attended by delegates from all of CFNI's 17 member countries was held to devise "A Strategy for the Control of Anemia in the English-speaking Caribbean." Since then, this regional strategy has been used to develop national programs for the control of anemia in several countries, mainly through assessment of data collected by health personnel and promotion of workshops on a broad range of subjects including clinic management, development of a national strategy for anemia control, training of personnel on the latest aspects of anemia control, introduction of appropriate methods for frequent determination of hemoglobin levels in the field, and development of surveillance systems. While such activities by themselves cannot be expected to provide a complete answer to the anemia problem, it is worth noting that the prevalence of anemia in Jamaica has declined since the fortification of wheat flour with iron was improved. Because not only this step but a wide variety of public health measures appear capable of producing additional positive results, CFNI should continue working with its member countries to further decrease the prevalence of anemia.

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