Anemia - can its widespread prevalence among women in developing countries be impacted?

A case study: Effectiveness of a large-scale, integrated, multiple-intervention nutrition program on decreasing anemia in Ghanaian & Malawian women.

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1.0 Anemia in Women: A Global Health Priority

1.1 Introduction

Anemia, defined as blood hemoglobin level below established cut-off points, is a pervasive global public health problem. An estimated 2 billion people are affected, or more than one third of the world's population[1]. Anemia prevalence is highest in developing countries. Although both males and females of all ages are affected, the most vulnerable groups are pregnant women and young children. Worldwide, more than 50% of pregnant women and over 30% of all women suffer from anemia.[2]

The devastating consequences of anemia in women range from increased fatigue, decreased cognitive ability, decreased work productivity and consequent economic costs of increased morbidity and mortality. In fact, women with severe anemia in pregnancy have a 3.5 times greater chance of dying from obstetric complications compared with non-anemic pregnant women.[3]

Iron deficiency is the most prevalent nutritional deficiency and the major cause of anemia worldwide. The World Health Organization (WHO) estimates that iron deficiency is responsible for approximately 50% of all anemia cases.[4] Other significant causes, the relative contributions of which vary by geographic location, include deficiencies of other nutrients, malaria, helminth (worm) infections, and a variety of other diseases. Effective management of anemia in high prevalence contexts requires an analysis of the main contributors, and implementation of an integrated package of interventions to address all major causes.

The international community, through the United Nations, has committed to reducing the global prevalence of anemia by one third by 2010.[5] This presents an enormous challenge, as progress

[1] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3)
[2] WHO. The prevalence of anaemia in women. Geneva, World Health Organization, 1992. (WHO/MCH/MSM/92.2)
[3] Brabin B, Hakimi M, Pelletier D. An analysis of anemia and pregnancy-related maternal mortality. J Nutr 2001;131:604S-615S.
[4] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3)
[5] Resolution adopted by the General Assembly: S-27/2: A world fit for children. United Nations General Assembly, 11 October 2002.

towards achievement of similar previously established goals has been very limited.[6] Despite the high prevalence and serious consequences of anemia, there have been few reported studies assessing the effectiveness of anemia prevention and control programs in developing countries. Moreover, although it is well known that anemia is a result of multiple causes, there are few reported examples of integrated programs addressing the various causes, or assessments of the effectiveness of combining several interventions on anemia prevalence among women. This chapter examines these issues in further detail and presents a case study of a comprehensive nutrition and health program, demonstrating that with effective programming, the international target for the reduction of anemia prevalence in women can be achieved.

1.2 Prevalence of Anemia in Women

1.2.1 Definition of Anemia

Anemia is defined as a low level of hemoglobin in the blood, resulting in lower quantities of oxygen available to support the body's activities. Internationally accepted hemoglobin values which define anemia in women are shown in Table 1. These values are applicable to most populations but need to be adjusted for high-altitude locations.

Table 1: Blood Hemoglobin Values (g/dL) Defining Anemia in Women[7]

	All Anemia	Mild Anemia	Moderate Anemia	Severe Anemia
Pregnant women	<11.0	10.0-10.9	7.0-9.9	<7.0
Non-pregnant women of childbearing age (>15 years)	<12.0	10.0-11.9	7.0-9.9	<7.0

1.2.2 Prevalence of Anemia

At the national level, anemia is considered a severe public health problem when the prevalence is equal to or greater than 40 percent in a vulnerable group (Table 2). Based on this criteria, anemia is a severe public health program in nearly all developing countries, as illustrated by the data presented in Tables 3-5. On the other hand, anemia prevalence in most industrialized countries is typically in the range of normal to mild public health significance.

Table 2: Public Health Significance of Anemia[8]

Anemia Prevalence	Public Health Significance
≥40%	Severe
20-39%	Moderate
5-19%	Mild
0-4.9%	Normal

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[6] We the children: end-decade review of the follow-up to the World Summit for Children: report of the Secretary-General. United Nations General Assembly, 2001.

[7] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3)

[8] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3)

Tables 3 and 4 show estimates of anemia prevalence for developing countries and different world regions. For all age groups, the risk of developing anemia is two to seven times greater in developing countries than in industrialized countries, and anemia prevalence is higher in rural areas compared with urban areas.[9]

Table 3: Prevalence of Anemia in Women, Developing and Industrialized Countries, 1998[10]		
	Non-pregnant Women (%)	**Pregnant Women (%)**
Developing Countries	43	55
Industrialized Countries	11	19

[9] Galloway R. Anemia prevention and control: what works; part 1: program guidance. USAID, World Bank, UNICEF, PAHO, FAO, MI, 2003.
[10] ACC/SCN. The 4th report on the world nutrition situation: Nutrition throughout the life cycle. ACC/SCN in collaboration with the International Food Policy Research Institute. Geneva: ACC/SCN, 2000.

Table 4: Anemia Prevalence Rates in Women, Selected Countries (by WHO region)

	Pregnant Women				Breastfeeding Women				Non-pregnant/Non-breastfeeding				All Women (15-49 yrs)			
WHO Region Country, Year	Total %	Severe %	Moderate %	Mild %	Total %	Severe %	Moderate %	Mild %	Total %	Severe %	Moderate %	Mild %	Total %	Severe %	Moderate %	Mild %
Africa																
Cameroon, 2004	51	0.7	31	19	43	0.4	10	33	44	1.0	9	34	46	0.9	12	33
Ghana, 2003	65	1.2	27	37	49	0.9	8	40	42	0.9	8	33	45	0.8	9	35
Tanzania, 2004	59	2.7	33	23	48	0.7	11	36	47	1.2	13	33	49	1.2	15	33
Uganda, 2000/1	41	2.0	17	22	32	0.4	6	26	27	0.6	6	20	31	0.7	8	22
Americas																
Bolivia, 2003	38	0.5	19	18	43	0.8	8	34	30	0.3	5	25	33	0.4	7	26
Haiti, 2000	64	3.7	30	30	52	2.2	14	36	55	3.2	15	37	55	3.0	16	36
Peru, 2000	39	2.0	17	20	40	0.2	7	33	29	0.2	5	24	31	0.3	6	25
South Eastern Asia																
India (1998/99)	50	2.5	25	22	57	1.6	16	39	50	1.9	13	35	52	1.9	15	35
Nepal (1997/98)	75	5.7	68.9	68.9	-	-	-	-	67	1.7	65	65	-	-	-	-
Eastern Mediterranean																
Egypt, 2000	46	0.6	10	35	31	0.2	4	27	26	0.3	4	22	29	0.3	5	24
Jordan, 2002	37	0.1	13	24	28	0.0	4	24	28	0.2	6	22	29	0.1	7	22
Europe																
Turkmenistan, 2000	-	-	-	-	-	-	-	-	-	-	-	-	47	1.1	8	38
Western Pacific																
Cambodia, 2000	66	4.3	35	27	67	2.6	17	47	56	0.7	10	45	58	1.3	13	44

Source: Demographic & Health Surveys, Macro International and the governments of the countries.

Anemia prevalence is highest in the South East Asia, Eastern Mediterranean and Africa regions, with the highest rates found in pregnant women (Table 5).

Table 5: Anemia Prevalence in Pregnant Women, 1998[11]	
WHO Region	**Anemia Prevalence (%)**
Africa	51
Americas	35
E. Mediterranean	55
Europe	25
South East Asia*	75
Western Pacific	43
* *includes South Asia*	

The fact that anemia prevalence in many areas persists at moderate to severe levels according to internationally accepted standards primarily reflects the difficulty of meeting the dietary iron needs of women. However there are several other key causes of anemia, which vary in their significance by geographic region. Understanding the main causes of anemia and interventions to address them is a critical component of any effort that aims to reduce the global burden of anemia in women.

1.3 Causes of Anemia and Interventions to Address Them

Hemoglobin is a component of red blood cells, responsible for transporting oxygen to the body's tissues. Anemia results when hemoglobin concentration falls below accepted levels, due to either compromised production, excessive destruction or excessive loss of red blood cells. The major factors directly causing these alterations in red blood cell levels are shown in Table 6.

Table 6: Major Causes of Anemia		
Compromised Red Blood Cell Production	**Excessive Red Blood Cell Destruction**	**Excessive Red Blood Cell Loss**
• **poor dietary iron intake and/or absorption (causes 50% of anemia)** • poor dietary intake and/or absorption of vitamins A, B12, folate • HIV/AIDS • infectious disease (e.g., chronic diarrhea; TB) • Genetic blood disorders (e.g., sickle cell trait, thalassemia)	• malaria	• helminth infections (e.g. hookworm, schistosomiasis) • bacterial or viral infections • reproduction • contraception (IUD)

On a global scale, the major causes of anemia in decreasing order of significance are iron deficiency; other nutritional deficiencies; malaria; helminth infections; chronic infections such as

[11] ACC/SCN. The 4th report on the world nutrition situation: Nutrition throughout the life cycle. ACC/SCN in collaboration with the International Food Policy Research Institute. Geneva: ACC/SCN.

HIV/AIDS; reproductive causes; and genetic conditions.[12] These are discussed in further detail below, along with the interventions that can be used to address them.

1.3.1 Iron Deficiency

The mineral iron has many functions in the body. One of these is its role as a component of hemoglobin, the oxygen-transporting molecule in red blood cells. However, iron deficiency is widespread and as the single greatest cause of anemia, is responsible for more than half the global cases of anemia.[13] Lack of adequate dietary iron intake is central to the development of iron deficiency and is a major nutritional issue in developing countries. In addition, iron deficiency is exacerbated through excessive blood loss as a result of infections, menstruation, childbirth and the post partum period.

Iron is the only nutrient for which women have higher requirements than men, due to the regular blood losses experienced during menstruation. Pregnancy, a period of rapid growth and expansion of blood volume, further increases women's need for iron. Iron requirements for different age/sex groups are shown in Box 1. Given the need for a high iron intake to compensate for menstrual losses and the demands of pregnancy, it is not surprising that women are particularly vulnerable to iron deficiency and anemia.

Box 1: Daily Iron Requirements (mg) for Selected Age Groups in Relation to Dietary Iron Bioavailability[14]

Age Group	Sex	Iron Bioavailability of the Diet:*		
		High	**Medium**	**Low**
1-3 years	both	3.9	5.8	11.6
4-6 years	both	4.2	6.3	12.6
7-10 years	both	5.9	8.9	17.8
11-14 years	M	9.7	14.6	29.2
	F	21.8	32.7	65.4
15-17 years	M	12.5	18.8	37.6
	F	20.7	31	62
18+ years	M	9.1	13.7	27.4
	F**	19.6	29.4	58.8
Lactating women		10	15	30

*See Box 2 for an explanation of diets of varying levels of iron bioavailability
**Non-pregnant, non-lactating, pre-menopausal

In contrast with the high iron needs of women, typical diets in many countries provide very little iron or iron that is poorly absorbed by the body. Both the quantity and quality of dietary iron intake contribute to iron status. The iron sources with greatest bioavailability (i.e. most readily

[12] Galloway R. Anemia prevention and control: what works; part 1: program guidance. USAID, World Bank, UNICEF, PAHO, FAO, MI, 2003.
[13] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3).
[14] FAO, WHO. Human vitamin and mineral requirements. Rome, Food & Agriculture Organization of the United Nations, 2001.

absorbed and utilized by the body) are from animal products, which contain heme iron. Plant sources of iron (such as grains, legumes, vegetables and nuts) are non-heme, and are much more poorly absorbed. See Box 2 for examples of diets with varying levels of iron bioavailability.

Box 2: Characteristics of Diets with Varying Iron Bioavailability[15]		
Low Bioavailability	**Medium Bioavailability**	**High Bioavailability**
• monotonous; very limited variety of foods • high intake of cereals, roots, tubers etc. • minimal intake of meat, fish and/or vitamin C rich foods	• simple; limited variety of foods • high intake of cereals, roots, tubers etc. • some intake of meat, fish and/or vitamin C rich foods	• wide variety of foods • high intake of meat, fish and/or vitamin C rich foods

Bioavailability is greatly influenced by substances in the diet that may either enhance or inhibit absorption and utilization of dietary iron, particularly non-heme iron. For example, phytates found in whole grains (especially maize, millet, rice, wheat and sorghum), polyphenols (e.g., tannins found in legumes, tea, coffee), oxalates (found in green leafy vegetables) and calcium salts (found in milk products and tortillas prepared with calcium oxide) all inhibit iron absorption. Animal products (meat, poultry, fish and other seafood), vitamin C, and some food processing methods (fermentation and germination) all enhance the absorption of non-heme iron.

In developing countries, daily diets are low in animal products. They are typically based around a staple food high in unrefined carbohydrates, with legumes and vegetables accompanying the staple. This combination provides a diet of low iron bioavailability that is also high in inhibitors and low in enhancers of iron uptake. For example, analysis of the iron intake of pregnant women in rural Malawi showed that 89% of dietary iron was non-heme, and that the intake of bioavailable iron was significantly associated with iron status.[16] Similarly in rural Tanzania, assessment of typical household eating patterns revealed a largely grain and vegetable based diet, which although relatively high in total iron content, was very low in absorbable iron due to the presence of high levels of phytates and polyphenols.[17] An analysis of the diets of rural Bangladeshi women also found a very low heme iron intake coupled with high phytate intake, leading to a diet of poor iron bioavailability. Hemoglobin status was predicted by bioavailable iron in the diet, women's height and mid-upper-arm circumference and consumption of iron tablets, and more than half of the study subjects were anemic.[18]

Standard diets in industrialized countries are usually adequate to meet routine iron requirements of women, but are insufficient to supply the additional iron requirements of pregnancy. Thus in

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[15] Allen LH, Ahluwalia N. Improving iron status through diet: The application of knowledge concerning dietary iron bioavailability in human populations. Arlington VA:OMNI/John Snow, Inc., 1997.
[16] Huddle JM, Gibson RS, Cullinan TR. The impact of malaria infection and diet on the anaemia status of rural pregnant Malawian women. Eur J Clin Nutr 1999;53(10):792-801.
[17] Tatala S, Svanberg U, Mduma B. Low dietary iron availability is a major cause of anemia: a nutrition survey in the Lindi District of Tanzania. AJCN 1998;68:171-8.
[18] Bhargava A, Bouis HE, Scrimshaw NS. Dietary intakes and socioeconomic factors are associated with the hemoglobin concentration of Bangladeshi women. J Nutr 2001;131:758-764.

both developing and industrialized nations, iron supplementation, along with an optimum diet, is needed to prevent iron deficiency and anemia during pregnancy.

It is important to note that anemia is the final stage of iron deficiency, and that the preliminary phases, prior to a detectable drop in hemoglobin concentration, also have functional consequences such as reduced work productivity. Many individuals suffer from iron deficiency without reaching the severe iron depletion that causes anemia. In populations where iron deficiency anemia prevalence is of severe public health significance in a particular age and sex target group, all members of that group should be considered iron deficient and at risk of anemia.[19]

1.3.1.1 Interventions to Increase Iron Intake

The main interventions currently promoted and implemented to improve dietary iron intake include supplementation, fortification and dietary diversification and modification. Each of these has its strengths and limitations, which are discussed below.

- **Supplementation** involves the provision of iron in tablet form to individuals or groups with or at risk for iron deficiency and anemia. The recommended dosing schedules for women are presented in Table 7.

Table 7: Dosage Schedules for Iron Supplementation to Prevent Iron Deficiency Anemia[20]

Age Groups	Indications for supplementation	Dosage Schedule	Duration
Women of Childbearing Age	Where anemia prevalence is above 40%	Iron: 60 mg/day Folic acid: 400 μg/day	3 months
Pregnant Women	Universal supplementation	Iron: 60 mg/day Folic acid: 400 μg/day	As soon as possible after gestation starts – no later than 3rd month – and continuing for the rest of pregnancy
Lactating Women	Where anemia prevalence is above 40%	Iron: 60 mg/day Folic acid: 400 g/day	3 months post-partum

The most commonly implemented anemia control intervention is daily iron supplementation for pregnant women. This strategy is widely promoted as a key component of maternal health care in most countries. There is no doubt as to the *efficacy* of daily iron supplementation to improve maternal hemoglobin status in pregnancy, as demonstrated in many controlled trials.[21] However, the *effectiveness* of large-scale iron supplementation

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[19] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3).
[20] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3).
[21] Sloan NL, Jordan EA, Winikoff B. Does iron supplementation make a difference? Arlington, VA: MotherCare Project, John Snow, Inc, 1995. (MotherCare Working Paper no. 15).

programs is questionable. For example, consistently high levels of maternal anemia were found in India (>80%) and Indonesia (>60%) through surveys conducted both before and after the introduction of iron supplementation programs.[22] A variety of constraints to effective large-scale supplementation programs for pregnant women have been identified, including irregular supply of tablets, limited access by women to health care services to obtain tablets, inadequate health counseling regarding the purpose and dosing regime of the supplements, and reluctance of women to consume the supplements.[23] These constraints can be overcome but a much higher level of supervision, training and support is required than is currently the norm in most places.

In addition, the importance of a lifecycle approach to anemia prevention and control is increasingly being recognized. Iron supplementation to pregnant women as a single anemia management strategy is likely to be ineffective, even if high coverage can be achieved, where pre-existing anemia prevalence (i.e., in non-pregnant women) is very high. This highlights the need to consider all women of childbearing age as a key target group for anemia prevention and control activities in high prevalence contexts. Iron supplementation will always be needed in pregnancy (as it is in industrialized nations), but if women enter pregnancy with adequate iron status the supplements consumed during pregnancy will be better able to maintain normal hemoglobin during a period of high demand for iron.[24]

While supplementation provides the best option for rapidly increasing hemoglobin concentration, it is not ideal as a long-term means of ensuring adequate iron status. Improving the dietary intake of bio-available iron through food-based approaches is key to sustainable prevention of iron deficiency anemia in developing countries. Food-based approaches include fortification, diversification of the diet, and modification of food preparation and consumption habits.

- **Fortification** is the process of adding vitamins and/or minerals to a staple food in order to improve its nutritional value. There are many benefits to this approach, including the potential to fortify a single food with multiple micronutrients, thus addressing various dietary deficiencies with one intervention. In addition, fortification provides the opportunity to reach an entire population with improved nutrition, without requiring any change in dietary habits.

  Development of a successful iron fortification program requires:
  - identifying a suitable food vehicle which is consumed on a frequent basis by a significant proportion of the target population;
  - technology for adding the iron to the food;
  - social marketing to promote consumption of the food and explain the purpose of fortification;

[22] Yip R. Iron supplementation during pregnancy: is it effective? Am J Clin Nutr 1996;63:853-5.
[23] Yip R. Iron supplementation during pregnancy: is it effective? Am J Clin Nutr 1996;63:853-5.
[24] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3).

- a quality control protocol to ensure that the food is fortified to consistent and safe levels.[25]

In many countries, national level initiatives provide increased dietary iron intake through fortification of staple foods and condiments by commercial or centralized processors. This approach is ideal in settings where the majority of the population purchases commercially processed food, and is highly cost-effective and sustainable.[26] However, in many developing countries a significant proportion of the population relies on subsistence farming and thus does not benefit from commercially fortified products. Efforts are being made to develop simple technologies to fortify foods at the community or household level in these contexts. One example of this type of fortification can be found in the description of anemia prevention activities implemented in Malawi, in the case study section of this chapter.

- **Dietary Diversification** refers to interventions that promote an increase in the range and nutritional quality of foods consumed on a regular basis. One of the main contributors to nutritional deficiencies is consumption of a limited variety of foods. In the case of iron deficiency, low intake of animal source foods (which provide highly bioavailable heme iron) is of particular importance. In some contexts where vegetarianism is an important cultural or religious value, promoting animal source foods is not appropriate, but in most developing countries intake of animal foods is limited by poverty rather than beliefs. Much attention has been focused on supplementation and fortification as strategies to improve iron intake, but efforts to increase poor households' access to animal source foods are expanding. The case study section of this chapter provides an example of one such initiative, implemented in rural areas of Malawi. A major advantage of expanding dietary variety and quality through increased consumption of animal source foods is that an overall improvement in nutritional status and intake of essential vitamins and minerals is achieved.

  In order to be effective in improving iron intake in vulnerable groups, dietary diversification activities must be geared towards household consumption of the animals raised rather than income generation through livestock sales. In addition, the selected animals must reproduce frequently enough to provide a regular source of meat, and must be culturally acceptable and able to thrive in the local environment. Inequitable distribution of food within households is a common risk to the success of dietary diversification programs, as in many cultures meat is preferentially served to men, with women consuming very little. However with delivery of carefully planned nutrition education messages, this constraint can be overcome.

  Although animal source foods are of primary importance in efforts to improve dietary iron intake, dietary diversification interventions may also target increased vitamin C intake. Vitamin C is a potent enhancer of iron uptake by the body and is readily found in many fruits and vegetables. Supporting families to cultivate fruit trees and backyard gardens, combined with nutrition education on the importance of consuming vitamin C rich foods with meals, is another means of contributing to anemia reduction.

[25] Lotfi M, Mannar V, Merx RJHM, Naber-van den Heuvel P. Micronutrient fortification of foods: current practices, research and opportunities. Ottawa, The Micronutrient Initiative, 1996.
[26] World Bank. Enriching lives: overcoming vitamin and mineral malnutrition in developing countries. Washington DC, World Bank, 1994.

- **Dietary Modification** is a term used to describe nutrition education initiatives aimed at changing the ways that foods are typically prepared, preserved and consumed, in order to improve the nutritional benefit of the diet. Small changes in traditional eating patterns can enhance uptake of available iron by the body. For example, tannins in tea and coffee can inhibit iron absorption, so these drinks should be consumed between rather than with meals in order to limit this effect. Germination and fermentation of grains can significantly increase iron bioavailability due to the breakdown of phytates, which are potent inhibitors of iron absorption. Limiting the cooking time of both iron-rich foods and vitamin C sources (fruits and vegetables) is also beneficial for improving iron uptake. These and other similar education messages related to maximizing iron bioavailability of the diet are an important component of improving iron status and reducing anemia prevalence.[27]

1.3.2 Other Nutritional Deficiencies

The presence of anemia often indicates broad spectrum nutritional inadequacy, not limited to insufficient iron intake alone. In particular, deficiencies of folic acid, vitamin A and vitamin B12 contribute to the development of anemia through their impact on red blood cell production. Since iron deficiency remains the dominant cause of anemia, promoting an overall improvement of dietary quality is an important approach to anemia prevention and control. For example, in a sample of 150 anemic pregnant women in Malawi, 55% were iron deficient but more than half of these had at least one other micronutrient deficiency as well. A further 26% had adequate iron status but were deficient in at least one other micronutrient, usually vitamin A.[28]

1.3.2.1 Interventions to Improve Micronutrient Status

The food-based interventions described above in relation to improving iron intake are also effective means of addressing other micronutrient deficiencies. For example, multiple micronutrients can be added as fortificants to staple foods. Increasing consumption of animal source foods increases intake of vitamin A, folic acid, vitamin B12 and many other essential nutrients in addition to iron. Supplementation is also used to meet women's needs for vitamin A, through the provision of high-dose capsules in the early post partum period, and folic acid is a standard component of iron supplements.

1.3.3 Malaria

Malarial infection leads to anemia through the destruction of red blood cells by the malaria parasites. Folate (folic acid) deficiency secondary to malaria can also develop as another cause of anemia. Malaria is a major cause of anemia in endemic areas, particularly in seasons of high transmission. One estimate suggests that 400,000 pregnant women in sub-Saharan Africa may develop severe anemia as a consequence of malaria infection in one year.[29] Malarial infection in pregnancy (although often asymptomatic) is a risk factor for maternal anemia as well as for delivery of a low birth weight infant and for anemia in the infant.[30, 31] Primigravida women are

[27] Allen LH, Ahluwalia N. Improving iron status through diet: The application of knowledge concerning dietary iron bioavailability in human populations. Arlington VA:OMNI/John Snow, Inc., 1997.
[28] van den Broek NR, Letsky EA. Etiology of anemia in pregnancy in south Malawi. AJCN 2000;72(suppl):247S-56S.
[29] Guyatt HL, Snow RW. The epidemiology and burden of *Plasmodium falciparum*-related anemia among pregnant women in sub-Saharan Africa. Am J Trop Med Hyg 2001 Jan-Feb;64(1-2 Suppl):36-44.
[30] Verhoeff FH, Brabin BJ, Chimsuku L et al. Malaria in pregnancy and its consequences for the infant in rural Malawi. Ann Trop Med Parasitol. 1999 Dec;93 Suppl 1:S25-33.

most vulnerable, due to an apparent suppression of acquired immunity during the first pregnancy.[32] However, HIV infection is associated with greater malaria parasitemia among pregnant women of all parities.[33]

1.3.3.1 Interventions to Treat and Prevent Malaria in Pregnant Women

- **Intermittent Preventive Therapy** refers to the provision of two doses of an anti-malarial drug (sulphadoxine-pyrimethamine) to women during pregnancy, through antenatal care services. Treatment of malaria in pregnancy by this method has been shown to reduce the prevalence of both severe maternal anemia[34] and low birth weight infants.[35] However, although intermittent preventive therapy is part of the national health policy of many countries, coverage is often low as many women have limited access to antenatal care services or do not seek care until late in pregnancy.
- **Insecticide-Treated Bed Net** use is the key intervention for prevention of malaria infection and has demonstrated a positive effect on the prevalence of malaria and anemia in pregnant women.[36]. Distribution of nets to vulnerable groups is a major focus of the global strategy of the Roll Back Malaria Partnership.[37] As a result, provision of insecticide-treated nets to pregnant women is incorporated into routine antenatal services in many endemic countries.
- **Environmental Management** to reduce the breeding grounds for mosquito larvae as well as larvicides can be part of a malaria prevention program where breeding sites are well defined.

1.3.4 Helminth Infections

Several species of worms contribute to anemia in developing countries, with hookworms and schistosomes being the most common. Both cause significant blood loss in the host, which leads to iron deficiency and anemia. An estimated one billion people worldwide are infected with hookworms, and although parasite control programs tend to focus on school children, women are also significantly affected and should be included in intervention programs.[38] For example, hookworm infection was identified as the strongest predictor of iron status in pregnant women in a study in rural Nepal, and anemia prevalence increased as intensity of hookworm infection increased.[39]

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[31] Gillespie S, Johnston JL. Expert consultation on anemia determinants and interventions. Ottawa, Micronutrient Initiative, 1998.
[32] Shulman CE, Dorman EK. Importance and prevention of malaria in pregnancy. Trans R Soc Trop Med Hyg. 2003 Jan-Feb;97(1):30-5.
[33] Verhoeff FH, Brabin BJ, Hart CA et al. Increased prevalence of malaria in HIV-infected pregnant women and its implications for malaria control. Trop Med Int Health 1999 Jan;4(1):5-12.
[34] Shulman CE, Dorman EK, Cutts F et al. Intermittent sulphadoxine-pyrimethamine to prevent severe anaemia secondary to malaria in pregnancy: a randomized placebo-controlled trial. Lancet 1999 Feb 20;353(9153):632-6.
[35] Rogerson SJ, Chaluluka E, Kanjala M et al. Intermittent sulfadoxine-pyrimethamine in pregnancy: effectiveness against malaria morbidity in Blantyre, Malawi, in 1997-99. Trans R Soc Trop Med Hyg 2000 Sep-Oct;94(5):549-53.
[36] Marchant T, Schellenberg JA, Edgar T et al. Socially marketed insecticide-treated nets improve malaria and anaemia in pregnancy in southern Tanzania. Trop Med Int Health 2002 Feb;7(2):149-58.
[37] Roll Back Malaria Partnership. Global strategic plan, 2005-2015. Geneva, RBM Partnership Secretariat, 2005.
[38] Stoltzfus RJ, Dreyfuss ML, Chwaya HM, Albonico M. Hookworm control as a strategy to prevent iron deficiency. Nutr Rev 1997 Jun;55(6):223-32.
[39] Dreyfuss ML, Stoltzfus RJ, Shrestha JB et al. Hookworms, malaria and vitamin A deficiency contribute to anemia and iron deficiency among pregnant women in the plains of Nepal. J Nutr 2000;130:2527-2536.

1.3.4.1 Interventions to Control Helminth Infections

- **Antihelminthic Treatment,** commonly known as deworming, is typically administered to school children in endemic areas. However it is also recommended that pregnant women in areas of high hookworm infection prevalence receive one dose of an antihelminthic medication after the first trimester.[40]
- **Improved Hygiene and Sanitation** is an important component of helminth control. Use of latrines, hand washing, avoiding stagnant water and wearing shoes when walking outdoors all contribute to reduced risk of parasitic infection.

1.3.5 Chronic Infections

The relationship between infection and anemia varies with the nature of the disease. Chronic diarrheal disease and bacterial or viral infections of the gastrointestinal tract cause iron deficiency and anemia secondary to malabsorption and intestinal blood loss. Chronic inflammation is also associated with anemia due to swelling of tissues, rather than nutritional iron deficiency. Some diseases, such as tuberculosis, greatly increase metabolism, thus increasing the body's requirement for iron, and other nutrients and for overall caloric intake. These higher needs are often difficult to meet which leads to malnutrition, including the nutritional deficiencies which cause anemia.[41]

HIV infection is strongly linked with anemia through a variety of mechanisms. These include chronic disease and inflammation; increased metabolic and nutritional needs; poor intake of iron and other nutrients due to reduced appetite and anorexia; malabsorption of nutrients; and direct suppression of red blood cell production. Anemia is associated with disease progression and increased risk of death in HIV infected individuals.[42] In settings where anemia prevalence is already high due to chronic malnutrition, micronutrient deficiencies and helminth or malarial infections, HIV infection is likely to exacerbate pre-existing anemia through the additional effects of chronic inflammation and compromised immunity. For example, researchers in Malawi found that HIV-infection was significantly more prevalent in anemic pregnant women (47%) compared with the overall antenatal population (30%), and was associated with greater severity of anemia.[43] A study of HIV-infected pregnant women in Tanzania found that iron deficiency and infectious diseases (including malaria) were the main contributing factors to the observed high prevalence of anemia (83%, including 7% severe anemia).[44]

Interventions to treat infectious diseases vary according to the condition, and such a discussion is beyond the scope of this chapter. However, in addition to disease-specific treatment, optimizing

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[40] World Health Organization. Report of the WHO Consultation on hookworm infection and anaemia in girls and women. Geneva, WHO, 1994. (WHO/CTD/SIP/96.1).

[41] Galloway R. Anemia prevention and control: what works; part 1: program guidance. USAID, World Bank, UNICEF, PAHO, FAO, MI, 2003.

[42] Piwoz EG, Preble EA. HIV/AIDS and nutrition: A review of the literature and recommendations for nutritional care and support in sub-Saharan Africa. Washington DC:Support for Analysis and Research in Africa/AED project, 2000.

[43] Van den Broek NR, White SA, Neilson JP. The relationship between asymptomatic Human Immunodeficiency Virus infection and the prevalence and severity of anemia in pregnant Malawian women. Am J Trop Med Hyg 1998;59(6):1004-1007.

[44] Antelman G, Msamanga GI, Spiegelman D et al. Nutritional factors and infectious disease contribute to anemia among pregnant women with Human Immunodeficiency Virus in Tanzania. J Nutr 2000;130:1950-1957.

the nutritional status of individuals suffering from chronic diseases is vital to anemia prevention as well as to improved immune function and recovery.

1.3.6 Reproductive Causes

The increased iron needs resulting from blood loss during menstruation and the demands of pregnancy make women particularly vulnerable to anemia. This risk is increased through frequent, closely spaced pregnancies, which do not allow time for maternal stores of iron and other nutrients to be replenished between pregnancies. Blood losses during childbirth and the post partum period also contribute to anemia in women, as do intrauterine contraceptive devices.[45]

1.3.7 Genetic Conditions

Hemoglobinopathies arising from genetic conditions such as sickle cell and thalassemia contribute to the burden of anemia in some regions of the world. Individuals with sickle cell disease (1-2% of sub-Saharan African infants) born in areas where health services are poor develop severe anemia in infancy and are unlikely to survive childhood, while those with sickle cell trait (30% of Africans) have altered hemoglobin production but are not at greater risk of severe anemia.[46]

1.3.8 Underlying Causes

The direct causes of anemia described in the preceding paragraphs are compounded by a variety of indirect factors, primarily related to poverty. These include food insecurity, which prevents consumption of a nutritionally adequate diet; lack of knowledge of anemia and its causes and prevention; poor hygiene and sanitation; and lack of access to health services. Thus the global burden of anemia is shouldered primarily by developing countries where resources are limited. However, there are effective interventions that can be implemented in resource-poor settings, dramatically reducing the prevalence of anemia in women and its associated morbidity, mortality and functional losses. Establishing comprehensive anemia control programs in high prevalence contexts is an urgent global health priority.

1.3.9 Multi-factorial Etiology of Anemia

Anemia in women of developing countries is typically caused by iron deficiency plus one or more health issues. The relative contribution of these factors varies by geographic region and must be determined before effective interventions can be implemented.

For example, a study of anemia in pregnant women, non-pregnant women, adolescent girls and boys in an urban area of Tanzania found that iron deficiency was the main underlying cause of anemia in all groups, but that malaria and other infections were particularly common in pregnant women.[47] Another study conducted in a rural area of Tanzania also identified iron deficiency as the strongest predictor of anemia in women, but also found a significant association between

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[45] Galloway R. Anemia prevention and control: what works; part 1: program guidance. USAID, World Bank, UNICEF, PAHO, FAO, MI, 2003.

[46] Galloway R. Anemia prevention and control: what works; part 1: program guidance. USAID, World Bank, UNICEF, PAHO, FAO, MI, 2003.

[47] Massawe SN. Anaemia in women of reproductive age in Tanzania. A study in Dar-es-Salaam. Acta Universitatis Upsaliensis. Comprehensive Summaries of Uppsala Dissertations from the Faculty of Medicine 1151. Uppsala, 2002.

anemia and malaria, schistosomiasis and hookworm infections.[48] An analysis of the etiology of anemia in pregnant women in rural Nepal found that 72.6% of the study subjects were anemic, and iron deficiency accounted for 88% of this anemia. However the strongest predictor of iron status was intensity of hookworm infection, with 74% of women affected. Infection with hookworm and *P. vivax* malaria were the strongest predictors of moderate to severe anemia, while low serum retinol (indicating vitamin A deficiency) was most strongly associated with mild anemia.[49] These studies illustrate the fact that although iron deficiency may be the primary cause of anemia, the disease factors contributing to depleted iron stores may vary and need to be assessed and addressed along with improving dietary iron intake.

1.4 Consequences of Anemia

Anemia in women leads to a variety of serious consequences, which are described below. These range from decreased work productivity and resulting economic losses, to maternal mortality. Anemia in pregnancy is also linked to adverse birth outcomes, thus contributing to an inter-generational cycle of poor health and compromised development.

1.4.1 Reduced work productivity

Hemoglobin transports oxygen in the blood for delivery to the body's tissues. Therefore one of the first signs of low hemoglobin, or anemia, is fatigue, due to lack of oxygen for physical activity. For the world's many anemic women, this causes work productivity and incomes to suffer, as well as the ability to carry out daily tasks and to nurture and care for children. The relationship between anemia and reduced productivity has been well documented. A literature review examining the association between iron deficiency and work capacity identified a strong causal effect of severe and moderate iron deficiency anemia on aerobic capacity, which translates into reduced physical activity and productivity.[50] Studies in a variety of countries have shown an improvement in work capacity for labourers in various occupations with the provision of iron supplementation.[51] A review of studies comparing work output in relation to changes in hemoglobin found consistent results across countries and contexts. A 10 percent increase in hemoglobin levels was associated with a 10 to 20 percent increase in work output.[52]

Given the clear relationship between iron deficiency anemia and reduced work capacity, there is value in improving iron status as a means of enhancing human capital, as well as for the health benefits to the individual. Anemia exacts a tremendous economic toll on developing countries. Anemia in young children is a widespread public health problem and is associated with irreversible cognitive deficits,[53] resulting in reduced wage-earning potential in adulthood. This

[48] Tatala S, Svanberg U, Mduma B. Low dietary iron availability is a major cause of anemia: a nutrition survey in the Lindi District of Tanzania. AJCN 1998;68:171-8.
[49] Dreyfuss ML, Stoltzfus RJ, Shrestha JB et al. Hookworms, malaria and vitamin A deficiency contribute to anemia and iron deficiency among pregnant women in the plains of Nepal. J Nutr 2000;130:2527-2536.
[50] Haas JD, Brownlie T IV. Iron deficiency and reduced work capacity: a critical review of the research to determine a causal relationship. J Nutr 2001;131:676S-690S.
[51] WHO/UNICEF/UNU. Iron deficiency anaemia: assessment, prevention, and control. Geneva, World Health Organization, 2001. (WHO/NHD/01.3).
[52] Levin H. A benefit-cost analysis of nutritional interventions for anemia reduction. Population, Health & Nutrition Department Technical Note 85-12. Washington DC, World Bank, 1985.
[53] Grantham-McGregor S, Ani C. A review of studies on the effect of iron deficiency on cognitive development in children. J Nutr 2001;131:649S-668S.

effect, combined with labour losses from anemic adults in the workforce leads to significant economic losses. These have been estimated for several countries. The median cost has been estimated at $4 US per capita or approximately 0.9% of a developing country's GDP. South Asia bears the greatest actual loss – estimated at more than $5 billion annually - as the prevalence of anemia is highest and reliance on manual labour significant in this region.[54]

1.4.2 Increased maternal mortality

Severe anemia (Hb<7 g/dL) in pregnancy is associated with increased risk of maternal mortality. It has been estimated that the increased risk of death for pregnant women with Hb <7 g/dL is 1.35, and that those with Hb <5g/dL have a 3.5 times greater risk of dying from obstetric complications compared with non-anemic women.[55] A causal link between moderate anemia and maternal mortality has not yet been established, although the management of mild and moderate anemia is an important component of preventing the onset of severe anemia, which is directly linked to maternal deaths. However, broad-based interventions aimed at preventing or treating milder forms of anemia (such as iron supplementation) are unlikely to effectively address severe anemia. Saving mothers' lives through management of severe anemia requires a more focused and aggressive treatment approach.[56]

Estimates of the contribution of anemia to global maternal mortality vary, with suggested figures ranging from 67,500[57] to 111,000[58] maternal deaths per year. The World Bank estimates that approximately 10% of maternal deaths could be averted if full coverage of treatment for both iron deficiency anemia and malaria were to be implemented globally.[59]

1.4.3 Adverse birth outcomes

The results of several studies have shown an association between maternal iron deficiency anemia in early pregnancy and a greater risk of preterm delivery and consequent low birth weight.[60] Low birth weight greatly increases the risk of neonatal mortality and morbidity,[61] and is also associated with a variety of deficits in health, development and cognitive growth for the surviving infant. In addition, infants of anemic mothers have reduced iron stores continuing into the first year of life, increasing their vulnerability to iron deficiency and anemia.[62] This in turn contributes to compromised cognitive development in early childhood, even if the iron deficiency is corrected.

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[54] Ross J, Horton S. Economic consequences of iron deficiency. Ottawa, Micronutrient Initiative, 1998.
[55] Brabin BJ, Hakimi M, Pelletier D. An analysis of anemia and pregnancy-related maternal mortality. J Nutr 2001;131:604S-615S.
[56] Rush D. Nutrition and maternal mortality. Am J Clin Nutr 2000;72(suppl):212S-40S.
[57] Vitamin and mineral deficiency: A global progress report. The Micronutrient Initiative, UNICEF, 2003.
[58] UN SCN. *Nutrition for Improved Development Outcomes:* 5th Report on the World Nutrition Situation. Geneva, 2004.
[59] Wagstaff A, Claeson M. The Millennium Development Goals for health: rising to the challenges. Washington: The World Bank, 2004.
[60] Allen LH. Anemia and iron deficiency: effects on pregnancy outcome. Am J Clin Nutr 2000;71(suppl):1280S-4S.
[61] Ashworth A. Effects of intrauterine growth retardation on mortality and morbidity in infants and young children. Eur J Clin Nutr 1998;52(S1):34-42.
[62] De Pee S, Bloem MW, Sari M et al. The high prevalence of low hemoglobin concentration among Indonesian infants aged 3-5 months is related to maternal anemia. J Nutr 2002;132(8):2215-21.

However, studies also show that abnormally high hemoglobin concentrations increase the risk of low birth weight and other adverse birth outcomes. This is caused by poor plasma volume expansion and hypertensive disorders of pregnancy, rather than iron status. Provision of supplementary iron in pregnancy will not elevate hemoglobin concentration above levels needed for optimum oxygen transport.[63]

1.5 Conclusion

Anemia is a widespread global public health problem. Women are particularly vulnerable, and more than half of all pregnant women in developing countries suffer from anemia. Iron deficiency is the primary cause, but a variety of other nutritional deficiencies and infectious diseases contribute significantly to the global burden of anemia. The consequences of anemia are serious and include economic losses, maternal mortality and adverse birth outcomes. A variety of interventions for anemia prevention and control are available, addressing all the major causes, but experience with effective program implementation has been limited. This issue is further explored in the remainder of the chapter.

2.0 Programs for Anemia Prevention and Control

2.1 Principles of Effective Programming

Despite the high prevalence of anemia and its serious consequences, very few examples of effective anemia control programs exist. This may be due to the multi-factorial etiology of anemia and the fact that there is not one easily administered solution available. Many individual interventions have been shown to be efficacious in research trials but when implemented on a wider scale in a non-controlled setting, they have typically not proven to be effective. This is particularly the case with iron supplementation, where issues of access, supply, compliance and poor health counseling regarding the purpose of the supplement have led to little change in anemia rates despite widespread implementation.[64, 65]

The lack of evidence of effective programs can lead to pessimism as to whether anemia really can be reduced on a wide scale. However the issue is not that appropriate interventions do not exist, but that the barriers to implementing them in an integrated manner in independent populations (as opposed to research settings) need to be better understood and overcome. The international community has made a renewed commitment to reducing anemia by one-third by 2010, and if this is to be achieved, it will require multiple interventions that target the various causes of anemia and also reach people at all levels of society. For example, commercial fortification of staple grains, condiments and other widely consumed products is an excellent strategy to increase iron intake of urban dwellers and other populations that purchase their food from commercial sources. However in settings where most people are subsistence farmers, this intervention will not have the desired impact, and other means of increasing iron intake, such as home-based fortification and raising of small animals, are needed.

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[63] Yip, R. Significance of an abnormally low or high hemoglobin concentration during pregnancy: special consideration of iron nutrition. Am J Clin Nutr 2000;72(suppl):272S-9S.

[64] Yip R. Iron supplementation during pregnancy: is it effective? Am J Clin Nutr 1996;63:853-5.

[65] Galloway R, Dusch E, Elder L et al. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Soc Sci Med 2002 Aug;55(4):529-44.

In summary, the development of effective anemia control programming first requires analysis of the main determinants of anemia in the target population and then selection of interventions that are most likely to be effective given the socio-demographic characteristics of the intended beneficiaries. This is best accomplished through collaboration with multiple partners and integration of anemia control interventions with appropriate existing structures and services.[66, 67]

2.2 Program Examples

Although they are few in number, examples of this type of programming do exist. As early as the 1970s the government of Thailand identified anemia control as a national priority. Pregnant women were selected as the primary target group, and an improved system of antenatal care, including iron supplement distribution, was instituted using a network of village health volunteers. Logistical improvements ensured a regular supply of supplements and qualitative research was used to strengthen health counseling services regarding anemia and iron supplements. Although a comprehensive evaluation of the program has not been undertaken, National Nutrition Survey data indicates an impressive reduction in the prevalence of maternal anemia, from approximately 32-48% in the 1980s (depending on geographic region) to 8-28% by the late 1990s. [68] Thailand's anemia control strategy is now focusing on other target groups and additional interventions, such as weekly iron supplementation to school children and women of childbearing age (implemented through workplaces), and food fortification.

In Egypt, anemia prevalence among adolescents was reduced by 20% (from 30% to 24%) through a school-based program that provided weekly iron supplements and nutrition education to both girls and boys. These interventions were selected after it was determined that neither hookworm nor malaria was a major contributor to anemia in the target population. Control of schistosomiasis in school-aged children was already an existing intervention and so the anemia control program focused exclusively on iron deficiency, with significant success.[69]

In the 1990s the Malawi Maternal Anemia Control Program assessed the contributors to anemia among pregnant women in Thyolo District. The analysis showed that both socio-economic status (suggesting dietary factors) and malaria were linked to anemia, and so the project interventions focused on iron supplementation and improving antenatal care services (which included malaria prophylaxis). Follow-up evaluation showed that the prevalence of anemia had been significantly reduced in post partum women (those who delivered in the 6 months prior to the survey), from 61% to 51%. Anemia prevalence also decreased in pregnant women, but the change was not statistically significant. However women's intake of iron supplements greatly increased and antenatal care services improved as a result of the program, and the need for anemia control measures reached the national health agenda, paving the way for future initiatives.[70]

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[66] Trowbridge F. Prevention and control of iron deficiency: priorities and action steps. J Nutr 2002; 132:880S-882S.
[67] Joint statement by the World Health Organization and the United Nations Children's Fund. Focusing on anemia: towards an integrated approach for effective anaemia control. Geneva, WHO, 2004.
[68] Winichagoon P. Prevention and control of anemia: Thailand experiences. J Nutr 2002; 132:862S-866S.
[69] Egypt's Adolescent Anemia Prevention Program: A report on program development, pilot efforts and lessons learned. Ministry of Health & Population and Health Insurance Organization.
[70] MotherCare. Malawi maternal anemia program 1995-1998. Technical Working Paper #10. Arlington, Va.: MotherCare/John Snow, Inc., project, 2000.

New endeavours that hold promise for reaching the international target of a 30% reduction in anemia by 2010 include the comprehensive approach currently being rolled out in five Central Asia countries. Kazakhstan, Uzbekistan, the Kyrgyz Republic, Turkmenistan and Tajikistan all share a common anemia prevention and control strategy that was developed in consultation with multiple partners. In line with the recommendation to address anemia through integration of key interventions, the strategy includes wheat flour fortification, iron supplementation to vulnerable groups, dietary diversification and nutrition education, and control of diseases such as malaria and helminth infections.[71] Although no evaluation results are available yet, this is a promising example of a multi-faceted, comprehensive approach to anemia control.

2.3 Conclusion

The current prevalence of anemia in women in developing countries is unacceptably high and a more intensive effort is required to address it. Although there are many challenges to the management of anemia, a few examples and models of successful initiatives do exist. Effective anemia prevention and control requires analysis of the main causes of anemia in the target population followed by implementation of a package of relevant interventions, integrated within existing structures and services, including health care, agriculture and education, and the private sector (e.g., food processing).

The final section of this chapter presents a more detailed case study of an anemia control program implemented in Malawi and Ghana, which demonstrates the principles of effective programming outlined above. As the other examples cited indicate, these principles can be applied in a wide range of program contexts, with positive results.

3.0 Case Study: Anemia Prevention and Control in Ghana and Malawi

3.1 Overview of MICAH Program

The MICronutrients And Health (MICAH) program was launched in 1995 by World Vision Canada with funding from the Canadian International Development Agency (CIDA). The goal of the program was to reduce the prevalence of micronutrient deficiencies in women and children, in line with international targets set at the 1990 World Summit for Children for the virtual elimination of vitamin A and iodine, and the reduction of iron deficiency anemia in women and children by one-third.

MICAH was implemented in five African countries (Ethiopia, Ghana, Malawi, Senegal and Tanzania) from 1996-2005. The first phase of the program (1996-2000) reached 3.8 million people, and the second phase (2001-2005) served a total beneficiary population of 2.7 million. The program design was based on the following characteristics:

- **Evidence based**. A baseline survey was conducted in each country to determine the major micronutrient deficiencies, target groups and priority intervention strategies. This led to context-specific program plans designed to address real needs. The program was

[71] Gleason GR, Sharmanov T. Anemia prevention and control in four Central Asian republics and Kazakhstan. J Nutr 2002; 132;867S-870S.

monitored on a regular basis and was rigorously evaluated through cross-sectional surveys in 2000 and 2004.

- **Comprehensive.** MICAH partners implemented multiple interventions to address anemia and other micronutrient deficiencies. In addition, the program influenced micronutrient deficiency control at various levels, from advocacy for national policy change, to supporting village health volunteers to distribute iron supplements to empowering women in households to raise small animals.
- **Collaborative**. Although World Vision was the key implementing agency in each country, partnerships with government ministries and other agencies working in the fields of nutrition, health and agriculture were essential to the success of the program, and MICAH interventions were integrated into existing systems, structures and services. In Ethiopia and Malawi, partner organizations directly implemented the interventions in many locations.

Results from Ghana and Malawi are presented as examples of how these programming principles were applied in different contexts in order to reduce the prevalence of anemia in women.

4.0 Ghana

4.1 Background

The MICAH Program was implemented in 110 rural farming communities in the Kwahu West and Kwahu South Districts of the Eastern Region of Ghana, covering a total population of about 150,000. The District Health Management Team (DHMT) of the Ministry of Health selected the communities with consideration being given to those that were under-serviced and inaccessible to health staff, and where a high prevalence of anemia and goiter (evidence of iodine deficiency) had been identified. HIV prevalence is low in Ghana, with an estimated infection rate among adults of 3.1%,[72] so this was not a major influence on the effectiveness of MICAH interventions.

The MICAH activities were implemented in close collaboration with the Ghana Health Service, Ministry of Food and Agriculture, Ghana Education Service, Environmental Health Unit, Ministry of Local Government and the District Assemblies.

4.2 Anemia Prevention and Control Strategy

The key strategy implemented by MICAH Ghana for anemia control was iron/folic acid (IFA) supplementation to vulnerable groups. Dietary diversification activities were also implemented, including promotion of household gardens and raising small animals for meat consumption. Household gardening activities included the promotion of citrus fruits as a source of vitamin C to enhance iron absorption. However the raising of small animals, which has the potential to significantly increase dietary iron intake and absorption, was introduced later in the program lifetime, with limited coverage. Although some malaria

[72] UNAIDS data: http://www.unaids.org/en/Regions_Countries/Countries/ghana.asp.

prevention activities were undertaken (particularly environmental measures to reduce mosquito breeding grounds), the prevalence of malaria in women was found to be low during the baseline survey[73] (6.0% in non-pregnant women) and so was considered unlikely to be a major contributor to the high prevalence of anemia in women. Hookworm prevalence in school-aged children (a measure of infection burden in the overall population) was also low (4.4%) and so the anemia strategy focused primarily on improving iron intake through supplementation, with a minor emphasis on preventing malaria and hookworm.

Two target groups were selected for iron supplementation: pregnant women, who received daily supplements through antenatal clinics, and non-pregnant women of childbearing age, who received weekly supplements through community health volunteers. Both these groups were included as a result of the baseline finding that anemia prevalence was at the level of a severe public health problem in all women, not just pregnant women.

The program achieved excellent coverage for IFA supplementation in both target groups and monitoring activities showed very high compliance rates. In fact, as women in the communities realized the benefits of improved hemoglobin levels, older women and men who were outside the target group for supplementation began to request IFA for themselves as well. This is a qualitative example of compliance and increased demand (beyond what the program could supply) for IFA supplements.

4.3 Methods of Evaluation of Program Effectiveness

The effectiveness of the MICAH program was evaluated through a series of cross-sectional surveys conducted at baseline in 1997, at mid-term in 2000 and at the close of the program in 2004. Multiple-indicator cluster survey methodology was followed. The 2000 and 2004 surveys included comparison groups from non-MICAH communities. Although these were not strict control groups they provide a basis of comparison with the neighbouring program areas. Further detail on the evaluation methodology is available in the final survey report.[74]

4.4 Results

The program was effective in decreasing the prevalence of anemia among pregnant and non-pregnant women, when compared both to initial levels and non-MICAH comparison areas (Table 8). Indeed, over the seven years of the MICAH program, there was a 65% or two-thirds reduction of 1997 levels of anemia. This is twice the international target of reducing anemia by one-third. Anemia among women in the MICAH areas of Ghana moved from a severe public health range to a mild (non-pregnant) or moderate (pregnant) range. In the non-MICAH comparison areas, the prevalence of anemia remained at the high end of the moderate range in both pregnant and non-pregnant women.

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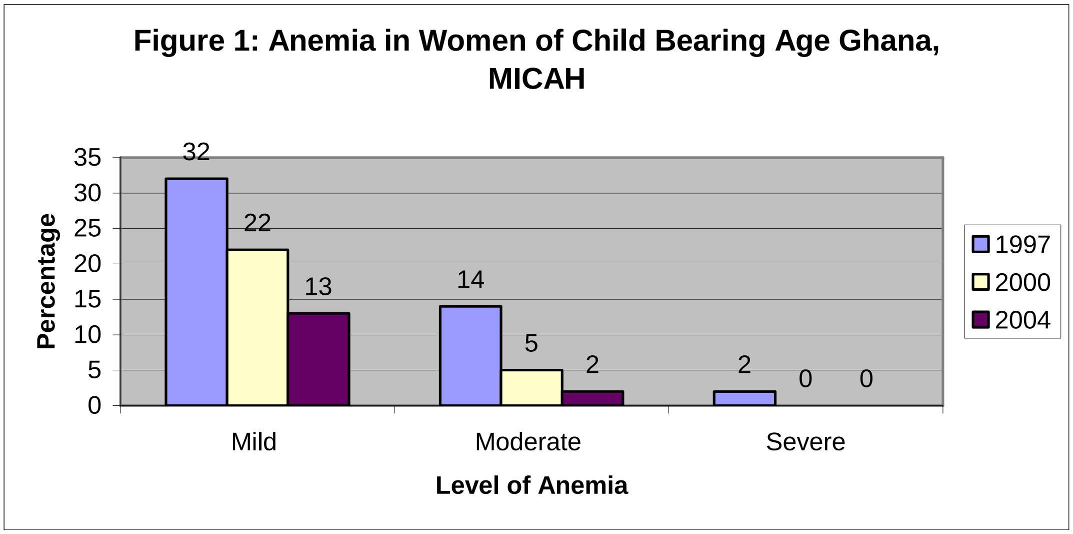
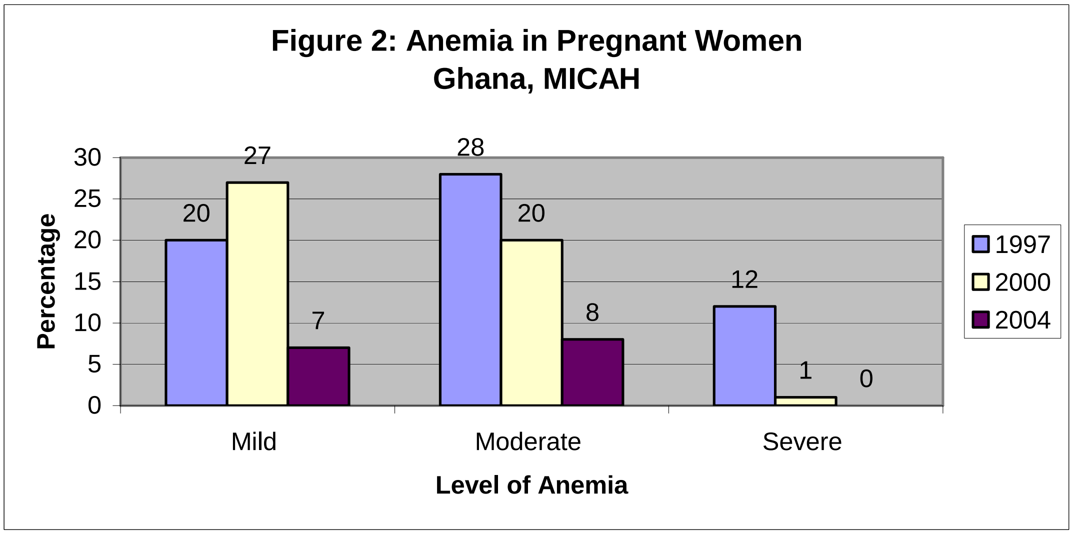
[73] MICAH Ghana Baseline Survey Report. World Vision, 1997.
[74] MICAH Ghana. Final survey report, 2006. World Vision Canada, 1 World Drive, Mississauga, Ontario.

Table 8: MICAH Ghana Anemia Results in Women of Child Bearing Age and Pregnant Women, Comparing Baseline and Follow-up Surveys					
Indicator	**Baseline Survey (1997)**	**Follow-up Survey (2000)**		**Final Survey (2004)**	
	MICAH (n)	**MICAH (n)**	**Non-MICAH (n)**	**MICAH (n)**	**Non-MICAH (n)**
Women of child bearing age:					
Anemia prevalence (Hb<12g/dL)	47.9 (261)	26.9* (450)	38.0 (50)	16.1* (323)	32.3** (127)
Mean Hb ± SD (g/dL)	11.7 ± 1.8 (261)	12.8* ± 1.6 (450)	12.5 ± 1.5* (50)	12.9* ± 1.2 (323)	12.6 ± 1.4** (127)
IFA supplement coverage (weekly) (%)	NA	93.9 (380)	0** (43)	75.7 (309)	1.6** (124)
Attended Antenatal Clinic (during previous pregnancy) (%)	91.8 (282)	94.3 (420)	93.8 (48)	98.4 (309)	95.2** (124)
Malaria prevalence (%)	6.6 (259)	6.0 (385)	10.0 (50)	3.0* (304)	8.8** (125)
Have mosquito net (%)	NA	NA	NA	38.2 (309)	14.5** (124)
Pregnant women:					
Anemia prevalence (Hb<11g/dL)	60.0 (25)	48.4* (159)	NA	18.2* (383)	35.9** (159)
Mean Hb± SD (g/dL)	10.3 ± 2.6 (25)	11.0* ± 1.5 (159)	NA	12.1* ± 1.5 (383)	11.6 ± 1.7** (159)
IFA supplement coverage during current pregnancy (%)	21.7 (23)	69.7* (155)	NA	69.2* (380)	65.2 (155)
Attended Antenatal Clinic (during previous pregnancy) (%)	75.0 (24)	92.9 (156)	NA	96.3 (380)	90.3** (155)
Malaria prevalence (%)	4 (25)	6.6 (136)	NA	2.4 (363)	17.6** (153)
Have mosquito net (%)	NA	NA	NA	34.2 (380)	10.3** (155)
School Age children:					
Hookworm prevalence (%)	4.4 (182)	3.2* (354)	NA	0.8* (491)	0.8 (132)
* = p value <0.05 for test of statistical difference between baseline and follow-up ** = p-value <0.05 for test of statistical difference between MICAH and non-MICAH					

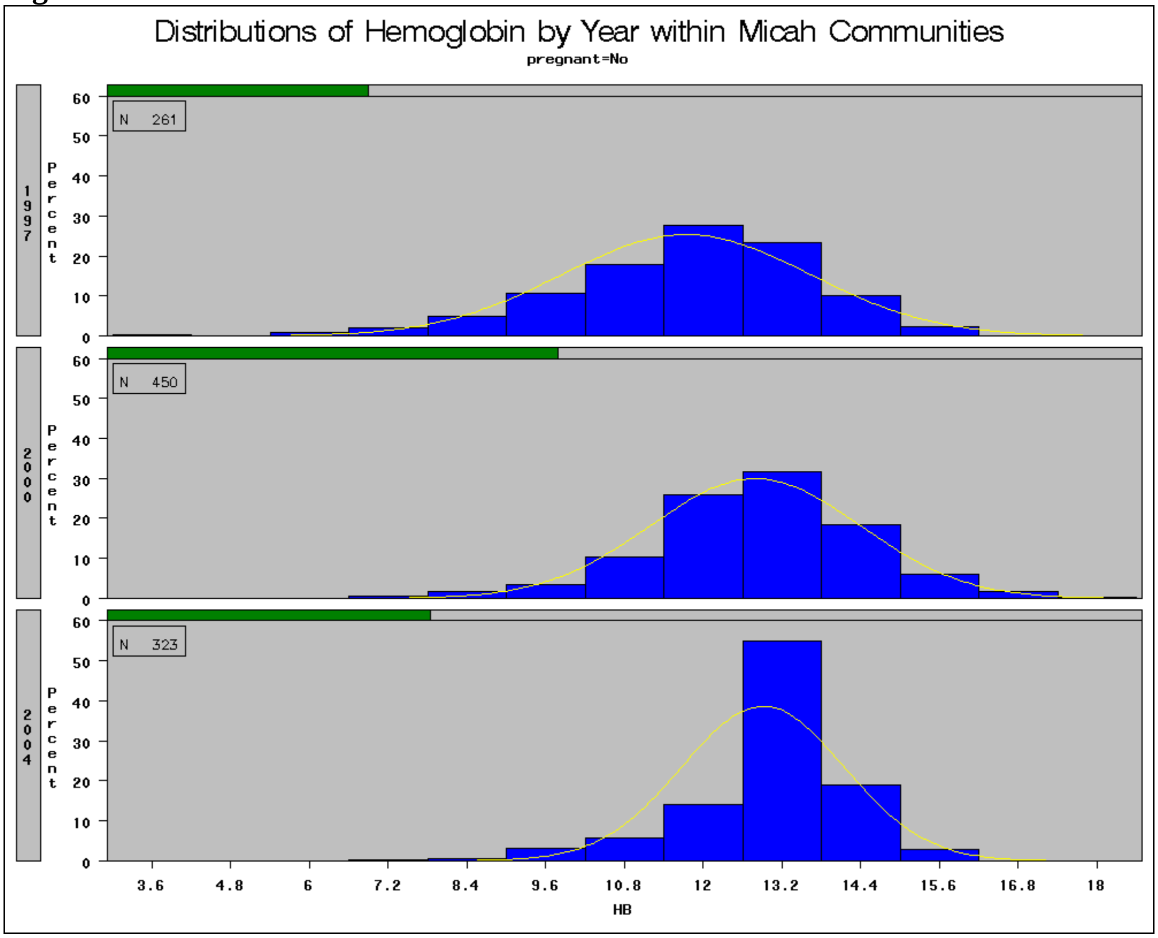
In addition to the overall reduction in anemia prevalence in MICAH areas, Figures 1 and 2 show the shift in relative proportion of mild, moderate and severe anemia over the program lifetime.





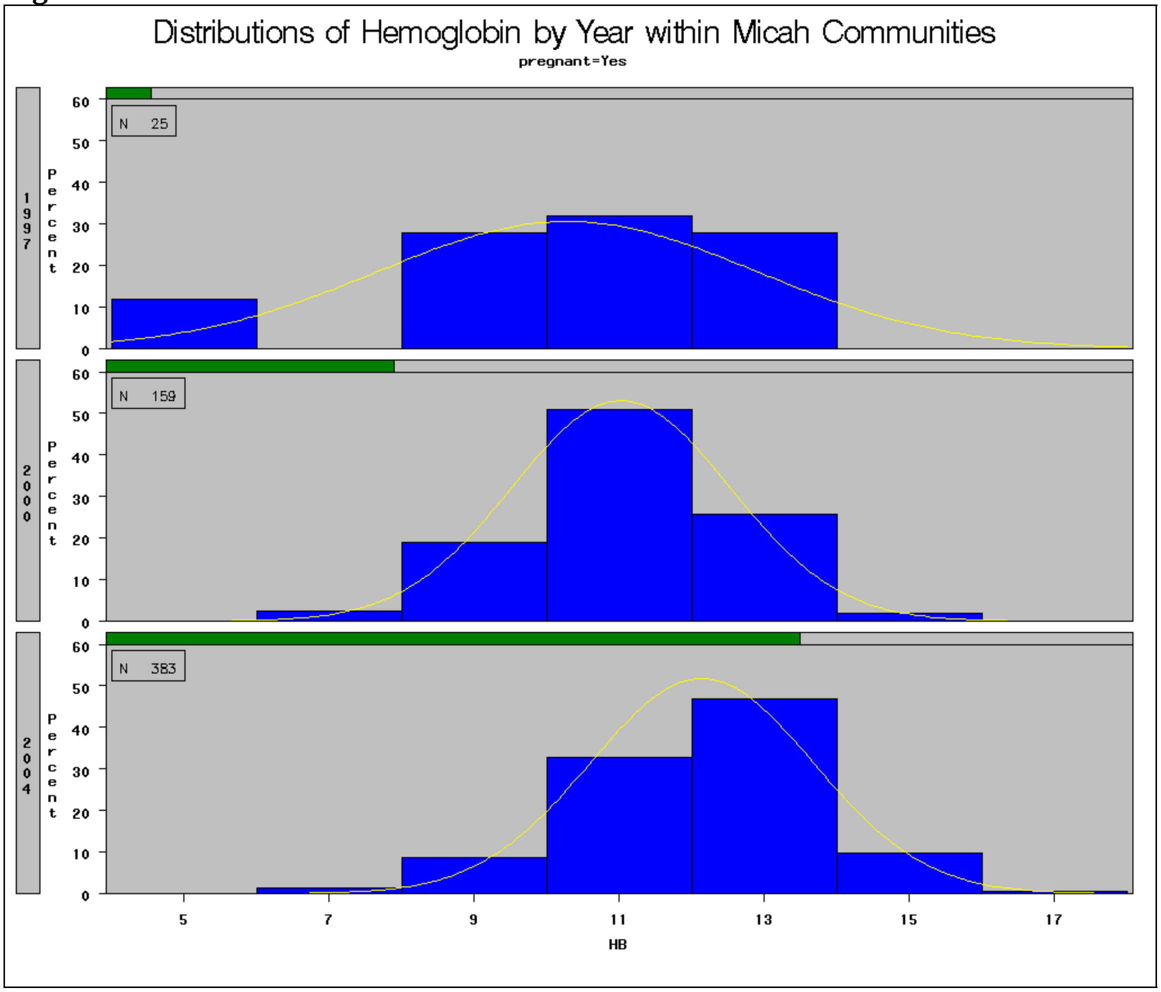
The clear trend of decreasing anemia prevalence is also reflected in the distribution of hemoglobin values. As Figures 3 and 4 illustrate, the distribution curves for both pregnant and non-pregnant women in MICAH areas shifted markedly to the right (higher Hb levels) over the course of the program.

Figure 3.



Distributions of Hemoglobin by Year within Micah Communities
pregnant=No
1997
2000
2004
Percent
N 261
N 450
N 323
0
10
20
30
40
50
60
3.6
4.8
6
7.2
8.4
9.6
10.8
12
13.2
14.4
15.6
16.8
18
HB

Figure 4.



4.5 Discussion

Two key observations from the MICAH Ghana experience provide useful lessons that may inform anemia control efforts in other settings. The first is that weekly IFA supplementation can be effectively implemented, reducing the prevalence of anemia in non-pregnant women. The second is that although coverage of IFA supplements to pregnant women was very high in both MICAH and non-MICAH areas in 2004, anemia rates were significantly lower in the MICAH areas, where women had received regular iron supplementation prior to becoming pregnant. This suggests that where anemia is in the severe public health range among non-pregnant women, provision of IFA only during pregnancy is insufficient to prevent maternal anemia. These two issues are discussed below in further detail.

4.5.1 Weekly iron supplementation is an effective means of reducing the prevalence of anemia in non-pregnant women of childbearing age

Extensive debate has taken place in the scientific community regarding the relative efficacy and effectiveness of daily versus intermittent (i.e. weekly) iron supplementation to high-risk groups. A review of available evidence led to the conclusion that daily supplementation remains the intervention of choice for anemia control in pregnant women.[75] However, the potential for weekly iron supplementation as an anemia prevention and control measure in other vulnerable groups continues to be explored, with many positive results. It may be that ultimately the issue of feasibility of supervision to ensure compliance will be what determines the benefit of one supplementation regime over another.[76]

Weekly IFA supplementation to women of childbearing age, along with increased prevention of malaria, through MICAH Ghana led to a 66% reduction in the prevalence of anemia in this group (from 48% to 16%) over the seven year program lifetime. By 2004 the prevalence of anemia was significantly lower in the MICAH (16%) compared with non-MICAH (32%) areas. The MICAH experience demonstrates that operational challenges to effective, long-term supplementation programs for anemia prevention can be overcome, with impressive results.

In order to accomplish this, MICAH Ghana implemented a well-planned approach to IFA distribution, designed to address the major points of weaknesses in many IFA supplementation initiatives. The typical limitations of such programs include irregular supply of tablets, inadequate supervision, and lack of appropriate health counseling regarding the supplements. However these common barriers were well managed in the MICAH approach and did not compromise results. The main contributors to the successful coverage of IFA supplementation to non-pregnant women in MICAH Ghana include the following:

- **Integration within existing health system**. The MICAH program relied on a strong partnership with the Ministry of Health at the district and sub-district levels. Responsibility for distribution of IFA supplements was integrated into the mandate of the existing Sub-District Health Teams, who provide a variety of maternal and child health services to the communities. However additional support for IFA supplementation was provided by a network of community health volunteers (CHVs) established by MICAH. The CHVs worked closely with the Sub-District Health Teams and were supervised by the Ministry of Health staff. MICAH provided regular training and capacity building opportunities for the CHVs, particularly related to counseling women regarding the importance, purpose and correct dosing of the IFA tablets.

- **Community-based distribution**. Using the network of CHVs, the program was able to provide IFA supplements to women within their own communities. This is a key aspect of achieving high coverage with routine supplementation. Compliance rates tend to drop dramatically if women are not able to access the supplements in their home area but must travel to obtain them. In MICAH Ghana, women would come to local distribution points and collect a month's supply of IFA supplements at a time. The CHVs were given small incentives on an annual basis in recognition of their work, and their role was key to the success of the weekly IFA supplementation for women of childbearing age.

[75] Beaton GH, McCabe GP. Efficacy of intermittent iron supplementation in the control of iron deficiency anemia in developing countries. The Micronutrient Initiative, Ottawa, 1999.
[76] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. Am J Clin Nutr 2000;72(suppl):257S-64S.

- **Management of supply and logistics**. The MICAH program was responsible for ordering IFA tablets on a semi-annual basis and ensuring their distribution to the sub-district level through the Ministry of Health system. Shortages in the supply of tablets was not an issue. However it is a concern for the future, as the sustainability of the intervention following the close of MICAH depends on reassignment of responsibility for managing the supply of tablets, as well as funding for their purchase. Advocacy for funding to ensure the continuation of routine IFA supplementation is being undertaken. Given the high economic costs of anemia to developing countries, the investment of core health care funding in a proven effective anemia prevention and control strategy would yield a high return.

- **Effective behaviour change communication**. The program included a strong nutrition education component, particularly at the community level. Messages regarding the causes and consequences of anemia and the importance of women taking regular IFA tablets were disseminated through a variety of culturally appropriate avenues. These included radio talks and presentations in mosques, churches, and marketplaces. The nutrition education activities included clear information aimed at improving compliance to IFA supplementation, such as descriptions of possible side effects and ways to manage them, and tips for remembering to take the tablets according to the dosing schedule.

Although contexts vary and creativity to adapt to local conditions is always needed in the development of effective health programs, inclusion of the factors outlined above is key to effective IFA supplementation programming. With careful planning and strong partnerships, the common failures of supplementation programs can be avoided, and the prevalence of anemia in non-pregnant women of childbearing age can be significantly reduced.

4.5.2 High IFA coverage to pregnant women does not effectively reduce maternal anemia prevalence when pre-existing levels of anemia are in the severe public health range

There was a significant decrease in anemia in pregnant women in MICAH areas, from 60% at baseline to 18% in 2004. At the same time, IFA coverage significantly increased from 22% to 69% in MICAH areas. In non-MICAH comparison areas IFA supplementation coverage was similarly high (65%) at the time of the final survey, but anemia prevalence was much greater (36%).

The difference in anemia prevalence rates may be partly due to the much higher prevalence of malaria among pregnant women in the non-MICAH areas (18%) compared with MICAH areas (2%).[77] The lower prevalence of malaria in the MICAH areas may have been due to higher mosquito net coverage (34% vs. 10% in non-MICAH areas). Coverage of anti-malarial medication (IPT) to pregnant women was significantly higher (p=0.04) in MICAH areas (61.5%) compared with non-MICAH (54.5%), but in both groups coverage of this intervention was greater than 50%.

However, notwithstanding the contribution of malaria, iron deficiency is likely to be the major cause of anemia in pregnant women in non-MICAH areas. This is typical in developing countries and was shown to be the case in the MICAH areas through the effective use of IFA supplementation to address anemia. The comparison between anemia rates and IFA coverage for

[77] MICAH Ghana Final Survey Report. World Vision, 2006.

pregnant women in MICAH and non-MICAH areas at the final survey strongly suggest that provision of IFA supplementation only to pregnant women is not an effective means of controlling maternal anemia in settings where anemia prevalence is in the range of a severe public health problem in all women of childbearing age. Given the body's additional demand for iron in pregnancy, it is unreasonable to expect that women entering pregnancy in an anemic or iron deficient state will be able to attain and maintain normal hemoglobin status even with high compliance to a daily IFA supplementation regime.

The international health community is increasingly adopting a lifecycle approach to anemia prevention and control. This includes the recognition that pre-existing iron deficiency or anemia is difficult to correct in pregnancy, and that reducing the widespread prevalence of maternal anemia requires improved iron intake in adolescent girls and women of childbearing age prior to first pregnancy, [78] in addition to the recommended universal daily IFA supplementation during pregnancy.[79] Weekly IFA supplementation to non-pregnant women followed by daily IFA supplementation during pregnancy, while also implementing measures to prevent malaria, can effectively reduce anemia in pregnancy, as the MICAH Ghana experience demonstrates. Similar results have been reported in other contexts. For example, a social marketing initiative in Vietnam promoted weekly IFA supplementation to women of childbearing age, with the result that when the women became pregnant, their hemoglobin levels were maintained at normal levels in the first two trimesters, and the prevalence of low birth weight infants was minimal.[80]

4.6 Conclusion

One of the chief limitations of IFA supplementation as a strategy for anemia prevention is the difficulty of effectively programming the intervention on a wide scale.[81] Issues of supervision, which include ensuring both regular supply of tablets and women's compliance with the supplementation regime, have frequently been cited as reasons for the ineffectiveness of many large-scale IFA supplementation initiatives.[82] However, where iron deficiency anemia is a severe public health problem, IFA supplementation still offers one of the most efficacious means of improving hemoglobin status in both pre-

[78] Viteri FE, Berger J. Importance of pre-pregnancy and pregnancy iron status: can long-term weekly preventive iron and folic acid supplementation achieve desirable and safe status? Nutr Rev 2005 Dec;63(12 Pt 2):S65-76.
[79] Allen LH. Iron supplements: scientific issues concerning efficacy and implications for research and programs. J Nutr 2002;132:813S-819S.
[80] Berger J, Thanh HT, Cavalli-Sforza T et al. Community mobilization and social marketing to promote weekly iron-folic acid supplementation in women of reproductive age in Vietnam: impact on anemia and iron status. Nutr Rev 2005 Dec;63(12 Pt 2):S95-108.
[81] Bothwell TH. Iron requirements in pregnancy and strategies to meet them. Am J Clin Nutr 2000;72(suppl):257S-64S.
[82] Yip R. Iron supplementation during pregnancy: is it effective? Am J Clin Nutr 1996;63:853-5.

pregnant and pregnant women. Women of childbearing age are an important target group for supplementation in areas where anemia prevalence is in the severe public health range. Improving women's iron status prior to pregnancy, followed by daily iron supplementation to maintain normal hemoglobin status during pregnancy, can significantly reduce maternal anemia and its associated consequences.

The experience of MICAH Ghana shows that the implementation challenges to providing routine IFA supplementation to women of childbearing age can be overcome if existing local systems and structures are appropriately utilized. In rural Ghana this involved strong partnership with the Ministry of Health and mobilization of a network of community health volunteers, but in other settings it may be more appropriate to deliver IFA through avenues such as workplaces or the private sector.[83] In Indonesia, the Ministry of Health and MotherCare project used marriage registries to reach young women with messages about IFA supplementation. Follow-up monitoring after 3-4 months of the intervention showed that anemia prevalence in the newly married women had decreased by 40%, from 23.8% at baseline to 14.0%.[84] More of this kind of innovative, context-specific approach to delivery systems for IFA supplementation to women of childbearing age is urgently needed as part of the global effort to reduce anemia.

5.0 Malawi

5.1 Background

Malawi is one of the world's poorest countries, with a largely rural population reliant on subsistence farming for survival. Large regions of the country are affected by recurrent drought, and in recent years HIV prevalence has dramatically increased. Official estimates suggest over 14% of the adult population is infected with HIV,[85] and a higher level of seropositivity (30%) has been identified in pregnant women.[86] As in other southern African countries, the HIV/AIDS epidemic has left a devastating impact on the labour force and social structure in Malawi.

The MICAH program was implemented in all three regions of Malawi (north, central and south), targeting1.8 million people. The program operated in 19 project sites, covering 14 of the 26 districts in the country. The program operated largely in the rural areas, where people are mainly subsistent farmers, growing crops of maize and beans. The selected project areas reflected expressed needs by communities, with assistance from government line ministries and assessment by the World Vision field staff in the areas. Proposals were submitted to the World Vision Malawi MICAH office for consideration and were funded if they met the set criteria of the steering committee.

Key program partners included government institutions such as the Agriculture Development Divisions (ADDs) of the Ministry of Agriculture and Irrigation, the Ministry of Health and

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[83] Yip R. Iron supplementation: country level experiences and lessons learned. J Nutr 2002;132:859S-861S.
[84] Jus'at I, Achadi EL, Galloway R et al. Reaching young Indonesian women through marriage registries: an innovative approach for anemia control. J Nutr 2000;130:456S-458S.
[85] UNAIDS data: www.unaids.org/en/Regions_Countries/Countries/malawi.asp.
[86] Van den Broek NK, White SA, Neilson JP. The relationship between asymptomatic Human Immunodeficiency Virus infection and the prevalence and severity of anemia in pregnant Malawian women. Am J Trop Med Hyg 1998;59(6):1004-1007.

Population (MOHP), and the Community Health Sciences Unit (CHSU). Other partner agencies included non–governmental organizations (NGOs) operating in the health and agriculture sectors, and mission hospitals.

5.2 Anemia Prevention and Control Strategy

A cross-sectional baseline survey at the start of the MICAH program confirmed the presence of significant levels of anemia and malaria (59 and 24 percent, respectively) in pregnant women, and intestinal parasites (20% hookworm) in school aged children (see Tables 9,10). Based on these findings, the program design included a comprehensive package of interventions to address the contributors to anemia. As the major contributor to anemia in Africa is known to be iron deficiency, a major component of the program thus included a variety of interventions to increase the intake and bioavailability of iron such as, iron supplements (weekly to all women of child-bearing age and daily to pregnant women); increasing iron-rich foods and iron enhancers (e.g., animal foods, citrus fruits); food processing methods (e.g., soaking maize to decrease phytate); and fortifying staple foods (i.e., maize) with iron. In addition, the program included interventions to decrease diseases affecting anemia (e.g., malaria prevention and treatment; construction and use of latrines), as well as capacity building and advocacy for improved anemia programs at all government levels.

These interventions were integrated into existing community structures and services, in partnership with relevant government agencies and other groups as follows.

Interventions to Increase Iron intake:

- **Iron supplements** were provided daily at the community level to pregnant women through Traditional Birth Attendants (TBAs), and weekly to all women of childbearing age through trained Community Health Volunteers (CHVs). In order to ensure high compliance rates, the iron tablets were consumed in front of the CHVs and TBAs, who maintained register books with detailed records of each woman's supplement intake.

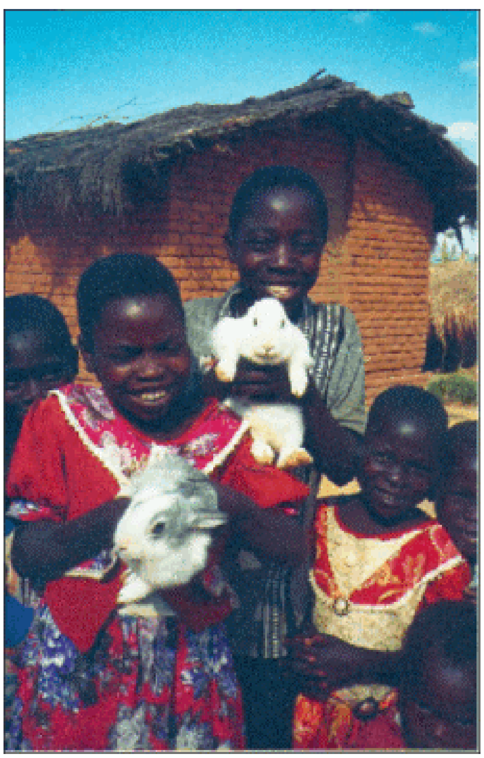
- **Dietary diversification** was a key component of MICAH Malawi's anemia control strategy. The typical diet in rural Malawi is very low in animal products and based on maize as a staple grain, which is very high in phytate, a potent inhibitor of iron absorption. MICAH Malawi intervened to increase household availability of animal foods for consumption by women through training and start-up assistance for small animal revolving schemes.

  By the end of the program in 2005, over 63% of total MICAH population reared and consumed small animals and fowl. The initial distribution of 36,243 animals resulted in revolving an additional 15,213 animals by end of program.

  A revolving scheme is a distribution method whereby the program provides initial animal stock to a number of individuals who have been selected according to criteria determined with the community. These individuals then give the first offspring from their animals to others in the community, and so on until full distribution is achieved. The beneficiaries were required to construct a shelter to house the animals or birds, according to training provided by staff from the Ministry of Agriculture Department of Veterinary Services. The animals included goats (initially), rabbits, chickens and guinea fowl. However, the accompanying nutrition education promoted the consumption of all animal source foods.

Initially the program focused on goats, by providing an improved variety of male goats for breeding with traditional local female goats to produce offspring with better meat and milk production potential. However a mid-term evaluation revealed that because goats are relatively large and important animals within the community setting, they were not being consumed on a regular basis by households, and were not under the control of the women, who provided meals for the household. Rather, they would be used for ceremonial purposes such as for a chief's wedding or funeral or major religious events. At these events, it was usually the men that would consume the meat and women would often only receive a small portion, if any at all. It was thus concluded that although the goats were valued as an input by the communities, the intervention was not directly contributing to an increase in women's consumption of animal source foods.

Through collaboration and discussion with the Ministries of Agriculture and Health and the MICAH implementing partners, the promotion of rabbits was identified as a possible means of improving the quality of dietary intake within the target area. Rabbits are small and therefore not as highly valued as the larger goats. Also, rabbits reproduce quickly, unlike the one goat kid per year, and were thus used by women for family meals. The lower perceived value of the rabbits also enabled the women to have decision-making control over the use of the rabbits, whereas the goats were under the control of the male household head.



Since the consumption of rabbit meat was new to most project communities, significant effort was required in introducing the concept. Cooking demonstrations and taste-tests involving influential members of the communities, particularly religious leaders, proved an effective means of overcoming initial hesitation regarding the rabbits. The staff also assessed each community to decide on the committee that would take up the responsibility of the rabbit revolving funds and identification of initial beneficiaries. In some cases, the initial beneficiary was the chief's household, or another influential member of the community. This was due to the fact that once these influential people adopted the new practice of rabbit rearing, it would be deemed acceptable by the others. In other cases, especially needy families would be identified as primary beneficiaries so that the community would be able to see the difference made in the diet and lives of the even people with few resources. In this way, the program adapted to the unique characteristics of each community in order to maximize the acceptance and coverage of the dietary diversification interventions.

In addition, MICAH Malawi promoted and supported the establishment of gardens at most households (final survey showed 55% of households with a garden) and 64 communal gardens, in close collaboration with the Ministry of Agriculture and Irrigation. The emphasis was on cultivation of fruits that enhance iron absorption through vitamin C (such as citrus fruits) or that are rich in vitamin A (mango, papaya), and dark green leafy vegetables from indigenous varieties. Solar driers were introduced as a best practice in preservation of fruits and vegetables, to provide a year-round source of micronutrients.

- **Fortification** was pilot-tested in MICAH Malawi through the addition of a micronutrient premix during grinding at the village mills. In rural Malawi, maize is grown on small plots by individual families and then brought by the women to village mills for grinding. Thus, the process of developing small scale fortification involved extensive consultation with local and international experts, experimentation with various methods of adding the micronutrient premix, and establishment of a strong partnership with the private sector (village mill owners and operators).

Effective communication to all stakeholders, particularly to the community members, was essential for acceptance of the fortified maize. During the initial start-up of the fortification services in any given project area, the community would be introduced to the concept of fortification through various media. Drama groups would make vivid demonstrations of the benefits of the fortified flour and how to fortify flour. Taste-testing competitions and cooking demonstrations enabled the community to try the fortified flour to demonstrate that there would be no changes in organoleptic properties. In communities where there was continued resistance to accept fortified flour, specific targeted messages were developed to address the key points of misconception. Also, project staff identified influential people in the community and targeted messages there.

After initial positive results, the intervention was expanded to cover 19 community mills, servicing approximately 8,000 households. By the end of the MICAH program, over twice as many households in the MICAH areas (13.8%) were using fortified flour than in the comparison areas (6.3%). Furthermore, the experience of pioneering the small scale fortification process in Malawi resulted in the MICAH program earning a good reputation with the national government. This was partly reflected in the fact that, when the National Fortification Alliance was formed, World Vision was the only NGO invited to be a member. The small scale fortification project started by MICAH was included as part of the National Fortification Program, and the MICAH experience helped shape the direction of the Alliance in establishing a fortification strategy for Malawi.

Interventions to reduce prevalence of Diseases Affecting Anemia:

Malaria:

- MICAH supported **malaria prophylaxis** for pregnant women through distribution of anti-malarials to pregnant women, in collaboration with local health facilities. This was accomplished in large part by creating **Drug Revolving Fund** (DRF) schemes in project villages.
- Community committees were formed and trained to operate and manage these DRFs, which increased accessibility to **treatment for malaria** and other common illnesses, at the community level.
- MICAH provided training in prevention of malaria, which included establishment of revolving funds for **insecticide treated mosquito nets (ITNs)** and training in re-treating of mosquito nets. The ITN revolving funds were part of the DRFs, and ITNs were purchased by MICAH for the DRFs. The ITNs were resold to general community members, sold at subsidized prices to pregnant women and women with children under five, and provided free of charge to those who were the poorest in the communities.

Prevention of Other Diseases (e.g., Helminth infections & schistosomiasis)

- **Environmental sanitation**: MICAH promoted the construction and use of latrines, garbage waste disposal and construction of utensil drying racks. Village Health Volunteers took the lead role to promote these activities in their own villages and communities. This strategy was very successful and resulted in the construction of over 12,000 pit latrines during the MICAH intervention period. In addition, communities were assisted to reduce schistosomiasis risk through clearing of bushes where snails tend to reproduce. The MICAH program also supported construction and maintenance of safe water supplies for households and schools.

Interventions to increase Capacity :

- **Advocacy and Capacity Building**. MICAH influenced the creation of the 'National Micronutrient Coordinator' position, housed in the Ministry of Health and Population and funded through the MICAH program. Advocacy through the Coordinator's office focused on national policy on anemia prevention, and national strategies for reducing anemia such as commercial scale fortification of maize flour. In addition, the National Micronutrient Coordinator and the MICAH Program Manager were members of the National Micronutrient Task Force. This group also influences policies in the country, such as the National Action Plan for Nutrition and the Poverty Reduction Strategy Paper, which included specific strategies and program guidelines for addressing anemia.

MICAH increased capacity at national, regional and community levels by including two line ministries (MOHP and MOAI) as implementing partners. This strong collaboration between MICAH and the government enhanced program influence by presenting a united approach to nutrition and health. MICAH also provided extensive capacity building to government staff and community workers and volunteers.

5.3 Methods of Evaluating the Program Effectiveness

As in Ghana, the effectiveness of the MICAH program in Malawi was evaluated through a series of cross-sectional surveys, conducted in 1997, 2000 and 2004. Multiple-indicator cluster survey methodology was followed. Details on evaluation methodology are available in the final survey report.[87]

In late 1999, an external mid-term evaluation recommended focusing more resources on fewer communities. As a result, MICAH Malawi scaled back the program implementation area. The areas chosen to continue with a more resource-intensive MICAH program were communities rated the poorest and most disadvantaged by the District Health Offices, and with the highest rates of malnutrition and communicable diseases. The remaining communities, where MICAH program interventions had been implemented for one year only, were then considered a ‘Comparison’ group in the 2000 and 2004 surveys. Those that continued to receive a full complement of MICAH interventions were considered ‘MICAH’ communities/clusters. Thus, by opportunistic criteria, an internal control group was identified. The inclusion of an internal control group allowed for a plausibility assessment of the program, and the different intensities of exposure to the program allows a stronger plausibility statement than findings from comparison between all and nothing groups.[88]

5.4 Results

The effectiveness of the MICAH program in improving hemoglobin (Hb) levels was evidenced among non-pregnant women by significant increased Hb levels in the MICAH communities from 2000 (11.8 ±1.7 g/dL) to 2004 (12.3±1.3 g/dL) while no change was observed in the Comparison areas (Table 9). Moreover, mean hemoglobin levels were significantly higher in MICAH than Comparison areas in 2004, while they were significantly lower than comparison areas in 2000. The significant interaction of MICAH and Comparison areas by year is illustrated in Graph 1.

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[87] MICAH Malawi final survey report. World Vision, 2006.

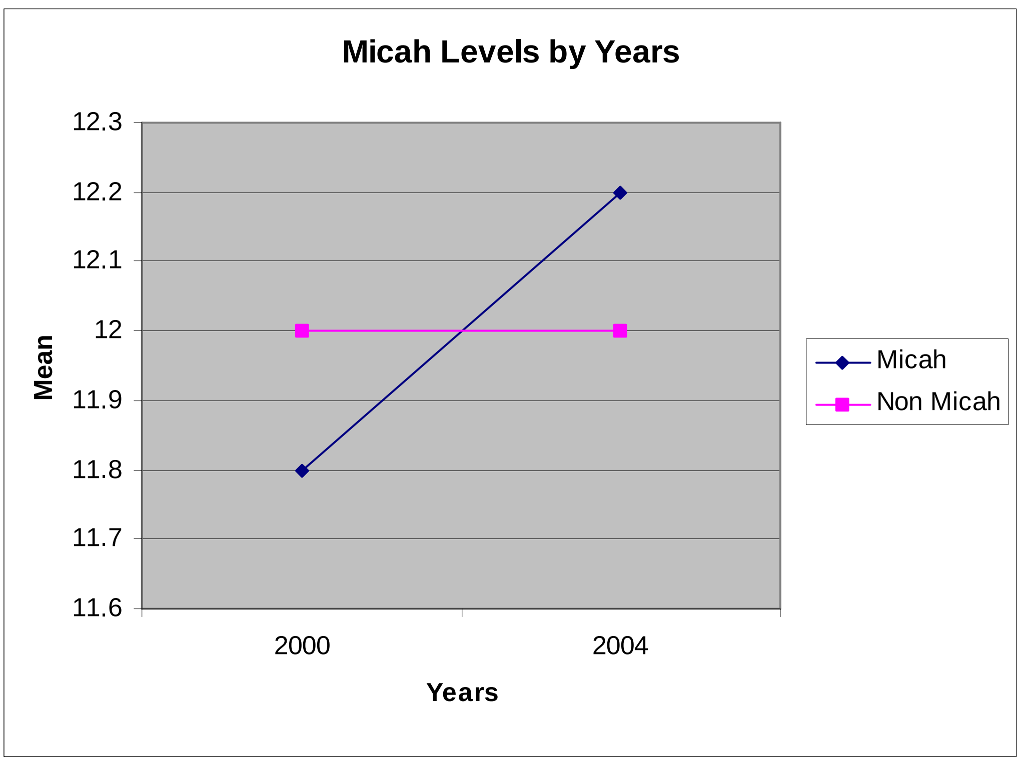
[88] Habicht, JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. Int J Epid 1999;28:10-18.

Table 9: MICAH Malawi Anemia Results in Women of Child Bearing Age and Pregnant Women, Comparing Baseline and Follow-up and Final Surveys

Indicator	Baseline Survey (1996)	Follow-up Survey (2000)		Final Survey (2004)	
		MICAH (n)	Comparison (n)	MICAH (n)	Comparison (n)
Women of child bearing age: Anemia prevalence (%) (Hb<12.0 g/dL)	NA	50.5 (1559)	45.7 (1442)	39.1 (1610)	44.9 (795)
Mean Hb ± SD (g/dL)	NA	11.8 $\pm$ 1.7 (1559)	12.0$^{\wedge}$ $\pm$ 1.7 (1442)	12.3** $\pm$ 1.3 (536)	12.1 $\pm$ 1.7^ (795)
Pregnant Women: Anemia prevalence (%) (Hb<11g/dL)	59.0 (417)	43.0* (156)	44.6* (175)	48.1 (208)	57.3 (89)
Mean Hb ± SD (g/dL)	10.3 $\pm$ 1.7 (417)	10.9* $\pm$ 1.5 (156)	11.0* $\pm$ 1.7 (175)	11.0* $\pm$ 1.5 (208)	10.8* $\pm$ 1.6 (89)

* = p value <0.05 for test of statistical difference between baseline and follow-up (2000) or final (2004)
** = p-value <0.05 for test of statistical difference between follow-up (2000) and final (2004)
^ = p-value <0.05 for test of statistical difference between MICAH and Comparison

Figure 5. Mean Hemoglobin of Malawian women (non-pregnant) in the Micah and Comparison groups by year (2000 and 2004).



A trend corresponding to hemoglobin results was observed by decreased prevalence of anemia in MICAH Malawi program areas, from 2000 (50.5%) to 2004 (39.1%), compared with no change in the Comparison areas (Table 9). Although not statistically significant, the reduction by 23% of 2000 levels of anemia, over a four-year period, is programmatically impressive, and approaches the international target of reducing anemia by one-third. Unfortunately, anemia was not evaluated at baseline for women of childbearing age.

In this same group, MICAH interventions, including coverage of weekly iron-folic acid (IFA) supplements and ITNs, increased between 2000 and 2004, and presence of small animals and fortified flour was significantly higher in MICAH than Comparison communities in 2004 (Table 10).

Among pregnant women, there was a 27% decrease in anemia in MICAH areas from 1996 (59%) to 2000 (43.0%) but no further statistically significant change by 2004 (48.1%) (Table 9). A corresponding improvement was observed in the hemoglobin levels, from 1996 to 2000, with no change occurring in 2004 (Table 9). In contrast, although Comparison areas also underwent a significant decrease from 1997 (59%) to 2000 (45%), there was a close to significant ($p=0.07$) increase in anemia in 2004 (57.3%).

In pregnant women, MICAH interventions including coverage of daily IFA and ITNs increased within the MICAH communities from 1996 to 2000 and again to 2004, as well as being higher in the MICAH than Comparison communities in 2004 (Table 10).

Hookworm prevalence decreased in school aged children over the program period in all groups. This was used as a proxy indicator for hookworm in women and indicated that hookworm was no longer a significant problem in these communities.

Table 10: Coverage of MICAH Malawi Interventions to address Anemia Women (non-pregnant and pregnant), Comparing Baseline and Follow-up and Final Surveys

Indicator	Baseline Survey (1996)	Follow-up Survey (2000)		Final Survey (2004)	
		MICAH (n)	Comparison (n)	MICAH (n)	Comparison (n)
Women of child bearing age:					
INCREASING DIETARY IRON: Coverage of **weekly** IFA supplements (%)	NA	68.5 (1565)	13.2^ (1276)	93.5** (1294)	25.1**^ (747)
Presence of small animals (% of households)	42.8 (1269)	61.9* (1900)	48.8*^ (1802)	63.9* (1582)	50.6*^ (856)
Presence of fortified flour (% of households)	NA	NA	NA	13.8 (1582)	6.3^ (856)
CONTROL OF PARASITES: Malaria prevalence (%)	NA	21.8 (1603)	11.2^ (1477)	5.7** (1382)	5.1** (766)
Households with mosquito nets (%)	NA	11.1 (1575)	4.6^ (1337)	75.5** (1370)	58.1**^ (754)
Presence of latrine (% of households)	70.7 (1268)	89.3* (893)	82.1*^ (1697)	93.6* (1569)	93.3* (847)
Pregnant Women:					
INCREASING DIETARY IRON: Coverage of **daily** IFA supplements (% in current pregnancy)	40.0 (168)	69.6* (289)	34.7^ (300)	91.9*** (173)	74.4*^ (82)
CONTROL OF PARASITES: Malaria prevalence (%)	23.1 (385)	16.8* (297)	15.9* (327)	6.6*** (182)	6.0*** (84)
Households with mosquito nets (%)	3.6 (168)	13.4* (284)	2.4^ (289)	69.0*** (184)	51.9***^ (81)
School Aged Children:					
Hookworm prevalence (%)	20.2 (690)	10.6* (1094)	6.2* (1029)	0.0** (1019)	1.5** (506)

* = p value <0.05 for test of statistical difference between baseline and follow-up (2000) or final (2004)
** = p-value <0.05 for test of statistical difference between follow-up (2000) and final (2004)
^ = p-value <0.05 for test of statistical difference between MICAH and Comparison

In addition to comparing changes in prevalence of these indicators over time and between MICAH and Comparison groups, further statistical analysis of the MICAH Malawi data was performed to determine the association between various factors and mean hemoglobin levels in both pregnant and non-pregnant women. The full 2000 and 2004 data sets were combined for this analysis, thus findings presented in Table 11 identify which factors associated with higher hemoglobin levels in Malawian women. Absence of malaria, presence of small animals, having a latrine, literacy, taking iron supplements (weekly), and clean drinking water are all factors positively affecting non-pregnant women's hemoglobin. Absence of malaria, taking iron supplements (daily), and having a latrine are factors positively associated with pregnant women's hemoglobin levels.

Table 11: Factors Associated with Higher Mean Hemoglobin Levels in Malawian Women

	Non-Pregnant Women	**Pregnant Women**
Not infected with malaria	√	√
Having small animals at the household	√	
Taking iron supplements	√	√
Having a household latrine	√	√
Able to read and write	√	
Clean drinking water in dry season	√	
Clean drinking water in rainy season	√	

5.5 Discussion

Two themes additional to those noted in the Ghana case study, emerge from MICAH Malawi's experience that may further inform anemia control efforts in similar settings. The first is that, despite the more challenging environment for anemia control in Malawi than in Ghana, progress can be made in reducing anemia. The second is that, the multiple factors associated with increased hemoglobin levels suggest that multiple interventions are essential to address anemia in the context of the multi-faceted etiology of anemia in Malawian women. These two issues are discussed below in further detail.

5.5.1 Anemia prevalence can be reduced even in settings with significant constraints such as high HIV prevalence and drought

The improvements in hemoglobin and reductions in anemia seen in non-pregnant women in MICAH communities are not as substantial as the changes observed in MICAH Ghana. However the context in Malawi is considerably more challenging. In addition to chronic poverty, Malawians face recurrent drought and high HIV prevalence, both of which have the potential to compromise the effectiveness of anemia prevention and control activities.

During the intervention period, a major drought in Malawi took place in the 2001/2002 maize growing season. In order to cope with the severe food shortage, households were forced to sell valuable resources in order to find food. This included the small animals distributed as part of the MICAH program, which were either sold to get money to buy maize, or were consumed. In normal circumstances, at least a breeding pair would be kept, but in such a times of severe food shortage, hunger and malnutrition, all resources available were used in order to survive. There were many hunger-related deaths reported in Malawi during this season. Although the MICAH program did not collect nutrition data during the drought period, it is assumed that levels of malnutrition of all types, including anemia, either did not improve or deteriorated during this crisis, and that recovery and nutritional repletion afterwards would require a significant period of time, as well as inputs from external programs such as the MICAH program. This assumption is supported by the fact that in Comparison areas, between 2000 and 2004, the mean hemoglobin did not increase nor did the prevalence of anemia decrease among non-pregnant women (Table 9), while anemia increased among pregnant women.

However, in the MICAH areas, the mean hemoglobin of non-pregnant women increased over this period and with a 22% decrease in anemia. The MICAH program launched an intensive animal restocking program in 2002-2003, and by the final program survey in 2004, 64% of households in the program area had small animals, similar to the level achieved prior to the drought (62%) (Table 10). In addition, the MICAH program continued with the integrated multiple interventions, including distribution of weekly iron supplements, fortified maize flour, distribution of insecticide treated nets, and treatment and prevention of other parasites, all of which had higher coverage in MICAH areas than non-MICAH (Table 10). It is possible that a greater reduction in anemia prevalence could have been achieved had the major setback of this food crisis not occurred.

As discussed in the first section of this chapter, HIV infection contributes both directly and indirectly to anemia. Anemia prevalence has been found to be much higher among HIV positive pregnant women in Malawi, compared with the overall antenatal population.[89] Thus the challenge of controlling maternal anemia in a high HIV prevalence context is intensified. The MICAH surveys did not assess HIV status of respondents, but considering the high HIV prevalence in the country and particularly among pregnant women, it is more than reasonable to consider it a major confounding factor, which prevented greater gains in anemia control from being achieved.

Despite the presence of these major confounding factors, MICAH Malawi was still able to achieve a reduction in anemia prevalence in non-pregnant women. In the Comparison group however, no change was observed in non-pregnant women, and improvements seen in pregnant women in 2000 were lost by 2004. These findings indicate both the challenging context for anemia control in Malawi, and the fact that gains can still be made. A continued intensive effort is required to reduce anemia in Malawian women to a more acceptable level, particularly in the face of ongoing high HIV prevalence.

5.5.2 An integrated approach is required to address anemia of multi-faceted etiology

The association between several factors and women's hemoglobin, as presented in Table 11, illustrates the importance of considering a variety of contributors to anemia when planning an effective intervention strategy. These include indirect contributors, such as women's education and household sanitation. MICAH Malawi implemented a comprehensive package of interventions for anemia prevention and control, as described earlier, and likely would not have

[89] Van den Broek NK, White SA, Neilson JP. The relationship between asymptomatic Human Immunodeficiency Virus infection and the prevalence and severity of anemia in pregnant Malawian women. Am J Trop Med Hyg 1998;59(6):1004-1007.

seen positive results from only one or two isolated interventions. Conversely, achievement of greater coverage of some interventions, such as increased animal foods (e.g., small animals) and iron-fortified flour, would likely have increased the impact on anemia prevalence. This is likely, as both Comparison and MICAH communities had similarly reduced levels of malaria and hookworm (as proxied by school children) in 2004, and so the main remaining contributor to anemia is likely to be dietary.

The association between presence of small animals in a household and women's hemoglobin is particularly noteworthy, indicating the critical importance of increased access to highly absorbable dietary iron. It is understood intuitively that improved dietary quality is the key to adequate iron intake and anemia reduction in populations with high levels of iron deficiency anemia and diets low in bioavailable iron. However there is a lack of published evidence of effective programming models that demonstrate a link between promotion of animal source foods and improved hemoglobin concentration in women. The MICAH Malawi results are therefore particularly valuable, and point to the legitimacy of investing in interventions that increase women's access to iron rich animal foods at the household level, accompanied by intensive nutrition education.

5.6 Conclusion

The MICAH program in Malawi invested considerably in anemia prevention and control using an integrated package of interventions designed to address the main contributors to anemia identified in the baseline survey (dietary iron intake, malaria and intestinal parasites). This approach proved to be successful in decreasing anemia prevalence in pregnant (1996 to 2000) and improving hemoglobin in non-pregnant (2000 to 2004) women of childbearing age. In particular, the emphasis on household rearing and consumption of small animals provides a programming model that may be suitable for replication in other similar rural African settings, as a means of increasing absorbable dietary iron intake.

The results achieved by MICAH Malawi are programmatically important, but anemia in both pregnant and non-pregnant women remains unacceptably high. It is likely that high HIV prevalence is a major contributor, set-backs from drought combined with inadequate dietary iron. While the success of the program demonstrates the validity of investment in anemia prevention and control in settings with high HIV prevalence, targets for anemia reduction need to take into account the impact of HIV. Although by 2004, MICAH Malawi achieved the goal of decreasing anemia among pregnant women by 19% over 8 years, and among non-pregnant women by 23% over 4 years, continued efforts need to be made to achieve the international goal of 30% reduction in anemia by 2010. Should Malawi also continue to face regular cycles of severe drought, achieving the international target will likely prove a significant challenge.

6.0 Summary of Case Studies

The MICAH program experience in Ghana and Malawi demonstrates that anemia prevention and control in women in developing countries is an achievable goal. However the approach and the expected results must take into account the local context.

In Ghana, iron deficiency was found to be the major cause of anemia in women, and an effective community-based IFA supplementation initiative was established, which led to dramatic reductions in anemia prevalence. Key success factors were the inclusion of all women of childbearing age as a target group for supplementation, and the use of community health volunteers to support the IFA distribution and provide appropriate health counseling messages regarding anemia and supplementation.

In Malawi anemia was found to have several contributors, including iron deficiency, malaria and intestinal parasites. The MICAH program addressed all of these with a comprehensive anemia prevention and control program. The interventions included distribution of small animals for household rearing and consumption through a revolving loan scheme, the pioneering of fortification technology for village mills, and public health measures to prevent malaria and hookworm infections. This comprehensive strategy was successful in reducing anemia prevalence in both pregnant and non-pregnant women, but the degree of improvement was lower than anticipated. Two major contextual factors that likely influenced this are high HIV prevalence and severe drought.

The following key lessons can be taken from the MICAH experience and applied in other developing countries:

- Analysis of the contributors to anemia and implementation of an integrated package of interventions is essential to designing an effective, context-specific anemia prevention and control program. Interventions to improve dietary iron intake need to be accompanied by public health control measures to address diseases such as malaria and hookworm which also contribute to anemia.
- In settings where iron deficiency anemia prevalence is in the severe public health range, IFA supplementation is necessary to improve hemoglobin levels. However at the same time the introduction of more sustainable strategies for the long-term maintenance of adequate iron status should be pursued. These strategies include fortification and dietary diversification.
- Community-based administration of anemia control interventions is critical to their success. Interventions should be integrated within existing structures and services, and implemented in partnership with relevant government ministries, community leaders and other agencies and partners as appropriate to the context.
- Dietary diversification, particularly the promotion of animal source foods, is a feasible strategy for sustainably improving intake and absorption of dietary iron and should be prioritized in anemia control programs.
- Monitoring the impact of program interventions is essential for improving the effectiveness of anemia prevention and control strategies. In addition to informing the program design and selection of interventions, MICAH survey results provided a valuable tool for advocacy to the national Ministries of Health for improved anemia control policies.

With the application of these programming principles, the international target for anemia reduction in women can be achieved. A renewed effort by the international health community towards this goal is required, but the MICAH experience demonstrates that with an integrated, comprehensive, context-specific program design, anemia in women can be effectively managed.