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Food-based approaches for combating iron deficiency

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Introduction

Iron deficiency is a serious and widespread public health problem. The scale and magnitude of the problem combined with the functional impact such deficiencies have on the quality of life, both physiologically and socioeconomically, require the urgent adoption of known and effective measures. However, the focus of development practitioners on their own narrow area of interest or expertise, be it health care or food, has prevented the realization of a truly comprehensive approach being taken to tackle this critical problem. This chapter is an effort to correct this imbalance and to place food-based approaches back into the center of the debate and to encourage their adoption on a broader scale as a matter of priority.

Micronutrient deficiencies exist in both developing as well as developed countries and may be considered as "hidden hunger." In developing countries they exist in the context of food insecurity, where meeting overall energy needs and dietary diversity continues to be the major challenge. Consequently, efforts to reduce micronutrient malnutrition need to be placed in the context that an estimated 854 million people are hungry (1), 20 million children under the age of 5 suffer from severe malnutrition, and around 1 million children die due to malnutrition each year.

The underlying causes of such high levels of malnutrition, including the high levels of micronutrient deficiencies, are poverty and insufficient agricultural development, which lead to food insecurity at national and household levels. To address these causes, FAO is placing emphasis on actions that promote an increase in the supply, access, and consumption of an adequate quantity, quality, and variety of foods for all population groups. By promoting and supporting sustainable food-based programs and strategies to improve nutrition, FAO is seeking to resolve the micronutrient deficiency problems of developing countries through increasing the consumption of an adequate and varied diet in combination with the use of supplements and fortification strategies rather than through the use of supplements or fortification strategies alone. This is in keeping with the right to food, a concept whose achievement means that all people should be able to gain access to a varied diet consisting of a variety of foods that provide all the energy and macro- and micronutrients sufficient to achieve a healthy and productive life.

Definitions and terminology

Iron has several vital functions in the body. It serves as a carrier of oxygen to the tissues from the lungs by red blood cell hemoglobin, as a carrier of electrons within cells, and as an integrated part of important enzyme systems in various tissues. Iron is reversibly stored within the liver as ferritin and hemosiderin and is transported between different compartments in the body by the protein transferrin. Hemoglobin (Hb), mean cell volume (MCV), transferrin saturation (TSAT), serum ferritin (SF), transferrin receptor (TfR), total iron binding capacity (TIBC), and erythrocyte protoporphyrin (EP) are measurements commonly used when investigating iron status. However, the sensitivity and specificity of these indicators is unclear and a combination of these indicators is sometimes used.

Iron deficiency may be defined as an absence of iron stores combined with signs of iron-deficient erythropoiesis (the making of red blood cells) implying there is an insufficient supply of iron to various tissues. This occurs at a serum ferritin level <15 μg/L. Under these conditions, an insufficient amount of iron is delivered to transferrin, the circulating transport protein for iron, resulting in a reduction in transferrin saturation. Formation of hemoglobin is reduced resulting in a reduction in mean corpuscular hemoglobin. The concentration of transferrin in plasma increases in an effort to compensate. Iron deficiency may be classified according to serum ferritin concentration with depleted iron stores (SF<24 ng/mL), mild iron deficiency (SF=18–24 ng/mL) and severe iron deficiency (SF<12 ng/mL).

Nutritional anemia is a condition in which the hemoglobin content of blood is lower than normal as a result of a deficiency of one or more essential nutrients. Because anemia is the most common indicator used to screen for iron deficiency, the terms anemia, iron deficiency, and iron deficiency anemia are sometimes incorrectly used interchangeably. However, there are cases where a person may not be anemic but is mildly or moderately iron deficient and consequently may be functionally impaired.

Iron deficiency anemia (IDA) is the most common nutritional cause of anemia and occurs when there is an inadequate amount of red blood cells caused by lack of iron. The prevalence of iron deficiency anemia is therefore less frequent than iron deficiency. Iron deficiency anemia is a rather imprecise concept and has no immediate physiologic meaning. Cut-offs may vary but WHO defines children under 5 years of age and pregnant women living at sea level as anemic if their hemoglobin concentration is <11 g/dL, non-pregnant women as anemic if Hb <12 g/dL, and men as anemic if Hb <13 g/dL. Mild-moderate anemia is Hb 7–10.9 g/dL, and severe anemia is Hb <7 g/dL. The main benefit of using cut-offs is to allow comparisons to be made between population groups. IDA is not normally symptomatic until hemoglobin level is about 8 g/dL or lower.

Recommended Nutrient Intakes (RNI) is the daily intake which meets the nutrient requirements of almost all (97.5 %) apparently healthy individuals in an age and sex-specific population group based on an estimated average nutrient requirement (EAR) plus two standard deviations. A requirement is an intake level which meets specified criteria of adequacy while preventing risk of deficit or excess.

Vitamins and minerals are referred to as **micronutrients** because the body needs them in very small quantities for growth, development, and maintenance.

A **food-based strategy** has the goal of improving nutrition through increasing the availability and consumption of a nutritionally adequate micronutrient rich diet made up of a variety of available foods.

Food-based dietary guidelines (FBDGs) recognize that people eat food, not nutrients, and focus on giving simple practical advice on the appropriate combination of foods that can meet nutrient requirements rather than on how each specific nutrient is provided in adequate amounts.

Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Requirements

Iron is required to replace basal losses, losses due to menstruation, and for growth. Losses from the skin and the interior surfaces of the body are estimated at 14 μg/kg body weight/day with a non-menstruating 55-kg woman losing about 0.8 mg iron and a 70-kg man about 1 mg iron/day. Menstrual losses range from 0.48–1.90 mg/day. Requirements to allow for growth up to 18 years years of age range from 0.23–0.60 mg/day depending on age and sex. By adding up these estimates we may calculate that total absolute iron requirements at the 50th percentile ranges from 0.46–1.68 mg/day and iron requirements at the 95th percentile ranges from 0.63–3.27 mg/day.

Requirements for iron vary depending on age, physiological status, growth rate, degree of physical maturity, body composition, and activity level. Increased requirements are also noted in patients with malaria, congenital hemoglobinopathies, and other causes of hemolysis. Iron requirements in relation to energy intake are highest during the last trimester of pregnancy, during the weaning period, and in adolescents. As explained below, it is only possible to meet these high requirements if the diet has a consistently high content of meat and foods rich in ascorbic acid.

Iron is present in foods in two forms, as heme iron, which is derived from flesh foods (meats, poultry, and fish), and as non-heme iron, which is the inorganic form present in plant foods such as cereals, pulses, legumes, grains, nuts, and vegetables. Heme iron is well absorbed with an average absorption of heme iron from meat-containing meals of around 25 %, ranging from about 40 % during iron deficiency to about 10 % when iron stores are replete. Non-heme iron has a lower rate of absorption (2–10 %), depending on the balance between iron absorption inhibitors and iron absorption enhancers present in the diet. Consequently, the amount of iron absorbed not only depends on the iron content of the meal but, and to a marked degree, on the composition of the meal (i.e., the balance among all factors enhancing and inhibiting the absorption of iron).

Reducing substances (i.e., substances that keep iron in the ferrous form) need to be present for iron to be absorbed. These enhancing factors include ascorbic and citric acids found in certain fruit juices, fruits, potatoes, and certain vegetables; cysteine-containing peptides found in meat, chicken, fish, and other seafood; and ethanol and fermentation products like vegetables, soy sauce, etc., which enhance the absorption of both heme and non-heme iron. Other foods contain factors (ligands) that strongly bind ferrous ions and inhibit absorption. These inhibiting factors (phytates, polyphenols, calcium, and phosphate) are found in bran products, bread made from high extraction flour, breakfast cereals, oats, rice (especially unpolished rice), pasta products, cocoa, nuts, soya beans, and peas; iron-binding phenolic compounds (e.g., tea, coffee, cocoa, certain spices, certain vegetables, and most red wines); calcium (e.g., milk, cheese); and soy proteins. In infant foods containing soy proteins, the inhibiting effect can be overcome by the addition of sufficient amounts of ascorbic acid. Consumption of betel leaves, common in areas of Asia, also has a marked negative effect on iron absorption. However, again the addition of certain vegetables or fruits containing ascorbic acid can double or triple iron absorption thereby counteracting many of the effects of these inhibitors depending on the other properties of the meal. As the effect is so marked, this may be considered as one of vitamin C's physiological roles. Each meal should preferably contain at least 25 mg of ascorbic acid and possibly more if the meal contains many inhibitors of iron absorption.

Bioavailability of meals with a similar content of iron, energy, protein, fat, etc. can vary more than tenfold. Just the addition of certain spices (e.g., oregano) or a cup of tea may reduce the bioavailability by one-half or more. Therefore to translate physiological iron requirements into recommendations for dietary iron intakes, the bioavailability of iron (i.e., its absorption for utilization by the body) in different diets therefore need to be calculated. A study on the bioavailability of different Indian diets found 1.7–1.8 % of iron was absorbed from millet-based diets, 3.5–4.0 % in wheat-based diets, and 8.3–10.3 % from rice-based diets. Other studies from South East Asia show absorption rates can rise significantly from less than 5 % to more than 15 % if animal products and vitamin C are amply provided. Recommended Nutrient Intakes (RNI's) for iron at four levels of dietary iron bioavailability (5, 10, 12 and 15%) and are given in Table 21.1. In nonpathological states the Recommended

Table 21.1: Recommended nutrient intakes for iron (i) from meals with bioavailability 5-15%.

Age	15 % bioavailability *mg/day*	12 % bioavailability *mg/day*	10 % bioavailability *mg/day*	5 % bioavailability *mg/day*
0–6 months	(k)	(k)	(k)	(k)
7–1 months	[6] (l)	[8] (l)	[9] (l)	[19] (l)
1–3 years	4	5	6	12
4–6 years	4	5	6	13
7–9 years	6	7	9	18
Males 10–18 years	10 (10-14 yrs)	12 (10-14 yrs)	15 (10-14 yrs)	29 (10-14 yrs)
	12 (15-18 yrs)	16 (15-18 yrs)	19 (15-18 yrs)	38 (15-18 yrs)
Females 10–18 years	9 (10-14 yrs) (m)	12 (10-14 yrs) (m)	14 (10-14 yrs) (m)	28 (10-14 yrs) (m)
	22 (10-14 yrs)	28 (10-14 yrs)	33 (10-14 yrs)	65 (10-14 yrs)
	21 (15-18 yrs)	26 (15-18 yrs)	31 (15-18 yrs)	62 (15-18 yrs)
Males 19+ years	9	11	14	27
Females:				
19–50 years pre-menopausal	20	24	29	59
51+ years menopausal	8	9	11	23
Pregnancy:				
First trimester	(n)	(n)	(n)	(n)
Second trimester	(n)	(n)	(n)	(n)
Third trimester	(n)	(n)	(n)	(n)
Lactation:				
0–3 months	10	12	15	30
4–6 months	10	12	15	30
7–12months	10	12	15	30

Source: Human vitamin and mineral requirements. Report of a FAO/WHO expert consultation FAO/WHO 2002

(i) Iron absorption can be significantly enhanced when each meal contains a minimum of 25 mg of vitamin C, assuming three meals per day. This is especially true if there are iron absorption inhibitors in the diet such as phytate or tannins.

(k) Neonatal iron stores are sufficient to meet the iron requirement for the first six months in full term infants. Premature infants and low birth weight infants require additional iron.

(l) Bioavailability of dietary iron during this period varies greatly.

(m) Non-menstruating adolescents.

(n) It is recommended that iron supplements be given to all pregnant women because of the difficulties in correctly evaluating iron status in pregnancy. In the non-anaemic pregnant woman, daily supplements of 100 mg of iron (e.g., ferrous sulphate) given during the second half of pregnancy are adequate. In anaemic women higher doses are usually required.

Nutrient Intake (RNI) for men ranges from 9 mg in diets with high bioavailability to 27 mg in diets where bioavailability is only 5 %. For menopausal women the range is similar, although levels are slightly lower (20 mg) due to variation in body size. In premenopausal women aged between 19 and 50 the recommended intake is 59 mg (2).

In summary, the amount of dietary iron absorbed is mainly determined by the amount of body stores of iron (absorption rates increase when body stores are depleted and decrease as iron stores are replenished), and by the properties of the meal as determined by the amount of heme and non-heme iron in the meal, food preparation practices in terms of cooking time and temperature, and the presence of enhancing dietary factors such as meat peptides and vitamin C, and inhibiting dietary factors such as phytates and calcium (e.g., milk, cheese), all of which affect bioavailability.

Prevalence of iron deficiency anemia

Iron deficiency and iron deficiency anemia are worldwide public health problems. Over 2 billion people – over 30 % of the world's population – are anemic, many due to iron deficiency, which is frequently exacerbated by infectious diseases particularly in resource-poor areas of low income countries. Malaria, hookworm, schistosomiasis, HIV/AIDS, and other infections such as tuberculosis are particularly important factors contributing to the high prevalence of anemia in some areas. Low levels of plasma iron, folate, zinc, and vitamins B_{12} and A have also been shown to be associated with anemia.

The latest preliminary estimate figures from WHO on the prevalence of iron deficiency anemia by age group and region show the highest prevalence is found in infants, children, adolescents, and women of childbearing age, especially pregnant women (preschool aged children: 47.6 %; non-pregnant women: 30.3 %; pregnant women: 41.6 %). Among children the determinants of iron deficiency anemia are age (the younger the child, the higher the risk with the weaning period in infants being especially critical because of the very high iron requirements in relation to energy requirements), sex (males are at higher risk), weight and height (stunted and underweight children are at greater risk), and plasma retinol levels (higher levels lower the risk of IDA). Among pregnant women the determinants are age, gravida, and stage of gestation with women below 20 years of age, those who have been pregnant before, and those in their second and third trimester being more prone to deficiency. Among lactating women the determinants are period of lactation and vitamin A status.

Africa has the highest prevalence rates of anemia in preschool children (65.4 %), nonpregnant women (44. 7%), and pregnant women (55 %). Asia has the highest number of cases of anemia with about half of the world's anemic women living in the Indian Subcontinent, the majority of whom develop anemia during pregnancies. In India, the National Family Health Survey (1998–1999) (3) showed anemia prevalence of 82 % in expectant mothers, 74 % in children under 3 years of age, 52 % in married woman 15–49 years of age, and more than 50 % in adolescents. The Indian Counsel of Medical Research (ICMR) (4) reported that 62 % of expectant mothers suffered from anemia, of whom 9 % had severe anemia defined as Hb <8 g/dL.

In many developing countries, anemia rates in children are high (above 50 %) and the severity of anemia is marked. In many cases this is due to low availability of dietary iron rather than low intakes, as 90 % of the total dietary supply in many of these countries comes from plants, which contain non-heme iron that is poorly absorbed. Prevalence among vegetarians and in those reliant on cereal or tuber foods is significantly higher than in omnivore populations. Further disaggregation shows agroecological and country and urban/rural differences, the variation in iron status in different populations being mainly related to variations in the diet.

Effects of iron deficiency and of iron deficiency anemia

Iron deficiency and iron deficiency anemias have a significant impact on human welfare both at the level of the individual and for the economic development of a country. At the individual level, iron deficiency has several negative effects on important functions of the body. Deficiency can slow growth, hinder physical and mental development, and reduce the ability of the body to maintain itself. It is associated with impaired immune response, lowered resistance to infection and increased morbidity and mortality rates, adverse pregnancy outcome, and reduced school performance. Growth faltering is associated with IDA, and the Body Mass Index (BMI) is positively correlated with hemoglobin concentration.

Iron nutrition is of great importance for the adequate development of the brain and iron deficiency has serious consequences for cognitive, psychomotor, physical and mental development of children. There is a relationship even with mild iron deficiency and brain development and there are functional defects affecting learning and behavior that cannot be reversed by giving iron later on. Infants with iron deficiency anemia (IDA) may have reduced interaction with the physical and social world and become “functionally isolated,” which impedes their cognitive development. Studies have found indicators of iron status associated with a number of cognitive abilities in young school children, and with information processing and level of cognitive development in adult women. Several structures in the brain have high iron content, with iron continuing to accumulate throughout the 20–30 year period of brain growth. There appears to be a relationship between iron deficiency and brain function and between iron deficiency and attention, memory, and learning in infants and small children (5). Administration of iron to nonanemic but iron deficient adolescent girls improved verbal learning and memory (6). These cognitive effects are a strong argument for the more active and effective combating of iron deficiency, especially in women up through the period of adolescence and into early adulthood prior to and during pregnancy, and for infants and children.

Iron deficiency negatively influences the body’s normal immunological defense mechanisms against infection. The cell-mediated immunologic response of T lymphocytes is im-paired as a result of a reduction in the formation of these cells. This in turn is due to reduced DNA synthesis that is dependent on the function of the radionuclide reductase, which requires iron for its function. Iron deficiency also impairs the phagocytosis and killing of bacteria by neutrophil leukocytes, with probable involvement of the iron sulfur enzyme NADPH oxidase and cytochrome b, a heme enzyme. Administration of iron reverses these changes within 4–7 days. Anemia increases the dangers of lead poisoning, particularly among young children.

Iron deficiency anemia during pregnancy increases maternal hemorrhages and maternal morbidity and mortality rates. Women with a low hematocrit of <37 % had twice the risk of a premature birth as women with a hematocrit between 41 % and 44 % (7, 8).

Iron deficiency reduces the physical capacity to do work, which seems to be less related to the degree of anemia than to the impaired oxidative metabolism in the muscles due to the lack of iron-containing rate-limiting enzymes for oxidative metabolism. This reduced ability to do work can be reversed with iron administration. Studies of adolescent girls show that iron deficiency without anemia is associated with reduced physical endurance and changes in mood and ability to concentrate. A study showed a re-duction in maximum oxygen consumption in iron deficient nonanemic woman unrelated to the decreased oxygen transport capacity of the blood (9).

Since the highest prevalence is found in infants, children, adolescents, and women of childbearing age, the burden falls not just on the individual but on society as a whole. The debilitating consequences include loss of human capital and reduced work capacity and therefore of productivity in adults. In economic terms, the World Bank and the US Agency for International Development (USAID) estimated iron deficiency cost the country of India about 5 % of its GNP annually (10) in the mid-1990s.

Determining factors

Worldwide the most common cause of iron deficiency is nutritional iron deficiency. Does this imply that the normal diet cannot cover physiological iron requirements? For many years nutritionists have assumed that all nutrients can be obtained from a diet containing a variety of foods drawn from a variety of sources. It has been thought that if people had access to a sufficient quantity and variety of foods, then they would meet their nutritional needs. This still may be true, but despite increases in the availability of a wide variety of foods in almost every country in the world, the continued existence of micronutrient deficiencies, including iron deficiency anemia, throws this general assumption into question. Why have improved food supplies not necessarily resulted in adequate vitamin and mineral intakes?

Factors that determine iron deficiency anemia include overall low incomes and poverty that result in low overall food intakes and poor monotonous diets low in micronutrient content. These may be compounded by a lack of understanding of the value of a varied diet and the importance of foods rich in micronutrients as well as the role of dietary inhibitors and enhancers that interfere with the absorption of iron. Illness and infections such as malaria, tuberculosis, and HIV/AIDS are also contributing factors.

Poor dietary intake both in terms of total quantity of food and of micronutrient rich food are often the major cause of micronutrient malnutrition. Virtually all traditional dietary patterns can satisfy the nutritional needs of population groups so long as the capacity to produce and purchase food is not limited for example by socioeconomic conditions or cultural practices that restrict the choice of foods. The erosion of these practices due to changing lifestyles and modernization can lead to unhealthy food choices, and the protection and promotion of those diets that can provide the nutrients we require need our continued support.

The most affected population groups in need of improved nutrition generally include vulnerable resource-poor subsistence farmers and landless laborers whose main food supplies come directly from the land and who often have restricted access to fortified foods due to low purchasing power and undeveloped distribution channels. Those who are physiologically vulnerable include those groups with special dietary problems or nutritional needs, including women of childbearing age, pregnant and lactating women, young children and famine-affected populations, who may lack access to a diet that is sufficient in quantity or quality to provide adequate levels of iron. Special attention is needed to meet the food and nutrition needs of both these vulnerable groups.

Iron requirements also tend to be difficult to meet, and replenishment remains challenging for those severely deficient. Low bioavailability of iron in cereal- and tuber-based diets is one of the main causes of iron deficiency anemia in low income countries, as they contain high amounts of polyphenols (tannins) and phytates that inhibit iron absorption. A number of practical actions and interventions that can reduce these effects are presented below.

A number of potential dietary sources need to be urgently promoted including many leafy vegetables and legumes that contain important quantities of iron, with special emphasis on increasing the consumption of animal products that are high in bioavailable iron and in iron absorption enhancers. In Kenya, a study showed that meat intake in children under 3 years of age was positively related to hemoglobin, suggesting low meat intakes are an important cause of anemia in this age group (11).

The addition of small quantities of particular foods to a cereal- or tuber-based diet increases the nutrient density considerably. The addition of legumes can slightly improve the iron content of cereal- and tuber-based diets. However, the bioavailability of this non-heme iron source is low. Therefore, it is not possible to meet the recommended levels of iron from staple-based diets unless some meat, poultry, or fish is included. Adding 50 g of meat, poultry, or fish increases total iron content as well as the amount of bioavailable iron. Variations in bioavailability of iron (mg/1000 kcal) with meal composition for each of the four basic staple diets of white rice, corn tortilla, refined couscous, and potato have been calculated and are presented in Table 21.2.

Under ideal conditions of food access and availability, food diversity should satisfy micronutrient and energy needs of the general population. Unfortunately, for many people in the world, access to a variety of micronutrient rich foods is not possible. As demonstrated in the analysis of typical staple-based diets, micronutrient rich foods including small amount of flesh foods and a variety of plant foods (vegetables and fruits) are needed daily. This may not be realistic at present for many communities living under conditions of poverty. Food fortification and food supplementation are important alternatives that complement food-based approaches to satisfy the nutritional needs of people in developing and developed countries.

Poor monotonous diets deficient in one micronutrient are also likely to be deficient in other micronutrients, as well as in other important foods such as fat and protein that further reduce absorption of what nutrients have been ingested, and of energy. Population groups consuming such diets are known to have multiple micronutrient deficiencies.

At the same time, increasing the consumption of a greater variety of plant foods, especially of fruits and vegetables, will provide most of the missing vitamins and minerals. In addition, a number of plant-based nutrients or phytochemicals will be consumed and there is emerging evidence on the health benefits from food phytochemicals. This double benefit of consuming a variety of foods could play a major role in offsetting what is called the double burden of malnutrition.

Intervention programs

Intervention programs to overcome and prevent micronutrient deficiencies are generally considered under four main strategies:

- Dietary enhancement and diversification
- Food fortification including biofortification
- Vitamin and mineral supplementation
- Global public health and disease control measures.

Table 21.2: Variation in iron (mg/1000 kcals) with meal composition (white rice, corn tortilla, refined couscous and potato).

	Rice 598g Veg oil 25g	Rice 590g Veg oil 25g Carrots 21g	Rice 570g Veg oil 25g Carrots 21g Oranges 60g	Rice 483g Veg oil 25g Carrots 21g Oranges 60g Lentils 95g	Rice 477g Veg oil 25g Carrots 21g Oranges 60g Beef 55g	Rice 468g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g	Rice 428g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Lentils 45g Spinach raw 50g
Iron (mg)	1.2	1.3	1.3	4.3	2.8	4.1	5,6
	Tortilla 368g Veg oil 20g	Tortilla 363g Veg oil 20g Carrots 21g	Tortilla 351g Veg oil 20g Carrots 21g Oranges 60g	Tortilla 314g Veg oil 20g Carrots 21g Oranges 60g Lentils 71g	Tortilla 297g Veg oil 20g Carrots 21g Oranges 60g Beef 55g	Tortilla 292g Veg oil 20g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g	Tortilla 266g Veg oil 20g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g Black beans 45g
Iron (mg)	5.2	5.2	5.1	6.9	6.0	7.3	7.9
	Couscous 697g Veg oil 25g	Couscous 690g Veg oil 25g Carrots 21g	Couscous 665g Veg oil 25g Carrots 21g Oranges 60g	Couscous 590g Veg oil 25g Carrots 21g Oranges 60g Lentils70g	Couscous 555g Veg oil 25g Carrots 21g Oranges 60g Beef 55g	Couscous 546g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g	Couscous 493g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g Black beans 45g
Iron (mg)	2.6	2.8	2.7	4.7	3.9	5.3	6.0
	Potato 907g Veg oil 25g	Potato 895g Veg oil 25g Carrots 21g	Potato 865g Veg oil 25g Carrots 21g Oranges 60g	Potato 770g Veg oil 25g Carrots 21g Oranges 60g Lentils 70g	Potato 723g Veg oil 25g Carrots 21g Oranges 60g Beef 55g	Potato 710g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Spinach raw 50g	Potato 649g Veg oil 25g Carrots 21g Oranges 60g Beef 55g Lentils 45g Spinach raw 50g
Iron (mg)	.8	2.9	2.9	4.9	4.1	5.4	6.7

Source: Human vitamin and mineral requirements. Report of a FAO/WHO expert consultation FAO/WHO 2002

A comprehensive intervention program combining elements from these strategies is consi-dered the most effective way to prevent deficiencies. To determine the most appropriate mix, a situation analysis should first be conducted on the magnitude, prevalence, and distribution of deficiencies, food consumption levels including the intake of micronutrients, and food habits and attitudes of vulnerable groups, including socioeconomic data to identify major constraints and opportunities.

The most successful approach to increasing consumption of micronutrient rich foods is likely to be a combined strategy that addresses both increased production (supply) and increased consumption (demand) of food. The special needs of particular groups such as children and women of childbearing age require particular attention. Food-based intervention programs, dietary enhancement and diversification, and food fortification including biofortification play a critical role in alleviating micronutrient malnutrition. Food-based strategies focus on improving the availability of, access to, and consumption of vitamin and mineral rich foods. Benefits of such food-based strategies include not only improved intakes of specific nutrients but also improved overall diets and health status.

Government policies and regulations can influence the availability and price of micronutrient rich foods. Vitamin and mineral deficiencies can be reduced with relatively small investments in agriculture, education, and public health. National agricultural planning strategies such as crop diversification to promote micronutrient rich crops, agroforestry, and the promotion of traditional and wild foods can have an impact on the availability of micronutrient foods. Regulations that prohibit urban gardening or which reduce the availability or sale of fresh foods by street vendors can reduce the availability of micronutrient foods. Examining the profitability of producing, processing, and marketing such foods and reviewing the impact of policies on micronutrient status are important steps in planning food-based strategies.

Policies, intervention programs and activities at the international, national, and community level are required to effectively alleviate micronutrient deficiencies. These efforts include:

1) increasing the overall quantity of foods consumed by those most vulnerable to deficiencies and at the same time
2) diversifying their diets with focus on micronutrient rich sources of food including animal products, vitamin C, fruit and vegetables; 3) better managing and controlling dietary inhibitors (e.g., phytates) and enhancers (e.g., vitamin C);
4) processing, preservation, and preparation practices that retain micronutrient availability including for example the use of iron cooking pots and improved drying techniques to reduce losses as well as the seasonal variation in availability;
5) nutrition education;
6) food quality and safety issues with implications for public health and disease control measures to reduce nutrient losses by the body and to maximize the potential of fruit and vegetables as high value commodities for income generation;
7) fortification including biofortification; and
8) supplementation.

Strategies to promote dietary diversification within the implementation of food-based approaches include:

1. Increasing overall food intakes

Micronutrient deficiencies are closely associated with poverty, food insecurity, and undernutrition and are common in those groups whose overall food intakes are not sufficient to meet nutritional requirements. Seldom is only one nutrient deficient. If a deficiency for one micronutrient exists it is likely that multiple deficiencies are also present. For those with inadequate food intakes, increasing overall food consumption provides several essential micronutrients thereby simultaneously addressing a combination of deficiency problems. In addition, physiological interactions between vitamins and minerals enhance the body's ability to absorb and utilize essential micronutrients. Consequently, intervention programs need to as a first priority to ensure that overall food supplies are adequate through increasing the production, availability, access to, and consumption of an adequate and nutritious diet, especially by those who are hungry and food insecure and most vulnerable to deficiencies.

By doing so, food-based strategies address the root causes of micronutrient malnutrition and assist communities and households to adequately feed and nourish themselves in both the short and long term. Stimulating the small scale agricultural sector can produce overall long-term economic benefits for those groups dependent upon agriculture for their livelihoods and for the economy as a whole, thereby encouraging sustainable development.

2. Increasing consumption of micronutrient rich foods

Most traditional diets and food habits provide a range of nutrients that are able to meet the nutritional requirements of most groups. However, those physiologically challenged such as the sick, young children, and pregnant and lactating women may require larger amounts of micronutrient rich foods to meet their increased needs. For those affected by relatively abrupt changes in lifestyle, for example due to civil disruption, migration, urbanization and modernization, traditional food practices may not be easy to maintain resulting in imbalanced and inadequate diets. Where iron deficiency is widely prevalent, the usual diet often does not provide enough bioavailable iron. Under such circumstances, promoting the increased consumption of micronutrient rich foods is key to good health and nutrition. The promotion of dietary improvement/diversification with a focus on improving the intake of bio-available iron through greater consumption of animal products, fruit and vegetables, especially those rich in vitamin C, is the only intervention that can lead to self-sustained success in improving iron status. Neither supplementation nor fortification can be effective on its own. Promoting consumption of micronutrient rich foods fosters better overall health for all members of society, provides sustainable improvements by encouraging market solutions and long-term behavioral changes among high risk groups and is often linked to income earning activities.

Efforts to address both increased production (supply) and increased consumption (demand) of food need to be undertaken simultaneously. At the district and national levels, implementation of large scale commercial livestock and vegetable and fruit production can provide micronutrient foods at reasonable prices. The objective is to provide micronutrient rich foods at reasonable prices through effective and competitive markets and distribution channels which can lower consumer prices without reducing producer prices. This will serve predominantly the urban and non-food-producing rural areas. Commercial oil seed production and red palm oil for example can increase the availability of low cost dietary fat crucial for the absorption of fat soluble vitamins (A, D, E and K) and of other micronutrients, including iron.

At the community level, small-scale community or home fruit and vegetable gardens can play a significant role in increasing production of micronutrient rich foods. Production of fish, poultry and small animals such as guinea pigs, rabbits, and goats are excellent sources of highly bioavailable essential micronutrients such as vitamin A, iron, and zinc. The production of animal foods at the local level may permit communities to access foods which otherwise are not available because of their high costs. These types of projects also need some support from local governments or non-governmental organizations to overcome the cost constraints of program implementation, including the training of producers. Horticultural programs and agricultural extension workers can encourage the production of animals, milk and dairy products, legumes, green leafy vegetables, and fruits. These projects should lead to increased production and consumption of micronutrient rich foods at the household level.

A micronutrient and health program in Malawi targeted to women used revolving funds to increase household access to animal food sources through a small animal (poultry, rabbits, guinea fowl, and goats) husbandry program. Over 10,000 households participated in the World Vision program which included an education component on the nutritional benefits of animal food consumption. Over a 4-year period, anemia rates in pregnant women fell from 59 % to 42 % and in children under 5 years of age from 84 % to 66 % (12). It is clear that if production gains are to be reflected in increased intakes, community participation, the involvement of women, and consumer education are essential elements. In Indonesia among adolescent girls given iron rich foods 6 times a week for 6 months, Helen Keller International found anemia was significantly reduced and concluded that foods naturally rich in iron increase hemoglobin concentration among anemic Indonesian adolescents (13).

Improving the micronutrient content of soils and in plants and improved agricultural practices can improve the composition of plant foods and enhance yields. Current agricultural practices can improve the micronutrient content of foods through correcting soil quality and pH and increasing soil mineral content depleted by erosion and poor soil conservation. Long-term food-based solutions to micronutrient deficiencies will require improvement of agricultural practices, seed quality, and plant breeding (by means of a classical selection process or genetic modification). Plant breeding through conventional methods or with genetic modification (biofortification) can increase the micronutrient content of staple and other crops and may play a significant role in combating iron deficiency anemia.

The success of such projects requires a good knowledge and understanding of local conditions as well as the involvement of women and the community in general. These are key elements for supporting, achieving, and sustaining beneficial nutritional change at the household level. Educational efforts need to be directed towards securing appropriate distribution within the family, considering the needs of the most vulnerable members, especially infants and young children. Separate food-based dietary guidelines (FBDG) for vulnerable groups, such as pregnant and lactating women, children, and the elderly, should be developed.

Foods that are rich sources of iron include:

- oysters
- liver
- lean red meat (especially beef)
- poultry, dark red meat
- lamb, pork, shellfish
- tuna, salmon
- iron fortified cereals
- eggs (especially egg yolks)
- whole grains: wheat, millet, oats, brown rice
- legumes: lima beans, soybeans, dried beansand peas, kidney beans
- seeds: almonds, Brazil nuts
- dried fruits: prunes, raisins, apricots
- vegetables: broccoli, spinach, kale, collards, asparagus, dandelion greens

Efficacy issues

It is argued that in order to generate greater interest as well as resources for implementing food-based approaches, the contributions that such interventions can make compared with other interventions such as supplementation and fortification need to be better quantified and more information generated to demonstrate their efficacy. However, evaluations of the efficacy of food-based aproaches are lacking in the literature partly because of the complexity of the interventions, the wide variety of food components contained in food, the large number of inputs, outcomes and confounding factors, the range of intermediary components and short and long term impacts that present difficulties for study design. While evaluation of the nutritional impact and cost benefit of food-based approaches in combating micronutrient deficiencies is a research priority, there are compelling reasons for supporting the wider implementation of a food-based approach.

3. Management and control of inhibitors and enhancers

Improved food preparation and cooking methods and the modification of consumption practices to increase dietary enhancers and eliminate inhibitors of absorption can safeguard the amounts of micronutrients that are available and maximize their uptake by the body. Practical interventions to reduce dietary inhibitors and increase iron absorption facilitators include:

- ensuring dietary intakes of oils and fats, vitamin A, and of ascorbic acid are adequate for enhancing absorption of micronutrients
- fermentation and germination for the enzymatic hydrolysis of phytates in cereals and legumes
- promoting nonenzymatic methods of reducing phytic acid content
- encouraging home processing techniques like malting
- avoiding drinking tea or coffee within 2 hours of eating meals
- reducing the use of tamarind as a souring agent and instead using tomato or lime juice in order to facilitate non-heme iron absorption
- adopting food to food fortification practices whereby dietary inhibitors (e.g., phytates) and enhancers (e.g., vitamin C) are better managed and controlled.

The bioavailability of non-heme iron rises to a level similar to that of meat products when consumed with a significant source (25 mg) of vitamin C in the same meal. In Nigeria the incorporation of baobab fruit pulp drink in the diet of children 6–8 years old for a 3-month period significantly increased hemoglobin from 10.85 to 12.92 g/dL and decreased the number of individuals with SF<12 mcg/L from 65% to 23 %. The study concluded that the high vitamin C content of the baobab which provided 60 mg of ascorbate per day promoted the absorption of iron (14).

Reducing phytates and tannins by oxidation with polyphenol oxidases, enzymes found in many fruits and vegetables, increases the bioavailability of iron. Incubation of cereals with fruit extracts such as banana can be done at the household level to increase the bioavailability of iron and may be encouraged as part of a food-based strategy to prevent iron deficiency anemia. Fermentation for a couple of days (sourdough fermentation) almost completely degrades the phytate of wheat bran and increases the bioavailability of iron in bread made from whole-wheat flour. Calcium inhibits iron absorption and so the practical solution for overcoming the negative effects of calcium on iron absorption is to increase iron intake, increase its bioavailability, and avoid the intake of foods rich in calcium and foods rich in iron at the same meal.

4. Processing, preservation and preparation to maintain micronutrient availability

Fruit and vegetables are perishable products and the reduction of postharvest losses and prevention of wastage through improved processing and handling and by adopting simple methods of storage practices may considerably increase availability throughout the year. By improving methods of processing and preservation of surplus foods produced during the peak season, further losses may be reduced leading to greater year-round availability of these foods, improving nutritive value, acceptability and shelf life, and thereby improving consumption. Local food preservation and processing facilities should therefore be strongly promoted. At the household level, the promotion of effective cooking methods and practical ways of preserving foods (solar drying of seasonal micronutrient rich foods such as papaya, grapes, mangoes, peaches, tomatoes, and apricots) may significantly increase the access to bioavailable micronutrient rich foods. At the commercial level, grading, packing, transport, and marketing practices can reduce losses, stimulate economic growth, and generate income.

Food preparation and dietary practices need also to be improved in efforts to combat iron deficiency. For example, it is important that vegetables rich in vitamin C, folate, and other water-so-luble or heat-labile vitamins be minimally cooked in small amounts of water. For iron bioavailability, it is essential to reduce the intake of inhibitors of iron absorption and to increase the intake of enhancers of absorption in a given meal. It is re-commended to increase the intake of germinated seeds, fermented cereals, heat-processed cereals, meats, and fruits and vegetables rich in vitamin C, and to encourage the consumption of tea, coffee, chocolate, or herbal teas at times other than with meals. This advice for meal preparation is particularly important for people who consume a high proportion of cereal and tubers and who are also most at risk for micronutrient deficiencies.

Cast iron pots and cookware can also be a source of significant quantities of dietary iron. Encouraging the use of cooking in iron pots has been shown to improve iron status. In Ethiopia, Malawi, and Brazil the use of cast iron cooking pots has been observed to increase the amount of iron in the diet and thereby reduce iron deficiency anemia (15).

5. Consumer education for behavioral change

Communication techniques can be used to help bring about changes in eating practices at the household level. As incomes rise, people often reduce breastfeeding, stop gathering wild foods, and eat fewer green leafy vegetables. Such nutritionally beneficial traditional practices are under threat of erosion from factors related to urbanization and modernization and need to be protected and supported by education campaigns and communication strategies that aim to preserve such positive traditional practices. This is especially the case for those foods which may be available but are not consumed in sufficient quantities to prevent deficiencies or perhaps not at all by some vulnerable groups. Mothers and others who directly influence food production, food purchasing, food preparation and child feeding behavior may be specifically targeted by such programs.

Intervention programs should always be accompanied by a public nutrition education and promotion program to encourage improved food consumption. Advice for a healthy diet should provide both a quantitative and qualitative description of the diet for it to be understood by individuals, and information on both size and number of servings per day should be provided. Quantitative aspects include the estimation of the amount of nutrients in foods and their bioavailability in the form they are actually consumed. Qualitative aspects relate to the biological utilization of nutrients in the food as consumed and the potential for modifying the balance between food enhancers and inhibitors.

A healthy diet can be attained in more than one way because of the wide variety of foods which can be combined. The development of food-based dietary guidelines (FBDGs) by FAO and WHO (16, 17) recognizes this and, noting that there are economic constraints which limit food supply at the household level, focuses on the combination of foods that can meet nutrient requirements rather than on how each specific nutrient is provided in adequate amounts. FBDGs are based on the fact that people eat food, not nutrients. The approach is first to define the significant diet-related public health problems in a community and to evaluate the adequacy of the diet by comparing the information available on dietary intake with Recommended Nutrient Intakes (RNIs). Food-based dietary guidelines can then be prepared that indicate what aspects of the diet could be modified to improve nutrition. Such FBDGs would need to take into account dietary patterns, the ecological, socioeconomic and cultural factors, and the biological and physical environment in which the targeted population live.

Nutritional status can be improved significantly by educating households on food preparation practices which minimize the consumption of inhibitors of iron absorption, for example, the fermentation of phytate-containing grains before the baking of breads to enhance iron absorption. The consumption of ascorbic acid preferably through foods rich in vitamin C along with foods rich in iron enhances absorption. The tannins contained in tea and coffee when taken with meals strongly inhibit iron absorption and education programs need to highlight this.

At the household level appropriate food distribution within the family must be considered to ensure that children and women receive adequate food with high micronutrient density. Household food distribution must be considered when establishing general dietary guidelines and addressing the needs of vulnerable groups in the community. In addition, education detailing the appropriate storage and processing of foods to prevent micronutrient losses at the household level is important.

6. Quality assurance – food quality and safety issues

Improving the quality and safety of food has obvious benefits for health and for business. The importance of improving public health as an intervention strategy to reduce nutrient losses by the body is clear and safe, good quality food makes an important contribution to that. Information campaigns may raise awareness of the health problems that can arise from improper food storage and handling practices. On the business side, fruit and vegetables are valuable commodities with high potential for income generation. Processed and marketed foods need to be quality assured to compete in the market place and this aspect often needs further support in the area of laws and regulations and on food quality control to ensure required standards are enforced.

7. Food fortification

Food fortification is the addition of nutrients at levels higher than those found in the original food. Increasing the micronutrient content of staple and other crops through biofortification has been referred to above. Biofortification enhances the nutritive value of foods using modern tools of biotechnology. Food fortification has a role in meeting iron, folate, iodine, and zinc needs and is recommended when dietary iron is insufficient or the dietary iron is of poor bioavailability, which is the reality for most people in the developing world and for vulnerable population groups in the developed world.

Because staple foods around the world provide predominantly non-heme iron sources of low bioavailability, the traditionally eaten staple foods represent an excellent vehicle for iron fortification. Examples of foods which have been fortified are wheat flour, corn (maize) flour, rice, salt, sugar, cookies, curry powder, fish sauce, and soy sauce. However, even with foods fortified with iron, the consumption of iron absorption enhancers should always be promoted to get the best out of the food consumed.

Fortified foods as part of food aid protect the nutritional status of vulnerable groups and victims of emergencies but under normal circumstances, fortified foods may not be widely available to the poorest and more isolated populations. Community-based approaches to fortification, for example using rural hammer mills, may be a useful way of reaching these rural populations. In Malawi, maize is being fortified with iron as well as with B vitamins, folate, zinc, and vitamin A. However, dietary diversification programs are of critical importance and should always be promoted.

Fortification of food with iron and other micronutrients is considered a valid technology and strategy for adoption as part of a food-based approach when and where existing food supplies and limited access fail to provide adequate levels of the respective nutrients in the diet, and where the fortified food is highly likely to be accessible to the target population. In such cases, fortification of food is seen as a valuable adjunct program to ongoing nutrition improvement programs. In FAO's view, fortification is not an alternative to the overall goal of improving nutrition through the consumption of a nutritionally adequate diet made up from a variety of available foods.

8. Supplementation

Supplementation refers to periodic administration of pharmacological preparations of nutrients as capsules, tablets, or by injection. Supplementation is necessary as a short-term emergency measure to reverse clinical signs or for prevention in groups at risk. Nutritional supplementation should be restricted to vulnerable groups which cannot meet their nutrient needs through food (women of childbearing age, infants and young children, elderly people, low socioeconomic groups, displaced people, refugees, and populations experiencing other emergency situations). Iron supplementation is used to control and prevent iron deficiency anemia in pregnant women and appears to be essential during the second half of pregnancy. However, there is some concern about possible negative effects of iron supplementation in that it may be toxic at high doses. It can cause diarrhea and other abdominal symptoms, and for newborns and in highly malaria-endemic areas it may increase the morbidity of infectious disease and reduce linear growth in iron-replete infants. Some studies suggest that iron negatively affects zinc status and that zinc and iron interact when administered together in therapeutic doses and thus should be supplemented independently to avoid this interaction. However, evidence is mixed.

Current and planned activities

Achieving food security for all is at the heart of FAO's efforts to ensure that people have regular access to enough high quality food to lead active and healthy lives. FAO has been leading efforts ensuring that agriculture, particularly in the developing world, can help meet the demand for healthy food and develop food production systems that are both economically and environmentally sustainable. Promoting the production and consumption of fruits and vegetables, and animal foods (fish and poultry) that are rich in micronutrients is central to FAO's efforts to eradicate hunger, alleviate poverty, and raise levels of nutrition and standards of living.

FAO advocates for and promotes the consumption of healthy diets and acknowledges the important role that dietary diversity can play in improving health and generating incomes for poor population groups. To enhance food and nutrition security in rural households, FAO promotes the production of vegetables and fruits, as well as animal foods (fish ponds and animal husbandry) in home, community and school gardens. Home and school gardening are frequently linked with school feeding programs, nutrition education, and promotional campaigns to encourage consumption of micronutrient rich foods. Owing to the rapid rise in the world's urban populations, FAO promotes urban gardening and agriculture as part of its Food for the Cities program to make available fresh micronutrient rich food and offer a means of self-employment and income generation for poor urban families.

Food and nutrition education play a vital role in FAO activities aimed at promoting healthy dietary intake. There is ample evidence to show that programs aimed at food and dietary diversification, such as home gardening and horticultural programs, are most effective when they are combined with promotional and educational activities (18, 19). Nutrition education in schools and the promotion of healthy eating is important as children's food habits and dietary patterns are formed when they are young, but it is equally necessary to reach adults and parents with clear messages that promote healthy food choices, food preparation and consumption. FAO promotes the development of national food-based dietary guidelines and provides technical assistance in the development and implementation of nutrition education programs and campaigns in communities and schools. Educational materials that promote the production and consumption of a variety of healthy foods, including indigenous ones, can be found on FAO's Food and Nutrition website at: *http://www.fao.org/ag/agn/sitemap_en.stm.*

Additional materials are available on the inter-departmental website on school gardens at: *http://www.fao.org/schoolgarden/* and FAO's Education for Rural People Tool Kit: *http://www.fao.org/SD/ERP/ERPtktoolkit_en.htm.*

Key initiatives through which FAO, in collaboration with governments, partners in the UN community, NGOs, and civil society, promotes the production and consumption of micronutrient rich foods and healthy diets include:

School Gardens for Better Education and Nutrition

School garden programs have the potential to improve education of rural children and their families by making it more relevant to local needs. They enhance the quality of education and can serve as an outdoor laboratory for practical learning across a broad range of subjects. With wider community involvement, they can also address nutritional deficiencies by supplementing school feeding and adding nutritional value to school meals. Foods produced within school gardens focus on easy to grow micronutrient rich vegetables and fruits, as well as animal foods, such as chickens and rabbits. A key function of school gardens is to encourage children to stay in school and to acquire a range of knowledge and skills, an aspect which is especially important in countries with a high prevalence of HIV and AIDS and a growing number of orphans. School gardens, in both urban and rural settings, can provide school children with hands-on experience in food production and natural resource management, as well as a focus for education on good nutrition and healthy eating. New skills and techniques that students acquire in the school garden can be taken home to their family farms or household gardens. For their full potential to be realized, school gardens are best developed within the context of a carefully designed, comprehensive national program which leaves ample room for local adaptation and promotes the full engagement of local communities. FAO collaborates with WFP's Food for Education Program, UNICEF, national and international NGOs, as well as community-based organization in the promotion and establishment of school gardens for children's better learning and nutrition worldwide. See FAO's school garden website: *http://www.fao.org/schoolgarden/.*

Global Fruit and Vegetable Initiative for Health

A recently published WHO/FAO report (20) recommends as a population-wide intake goal the consumption of a minimum of 400 g of fruit and vegetables per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases such as heart disease, cancer, diabetes, and obesity, as well as for the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries.

Recognizing the increasing scientific evidence that low fruit and vegetable intake is a key risk factor for several noncommunicable diseases and plays an important role in the prevention and alleviation of micronutrient deficiencies, WHO and FAO launched a joint fruit and vegetable promotion initiative in Rio de Janeiro in November 2003. The overall goal of this initiative is to strengthen, promote, and protect health in the context of a healthy diet by guiding the development of sustainable actions at community, national and global levels that, when taken together, will lead to reduced risk of chronic diseases through increased fruit and vegetable consumption. The WHO/FAO Global Fruit and Vegetable Initiative for Health (GlobFaV) seeks to maximize synergies between WHO's global work on diet, physical activity, and health, and FAO's programs on nutrition, food security, and the horticultural supply chain. In concert with other UN agencies, the initiative will support national programs in developing countries involving coalitions of stakeholders ranging from ministries of agriculture, health and transport, to farmers, extension services, schools, and the food industry. See the WHO/FAO Global Fruit and Vegetable Initiative for Health at: *http://www.fao.org/ag/magazine/0606sp2.htm* and the framework document developed at the Kobe workshop at: *http://www.fao.org/ag/magazine/FAO-WHO-FV.pdf*

International Fruit and Vegetable Alliance

An International Fruit and Vegetable Alliance (IFAVA) has called for increasing fruit and vegetable consumption in order to help stem the rise of obesity and chronic diseases arguing that this should be a primary goal within a health, food and agricultural policy. Health authorities in many countries support the "5 a day" campaign that encourages people to eat at least five servings of fruits and vegetables daily. The reason why fruit and vegetables are so beneficial is because of their array of compounds. In addition to vitamins, minerals and trace elements, fiber, and some food energy, fruit and vegetables also contain antioxidants and many other complex plant components (called phytochemicals). It appears that the benefits stem not only from the individual components, but also from the interactions between these components. Dietary supplements containing isolated vitamins or minerals do not appear to have the same beneficial effects as fruit and vegetables themselves. Indeed, in some studies, supplements caused more harm than good. FAO is able to provide advice on strategies for increasing the production, availability, processing, preservation, and consumption of micronutrient rich foods.

Nutrition-Friendly Schools Initiative

Based on the understanding that effectively addressing the increasing global burden of malnutrition (both undernutrition and obesity and related chronic diseases), requires common policy options, the Nutrition-Friendly Schools Initiative (NFSI) has been developed as a follow-up to the WHO Expert Meeting on Childhood

Obesity in Kobe, in 2005. The main aim of the NFSI is to provide a framework for designing integrated school-based interventions that address all forms of malnutrition that affect school-age children, building on the ongoing work of various agencies and partners, including the UNESCO coordinated FRESH Initiative (Focusing Resources on Effective School Health), Child-Friendly Schools (UNICEF), Essential Package (UNICEF/WFP), Health Promoting Schools (WHO), and Food and Nutrition Education Programs (FAO). The NFSI applies the concept and principles of the Baby-Friendly Hospital Initiative.

Improving the nutritional status of school-age children is an effective investment for the future generation. Preschools and schools offer many opportunities to promote healthy diets and physical activity for children and are also a potential access point for engaging parents and community members in preventing child malnutrition in all its forms (i.e., undernutrition, micronutrient deficiencies, and obesity and other nutrition-related chronic diseases). The universality of the school setting for gaining access to children makes it highly relevant to global efforts to combat the increasing public health problems of nutrition-related ill health. The NFSI framework is currently being pilot-tested in 30 countries around the world prior to its official release.

Conclusions

Iron deficiency and iron deficiency anemia are serious and widespread public health problems. Their global scale and magnitude, combined with their damaging physiological socioeconomic effects, require the urgent adoption of known and effective measures to tackle this critical problem.

With the knowledge that the intake of foods rich in iron increase hemoglobin concentration and reduce the prevalence of anemia significantly, much focus has been placed on iron fortification and supplementation programs rather than on increasing food consumption and improving and diversifying diets. This is partly because governments, international agencies, and donors have considered both fortification and supplementation programs attractive for their apparent simplicity and cost-effectiveness. However, in practice many such programs are proving to be difficult to manage, more costly than expected to implement, and less effective than promised.

As these programs have had little reported success in reducing anemia, interest is turning to food-based approaches that have higher potential for achieving far-reaching and long-lasting benefits for the control of iron deficiency. Food-based approaches aim to improve nutrition through increasing the availability and consumption of a nutritionally adequate and micronutrient rich diet made up from a variety of available foods. Food-based approaches are recognized as an essential part of an urgently needed more comprehensive strategy to combat iron and other micronutrient deficiencies.

There are a number of actions that may be taken by international agencies, governments, line ministries of agriculture, health, education, industry and the private sector, communities and households themselves that are feasible and practical and that will increase the consumption and bioavailability of iron. As food-based strategies aim to improve the quality of the overall diet by increasing the availability and consumption of a wider range of foods, they address multiple nutrient deficiencies simultaneously. By so doing, food-based strategies are preventive, cost-effective, and sustainable. They also encourage popular demand for safe, wholesome food, and foster the development of sustainable agriculture that has positive knock-on effects for the rural economy.

The strategies proposed to promote dietary diversity need strong community-level commitment and their successful implementation requires advocacy to obtain community acceptance of and political support for programs. Involving local people in program assessment, analysis, and actions will facilitate community acceptance. The support of local authorities and government may facilitate the implementation of such projects because these actions require economic resources, which sometimes are beyond the reach of the most needy.

Success also depends upon well financed food-based initiatives at the international level. FAO can provide technical assistance to governments in concert with international agencies, non-governmental organizations, and public and private institutions and the food industry to support planned and ongoing government food-based programs for meeting a broad spectrum of micronutrient needs, including iron. By adopting food-based strategies on a broader scale as a matter of priority, we will have a balanced, more comprehensive approach that has the greatest potential for overcoming not only iron but also other micronutrient deficiencies.

Work in pursuit of this strategy includes continuing efforts to ensure that dietary diversification, food fortification, supplementation, and public health measures are taken comprehensively to combat iron deficiency, specifically:

- Increase overall food intakes of those who are food insecure through support for enhanced food production, availability, processing, preservation, and consumption.
- Increase the consumption of micronutrient rich foods that meet dietary needs and food preferences.
- Explore ways to increase financial investments in food-based initiatives at the country level including by better quantifying the contribution that such interventions can make to demonstrate their efficacy.
- Draw up a list of best practices that households can adopt to prevent iron deficiency anemia (IDA) based on local Trials of Improved Practices (TIPs) and design a communication strategy for affecting behavioral change
- Research on the amounts of phytates and iron-binding polyphenols in food, condiments, and spices and in common meals and their usual variations in composition in order to make realistic recommendations about changes in meal composition, taking into consideration the effect of such changes on other nutrients (e.g., vitamin A).
- Evaluate the nutritive value of diets not only on energy and protein adequacy but also on micronutrient density.
- Explore home fortification of weaning foods.

References

1. Food and Agriculture Organization of the United Nations. The state of food insecurity. Washington, DC: FAO, 2006.
2. Food and Agriculture Organization of the United Nations, World Health Organization. Human vitamin and mineral requirements. Report of a joint FAO/WHO expert consultation, Bangkok, Thailand. Rome: FAO, 2002.
3. International Institute for Population Sciences. National Family Health Survey-2. Anemia among women and children. Mumbai: IIPS, 2000.
4. Nair MK. Iron absorption and its implications in the control of iron deficiency anaemia. Nutrition News 1999;20(2):1–4.
5. Scrimshaw NS. Functional consequences of

iron deficiency in human populations. J Nutr Sci Vitaminol (Tokyo) 1984;30:47–63.

6. Bruner AB, Joffe A, Duggan AK, Casella JF, Brandt J. Randomised study of cognitive defects of iron supplementation in non-anaemic iron-deficient adolescent girls. Lancet 1996;348:992–6.

7. Lieberman E, Ryan KJ, Monson RR, Schoenbaum SC. Association of maternal hematocrit with premature labor. Am J Obstet Gynecol 1988;159:107–14.

8. Garn SM, Ridella SA, Petzold AS, Falkner F. Maternal hemologic levels and pregnancy outcomes. Semin Perinatol 1981;5:155–62.

9. Zhu YI, Haas JD. Iron depletion without anemia and physical performance in young women. Am J Clin Nutr 1997;66:334–41.

10. Sanghvi TG. Economic rationale for investing in micronutrient programs. A policy brief based on new analyses. Office of Nutrition, Bureau for Research and Development, United States Agency for International Development. Washington, DC: USAID 1996.

11. Neumann C, Long J, Weiss R, Murphy S, Liang J, Gewa C, et al. Predictors of anemia in rural Kenyan children: malaria, infection, vitamin B12 and A, and meat intake. Report of the 2004 INACG Symposium; 2004 Nov 18; Lima, Peru. Washington, DC: ILSI, 2005 (abstr Th67).

12. Namarika R, Yiannakis M, Main B, Siekmans K. Small animal revolving fund addresses iron deficiency anaeia in Malawi. Report of the 2004 INACG Symposium; 2004 Nov 18; Lima, Peru. Washington, DC: ILSI, 2005 (abstr Th34).

13. Sari M, de Pee S, Yip R, Martini E, Sugiatmi, Soekarjo D, et al. Foods naturally rich in iron increase hemoglobin concentration in anemic Indonesian adolescents. Report of the 2004 INACG Symposium; 2004 Nov 18; Lima, Peru. Washington, DC: ILSI, 2005 (abstr Th30).

14. Nnam NM. Baobab fruit pulp (Adansonia digitata L.) improves iron status in Nigerian children. Report of the 2004 INACG Symposium; 2004 Nov 18; Lima, Peru. Washington, DC: ILSI, 2005 (abstr Th90).

15. Berti PR, Zlotkin S, Hoang MA, FitzGerald S, Tuan T, Sharieff W, et al. The efficacy of iron and steel pots in reducing prevalence of anaemia in Vietnam: report of midline findings. Report of the 2004 INACG Symposium; 2004 Nov 18; Lima, Peru. Washington, DC: ILSI, 2005 (abstr Th20).

16. World Health Organization, Food and Agriculture Organization of the United Nations. Preparation and use of food-based dietary guidelines. Report of a joint FAO/WHO consultation, Nicosia, Cyprus. Geneva: WHO Nutrition Programme, 1996.

17. Food and Agriculture Organization of the United Nations, International Life Sciences Institute. Preventing micronutrient malnutrition: a guide to food-based approaches. Washington, DC: ILSI Press, 1997.

18. Ruel MT, Levin CE. Assessing the potential for food-based strategies to reduce vitamin A and iron deficiencies: a review of recent evidence. Washington DC: International Food Policy Research Institute, 2000. [Food Consumption and Nutrition Division Discussion Paper, No. 92]

19. Faber M, Phungula AS, Venter SL, Dhansay MA, Benade AJ. Home gardens focusing on the production of yellow and dark-green leafy vegetables increase the serum retinol concentrations of 2–5-y-old children in South Africa. Am J Clin Nutr 2002;76:1048–54.

20. World Health Organization. Diet, nutrition, and the prevention of chronic diseases. Report of a joint FAO/WHO Expert Consultation. Geneva: WHO, 2003. [Who Technical Report Series, No. 916]