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SPECIAL ISSUE SUCCESSFUL MICRONUTRIENT PROGRAMS

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guest editors*

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Introduction: Lessons from successful micronutrient programs

Deficiencies of vitamin A, iodine, and iron continue to affect large numbers of people in most parts of the developing world. In developing countries, more than 40% of women are reported to be anemic, nearly 20% of people suffer from iodine deficiency, and approximately 25% of children are estimated to have marginal deficiencies of vitamin A [1]. The prevalence rates for micronutrient deficiencies are highest for South Asian countries. In South Asia alone, 36% of children are estimated to have subclinical deficiency of vitamin A, 25% to have iodine deficiency, and 53% of preschool children to be anemic. The prevalence of multiple deficiencies in preschool children is estimated at 27% to 36% (49–60 million) in South Asia [1, p. 38]. Although the prevalence rates are lower in the East Asia and Pacific region (in many cases half that of South Asia or less), the problem of micronutrient deficiencies is nevertheless still severe; in East Asia and the Pacific, 18% of children are estimated to be marginally deficient in vitamin A, another 18% to have deficiencies in iodine, and 14% to be anemic.

With support from the Micronutrient Initiative and the Centers for Disease Control and Prevention, and in collaboration with UNICEF, the Tulane University School of Public Health and Tropical Medicine, Department of International Health and Development, New Orleans Louisiana, USA, undertook a research study of country experiences in micronutrient-deficiency control, in 2000–2002. The university and research partners were Emory University (Department of International Health), Atlanta, Georgia, USA, the Institute of Nutrition at Mahidol University (INMU, Thailand), the University of the Philippines at Los Baños, and the Public Health Program, University of the Western Cape, South Africa).

The study focuses on programs in South and South East Asia, including 11 Asian countries: Bangladesh, Cambodia, China, India, Indonesia, Laos, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam; in addition, South Africa participated, for a total of 12 countries. The project involved a workshop in Bangkok in June 2001 and a satellite meeting at the International

Union of Nutritional Sciences (IUNS) International Congress of Nutrition, Vienna, in August 2001. At these meetings, participants from the different countries gave presentations on national programs for the control of deficiencies of vitamin A, iodine, and iron. The topics were organized into program initiation, implementation, and impact. These presentations form the country case studies section of this publication. Summaries of the case studies are given on pages 79–88 of this issue. The complete texts of the case studies are available at www.inffoundation.org. No summaries or texts are available for the case studies from India and Myanmar.

The findings across countries have been synthesized to propose lessons and conclusions from these programs in three overview papers that cover the initiation of national (or large-population) programs, their implementation, and what can be concluded about their impact. The overall aim of these three papers is to provide an analysis that can be applied to making future programs more effective.

Among countries participating in the study, there is wide-scale adoption of national policies for addressing micronutrient deficiencies. This may be compared with experience in other regions of the world. In an earlier review in 2001 [1], we reported that 28 out of 99 developing countries had adopted national policies to address all three of the micronutrient deficiencies of focus here, and all but 15 countries had policies or programs for at least one. By region, 20% of the countries in Eastern and Southern Africa, 21% of the countries in Western and Central Africa, 21% of the countries in Latin America and the Caribbean, and 18% of the countries in the Middle East and North Africa have, as of 2001, national policies to address all three micronutrient deficiencies. For the countries studied here, 9 out of the 12 participating countries (75%) had, in 2002, adopted national policies for the control of vitamin A, iodine, and iron deficiency (thus these are more advanced in this respect than the developing world average), making their experience perhaps particularly useful for application elsewhere.

Most of the project countries have implemented programs long enough that some data are available for drawing some conclusions on program effectiveness, although rigorous evaluations are scarce. Survey data on clinical or biochemical indicators of vitamin A deficiency, iodine deficiency, and iron-deficiency anemia are available for nearly all countries participating. Multiple rounds of survey data have assessed the extent of clinical vitamin A deficiency (9 countries), goiter (12 countries), and anemia (12 countries). In addition, nearly all of the project countries have subnational or national biochemical data (serum retinol) available on vitamin A deficiency, and 7 of the 12 project countries have biochemical data (urinary iodine excretion) available for assessing the extent of iodine-deficiency disorders. Not all of these data, however, are suitable

for evaluation purposes.

Using these data, each participating project country was asked to prepare a paper in which various aspects of the ongoing micronutrient programs in the country were described; these aspects ranged from how programs were adopted to a description of what is known about program effectiveness. The overview papers then aim to bring together the findings across all project countries in order to draw conclusions about common steps to program initiation, successful factors in program implementation, and approaches for meeting programmatic challenges. All three micronutrients (vitamin A, iodine, and iron) are compared and contrasted in each paper. Details on individual country programs can be found in the country case study papers.

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Lessons from successful micronutrient programs.

Part I: Program initiation

Megan Deitchler, John Mason, Ellen Mathys, Pattanee Winichagoon, and
Ma Antonia Tuazon

Abstract

Internationally recognized research findings on the potential health benefits of preventing micronutrient deficiencies—especially reduced child mortality from vitamin A deficiency and prevention of in utero developmental damage and mental retardation from iodine deficiency—have contributed to raising the awareness of deficiencies and the commitment of many governments to their reduction or near-elimination. The procedures undertaken to decide on large-scale programs followed conventional patterns in the 12 countries included in this study (11 Asian countries plus South Africa). Thus, a sequence of national surveys, institutional arrangements through intersectoral technical committees, legislation, incorporation of programs into national plans, and resource mobilization, including external assistance, was similar for all three micronutrients. Vitamin A supplementation twice yearly to children, then to women postpartum, has reached the national level. Iodized salt is universally adopted at the national level in most countries, with a need for continuing efforts to reach underserved populations and to implement legislation and quality control. Iron programs, usually aiming at daily supplementation during pregnancy, have been pursued, but with less intensity. However, it is clear that these procedures have succeeded in creating a rapid expansion of large-scale deficiency-control programs, which while evolving are generally being maintained.

Key words: anemia, Asia, fortification, goiter, iodine, iron, micronutrients, South Africa, supplementation, vitamin A

Introduction

In the last decade, the governments of most developing nations responded to the declared goals of the 1990 World Summit for Children [1] by making a commitment to major reductions in micronutrient deficiencies by the year 2000—especially in vitamin A and iodine deficiencies, for which “virtual” elimination was the aim; smaller but substantial reductions in iron deficiency were also agreed upon. In an effort to meet the commitment, the years following the summit saw increased commitment to preparation and implementation of micronutrient-deficiency control measures in developing countries. By the early 1990s, micronutrient deficiencies had become a priority health concern for many governments, leading to large-scale micronutrient-deficiency control programs. By 2001, nearly one-third of developing countries reporting (28 of 73) had adopted policies for the control of all three deficiencies [2]. Among the 12 project countries (Bangladesh, Cambodia, China, India, Indonesia, Laos, Myanmar, Philippines, South Africa, Sri Lanka, Thailand, and Vietnam), almost all had, by 2001, adopted national policies and implemented national programs to address deficiencies in all three micronutrients (the exceptions were China, Thailand, and India). South Africa and Sri Lanka had policies to address all three micronutrients but Sri Lanka had not yet implemented the vitamin A-supplementation program, and South Africa had not yet implemented the vitamin A-supplementation or the iron-supplementation program for children.

Across countries and for each of the micronutrients, some common processes led to the adoption of these national programs. Many countries, for example, launched national surveys to document the extent of the deficiencies prior to adopting a national program, requiring institutional arrangement (such as intersec-

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toral technical committees), and so on. This paper assesses the approaches undertaken, considering which aspects were important in leading to decisions and commitments on programs. Initial strategies and their evolution are then included. The primary source material is the country case studies. Summaries of the case studies are given on pages 79–88 of this issue. The complete texts of the case studies are available at www.inffoundation.org.

Vitamin A

Steps leading to decisions on programs

Experience across project countries suggests that adoption of programs for the control of vitamin A deficiency was stimulated by increased awareness of internationally available data showing a strong association between vitamin A deficiency and mortality. The process leading to decisions for a vitamin A program often included many of the following steps: national surveys documenting the extent of vitamin A deficiency, national workshops on vitamin A deficiency, establishment of technical committees for the control of vitamin A deficiency, and the assistance of bilateral and international agencies, often through nongovernmental organizations (table 1). An outline of the sequence of events for program initiation can be found in table 2.

National survey

National surveys were an important first step in leading

to the decision to adopt national vitamin A programs. Those surveys launched prior to the mid-1990s tended to collect data on night-blindness and provide estimates of clinical vitamin A deficiency among children under five years of age (e.g., Bangladesh, Philippines, Vietnam). More recent surveys that have been launched have tended to collect data on serum retinol in addition to data on clinical indicators of vitamin A deficiency (e.g., Bangladesh, Laos, South Africa, Sri Lanka). The national surveys established the extent of the vitamin A deficiency problem in the countries, and the results were linked to international data documenting the public health consequences of vitamin A deficiency. Documentation of the problem helped to heighten the action mobilized for controlling vitamin A deficiency at the national level. Survey data available on clinical and subclinical vitamin A deficiency are listed in tables 3 and 4, respectively.

National workshops on vitamin A deficiency

The convening of national workshops on vitamin A deficiency (e.g., Cambodia, Vietnam) allowed collaborating organizations and government representatives working in the country to become aware of and suggest actions to address the problem at the national level. In certain cases, national workshops have helped to develop proper justification and to consolidate action in support of a vitamin A deficiency initiative. In Vietnam, for example, the convening of a national workshop facilitated commitment to the vitamin A–deficiency control project at all levels of the government [4].

TABLE 1. Steps for initiation of vitamin A and iron-supplementation programs and salt iodization

Country	National survey			National committee, plan, and/or legislation			External assistance		
	Vitamin A	Iodine	Iron	Vitamin A	Iodine	Iron	Vitamin A	Iodine	Iron
Bangladesh	Yes	Yes				Yes		Yes	
Cambodia	Yes	Yes	Yes ^a	Yes ^a	Yes	Yes ^a	Yes ^a	Yes	Yes ^a
China	^b	Yes	Yes	No	Yes	Yes	Yes ^a	Yes	
India	Yes ^a	Yes		No			Yes ^a	Yes ^a	
Indonesia		Yes				Yes	Yes	Yes	Yes
Laos	Yes	Yes				Yes		Yes	Yes
Myanmar	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Philippines	Yes	Yes	Yes ^a	Yes ^a	Yes	Yes ^a	Yes ^a	Yes ^a	Yes ^a
South Africa	Yes	Yes	Yes ^a	No	Yes ^a	Yes	Yes ^a	Yes ^a	Yes ^a
Sri Lanka	Yes	Yes							Yes
Thailand	No	Yes	Yes	No	Yes	Yes	No	Yes	
Vietnam	Yes	Yes	Yes	Yes ^a		Yes	Yes	Yes ^a	Yes

a. Additional data were derived from a global micronutrient survey conducted by Tulane University and the Micronutrient Initiative in 2002. Results are available at <http://www.tulane.edu/~internut/Countries/countrypage.htm> [3]. Blank cells indicate that no information was reported.

b. Survey was conducted at a subnational level.

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

TABLE 2. Time sequence of initiation of a vitamin A-supplementation program

Country	Children		Mothers	
	Year of program initiation	Mechanism for capsule distribution	Year of program initiation (time after delivery for supplement)	Mechanism of capsule distribution
Bangladesh	1973: Began distribution of capsules to children	Program started as universal supplementation, then transitioned to targeted supplementation, and in 1995 NIDs began to be used as the system for capsule distribution; NIDs expected to phase out eventually	1995 (within 2 wk)	200,000 IU to lactating women; distribution of capsules through BINP (1995–July 2001), women with body mass index < 18.5 targeted. After July 2001, distribution through NNP
Cambodia	1993: Began small-scale distribution of capsules to children 1996: Began nationwide capsule supplementation program	1988: WHO states high probability that significant vitamin A deficiency exists in Cambodia 1990: National VA workshop 1993: VA survey and 2nd national VA workshop 1995: Trial integration with NIDs 1996: Full integration into NIDs once yearly 1997: Integration into NIDS twice yearly 1998: Began to phase out NIDs (SNIDs and routine immunization outreach used as methods of capsule distribution); thereafter only routine immunization outreach (with school health days and insecticide-treated bed net distribution) is used as the system for capsule distribution Not applicable	2000 (within 8 wk)	200,000 IU to lactating women; distribution of capsules through health services and routine immunization outreach
China	No national vitamin A-supplementation program implemented	Not applicable	No national vitamin A-supplementation program implemented	Not applicable
India	1970: Began distribution of capsules to children	Periodic dosing initiated by government in 1970 through PHC (1–5 yr), then with UIP for children 6–36 mo of age; 1st dose with measles vaccine, 2nd with diphtheria, pertussis, tetanus vaccine, and subsequent doses by ICDS program staff	Not reported	Not reported
Indonesia	1974: Began distribution of capsules to children 1–5 yr of age 1998: Began distribution of capsules (100,000 IU) to infants 6–12 mo of age	200,000 IU 2 times per year to children 1–5 yr of age; distribution of vitamin A capsules through mass campaigns 100,000 IU to infants 6–12 mo of age; one-time distribution through <i>posyandu</i> (village health post) health workers, immunizations, private hospitals, and clinics	1974 (not reported)	

continued

TABLE 2. Time sequence of initiation of a vitamin A-supplementation program

Country	Children		Mothers	
	Year of program initiation	Mechanism for capsule distribution	Year of program initiation (time after delivery for supplement)	Mechanism of capsule distribution
Laos	Vitamin A-supplementation program initiated in 1996, following a national vitamin A deficiency survey in 1995	200,000 IU to children 1–5 yr of age, 2 times per year; distribution initially linked with NIDs. With phaseout of NIDs, distribution of capsules will begin to be integrated in health-care system	1996 (within 4 wk)	
Myanmar	Vitamin A-supplementation initiated in 1993, following a vitamin A deficiency survey	200,000 IU to children 6 mo–5 yr of age, 2 times per year, initially targeting high-prevalence areas, now covering whole country and integrated with NIDs (from 2000 onwards).	Postpartum supplementation program implemented, but year of initiation not reported	
Philippines	Initial policy for control of vitamin A deficiency focused on cases of xerophthalmia and high-risk children 1993; Began program for universal vitamin A supplementation to children under 5 yr of age	100,000 IU to children 6–11 mo of age, once 200,000 IU to children 12–72 mo of age, 2 times per year Distribution of capsules during NIDs, national campaigns (Garantisadong Pambata, ASAP) or via existing health-care system	Postpartum supplementation program implemented, but year of initiation not reported (not reported)	200,000 IU to lactating women
South Africa	Policy for vitamin A supplementation to children in place since 2000; no vitamin A-supplementation program yet implemented	100,000 IU to children 6–11 mo of age, every 3 mo 100,000 IU to children 12–60 mo of age, every 3 mo; or 200,000 IU to children 12–60 mo of age, every 6 mo	2000 (within 8 wk)	200,000 IU to lactating women
Sri Lanka	Policy for vitamin A supplementation to children adopted in 1996, following a national vitamin A deficiency survey; no supplementation program yet implemented	100,000 IU to children at 9 and 18 mo of age 100,000 IU to children at 1, 4, and 7 yr of age	Postpartum supplementation program implemented, but year of initiation not reported (within 4 wk)	200,000 IU to lactating women
Vietnam	1988: Began distribution of capsules to children as pilot program in 7 districts; expanded program to all communes in 1993	200,000 IU to children 6 mo–3 yr of age, 2 times per year; distribution of capsules through NIDs	Postpartum supplementation program implemented, but year of initiation not reported (not reported)	200,000 IU to lactating women

NID, National immunization day; BINP, Bangladesh Integrated Nutrition Programme; NNP, National Nutrition Program; WHO, World Health Organization; VA, vitamin A; SNID, subnational immunization day; PHC, Primary Health Care; UIP, Universal Iodization Programme; ICDS, Integrated Child Development Services; ASAP, Arawa ng Sangkap Pinoy (National Micronutrient Day). Source: refs. 4–6, 15, 16, 19, 23–25, 28; also *Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.*

TABLE 3. Clinical survey data on vitamin A deficiency

Country	Survey year	Indicator ^a	Sample group (survey coverage) ^b	Reported prevalence (%)
Bangladesh	1982–83	XN	Children 6–59 mo	3.6
	1983	XN + X1B	Preschool children	4.6*
	1997	XN	Preschool children	0.6
	1999	XN	Pregnant women	2.7
	1999	XN	Lactating women	2.4
	1999	XN	Women, not pregnant or lactating	1.7
Cambodia	1993	XN	Children 1–6 yr (subnational)	5.6
	1993	X1B	Children 1–6 yr (subnational)	0.6
	2000	XN	Children 18–59 mo (national)	0.2–2.0
	2000	XN (I)	Pregnant women	2.5–8.4
China	1999–2000	XN	Children 0–5 yr (subnational, 14 provinces)	0.14
	1999–2000	Xeroma	Children 0–5 yr (subnational, 14 provinces)	0.12
India	1975–79	X1B	Preschool children	1.8
	1988–90	X1B	Preschool children	0.7
	2001	XN	Children 24–71 mo	1.03
	2001	XN	Pregnant women	2.8
	2001	X1B	Preschool children	0.7
Indonesia	1978	XN + X1B	Preschool children	1.3
	1992	XN + X1B	Preschool children (subnational)	0.30*
	1995	XN + X1B	Preschool children	0.33
Laos	1995	XN (I)	Children 24–71 mo (national)	0.7
	1995	XN (I)	Women, not pregnant or lactating (national)	3.2
	1995	XN (I)	Pregnant women (national)	9.0
	2000	XN (I)	Children 6–59 mo (national)	0.47
	2000	XN (I)	Pregnant women (national)	11.9
Myanmar	1987	XN + X1B	Preschool children (subnational)	2.0*
	1991	X1B	Children < 5 yr	0.6
	1994	X1B	Children < 5 yr	0.38
	1997	X1B	Children < 5 yr	0.23
	2000	X1B	Children 0–5 yr (subnational)	0.03
Philippines	1982	XN	Preschool children	1.8
	1987	XN	Preschool children	0.7
	1993	XN	Preschool children	0.4
	1982	X1B	Preschool children	1.4
	1987	X1B	Preschool children	0.2
	1993	XN + X1B	Preschool children (subnational)	0.4*
	1993	X1B	Preschool children	0.1
South Africa	1994	XN	Children 6–71 mo	12
	1994	X1B	Children 6–71 mo	0.4–0.8
Sri Lanka	1987	XN + X1B	Preschool children (subnational)	0.5*
	1995–96	XN (I)	Children 24–71 mo (national)	0.8
	1995–96	X1B	Children 6–71 mo (national)	0.8
Thailand	No clinical data on vitamin A deficiency reported			
Vietnam	1988	XN + X1B	Preschool children (subnational)	0.60*
	1985–88	XN	Children < 5 yr (national)	0.37
	1985–88	X1B	Children < 5 yr (national)	0.16
	1985–88	Keratomalacia	Children < 5 yr (national)	0.07

continued

TABLE 3. Clinical survey data on vitamin A deficiency

Country	Survey year	Indicator ^a	Sample group (survey coverage) ^b	Reported prevalence (%)
	1985–88	Corneal scar	Children < 5 yr (national)	0.12
	1994	XN	Children < 5 yr (national)	0.05
	1994	XN	Pregnant and lactating women (national)	0.58
	1994	X1B	Children < 5 yr (national)	0.045
	1994	Corneal ulcer	Children < 5 yr (national)	0.005
	1994	Corneal scar	Children < 5 yr (national)	0.048
	1998	XN	Children < 5 yr (national)	0.20
	1998	XN	Pregnant and lactating women (national)	0.90

a. XN, night-blindness (by testing); X1B, Bitot's spots; XN (I), night blindness, by interview.

b. Subnational and national surveys have been indicated as known; in other cases, information on coverage of survey was not reported.

Source: refs. 4–6, 15, 16, 19, 23–25, 28, except for numbers with an asterisk (*), for which the source is United Nations [1]; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

Establishment of technical committees

In some cases, national technical committees and/or intersectoral working groups were established to develop country-specific policy and program guidelines. In Myanmar, the technical committee had the responsibility for making the decision to institutionalize the vitamin A-supplementation program at the national level.*

External assistance

Resource mobilization, alliance building (within countries as well as with international agencies), and external assistance played a critical role in the initiation of vitamin A programs. Across countries, vitamin A capsules were usually provided by the Canadian International Development Agency and the Micronutrient Initiative, and additional financial and logistic support to the program was provided by international agencies such as Helen Keller International and UNICEF.

Strategic approaches

Supplementation

The strategy adopted for the control of vitamin A deficiency was, for nearly all project countries (though adopted at widely varying times across countries), universal vitamin A supplementation, initially targeting children under five and later (mid-1990s to 2000) also targeting postpartum women shortly after delivery (within two to eight weeks). The World Health Organization recommended distribution of one 200,000 IU vitamin A capsule to children aged 12 to 59 months every 4 to 6 months. The dose recommended in most project countries was one 200,000 IU capsule two times per year to children one to five years of age.

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, Institute of Nutrition of Mahidol University (INMU), Bangkok, Thailand, June 2001.

Vietnam and Sri Lanka recommend slightly different dosing: Vietnam targeted children aged six months to three years with one 200,000 IU vitamin A capsule twice per year [4], and Sri Lanka had adopted a dosing schedule consisting of one 100,000 IU capsule given to the child at 9 months, 18 months, and years 1, 4, and 7 [5]. Countries not adopting vitamin A supplementation as a national policy for the control of vitamin A deficiency were Thailand and China. Neither of these countries had a national vitamin A program, although Thailand had efforts under way to fortify multiple products with vitamin A (table 5). However, in both countries, substantial improvements in general malnutrition have been seen; even with a specific vitamin A program, signs of clinical deficiencies were not reported from sample surveys (e.g., of preschool children in rural areas of Thailand).

Although both Sri Lanka and South Africa have adopted a policy of vitamin A supplementation to children, neither of these countries has yet implemented a national program. In the case of Sri Lanka, the delay in program implementation is due to an inadequate supply of vitamin A capsules (C. Piyasena, personal communication, 2001). In South Africa, the cost of 200,000 IU capsules was, until August 2001, too high to permit wide-scale program implementation [6]. The alternative of using 100,000 IU capsules for supplementation was not possible either, since the 100,000 IU dose was not yet registered by the South African Medicines Control Council. Without authorization of the South African Medicines Control Council, drugs could not be bought, imported, or accepted as a donation in the country, thus preventing implementation of universal vitamin A supplementation in the country.

Food-based

Most countries that have adopted a vitamin A-supplementation program have regarded supplementation as a short-term solution to vitamin A deficiency. Across countries, there is recognition of the need for diversi-

TABLE 4. Biochemical survey data on vitamin A deficiency

Country	Survey year	Indicator	Sample group (survey coverage) ^a	Prevalence (%)
Bangladesh	1997	Serum retinol	Children 1–4 yr	22.0 ^b
	1997	Serum retinol	Pregnant women	23.7 ^b
	1997	Serum retinol	Lactating women	14.0 ^b
	1997	Serum retinol	Women, not pregnant or lactating	5.0 ^b
	1997	Serum retinol	Adolescent girls	12.0 ^b
Cambodia	1992	Serum retinol	Preschool children (subnational)	19.7 ^{b*}
China	1982	Serum retinol	Preschool children (subnational)	18.5 ^{b*}
	1999–2000	Serum retinol	Children 0–5 yr (subnational, 14 provinces)	11.7 ^b
India	No biochemical data on vitamin A deficiency reported			
Indonesia	1978	Serum retinol	Preschool children	67.0 ^b
	1991	Serum retinol	Preschool children (subnational)	57.5 ^{b*}
	1995	Serum retinol	Preschool children (national)	50.0 ^b
Laos	2000	Serum retinol	Children < 5 yr (national)	44.7 ^b
Myanmar	1987	Serum retinol	Preschool children (subnational)	32.4 ^{b*}
Philippines	1993	Serum retinol	Children 6 mo–5 yr	35.3 ^b
	1998	Serum retinol	Children 6 mo–5yr	38.0 ^b
	1993	Serum retinol	Lactating women	16.4 ^b
	1998	Serum retinol	Lactating women	16.5 ^b
	1993	Serum retinol	Pregnant women	16.4 ^b
	1998	Serum retinol	Pregnant women	22.2 ^b
South Africa	1991	Serum retinol	Preschool children (subnational)	49.0 ^{b*}
	1994	Serum retinol	Children 6–71 mo	33.0 ^b
Sri Lanka	1995–96	Serum retinol	Children 6–71 mo (national)	35.3 ^{b*}
Thailand	1990	Serum retinol	Preschool children (subnational)	20.0 ^{b*}
	1995	Breastmilk retinol	Lactating women	41.1 ^c
	1998	Breastmilk retinol	Lactating women	58.3 ^c
	1997	Breastmilk retinol	Lactating women	48.5 ^c
	1998	Breastmilk retinol	Lactating women	56.3 ^c
	2000	Breastmilk retinol	Lactating women	43.1 ^c
	1995	Serum retinol	Preschool children	15.0 ^b
	1997	Serum retinol	Preschool children	12.0 ^b
	1998	Serum retinol	Preschool children	10.8 ^b
	1999	Serum retinol	Preschool children	10.5 ^b
	2000	Serum retinol	Preschool children	4.0 ^b

a. Whether survey coverage was subnational or national has been indicated when this is known.

b. Vitamin A deficiency was defined as serum retinol < 20 µg/dl.

c. Vitamin A deficiency was defined as breastmilk retinol < 1.05 µmol/L.

Source: refs. 4–6, 15, 16, 19, 23–25, 28, except for numbers with an asterisk (*), for which the source is United Nations [1]; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

fied approaches and a longer-term, sustainable strategy for the control of vitamin A deficiency. Table 5 indicates the different strategic approaches implemented by countries.

Efficacy trials of fortification and diet modification for the control of vitamin A deficiency have been conducted in some project countries. Most of these trials

were conducted in Bangladesh, Indonesia, and the Philippines in the late 1980s to the early 1990s [7]. The results from the fortification trials generally showed an improvement in biochemical and clinical indicators of vitamin A deficiency among the experimental groups [8, 9]. The results of diet-modification trials were somewhat weaker and varied among studies [10–12].

TABLE 5. Strategic approaches initiated for the control of vitamin A deficiency

Country	National supplementation program		Home gardening	Information, education, communication (IEC) activities	Mandatory fortification	Voluntary fortification	Fortification explored
	Children	Women					
Bangladesh	Yes	Yes	Yes	Yes	No	No	No
Cambodia	Yes	Yes	Yes	Yes	No	No	Yes
China	No	No	No	No	No	No	No
India	Yes	No	Yes	Yes	No	Not reported	Not reported
Indonesia	Yes	Yes	Yes	Yes	No	Noodles, margarine	Yes
Laos	Yes	Yes	No	Yes	No	No	Yes
Myanmar	Yes	Yes	Yes	Yes	No	Not reported	Not reported
Philippines	Yes	Yes	Not reported	Not reported	No	Flour and other products	Yes
South Africa	No	No	Not reported	Not reported	No	Not reported	Yes
Sri Lanka	No	Yes	Not reported	Not reported	No	Thriposh (a nutritional supplement for pregnant women)	Yes
Thailand	No	No	Yes	Yes	Sweetened condensed milk, infant formula, breastmilk substitutes	Triple-fortified (vitamin A, iodine, iron) instant noodle soup mix	Yes
Vietnam	Yes	Yes	Not reported	Yes	No	Pilot study on double-fortified (vitamin A and iron) biscuits for children	Yes

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

More recently, a study in China was conducted to assess whether plant carotenoids could sufficiently sustain or improve vitamin A status during vitamin A-deficient seasons. The study results showed that green and yellow vegetables could provide adequate vitamin A nutrition for kindergarten-aged children and, if eaten in sufficient amounts, could protect them from becoming vitamin A deficient during high-risk seasons [13]. In contrast, in a controlled trial in Indonesia, de Pee et al. [14] showed that the intake of dark-green leafy vegetables had little impact on vitamin A status among lactating women with low hemoglobin.

In addition to distribution of vitamin A capsules, most national vitamin A programs have included complementary community-based strategies oriented toward diet modification. Information, education, and communication (IEC) and social mobilization activities in Vietnam consist of education provided through

various channels of the mass media and regular micronutrient training for program staff [4]. An implementation network for these activities has been established from commune localities to central levels and involves the active participation of mass organizations such as women's groups and education departments. In Bangladesh, complementary strategies for controlling vitamin A deficiency include IEC activities to encourage increased consumption and production of fruits and vegetables rich in carotene. Homestead gardening is promoted in all levels of educational institutions, and the benefits of producing micronutrient-rich fruits and vegetables are emphasized [15]. IEC activities and nutrition education for improved breastfeeding and infant-feeding practices have been pursued in several countries, including Laos and Vietnam [4, 16]. Thailand has successfully used social marketing methods to promote vitamin A-rich foods.

Vitamin A food-fortification activities vary across project countries. Active efforts for fortification were under way in the Philippines, Indonesia, Thailand, South Africa, and Vietnam. Thailand has approved a law for the mandatory fortification of sweetened condensed milk, infant formula, and breastmilk substitutes with vitamin A [17]. A program for development of flour fortification of *pan de vida* (bread) has been adopted in the Philippines [18]. Indonesia has voluntary fortification of noodles and margarine, and in the Philippines, in addition to flour, many other food products fortified with vitamin A are available (e.g., Minola Margarine and cooking oil, Tang juice drink, UCARE milk, Ovaltine, and infant cereal) [18].

Bangladesh, Cambodia, China, India, Laos, Myanmar, and South Africa were not fortifying any food products with vitamin A, although Cambodia was exploring possible vehicles for vitamin A fortification. In Laos, sugar was initially identified as a potentially suitable vehicle for fortification; however, upon research, it was recognized that only 35% of those women with night-blindness consumed sugar regularly, and therefore no efforts to promote the fortification of sugar in Laos were pursued. Although appropriate vehicles for vitamin A products had already been identified in South Africa, implementation had not yet occurred due to administrative difficulties [6]. In Sri Lanka, Thripsha, a mixed food product fortified with small amounts of vitamin A, was provided to women and children as part of the national nutrition program. Other than this nutrition supplement package, there were no vitamin A-fortification activities in Sri Lanka.

Evolution of programs

Beyond program adoption, *institutionalization* of vitamin A programs at the national level has relied on international agencies working closely with departments of health, various national ministries, and in some countries (e.g., Vietnam) also with large organizations such as the Women's Union and Education sectors. Provision and distribution of vitamin A capsules required coordination from the national to the local levels and the involvement of local, national, and international institutions.

Initially the mechanism identified for distribution of the vitamin A capsules tended to be through the existing primary health centers. In the case of Bangladesh, India, Indonesia, and Vietnam, all of which initiated vitamin A-supplementation programs relatively early (prior to the 1990s), distribution usually occurred through hospitals and health clinics or door-to-door by community health workers.

By the mid-1990s, most countries implementing door-to-door distribution began to move to a more centralized distribution system usually linked to or integrated with other existing programs. National

immunization days (NIDs) became recognized as a potentially useful mechanism for wide-scale distribution of vitamin A capsules and were adopted as a distribution system by most countries that had previously used other door-to-door methods. Rather than distributing vitamin A capsules throughout a designated month-long period, as in the case of Bangladesh, distribution began to be concentrated on a fixed day- or week-long campaign-based program.

Those countries that had not implemented a national vitamin A program prior to the mid-1990s typically initiated a supplementation program with national immunization days identified as the system for capsule distribution. Myanmar scaled up from targeting high-risk and high-prevalence areas to blanket distribution eventually integrated with national immunization days, and Cambodia conducted trial integrations of vitamin A capsule distribution with national immunization days before fully integrating the program into national immunization days [19]. Laos and the Philippines, however, upon adoption of a universal supplementation policy, immediately used large-scale campaigns with national immunization days as the mechanism for distribution and the venue for nutrition education and information.

Policies for supplementation to mothers postpartum were typically decided on much later than those for universal supplementation to children. In the case of maternal supplementation, most countries adopted a policy and implemented a wide-scale program without documentation of the extent of the problem. Again, across countries, few country-specific efficacy trials were conducted. Bangladesh and Indonesia are the only project countries for which country-specific efficacy trials to assess the potential impact of postpartum supplementation could be identified [7]. One of the first such trials was conducted by Roy et al. [20] in Bangladesh. The study provided 200,000 IU to Bangladeshi women within 24 hours after delivery and showed vitamin A capsule supplementation to have significant impact among lactating women, but the effect appeared to be transient, with most of the impact waning after one to three months following supplementation. Later, Stoltzfus et al. [21] provided lactating women in Indonesia with a vitamin A dose having 100,000 more IU than was provided to women in the Bangladesh. The results showed significant improvements in both maternal and infant vitamin A status at follow-up, paving the way for widespread application of postpartum supplementation.

Iodine

Steps leading to decisions on programs

All countries studied here currently have programs for

salt iodization, although the degree to which these programs are governed by legislation varies across countries. Although most project countries have legislation for iodized salt, India and Cambodia do not. India formerly had a nationwide law for salt iodization, but the legislation was subsequently rescinded, and decisions for adoption and enforcement of laws governing salt iodization are now at the discretion of individual states. The Cambodia National Council of Nutrition adopted a policy statement for iodized salt, but this had not been formally signed; the country therefore lacked legislation for salt iodization.

Of the project countries, Myanmar provides an example of what may have been the typical process for adoption of a national iodized salt program. The steps to program initiation in Myanmar consisted mainly of the following steps (box 1). The strong message from stressing the role of iodine in preventing cretinism, and its effect on mental ability more generally, has proved effective, for instance in Thailand, in generating support for program initiation. A summary of the processes of program initiation by country can be found in tables 1 and 6.

National survey

Similar to the control of vitamin A deficiency, national

BOX 1. Initiation of a national iodized salt program in Myanmar

1960s	Scattered data on iodine deficiency in the country
1969–72	Pilot program of iodized salt in hilly high-risk areas
1982–86	Mass iodized-oil injection program in endemic goiter areas Survey in lowland Myanmar indicated goiter not limited to hilly regions
1991	Formation of Central Committee for Control of Iodine-Deficiency Disorders
1991	Establishment of subnational committees in every state/division and township
1991	Involvement of private sector in iodized salt production
1994	National survey documenting the extent of iodine deficiency in the country
1997	Decision by national health committee to implement universal salt iodization
1997	Convening of a national iodine-deficiency disorders workshop (involving United Nations agencies, international and national nongovernmental organizations, and the private sector)
1998	Ministerial decree for iodization of all salt for human and animal consumption

Source: Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

documentation of the extent of iodine deficiency served as an important milestone in mobilizing organizations, ministries, and the government to address the problem of iodine deficiency in the countries. Across most project countries, a national goiter survey was conducted, and later (sometimes after five years or so), a decree for mandatory iodized salt was signed. Survey data available for clinical and biochemical indicators of iodine deficiency [22] have been compiled in tables 7 and 8.

Once the extent of the problem in the country was documented, the potential consequences of iodine deficiency were usually drawn from international data. Knowledge of important long-term effects of iodine deficiency, such as impaired motor and cognitive development and mental retardation, helped to motivate action for the control of iodine deficiency.

Establishment of national subcommittee

In many countries, national committees or subcommittees were established to create an administrative body for efforts to control iodine deficiency nationally. The committees have typically been composed of leading groups from the central government, interministerial representatives, and influential local counterparts. In many cases, the committee was given responsibility for exploring provisional ways to control iodine deficiency [23]. The committee often helped to steer nutrition-related policies and to establish the national program for iodine-deficiency disorder control. As iodized salt became identified as a feasible and efficacious means for controlling iodine deficiency, the national committees worked to involve private companies in the process of developing a national program (as much as possible from the beginning of program establishment), instilling a sense of ownership, pride, and responsibility among them for their efforts in helping to improve the health status of the country's population.

Establishment of subnational committees at country localities

In some project countries, subnational committees were established at country localities. The establishment of subnational committees allowed every state or division and township to be included in the national effort to control iodine deficiency. Myanmar, for example, requested the involvement of local governments from the time of the program's inception, thus allowing for the iodine-deficiency program to devolve to local levels with an organized body to oversee the implementation of and advocacy for the program at a decentralized level. In the Philippines, efforts were made to incorporate iodized salt activities into the plans of the local government units. It was anticipated that local resolutions for the use of iodized salt would be adopted. However, up to October 2001, only 161 local government units out of a total of 78 provinces,

TABLE 6. Time sequence of initiation of iodized salt programs

Country	Timeline of process to initiation	Year of adoption of policy for iodized salt	Year of adoption of legislation for iodized salt
Bangladesh	1993: National goiter survey	Not reported	1995: Committee for IDD law and establishment of salt committees at different levels
Cambodia	1996-97: National goiter survey, establishment of national subcommittee for IDD; committee has responsibility for legislation, monitoring of program, and collaborating with private sector 1997: Implementation of salt iodization program begins	Policy for iodized salt adopted by National Council for Nutrition in 1999	No legislation for salt iodization yet adopted
China	1956: Prevention and treatment of endemic goiter placed on the national program for agricultural development (iodized salt tested at selected sites) 1960: Leading groups in center and localities set up (to establish the administrative body) 1966: Comprehensive preventive and treatment activities for IDD (mainly iodized salt) in some areas 1979: Provisional methods of using iodized salt for preventing and treating endemic goiter approved by state council 1985: Work on iodized salt began	1993: State council convened a mobilization meeting; worked out a series policy, regulation, and relevant documents on preventing and treating IDD	1994: State council successively promulgated decrees on prevention and treatment of IDD
India	1966: Iodized salt distribution began	Not reported	Ban on noniodized salt, rescinded May 2000
Indonesia	1980: National goiter survey; studies on cost-effectiveness of iodated water, iodized salt, and lipiodol for control of IDD	Not reported	1986: Joint decree by Ministry of Health, Ministry of Industry and Trade, and Ministry of Home Affairs on salt iodization. 1998: National standards in Indonesia for salt and wheat established
Laos	1993: National survey showed iodine deficiency to be an important public health problem 1994: Universal salt iodization program initiated	1993: IDD elimination included in the National Program of Action	1995: Prime minister's decree for national salt iodization signed

continued

84 cities, 1,525 municipalities, and 41,940 barangays (villages) had so far passed local resolutions [24].

National workshops and mobilization meetings

National workshops often provided a mechanism for a collaborative meeting involving government members, steering committees, national subcommittee members, subnational committee members, and representatives from the private sector. Across countries, the workshops were organized for different purposes. Sometimes they

were used to increase awareness of iodine-deficiency disorders and to promote provisional methods for their prevention and treatment (e.g., with iodized salt). At other times, the workshops served as a mobilization meeting in which the national policy on iodized salt was finalized (China) or by which the national program was prepared for official launching (Myanmar).

External assistance

Across countries, the support of international organi-

TABLE 6. Time sequence of initiation of iodized salt programs (*continued*)

Country	Timeline of process to initiation	Year of adoption of policy for iodized salt	Year of adoption of legislation for iodized salt
Myanmar	1967-68: Goiter survey in Chin hill and Northern Sagaing 1969: Iodized salt as pilot program 1991: Formation of central committee for control of IDD and establishment of sub-national committees in every state/division and township; involvement of private sector in iodized salt production 1994: National goiter survey 1996: Acceleration of IDD control program with iodized salt 1997: National goiter survey	1997: Decision by National Health Committee to iodize all salt and implement universal salt iodization program; national IDD workshop	1998: Ministerial decree for iodized salt 2000: Universal salt iodization incorporated into the National Health Plan
Philippines	1987: National goiter survey 1993: National goiter survey shows an increase in goiter prevalence from 1987	1993: Elimination of IDD in Philippine Plan of Action for Nutrition (1993-98, 1999-2004)	1993: ASIN Law passed; requires all food-grade salt to be iodized; mandates all salt producers and traders to make iodized salt available; mandates Department of Health to act as lead agency; directs Salt Iodization Board to report the status of salt iodization program annually to Philippine congress
South Africa	1994: National goiter survey	Not reported	1995: Mandatory salt iodization initiated
Sri Lanka	1989: National goiter survey	Not reported	1993: Food regulations for iodized salt enacted 1995: Program for iodized salt came into operation
Thailand	Initial surveys reveal high prevalence in parts of country (e.g., Northern provinces) 1965: Pilot project for salt iodization begun in the North 1968: Salt iodization project expanded into countrywide program Mid-1970s: IDD becomes a lower priority for Thai government 1988, 1993: National goiter surveys	National goal defined in 1982; national committee established in 1991	1994: Iodized salt legislation adopted 1995-2001: Concrete Action Plan of IDD Control Program implemented
Vietnam	1993-5, 1998: National goiter surveys		1999: Decree for iodized salt

IDD, Iodine-deficiency disorders; ASIN, Act Promoting Salt Iodization Nationwide and for Other Purposes.

Source: refs. 4-6, 15, 16, 19, 23-25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

zations (particularly UNICEF) was almost universal and was thus important for the initiation of national iodized salt programs. In most cases, UNICEF worked with the private sector and provided both the machinery and the potassium iodate necessary for salt fortification. In addition, UNICEF provided mixers and

fortificants to small-scale salt producers and supplied replacement parts for broken machinery.

Iodine-deficiency disorder control strategy incorporated in national plan of action

Including iodine-deficiency disorder control strate-

TABLE 7. Clinical survey data on iodine deficiency^a

Country	Survey year	Indicator ^b	Sample group (survey coverage)	Reported prevalence (%)
Bangladesh	1981	TGR	Children 6–12 yr (national)	11.3*
	1993	TGR	General (national)	49.9*
	1993	Cretinism	Not reported	0.5
Cambodia	1996–97	TGR	Children 8–12 yr (national)	17.0
China	1986	TGR	School-aged children (national)	9.2*
	1995	TGR	Not reported	20.43
	1999	TGR	Not reported (national)	8.0
India	Not reported	TGR	School-aged children (national)	9.0*
Indonesia	1982	TGR	School-aged children (national)	37.0*
	1988	TGR	School-aged children (national)	27.7*
	1996	TGR	School-aged children (national)	9.8
Laos	1988	TGR	School-aged children (national)	25.0*
	1993	TGR	School-aged children (Northern region)	24.9
	1993	TGR	School-aged children (Southern region)	14.9
	2000	TGR	Children 6–12 yr (Northern region)	9.1
	2000	TGR	Children 6–12 yr (Southern region)	11.5
	2000	TGR	Children 6–12 yr (national)	9.1
Myanmar	1990	TGR	School-aged children (national)	18.01*
	1994	VGR	Children 6–11 yr (national)	33.08
	1997	VGR	Children 6–11 yr (national)	25.1
	1999	VGR	Children 6–11 yr (national)	12.16
Philippines	1987	TGR	Boys 7–14 yr (national)	0.8
	1993	TGR	Boys 7–14 yr (national)	0.6
	1987	TGR	Girls 7–14 yr (national)	6.4
	1993	TGR	Girls 7–14 yr (national)	4.8
	1987	TGR	Pregnant women 13–20 yr (national)	17.6
	1993	TGR	Pregnant women 13–20 yr (national)	27.4
	1987	TGR	Pregnant women 21–49 yr (national)	12.4
South Africa	1994	VGR	Children 6–71 mo	1.0
Sri Lanka	1986	TGR	Children and young adults 5–20 yr (national)	14.40*
	1989	TGR	School-aged children (17 districts)	18.8
	2000	TGR	Not reported	21.0
Thailand	1989	TGR	School-aged children (15 provinces)	19.31*
	1990	TGR	School-aged children (15 provinces)	16.8
	1992	TGR	School-aged children (39 provinces)	12.24*
	1994	TGR	School-aged children (57 provinces)	7.9*
	1996	TGR	School-aged children (75 provinces)	4.3
	1997	TGR	School-aged children (75 provinces)	3.3
	1998	TGR	School-aged children (75 provinces)	2.6
	1999	TGR	School-aged children (75 provinces)	2.2
Vietnam	Not reported	TGR	General (national)	34.9*
	1993	TGR	School-aged children (national)	24.0*
	1993–95	TGR	Children 8–12 yr (national)	27.1
	1998	TGR	Children 8–12 yr (national)	14.9
	2000	TGR	Children 8–12 yr (national)	10.1

a. When listed as not reported, the data have not been specified. In general, however, total goiter rate has most likely been used as an indicator, and School-aged children have been surveyed as the sample group, as recommended by WHO/UNICEF/ICCIDD [22].

b. TGR, Total goiter rate; VGR, visible goiter rate.

Source: refs. 4–6, 15, 16, 19, 23–25, 28, except for numbers with an asterisk, for which the source is United Nations [1]; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

TABLE 8. Biochemical survey data on iodine deficiency

Country	Survey year	Sample group (survey coverage) ^a	Reported median urinary iodine value	Reported prevalence of iodine deficiency ^b (%)
Bangladesh	1993	Not reported	Not reported	68.9
	1999	Not reported	Not reported	43.0
China	1995	Not reported	164.8 µg/L	Not reported
	1999	Children 8–10 yr (national)	306.0 µg/L	Not reported
Indonesia	No biochemical data on iodine deficiency reported			
Laos	1993	School-aged children	Not reported	95.0
	2000	Children 8–12 yr (national)	Not reported	26.9
Philippines	1998	Children 6–12 yr (national)	71.0 µg/L	65.3
Vietnam	1993–95	Children 8–12 yr (national)	Not reported	84.0
	1998	Children 8–12 yr (national)	16.6 µg/dl	32.9
	2000	Children 8–12 yr (national)	12.6 µg/dl	31.2

a. When listed as not reported, the data have not been specified. In general, however, School-aged children have most likely been surveyed as the sample group, as recommended by WHO/UNICEF/ICCIDD [22].

b. Iodine deficiency is defined as a urinary value < 10 µg/dl.

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

gies in the national plans of action provided a long-term commitment to controlling iodine-deficiency disorders, and signified that control of iodine-deficiency disorders was recognized as a health priority for the country. Although the timing of the incorporation of iodine-deficiency disorder control strategies into the national health plan varies across countries—some project countries have incorporated iodine-deficiency disorders in the national health plan prior to the signing of a decree for iodized salt (Philippines and Laos), whereas other countries (e.g., Myanmar) have initiated a universal salt iodization (USI) program and later incorporated iodine-deficiency disorders into the health plan—the eventual integration of the control strategy into the health plan is symbolically important; not only does it represent a clear commitment to an iodized salt initiative, but integration into a national plan of action makes enforcement of supporting legislation, continued financial assistance, and sustainability of the program more likely.

Signing of decree

A signed decree represents legislation mandating that salt for human consumption be iodized. A signed decree therefore motivates a strong program initiation and provides legal enforcement for iodized salt activities. All project countries except Cambodia and India have enacted a signed decree marking the formal initiation of national legislation for salt iodization.

Strategic approaches

Myanmar, Thailand, Laos, and China implemented iodized salt as a pilot program before initiation of a national iodized salt intervention. In the case of Myanmar, iodized salt efforts were initiated relatively early. Following a goiter survey in three areas of the country, a pilot control program was launched in 1969, with the assistance of UNICEF. An assessment of the program was carried out in 1972. The results showed that goiter rates fell from 90% in 1969 to 25% in 1972. Although the pilot program was found to be efficacious, the government soon afterwards deregulated salt, thereby making noniodized salt available in the markets. Goiter rates subsequently increased in the pilot areas. Alternative short-term approaches for the control of iodine deficiency were implemented in the country later (1982–86). More than 25 years after the first efforts for salt iodization in the country, the government reestablished iodized salt as a priority initiative. In 1997, Myanmar adopted a policy for universal salt iodization; one year later, the decree for iodized salt was signed.*

The case of Thailand is similar, with high goiter rates in the 1950s in those areas of the country for

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

which data are available. Pilot studies of the use of iodized salt began in 1965, and in 1968 the project was expanded into a countrywide program. However, as in the case of Myanmar, government support for the program diminished in the early to mid-1970s. Efforts for a well-controlled salt iodization program were not undertaken again until 1989 with the National IDD (Iodine-Deficiency Disorders) Control Project. Legislation to provide for mandatory iodization was adopted in 1994, and an action plan for the control of iodine deficiency implemented as a result.

More common than the cases of Thailand and Myanmar short-term strategies were implemented prior to initiation of an iodized salt program. From the mid-1970s to the early 1990s, iodized oil capsules or lipiodol injections were common programmatic approaches. Typical target groups included infants, School-aged children, or women of childbearing age in iodine-deficient areas. Indonesia, for example, provided lipiodol injections to School-aged children and newly married women in highly endemic areas in the years 1974–86. The decree for salt iodization was adopted by the Ministry of Health, the Ministry of Industry and Trade, and the Ministry of Home Affairs in 1986 [25].

By the early 1990s, most of the project countries were beginning to opt for iodized salt as a long-term approach to controlling iodine deficiency. In the meantime, some countries have continued to use iodine supplementation as a complementary strategy to reach vulnerable groups, usually targeting women of childbearing age or school-age children. In the Philippines, the week-long campaigns used for immunization and vitamin A supplementation were also used to provide iodine capsules to women of childbearing age in the years 1993–95. Indonesia continued to provide iodized oil capsules to women of childbearing age and School-aged children, while also implementing a national iodized salt program. Other countries providing iodized oil capsules at some time include Bangladesh, Cambodia, China, Laos, Myanmar, Sri Lanka, and Thailand. A more detailed list of the strategic approaches adopted for the control of iodine deficiency according to country is given in table 9.

Evolution of programs

Currently all project countries use a national salt iodization program as their main method for addressing iodine deficiency. At the same time, many countries have explored intervention strategies to complement iodized salt programs. The use of iodinated water, for example, has recently been studied as a pilot project in some countries. China conducted several studies to explore the efficacy of iodized water. Cambodia, Myanmar, and Thailand have also made targeted efforts for iodinated water. In 1997, Cambodia installed iodine containers in wells in two provinces. In Myanmar,

small-scale efforts were made to control iodine-deficiency disorder among School-aged children by using iodinated drinking water. In Thailand, iodinated water was being targeted to all primary schools and households in 39 provinces (covering 50% of the total population), and iodized oil capsules provided to pregnant women and women of childbearing age as well as to School-aged children in areas where the prevalence of iodine-deficiency disorders is above 20%. Data on the effectiveness of these interventions are not available.

Additional fortification vehicles for the control of iodine deficiency were being explored in some countries. Cambodia, for example, is considering fortifying additional food products with iodine. Other countries are exploring the possibility of fortifying food products with multiple micronutrients. India was evaluating a double-fortified (iodine and iron) salt product (Vijayraghavan, personal communication, 2001), and Indonesia has recently studied the potential impact of providing a multimicronutrient (iodine included) biscuit to pregnant women. In Thailand, a triple-fortified (iodine, vitamin A, and iron) noodle is available in the market, and a double-fortified (iodine and iron) fish sauce is ready for the market [26].

Iron

Steps leading to decisions on programs

Efforts to address anemia have not been launched with the same level of intensity as those for the control of vitamin A and iodine deficiency. Across countries, iron programs tend to be less well developed. As a result, comparably fewer data on iron programs have been reported by project countries. The steps leading to initiation of iron-deficiency control programs are therefore less clear than for other micronutrient-deficiency control programs. The available data and a corresponding timeline for program adoption have been compiled in tables 1 and 10.

National survey

Despite recognition of the problem of anemia worldwide, not all countries have yet collected national data on anemia among all high-risk groups. Although most countries have survey data on the prevalence of anemia among pregnant women (table 11) and young children, in general there tends to be a lack of national surveys documenting the prevalence of anemia among other at-risk groups, such as lactating women and the elderly. Moreover, few country-specific studies have examined the causes of anemia among high-prevalence groups and in high-prevalence areas.

Programs to address iron deficiency most often target the prevention and treatment of anemia among pregnant women. All countries that have conducted surveys

TABLE 9. Strategic approaches implemented for the control of iodine deficiency

Country	National salt iodization legislation	Capsule supplementation	Target group (year)	Iodated water	Target group (year)	IEC activities	Fortification (other than salt) explored
Bangladesh	Yes	Yes	Not available (phased out)	Not reported	Two provinces (1997)	Yes	Not reported
Cambodia	No	Yes	Women of childbearing age (2000, phased out)	Yes	Target groups and year not reported	Yes	Yes
China	Yes	Yes	Pregnant women and women of childbearing age in areas of severe endemic goiter and cretinism (2001)	Yes, as pilot projects		Yes	No
India	No	Not reported		Not reported		Not reported	Double-fortified salt (iodine, iron)
Indonesia	Yes	Yes	School-aged children and young married couples (1987 to 2001)	No		Yes (television advertisements)	Multimicronutrient-fortified biscuit
Laos	Yes	Yes	Urban residents in 2 provinces (1990–93)	No		Yes	Yes
Myanmar	Yes	Yes	Lipiodol injection in 95 townships (1982–86)	Yes	Target groups not reported (2001, for 2 yr)	Yes	Not reported
Philippines	Yes	Yes	Pregnant women (1993), married women of childbearing age (1994), and women aged 15–40 (1995)	No		Yes	Not reported
South Africa	Yes	Not reported	High-risk groups (1950s, phased out)	Not reported		Not reported	Not reported
Sri Lanka	Yes	Yes	Pregnant women, women of childbearing age, and School-aged children in areas with IDD prevalence > 20% (2001)	No		Yes	Not reported
Thailand	Yes	Yes		Yes	All primary schools and households in 39 provinces and some provinces in Southern region (2001)	Yes	Triple-fortified (iodine, vitamin A, iron) noodles, double-fortified fish sauce (iodine, iron)
Vietnam	Yes	No		No		Yes	Not reported

IEC, Information, education, and communication; IDD, iodine-deficiency disorders.

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

TABLE 10. Time sequence of initiation of iron-supplementation program

Country	Timeline of process to initiation	Iron supplementation policy implemented
Bangladesh	Iron tablets distributed through BINP 1995–2001 and through NNP and health service network from 2001 onwards	Pregnant women with body mass index < 18.5 targeted for iron tablet supplementation (60 mg iron, 250 mg folic acid twice daily) through pregnancy, 6 mo of lactation
Cambodia	Not reported	Iron/folate tablets distributed to pregnant women through ANC
China	National long-term program for Chinese child development was adopted in the 1990s, although supplementation of pregnant women with iron tablets to control anemia had not begun (2001)	Not applicable
India	Not reported	Iron/folate tablets distributed to pregnant and lactating women
Indonesia	1974: UPGK initiated iron tablet distribution to pregnant women from UNICEF and GOI 1986: Iron tablet modified to include sugar, folic acid, and vitamin C 1997: Iron program expanded to women workers and brides-to-be	Iron/folate-vitamin C tablets distributed to pregnant women and women of childbearing age; iron syrup provided for undernourished children
Laos	1996: Iron supplementation to pregnant women incorporated into National Plan of Action for Nutrition 1997: Plan of Action for Implementation adopted	Pregnant women targeted for iron tablet supplementation (60 mg elemental iron, up to 0.25 µg folic acid) from first ANC visit to first 3 mo of lactation
Myanmar	Upon finding of high prevalence of anemia among pregnant women, iron-supplementation program was incorporated into the National Health Plan	Iron/folate tablets distributed to women in 3rd trimester of pregnancy; tablets distributed through ANC; women receive 2 tablets daily during 3rd trimester
Philippines	Not reported	Iron/folate tablets distributed to pregnant women through ANC
South Africa	Policy for iron tablet supplementation to pregnant women adopted, but no program implemented (2001)	Iron/folate tablets distributed to pregnant women, and high-dose supplementation to children 6–24 mo of age
Sri Lanka	Not reported	Iron/folate tablets distributed to pregnant women through ANC
Thailand	Mid-1970s: Reduction of iron-deficiency anemia included as goal in the national development policy (with focus on School-aged children and pregnant women)	Iron/folate tablets distributed to pregnant women through ANC (facilitated by VHV); weekly iron supplementation to School-aged children piloted; voluntary for women of childbearing age in workplace
Vietnam	Not reported	Iron/folate tablets (60 mg iron, 0.25 mg folate) distributed to women through pregnancy and 1st month of lactation; weekly supplementation to children and adolescents 6–15 yr of age through schools; weekly supplementation to nonpregnant women 15–35 yr of age through organizations; supplementation to infants and children tested

BINP, Bangladesh Integrated Nutrition Programme; NNP, National Nutrition Program; ANC, antenatal care; UPGK, Village Family Nutrition Improvement Programme (Indonesia); GOI, Govt of India; VHV, village health volunteer.

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

TABLE 11. Survey data on anemia among pregnant women (only national data where indicated)

Country	Survey year	Reported prevalence (%)
Bangladesh	1975	58.0*
	1980	62.0*
	1981	77.0*
	1997 (national)	49.2
Cambodia	2000 (national)	50.0–80.0
China	1979	13.0*
	1982	43.5*
	1984	35.0*
	1985	20.0*
	1987	35.0*
	1992	35.0*
	India	1978
1979		71.11*
1980		66.5*
1982		73.7*
1984		76.77*
1985		84.0*
1986		65.5*
1988		90.0*
Indonesia	1975	37.0*
	1980	64.0
	1980	70.0*
	1982	68.0*
	1986	72.13*
	1991	50.1*
1995	50.9	
Laos	No data	
Myanmar	1978	72.67*
	1979	58.0*
	1993	58.1
	1995	58.0*
Philippines	1978	53.0*
	1980	53.67*
	1982	33.8*
	1986	48.0*
	1993 (national)	43.6
	1998 (national)	50.7
South Africa	1978	35.07*
	1980	23.0*
	1982	28.5*
	1984	35.5*
	1986	35.0*
Sri Lanka	1994	39.0*
Thailand	1986	36.0
	1996–97	22.3
Vietnam	1987	46.5*
	1995	52.7
	2000 (national)	32.2

Source: refs. 4–6, 15, 16, 19, 23–25, 28, except for numbers with an asterisk, for which the source is United Nations [1]; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

among pregnant women have found high prevalence rates of anemia, generally higher than 40%. All countries with survey data were implementing national programs for iron supplementation to pregnant women. No national survey data on the prevalence of anemia among pregnant women could be identified for Laos, where a program for the control of iron-deficiency anemia among pregnant women has been adopted, despite the lack of survey data for the target group.

Incorporation in national nutrition plan

Some project countries with programs for the control of iron-deficiency anemia have incorporated programmatic approaches and goals related to the control of iron-deficiency anemia into a national plan of action for nutrition. The plan of action has often been established in collaboration with international agencies such as the Food and Agriculture Organization, the World Health Organization (WHO), and UNICEF, and it is sometimes coupled with a government decree to formalize the goal and further mobilize efforts for its achievement.

Plan of action for implementation

In some countries, a plan of action for implementation has followed the national plan of action. In Laos, for example, a goal of reduction of the prevalence of anemia in pregnant women to less than 10% by the year 2002 was established in collaboration with WHO and UNICEF and was stated in the National Plan of Action for Nutrition [16]. The Plan of Action for Nutrition (along with the stated goal for anemia reduction) was adopted by government decree in January 1996, and a Plan of Action for Implementation developed in November 1997 then followed [16].

External assistance

Initiation of an iron-supplementation program has almost always been dependent on external assistance. Iron tablets are supplied to countries by UNICEF and are usually at least partially (if not fully) funded by UNICEF offices. Bangladesh and Thailand have each established an independent system for procurement of iron tablets.

Strategic approaches

Strategic approaches to control iron deficiency generally revolve around supplementation distributed through antenatal-care centers, but are often complemented with IEC activities or, less commonly, fortification efforts (table 12). Most often the national program provides iron tablets for pregnant women from first presentation at the antenatal center to the end of pregnancy or, in some cases, up to six months after delivery. Iron/folate tablets (usually 60 mg of iron and 250 mg of folate) are usually provided, although there is some

TABLE 12. Strategic approaches implemented for the control of iron deficiency [3]

Country	Iron tablet supplementation				Malaria control	Deworming	Fortification	IEC activities
	Children	Nonpregnant women	Pregnant women	Lactating women				
Bangladesh	No	No	Yes	Yes (1st 6 mo)	No	Yes	No	Yes
Cambodia	No	Yes (pilot study)	Yes	No	Yes (in some areas)	Yes (in some areas)	No	Yes
China	No	No	No	No	Yes	Yes	Yes (pilot program for NaFeEDTA-fortified soy sauce)	No
India	No	Yes (pilot study in Orissa)	Yes	Yes	Not reported	Not reported	Yes (pilot program for salt fortified with iron and iodine)	Not reported
Indonesia	Yes (iron syrup to undernourished children)	Yes (targeted to newly married women)	Yes	No	Not reported	Not reported	Yes (mandatory fortification of wheat flour; voluntary fortification of noodles, efficacy study on multi-cronutrient-fortified biscuit)	Not reported
Laos	No	No	Yes	Yes (1st 3 mo)	No	No	No	Yes
Myanmar	No	No	Yes	No	No	Yes	No	Yes
Philippines	Not reported	Not reported	Yes	Not reported	Not reported	Not reported	Not reported	Not reported
South Africa	No	No	Yes	No	Not reported	Not reported	Not reported	Not reported
Sri Lanka	No	No	Yes	No	Yes (targeted to pregnant women after 1st 3 mo, preschool children, and school-aged children in grades 1, 4, 7)	Yes (targeted to pregnant women after 1st trimester)	Yes (Thriposha iron-fortified supplement to pregnant women; fortification of wheat flour explored, but not pursued)	Yes
Thailand	Yes	Yes	Yes	Protocol exists; no monitoring	In endemic border areas	Twice yearly for school-aged children, interrupted by economic crisis	Yes (instant noodle fortified with iron, vitamin A, and iodine; fish sauce fortified with iron and iodine ready for markets)	Yes
Vietnam	Yes (pilot phase)	Yes (pilot phase)	Yes	Yes (1st mo)	No	Yes (targeted to children and nonpregnant women)	Yes (fortified biscuit in pilot phase, NaFeEDTA-fortified fish sauce in pilot phase)	Yes

IEC, Information, education, and communication.

Source: refs. 4–6, 15, 16, 19, 23–25, 28; also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

variance in tablet composition and dosing schedule across countries. Indonesia, for example, provides pregnant women with a tablet containing iron, sugar, folic acid, and vitamin C. Although most countries recommend that women take one tablet daily for the duration of pregnancy, Bangladesh and Myanmar recommend that the pill be taken twice daily. Myanmar is the only country for which the recommended dosing schedule does not cover the entire duration of pregnancy; the national policy instead recommends supplementation only during the third trimester of pregnancy.

Problems with iron-supplementation programs include poor absorption of iron tablets due to dietary factors and lack of compliance with the daily supplementation regime. Side effects reported include black stools and nausea. In response to reported low tablet compliance, a strategy for weekly rather than daily iron tablets has been explored. Trials have been conducted in project countries such as Bangladesh [27] and Indonesia [28]. Beaton and McCabe [29] recently conducted a meta-analysis of studies comparing the efficacy of weekly and daily iron supplementation to pregnant women. The meta-analysis was interpreted as showing that weekly supplementation was less efficacious than daily supplementation. No project country had yet adopted weekly supplementation in lieu of recommending daily supplementation to pregnant women.

Complementary approaches for the control of anemia include deworming activities and malaria control in endemic areas. The extent to which complementary strategies are implemented varies across countries. For example, in Vietnam, deworming of nonpregnant women and children is initiated annually during a national deworming campaign [4], whereas in Sri Lanka, deworming is initiated among women after the first trimester of pregnancy [5]. In Sri Lanka, malaria chemoprophylaxis is part of the national health sector interventions and is targeted to women after the first trimester of pregnancy. In Vietnam, there has not yet been any study exploring the role of malaria in anemia. As a result, the contribution of malaria to the prevalence of anemia among pregnant women is not known. Although a high incidence of falciparum malaria is known to exist in certain areas of the country, malaria chemoprophylaxis has not yet been included as part of the iron-deficiency control program in Vietnam [4].

IEC activities are also a priority approach for many countries. Community nutrition education is often provided, focusing on promoting anemia awareness and dietary diversification. Community education in some countries also includes sessions during which techniques are shared for increasing the bioavailability of iron through food preparation. Among countries, it is most common for health and anemia education to be provided at the community level by village health workers. In certain countries, the private sector also has a role in the promotion of health education and anemia

awareness. In Myanmar, for example, the private sector has the responsibility for educating the public about the importance of consuming iron-rich foods and for providing information on home gardening strategies, proper birth spacing, and family planning.

Iron supplementation is not recognized as a strategy that can alone sufficiently reduce the prevalence of anemia. The strategy is seen as difficult to implement effectively and with wide coverage. Food-fortification technology is a promising alternative strategy, with better long-term prospects, and is being explored in many countries. However, identifying suitable vehicles for iron fortification has proved difficult for most countries. In Bangladesh, for example, fortification of wheat flour appears technologically feasible as well as cost-effective. Unfortunately, wheat flour is not the most commonly consumed item among the most vulnerable target group in the country. Instead, food items such as common salt, rice, and potatoes are regularly consumed. Although these food products are logistically more difficult to fortify, they may, in fact, be the most effective food products to consider for iron fortification in Bangladesh.

Indonesia is the only project country that has legislation for mandatory fortification of a food product with iron. In 1998, fortification of wheat flour became mandatory in Indonesia [25]. A ministerial health decree mandates that all wheat flour in Indonesia now be fortified with iron, zinc, thiamine, riboflavin, and folate. Voluntary fortification of food products with iron is more common, though still only found in a few countries. Indonesia has voluntary fortification of noodles, and Thailand has developed both double-fortified fish sauce (iodine and iron) and a triple-fortified (vitamin A, iron, and iodine) instant noodle food product [17].

Sri Lanka, Vietnam, India, and China have also explored the possibility of fortifying food products with iron. In 1997, Sri Lanka conducted a study in six estate areas to assess the potential impact of fortifying wheat flour with iron. The study collected data on flour availability and distribution, food prices, food consumption, school attendance, and morbidity patterns, and obtained blood samples. No program for fortification of wheat flour was later pursued. In Vietnam a pilot study examined the efficacy of a NaFeEDTA-fortified fish sauce. India was testing the effectiveness of a double-fortified (iron and iodine) salt product. In 2000–02, China was conducting an intervention study to explore the potential to use NaFeEDTA-fortified soy sauce as a national strategy for the control of iron-deficiency anemia, which showed beneficial effects.

Evolution of programs

Although iron supplementation in most countries is focused on pregnant women, some countries are beginning to initiate iron programs directed to other

population groups. Anemia is recognized as a public health problem affecting all demographic groups, and as a result, more countries are beginning to collect anemia data for nonpregnant women, preschool children, infants, men, and the elderly.

Almost all project countries have national data on anemia prevalence among nonpregnant women (not shown here). Among these, five countries were implementing programs or testing iron-supplementation interventions for nonpregnant women. Indonesia has established a program to distribute iron tablets to women workers and brides-to-be, and Thailand provides weekly iron supplementation to women of childbearing age in the workplace [17, 25]. Some countries (e.g., Vietnam) are testing iron supplementation to nonpregnant women. Cambodia has recently initiated a pilot study of iron supplementation to women factory workers and School-aged children of childbearing age.

In the last decade, every project country except India and Sri Lanka has collected data documenting the prevalence of anemia in infants or young children. The surveys indicate alarmingly high prevalence rates across countries, yet only Thailand and Indonesia have national programs directed to this target group. Thailand provides weekly iron supplementation to School-aged children, and Indonesia provides iron syrup to undernourished children. Although Vietnam has implemented weekly supplementation programs to infants, young children, adolescents, and nonpregnant women, all of these interventions were small-scale pilot projects implemented in select areas. Although South Africa has established a policy of high-dose supplementation to children aged 6 to 24 months, no program had yet been implemented.

Similarly, few interventions targeting lactating women have yet been implemented. Bangladesh, Laos, Thailand, and Vietnam are the only countries with policies providing for iron supplementation to pregnant women beyond delivery. Across these three countries, the policy varies from provision of iron tablets for one month to six months following delivery.

Only four project countries (Laos, Thailand, the Philippines, and Vietnam) have anemia data for men. Although the rates for men are much lower than those for other population groups, anemia is still shown to be prevalent among this population (a prevalence of around 10% to 20% has been documented across the countries). No strategies for the control of iron-deficiency anemia in any project country have yet been specifically targeted to men.

The prevalence of anemia among the elderly is even less well documented. Only three project countries (Indonesia, Laos, and the Philippines) had data on the prevalence of anemia among the elderly. All data show prevalence rates above 30%, yet no national programs are targeted to this age group.

Summary of lessons learned on micronutrient-deficiency control program initiation and associated recommendations

The key steps taken in the initiation of national micronutrient-deficiency control programs are similar across study countries (fig. 1). For the establishment of national vitamin A-supplementation programs, these key steps have included:

- » national surveys documenting the extent of vitamin A deficiency in the country;
- » national workshops and advocacy meetings on vitamin A deficiency;
- » establishment of national technical and intersectoral committees for the control of vitamin A deficiency;
- » securing of assistance from bilateral and international agencies to support the program.
- » For the initiation of salt iodization programs for iodine-deficiency control, the key steps have included:
 - » national surveys to document the prevalence of iodine-deficiency disorders in the country;
 - » establishment of one or more national subcommittees to oversee national control efforts;
 - » conduct of national workshops or advocacy/mobilization meetings;
 - » securing of international assistance;
 - » integration of the iodine-deficiency disorders control strategy into the national plan of action for nutrition;
 - » signing of a decree mandating that salt for human consumption be iodized.

For the initiation of iron tablet distribution programs, the key steps were similar:

- » conduct of a national survey documenting the problem to be addressed;
- » incorporation of iron-deficiency control into the national plan of action for nutrition;
- » development of a plan of action for program implementation;
- » securing of external assistance.

These steps worked well in initiating programs and are generally *recommended* for establishing new programs and strengthening others. One constraint (here as in other phases) has been lack of monitoring information as programs take off, which could receive more attention in the future. Specifically for iron, more effective approaches (e.g., fortification of staple foods) need research and development. Some important modifications of program design (e.g., more frequent distribution of vitamin A capsules, possible targeting to most deficient populations) may need to be incorporated as more results become available.

The most commonly undertaken step in initiation was a national micronutrient survey. Many (8 of 12) countries undertook a national vitamin A deficiency survey for children, although few data are available document-



FIG 1. Stages in the initiation of national micronutrient-deficiency control programs [3]. Data updated to July 2003, based upon available information. Key: + applies to one deficiency, ++ to two, +++ to all three, and - to none.
 a. In China, one survey was conducted at a subnational level.

ing the prevalence in women postpartum. In the earlier surveys, data on night-blindness were most commonly collected. Since the later 1990s, measurements of serum retinol have been collected as well (e.g., Bangladesh, Laos, South Africa, and Sri Lanka). Almost all countries undertook a national iodine-deficiency disorders survey, consisting in most cases of determination of the total goiter rate. National surveys of iron-deficiency anemia were the least common. Only three have been documented (China, Myanmar, and Thailand); national data collection has focused mainly on pregnant women, and recently there has been an increased focus on children. A focus on other at-risk groups, such as the elderly, would be useful in the future.

More systematic surveying is *recommended* to improve the information basis for program initiation and design. For example, better methods for estimating the prevalences of vitamin A deficiency and anemia (with representative sampling of wider age groups) would contribute information and should be developed and applied.

External assistance was widely sought by study countries. International support for the control of iodine-deficiency disorders (in most cases, for salt iodization) was documented in most study countries. UNICEF played a central role in funding iodization activities, funding that was critical for capital and equipment purchase and maintenance as well as for the purchase of fortificant. At least six of the study countries have documented external support for vitamin A capsule and iron tablet distribution programs. Institutions providing support to vitamin A-supplementation programs include the Canadian International Development Agency, Helen Keller International, and UNICEF, which provided both financial support and technical assistance. Iron tablet distribution programs often suffer from failures of supply, purchase, and management, despite considerable support from UNICEF.

Donors are *recommended* to continue support to programs, including support to build the capacity for

program design and advocacy, until they are demonstrably self-sustaining.

National workshops have served as an important mechanism to raise awareness, mobilize expertise, and promote policy and program development for national micronutrient-deficiency control programs. National workshops have often benefited from recently undertaken population-representative micronutrient-deficiency surveys, which have facilitated advocacy among governmental and nongovernmental stakeholders. Clinical research conducted in the 1990s that estimated the impact of micronutrient deficiencies on human growth and development and on child survival [30] provided an impetus to translate survey data into action. National workshops also provided the foundation for the establishment of national committees and subcommittees to guide government response. Committees were charged with the development of program and policy guidelines, as well as plans of action for institutionalization and implementation of those guidelines. For vitamin A-deficiency control programs, committees identified mechanisms for service delivery, a process that resulted in large-scale campaign-model programs (e.g., national immunization days) combined with routine facility-based distribution for target groups. The committees also oversaw an increased focus on postpartum women in addition to children as focal groups. In terms of iodine-deficiency disorder control programs, the committees typically contained interministerial representatives, private industry representatives, and other stakeholders to form the broad-based coalition required for successful fortification. In addition, the committee provided a forum in which national decrees and legislation could be formulated to require salt iodization. Finally, national workshops and committees were less commonly seen. Yet, the principal stakeholders incorporated national iron-deficiency control strategies into national plans of action for nutrition in at least eight countries, indicating the institutionalization of program strategies.

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Lessons from successful micronutrient programs

Part II: Program implementation

Megan Deitchler, Ellen Mathys, John Mason, Pattanee Winichagoon, and Ma Antonia Tuazon

Abstract

National programs for vitamin A supplementation and iodization of the salt supply were launched and sustained with high (but not universal) coverage in most of the countries studied. Iron programs (requiring daily or weekly supplementation, in contrast to vitamin A), which were distributed mainly through antenatal care, had lower coverage and acceptance. Constraints to supplementation were supply, awareness of health staff and communities, and (for vitamin A) insecurity with phasing out of the national immunization days, which have been a major vehicle for distribution. Administration to women postpartum becomes even more important and needs greater coverage. Iodized salt programs have expanded well, with good interagency collaboration and local management, supported by legislation (which may need strengthening); constraints remain in terms of too many salt producers, inadequate quality, import issues, and prices. More integrated, multifaceted programs are needed, with priority to developing and implementing fortification—especially in finding effective ways to iron-fortify rice. Data are lacking, with fewer surveys once programs start, constraining monitoring and program control and adaptation. Nonetheless, interventions appear to have gone to scale remarkably successfully.

Introduction

This series of three papers, “Lessons from Successful Micronutrient Programs,” describes the establishment

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of successful national micronutrient-deficiency control programs, focusing on Asia. The first paper [1] identified key steps in the establishment of national programs, including:

- » *The completion of a large-scale population survey* that measures the extent of micronutrient deficiencies (e.g., vitamin A, iodine, and iron) in vulnerable groups, serving as a stimulus for advocacy and mobilization by key partners and the general public;
- » *The convening of a national workshop* among governmental, nongovernmental, and international partners to discuss the implications of the problem and potential frameworks for national control programs;
- » *The establishment of technical and intersectoral committees* to develop country-specific and subnational program guidelines;
- » *The development of a national plan of action for nutrition*, accompanied by legislation in the case of salt iodization and micronutrient fortification;
- » *The securing of international assistance until program sustainability is feasible*, particularly for vitamin A capsules, iron tablets, and iodization equipment and fortificant.

When programs established since the early 1990s were reviewed, several program strategies emerged as predominant. Nearly all study countries reported aiming at universal distribution of vitamin A capsules to preschool children and postpartum women. All reported iodization of salt as the principal strategy for reducing iodine-deficiency disorders. Despite operational and logistical difficulties, iron supplementation is commonly integrated into antenatal-care protocols. Many countries are exploring alternative, sustainable approaches to deficiency control, including fortification and information, education, and communication (IEC) campaigns for dietary change.

This paper (the second of three in this issue) discusses lessons about the implementation of these programs. Constraints to program implementation are identified. Issues that emerged related to the establishment of program monitoring systems are discussed. Finally,

the key lessons are summarized, with the objective of elucidating principles for successful implementation in other countries, as well as suggesting some solutions to common problems that have emerged. The main sources of information are country case studies summarized later in this issue and available on the Internet, from Bangladesh [2], Cambodia [3], China [4], Indonesia [5], Laos [6], Philippines [7, 8], South Africa [9], Sri Lanka [10], Thailand [11], and Vietnam [12], and unpublished case studies from India* and Myanmar.** Additional information is taken from recent regional [13] and global [14, 15] surveys.

Vitamin A

Summary of Vitamin A Program Implementation

The most common approach for the control of vitamin A deficiency in developing countries is vitamin A capsule distribution. Almost all project countries have vitamin A-supplementation programs with universal targeting to children under five years of age. China and Thailand do not have programs for universal supplementation to children, Vietnam targets children under three years of age, and although Sri Lanka and South Africa have policies for supplementation of children, no programs have yet been implemented. The programs usually consist of twice-yearly vitamin A dosing (with 200,000 IU vitamin A capsules) distributed through large-scale campaigns such as national immunization days or a designated micronutrient week. The characteristics of vitamin A programs are summarized in table 1.

Complementary strategies often implemented with capsule supplementation include promotion of home gardening, social marketing, and IEC activities. In addition, more countries are now beginning to explore suitable vehicles for vitamin A fortification. Although in other regions, notably in Latin America, fortification of sugar with vitamin A has become a primary strategy, this is not as widely implemented across countries in Asia; in fact, sugar may not be as practical an option for fortification in Asia because it is not consumed by vulnerable groups as commonly as in Latin America. Noodles, margarine, and breastmilk substitutes are among the most common commodities fortified with vitamin A in Asia. Only four project countries—Indo-

nesia, Philippines, Sri Lanka, and Thailand—reported fortification (mandatory or voluntary) of food commodities with vitamin A. Adequate technologies have not yet been developed for the fortification of rice with vitamin A, so it is necessary to fortify other commodities, such as fats and oils, pasta, and condiments.

Among project countries, most vitamin A-supplementation programs targeted to children achieve coverage rates of 60% or more of the child population (fig. 1 and table 1, third column). Bangladesh and Myanmar reported coverage rates above 99% for 2001. The associated impact data are discussed in the third paper in this series [16].

To maintain adequate vitamin A stores among infants and to protect lactating women from becoming vitamin A deficient, the World Health Organization (WHO) recommends distribution of high-dose vitamin A capsules also to women shortly after delivery [17]. Although many countries have now adopted this intervention, implementation has typically been more recent than that for children. As a result, in most cases, vitamin A programs for lactating women tend to be less well developed, and effective capsule distribution systems are comparatively lacking. There are also fewer data available on coverage of women postpartum than on coverage of children under five years of age. However, those countries having coverage data report rates significantly lower than those for children. Only in Vietnam was coverage of postpartum women reported to be above 50%. No project country has national impact data for lactating women yet available. Although Vietnam has multiple rounds of biochemical data for lactating women, the data are subnational (e.g., for Thanh Mien District).

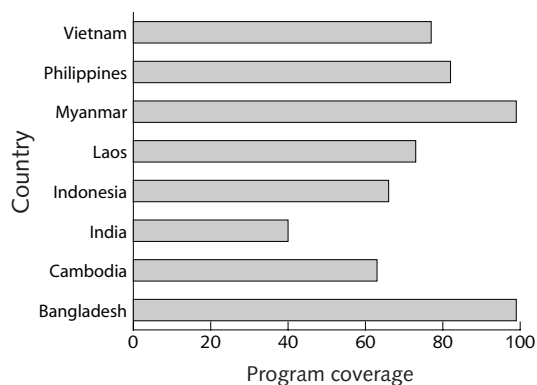


FIG. 1. Coverage of vitamin A programs for children according to country (most recent year for which data are available) Source: materials provided by study countries [2–15]. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001. Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

* Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001.

** Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

TABLE 1. Characteristics of programs addressing vitamin A deficiency

Country	Type and content	Coverage, target groups	Resources
Bangladesh	VAC distribution to children < 5 yr of age with NIDs and routine EPI; VAC distribution to women postpartum (< 18.5 BMI) through BINP; home gardening; IEC activities	Coverage rates of over 99% reported for supplementation to children during the 2 semiannual campaigns of 1999. Coverage of postpartum women not reported	\$0.8/capita/yr for VAC to children
Cambodia	Formerly VAC distribution with NIDs (now phased out); subsequently VAC distribution to children through routine EPI outreach; VAC distribution to women postpartum through health services and routine immunization outreach; home gardening; IEC activities	Coverage with NIDs for years 1995–96 reported as approximately 95%. Coverage with routine immunization outreach for March, July, and November 1999 and March 2000 reported as 70%, 69%, 63%, and 63%, respectively. Coverage of 47% shown by survey. Wide range of coverage reported among provinces (10%–55%) and within provinces (0%–100%). Coverage of postpartum women not reported	
China	No national vitamin A program implemented		
India	Vitamin A by liquid distributed to children 6–36 mo of age with UIP (1st dose with measles immunization, 2nd dose with diphtheria, pertussis, tetanus booster); subsequent doses to children < 5 yr of age provided by ICDS/health functionaries; home gardening; social marketing strategies	Low coverage of children reported for 1997. No state achieved more than 40% coverage for children receiving 1 dose of vitamin A	2,100 million Rs (US\$ 50 million)
Indonesia	VAC distribution to children 1–5 yr of age through large-scale campaigns for VAC; VAC distribution to women postpartum by midwives; home gardening; fortification of noodles and margarine	Coverage of children reported as 66%. Coverage of women postpartum reported as 40%.	
Laos	VAC distribution to children < 5 yr of age through SNIDs (NIDs are being phased out); VAC distribution to women postpartum through health centers; IEC activities	Coverage of children reported by Ministry of Health as 80% and 73% for two distribution rounds in 1999. National Health Survey 2000 reported coverage for 2nd round of distribution in 1999 as 28.8%. Coverage of women postpartum in 1997 reported as 16.5% in Luang Prabang Province, and as a mean of 6% for those provinces reporting (6/17)	
Myanmar	VAC distribution to children < 5 yr of age through NIDs; VAC distribution to women postpartum; home gardening in 10 townships; IEC activities for consumption of vitamin A-rich foods	Coverage for VAC distribution reported usually to reach 90% of targeted children. When distribution was integrated with NIDs in January 2000, a coverage rate of 99% was achieved	
Philippines	VAC distribution to children < 5 yr of age through designated days known as <i>Garantisadong Pambata</i> ; VAC distribution to women postpartum; fortification of several foods, including flour, with vitamin A	Coverage for 2000 reported as 80% for 1st round and 80%–84% for 2nd round of distribution. Coverage of women postpartum not known	VAC \$0.4/capita/yr, including program costs
South Africa	Policy for distribution of VAC to children and women postpartum, but no program yet implemented		
Sri Lanka	Policy for distribution of VAC to children, but no program yet implemented; distribution of VAC to women postpartum; supplement food for poor mothers and children (Thripasha) fortified with vitamin A and other micronutrients	Coverage of women postpartum not known	

continued

TABLE 1. Characteristics of programs addressing vitamin A deficiency (*continued*)

Country	Type and content	Coverage, target groups	Resources
Thailand	No national vitamin A supplementation program implemented; mandatory fortification of sweetened condensed milk, infant formula, and breastmilk substitutes; voluntary fortification of instant noodle soup mix		
Vietnam	VAC distribution to children 6 mo to 3 yr of age through NIDs; VAC distribution to women postpartum; IEC activities	Coverage for children reported as 76.9% in 2000. Coverage for women postpartum reported as 52.2% in 2000	878 commune workers, 940 districts, 106 provinces; \$0.08/capita/yr

VAC, Vitamin A capsule; NID, national immunization day; EPI, Expanded Program of Immunization; BMI, body mass index; BINP, Bangladesh Integrated Nutrition Project; IEC, information, education, communication; UIP, Universal Immunization Programme; ICDS, Integrated Child Development Services; SNID, subnational immunization day.

Source: materials provided by study countries (refs. 2–12) and refs. 13–15. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001. Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

Constraints and achievements in vitamin A capsule distribution

Inadequate supply and delivery of capsules

Problems with adequate capsule supply are common across countries with vitamin A-supplementation programs. Underestimated program participation or undersupply of capsules can cause shortages. The Canadian International Development Agency, a leading supplier of vitamin A capsules to developing countries, provides approximately a half-billion capsules annually, mainly through Micronutrient Initiative and UNICEF. India provides its own supplement but has reported insufficient supplies of vitamin A for its ongoing national program.* Similarly, Sri Lanka reported difficulty launching its program due to insufficient vitamin A supplies.

Countries also report problems with timely receipt of capsules. Delivery of capsules, both from the supply warehouse in the Netherlands and from central to local levels in-country, can be delayed because of logistic or transportation problems. The problem of on-time delivery to local sites has important consequences for program participation. For instance, health workers may be on their designated location at the scheduled time for distribution but may have insufficient supplies for the intended coverage. The Philippines, for example, reports low public response to the vitamin A-supplementation program, due in part to late arrival of supplies and to lack of promotion and social mobilization for program implementation [18].

Lack of awareness of vitamin A deficiency by health personnel and community members

Several countries report a lack of awareness among

mothers of vitamin A deficiency in general, and of vitamin A-supplementation programs in particular. A lack of knowledge among health workers of vitamin A deficiency, recommended capsule supplementation schedule, and correct dosing quantity has also been reported. The two problems are likely to be linked, since poorly informed and motivated health workers are hampered in their ability to motivate community members to participate in the program. Both India and the Philippines, for example, cite a lack of awareness among the community and a lack of training among health workers as reasons for achieving lower than ideal coverage [18]. Specifically, India reports difficulty in engaging community participation in the program. Vitamin A, when distributed in India, is passively received; supplementation is rarely sought actively.* Further, there is a reported lack of knowledge of micronutrients and the vitamin A program among health personnel in India, and a lack of supervision of the health workers for micronutrient activities. Likewise, the Philippines reports low awareness among the community as well as among health workers [7]. The nutrition program is reported to hold low priority among local government units in the Philippines. Lack of local executive support for the program has caused decreased enthusiasm among health workers. As a result, the Philippine supplementation program faces a low number of volunteer workers at the local levels. Further, many of the health workers who participate in the program are not adequately informed about the benefits and importance of micronutrients.

Insecure program sustainability

Some countries express concern about the sustainabil-

* Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001.

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ity of national vitamin A–supplementation programs. Most countries obtain their national capsule supply through UNICEF and question how the program could be maintained if donors no longer were to support the purchase of the capsules. The Vietnam government, for example, reported a lack of financial means to support future sustainability of the vitamin A program should donors no longer be able to provide the capsules [19]. The Philippines may be the only project country that reserves funds for the purchase of vitamin A capsules. In the Philippines, the government allocates a budget of approximately $\text{US}\$0.02 \times \text{total no. of children } 0\text{--}5 \text{ years old} \times 80\%$ of the population targeted for the purchase of vitamin A capsules alone [5]. The sustainability of the capsule delivery system may also be at risk with the phasing out of national immunization days, as discussed below.

High vitamin A capsule coverage achieved with national immunization days

The successful coverage of vitamin A capsule programs (fig. 1) can be attributed, in part, to distribution of capsules through national immunization days (table 1, second column). Among those countries having initiated early vitamin A–supplementation programs, a marked increase in coverage was generally achieved when distribution of capsules began to be linked with national immunization days. In Myanmar, supplementation reportedly covered more than 90% of targeted children before it was incorporated with national immunization days; coverage of the program then increased to 99% when it was incorporated with national immunization days in January 2000.*

Variation in subnational vitamin A capsule coverage achieved

Within countries, not all areas are achieving equally high rates of coverage. In Cambodia, data from 2001 show a large range in program coverage both among provinces (10% to 55%) and within them (0% to 100%) [3]. In Vietnam the difference in coverage between regions is not as large but still shows a range of almost 25 percentage points; data for 2000 show a low coverage of 59.9% for the Central Highlands area and a rate of 82.3% for the Red River Delta area [12]. Possible reasons for the variation in vitamin A capsule coverage by area include differences in knowledge of the vitamin A capsule program by the health center staff, differences in motivation of the health center staff to implement the program, differences in logistical and operational support to the program (due to accessibility and other factors), and differences in community

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

knowledge of and attitudes toward the program.

Phaseout of national immunization days

With the expected eradication of polio, many countries are now beginning to phase out national immunization days. As a result, country programs must consider alternative systems for the distribution of vitamin A capsules. Alternative distribution methods are often pilot tested in selected areas before being implemented more widely.

The results of a pilot test in Cambodia are informative (table 2). Here the use of routine immunization services was tested as an alternative distribution method to national immunization days in 1996 [3]. One district was selected as the pilot area in 1996, and the target area was then expanded to two provinces for 1997. In March 1998, six provinces were targeted through routine immunization outreach. By 1999, the vitamin A program in Cambodia was using routine immunization outreach as the only mechanism for capsule distribution. Although routine immunization reportedly achieved high coverage during its pilot phase in Cambodia (1997), program coverage showed a marked decline thereafter [3]. When piloted in only two provinces (March 1997), distribution through immunization outreach achieved a coverage rate of 82%, only 7 percentage points lower than the rate achieved in these provinces targeted by national immunization days for that same time period. In 1998, with wide-scale use of routine immunization outreach as a capsule distribution method, the coverage rate decreased to 48% and 60% in March and November, respectively. For those same months, those provinces targeted instead by subnational immunization days achieved coverage rates above 95%. In comparison with national immunization days, coverage through routine immunization outreach, while still reaching the majority of the population, thus showed a marked decrease in the proportion of the population reached (table 2).

Although few countries besides Cambodia have yet completely phased out national immunization days as a distribution system for vitamin A capsules, the challenge of maintaining high program coverage

TABLE 2. Vitamin A capsule coverage in Cambodia according to method of distribution

Method	% of target covered			
	Mar 1997	Nov 1997	Mar 1998	Nov 1998
National or subnational immunization day	89	91	> 95	> 5
Immunization outreach	82	Not available	48	60

Source: Poly O [3].

with alternative methods of distribution is likely to be experienced also among other countries that are soon to phase out national immunization days.

Postpartum vitamin A capsule coverage

Although coverage data on postpartum programs are scarce, the data available suggest that programs for supplementation of women postpartum have not yet achieved wide-scale coverage in project countries. In fact, programs for supplementation of women postpartum rarely achieve above 50% coverage. Indonesia reported a coverage rate of 40% in 2001 [5], Vietnam reported a rate of 52.2% in 2000 (with the Central Highland area reporting much lower coverage), and Laos (1997), for the six provinces reporting, reported postpartum coverage as 6% in 1997 [6, 19].

Monitoring vitamin A capsule programs

Variation in estimation of vitamin A capsule coverage

Data reported from national surveys such as the Nutrition Surveillance Project, Demographic and Health Surveys, or other National Micronutrient Surveys (sometimes launched by Helen Keller International, UNICEF, and ministries of health) often show rates of coverage that differ markedly from the coverage rates reported from district and provincial health offices. In Laos, for example, data from the 2000 National Health Survey showed coverage as 28.8% for children 6 to 59 months of age, whereas data from the provincial offices showed coverage for that same time period as 83% [6].

The variation in the estimation coverage is explained by the difference in methods used for the collection of data. For both Cambodia and Laos, the data reported from the two sources, though they reflect the same time period, derive from different methods of estimation of program coverage. National survey data (e.g., Micronutrient Survey in Cambodia, National Health Survey in Laos) assess program coverage by interviewing mothers. Women with children 6 to 59 months old are asked whether their child has received a vitamin A capsule in the last six months. The Ministry of Health data, on the other hand, rely on provincial-level reports of program coverage.

Although the exact reason for the variation between methods of estimation cannot be determined, it is likely that each source of data is prone to its own estimation error. National survey sources may underestimate program coverage due to recall and reporting bias on the part of children's caretakers. Mothers may not be aware that their children have received vitamin A capsules, either because a health worker has not explained the multiple interventions being administered during the national immunization days and vitamin A visits, or because the mothers may have forgotten that their children had received vitamin A during the visit. For

provincial reports, on the other hand, coverage data are reported to the central level from provincial areas, the provincial areas basing their coverage estimate on a calculation performed by dividing the number of capsules provided by the size of the target population in the area. There is a question, however, as to the accuracy of the target population denominator upon which the coverage calculations are based, which can often be an underestimate, giving spuriously high coverage reports. Some countries reported such problems of maintaining accurate records at provincial and district levels based upon program data and population estimates.

Estimating postpartum vitamin A capsule coverage

The capacity of countries to collect regular coverage data on supplementation to postpartum women is generally more limited than that for supplementation to children. Coverage data on postpartum supplementation are, on average, less available. The difficulties lie in estimating an accurate denominator to represent the number of women who have given birth in the reporting period. In addition, records of the number who have received postpartum supplementation are sometimes imprecise. In some cases, provinces report the data to the central level; in other cases, small-scale community projects may take responsibility for record keeping in a certain locality or provincial area. In the case of Laos, coverage data on the program are available both from a subset of provinces (6 of 15) that report on postpartum supplementation coverage, and by a safe motherhood project operating in Luang Prabang Province [6].

Establishing vitamin A capsule coverage targets

Other countries report difficulties in setting appropriate coverage targets for the vitamin A program. The Philippines, for example, bases coverage targets on National Economic and Development Authority (NEDA) population estimates, which are recognized, in many cases, as either very high or very low estimates for subnational areas. Moreover, in the Philippines, the vitamin A program aims to achieve 80% coverage. A coverage rate reported as 80% of target achieved is therefore not actually 80%, but 80% of 80%, or 64% of the target projection. (For cross-country comparison, all coverage estimates cited in this report are based upon the percentage of the total target population participating in the program.) Further, the 64% represents a figure that has been derived by using a denominator (NEDA population) of questionable accuracy.

Lessons learned

Countries have identified several key factors as important for successful implementation of a national vitamin A program. Some of the enabling mechanisms have been achieved already to varying extents by

different countries; others are next steps identified as important to accomplish for improving program implementation.

Interagency collaboration

Although important for program planning, interagency collaboration is also vital for successful implementation of a national vitamin A program. Across countries, UNICEF and the Canadian International Development Agency offer strong support for vitamin A programs; other international agencies also collaborate and provide assistance. Successful implementation of programs is due, in part, to the strong interagency relations that support and facilitate program delivery. In these countries, there is close integration between sectors involved in the project and a high level of support for the program from authorities at all levels. Project leaders express a high level of commitment to the program, and there is a high level of interaction between sectors. Such coordination between agencies and sectors for support of the program is helpful not just for strong implementation of the program, but also for facilitating sustainability of the program, although the long-term financial sustainability of supplementation programs remains a concern in study countries. One important area in which interagency collaboration could be enhanced is the improvement of logistical and supply management procedures to minimize the effects of interrupted vitamin A capsules on distribution program operations.

Strong program management at local levels

Vitamin A programs require good coordination from the central to the local level and effective program management at each level. Strong program management at local levels has been identified as a factor facilitating smooth program implementation and increased community participation. In Vietnam, for example, the project network is based on the provincial preventive health system. There is a high level of community participation in the program, and the commitment of local and central authorities helps to ensure that training and management of the program are performed to the highest level possible. The Philippines, on the other hand, has identified the strengthening of local management as a future goal for the vitamin A program. Specifically, the Philippines intends to strengthen the management capability of the local government units and to increase the motivation of the barangay (village) health workers to reach the poor and seek out target children to receive vitamin A capsule supplementation [7]. The mixed success with postpartum vitamin A capsule coverage through established health services, relative to campaign-based programs, suggests that increasing the knowledge and motivation of the large number of health workers involved in program implementation of facility-based services remains a key priority inter-

nationally. Given that study countries identified inadequate community awareness and mobilization as key barriers to vitamin A capsule coverage, local program management is particularly important in addressing this constraint. Improving local management would also assist in reducing the large subnational variation in program coverage.

Well-developed system for monitoring and evaluation

Most project countries identify strengthened capacity for monitoring and evaluation of the program as an area requiring further development. Many countries, for example, have yet to fully establish an accurate monitoring system for capsules targeted to children under five years of age, and few countries have yet achieved precise monitoring systems for capsules provided postpartum. The integration of micronutrient program coverage indicators into large-scale population surveys would be a valuable contribution to program implementation and impact evaluation. Nationally representative population surveys would also measure subnational variation in vitamin A capsule coverage and vitamin A deficiency to assist in program targeting, without the need for accurate population estimates to calculate coverage rates.

Integrated and alternative deficiency control programs

The eventual phaseout of national immunization days in favor of service delivery through established health services underscores the importance of establishing complementary strategies for deficiency control. Almost all of the study countries (10 of 12) reported implementing complementary vitamin A–deficiency control or prevention programs. These programs included the promotion of home gardens to increase domestic production of vitamin A–rich foods, IEC campaigns to increase consumption of foods rich in the nutrient, and micronutrient fortification (mandatory or voluntary) of commonly consumed food commodities. Yet, fortification is the least common among these, having been made mandatory in only one country (Thailand). The fortification of widely consumed food commodities, particularly rice, warrants continued scientific, field-based, and technological development.

Iodine

Summary of Iodized Salt Program Implementation

Fortification of salt with iodine is recognized as a highly effective strategy for the control of iodine-deficiency disorders. The characteristics of programs are summarized in table 3. Salt provides a suitable vehicle for iodine fortification and is consumed by all populations. Moreover, salt iodization represents a long-term public health strategy, with a minimal cost per capita required (a range of \$0.05 to \$0.50/ capita/year

TABLE 3. Characteristics of programs addressing iodine deficiency

Country	Type, content	Coverage, target groups	Issues, resources
Bangladesh	Salt legislation enacted 1995; salt committees established at different levels; IEC activities; iodized oil injections phased out	Coverage of iodized salt showed a large increase from 1994 to 1999 (20% to 70% of households), but recent reduction from 78% to 55% (2001); highly variable iodine content in salt; 265 salt refineries	Monitoring of iodized salt and quality control is a problem; importing of noniodized salt is a problem
Cambodia	Government adopted iodized salt in 1999; no legislation adopted for iodized salt; IEC activities; Provincial Coordination Committee established to inform custom officers and health workers from each province about IDD; iodine container in wells in 1997; iodized oil capsules distributed in 2000	Low coverage of iodized salt reported; Demographic and Health Survey in 2000 reported 13.8% of households had access to adequately iodized salt; most salt production is at one factory in Kampot Province, which has difficulty producing enough salt to meet annual need; large quantity of salt imported	\$0.50/capita/yr; importing of noniodized salt is a problem; iodized salt reported to cost more than noniodized salt
China	1994 State Council established decree on IDD prevention and treatment by iodized salt; iodized oil to pregnant women and women of childbearing age; pilot projects for iodinated water	Coverage of iodized salt reported as 76.3% in 1995	Not reported
India	Distribution of iodized salt since 1966; later adopted ban on entry of noniodized salt; recent withdrawal of ban on noniodized salt; 650 salt iodization plants established; mobile labs used for testing iodine content of salt; IEC activities	Recent rescinding of ban on noniodized salt leaves legislation for iodized salt to discretion of individual states. As a result, coverage of iodized salt is expected to decline; effectiveness of double-fortified (iodine and iron) salt is being tested (2003)	Quality of iodized salt is highly variable; iodized salt reported to cost more than noniodized salt; 3,300 million Rs (US\$70 million) invested for iodization of salt
Indonesia	Decree for iodized salt in 1986; iodized oil capsules to schoolchildren and young married couples in endemic areas since 1987; national IDD mapping and evaluation since 1989; national salt intake survey since 1996; lipiodol injection for schoolchildren and young married couples in endemic areas phased out since 1986	Coverage of iodized salt reported as 58.1%, 62.1%, 65.2%, and 63.6% for years 1996, 1997, 1998, and 1999, respectively. Coverage of iodized salt for 2000 reported as 64.5%. Controlled trial with multimineral- (iodine included) fortified biscuit to evaluate effect on pregnancy weight gain	Not reported
Laos	Decree for iodized salt signed in 1995; IEC materials at all health facilities; 8 large salt factories, approximately 20 small-scale producers; iodized oil distributed from 1990 to 1993	Coverage of adequately iodized salt reported as 71.1% in 2000; 90% of salt needs produced in-country	Not reported
Myanmar	Ministerial decree for iodized salt in 1998; iodinated water to schoolchildren; social marketing and IEC activities; mass iodized oil injection program phased out (1982–86)	Coverage of iodized salt reported as 18.03%, 41%, 50%, and 60% for years 1995, 1996, 1997, and 1998, respectively; in 1999 coverage of salt containing ≥ 30 ppm iodine reported as 30%, and coverage of salt containing 15 to < 30 ppm iodine reported as 23%	Not reported

continued

TABLE 3. Characteristics of programs addressing iodine deficiency (*continued*)

Country	Type, content	Coverage, target groups	Issues, resources
Philippines	Decree for iodized salt in 1993; 161 local government units out of a total of 78 provinces, 84 cities, 1,525 municipalities, and 41,940 <i>barangays</i> have passed local resolutions for iodized salt; IEC activities; supplementation to women of child-bearing age with iodized oil capsules phased out (1993–95)	Coverage by Department of Health reported as 22%, 14%, 18%, and 10% for years 1995, 1996, 1997, and 1998, respectively. Coverage with iodized oil capsules was 57.72% in 1993, 85.72% in 1994, and 84.82% in 1995	Iodized salt, \$0.30/capita/yr; iodized oil capsules, \$0.10/capita/yr
South Africa	Legislation for iodized salt in 1995	Coverage of iodized salt prior to legislation reported as 30%; coverage of iodized salt since passing of legislation for iodized salt reported as 62% (for households using salt with ≥ 15 ppm iodine content)	Not reported
Sri Lanka	Food regulations for iodized salt enacted in 1993, and iodized salt program from 1995; IEC activities; distribution of potassium iodide tablets to high-risk groups in 1950s (phased out)	Coverage of iodized salt reported as 48% in 1995–96; 116 registered microenterprises	Quality of iodized salt an issue (varying content of iodine in salt at retail level: 5.3–418 ppm)
Thailand	Legislation for iodized salt enforced since 1994; iodinated water to all primary schools and households of 39 provinces and some areas in Southern region; iodized oil capsules to pregnant women, women of childbearing age, and schoolchildren in high-prevalence areas; IEC activities	Coverage of iodized salt reported as 50% (1992–96)	From 1995 to 2001, 216 baht (US\$4.8 m) for surveillance, 140 million baht (US\$3.1 m) for IEC, 68 million baht (US\$4.6 m) for promotion of iodine consumption, 291 million baht (US\$6.5 m) for promotion of iodized salt and iodinated drinking water, 284 million baht (US\$6.3 m) for iodized oil capsules, and 14 million baht (US\$0.3 m) for M&E

IEC, Information, education, communication; IDD, iodine-deficiency disorders; M&E, monitoring and evaluation.

Source: materials provided by study countries (refs. 2–12) and refs. 13–15. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001. Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

reported by project countries; table 3, column four). Almost all project countries had national legislation for mandatory iodization of salt for human consumption. Even those countries lacking a decree for mandatory salt iodization (Cambodia and India) nevertheless have substantial ongoing activities for promotion of iodized salt production.

Although iodized salt programs have the potential to virtually eliminate iodine-deficiency disorders, not all salt programs are implemented effectively. Many iodized salt programs, for instance, do not reach national coverage targets. The coverage rates for iodized salt programs remain somewhat lower than those for

vitamin A programs (fig. 2, table 3). Of all project countries, only Vietnam reports a national coverage rate above 80%. Most project countries report coverage rates between 50% and 75%. Cambodia reported a coverage rate of 13.8% for the year 2000. Low rates of coverage of iodized salt in the Philippines (less than 25%) are partially compensated for by the coverage of iodized oil capsules, which exceeded 80% by the mid-1990s.

Well-developed monitoring systems for quality control of iodized salt are often lacking. In cases where data are available, many project countries report problems with variable iodine content in salt. A range as large

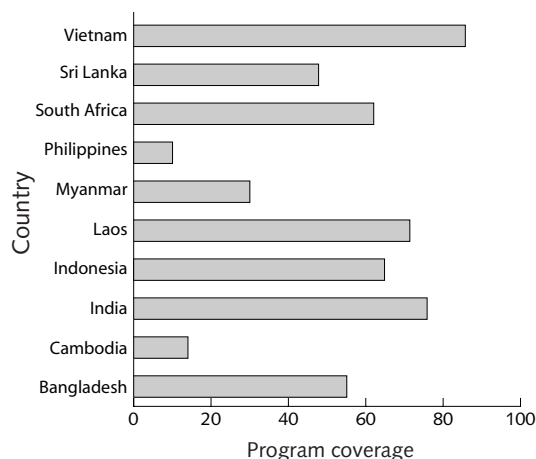


FIG. 2. Coverage of iodized salt programs according to country (for most recent year data are available)

Source: materials provided by study countries (refs. 2–12) and refs. 13–15. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001. Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

as 5.3 to 418 parts per million at the retail level was reported by Sri Lanka. Further constraining effective program implementation is the inability of most countries to produce an adequate quantity of salt to meet national consumption requirements. As a result, almost all project countries import salt, much of which is often not adequately iodized, and iodization may be poorly monitored.

Impact data are available for most project countries and, with the possible exceptions of the Philippines and Sri Lanka, show encouraging progress [16]. Most countries have at least two rounds (baseline and following program implementation) of clinical data on iodine-deficiency disorders (goiter) available. In addition, several countries have one round of biochemical data (urinary iodine excretion), and four project countries (Bangladesh, China, Laos, and Vietnam) have two rounds of urinary iodine excretion data available. The impact demonstrated by iodized salt programs in project countries is addressed later, in the third paper in this series [16].

In addition to programs for iodized salt, most countries have explored alternative strategies for the control of iodine deficiency, either prior to initiating a national iodized salt program or as a complementary approach to iodized salt. Supplementation of high-risk groups with iodized oil capsules has been explored by many project countries. Although only China, Indonesia, and Thailand were providing target groups with iodized oil capsules, nearly all project countries report having implemented capsule supplementation

or lipiodol injection activities at some point in time. Less frequently explored has been the iodination of water. Still, as many as four project countries report having had pilot projects or highly targeted small-scale projects for iodination of water at some point in time. Thailand and China may be the only project countries having iodine-deficiency disorders programs with iodination of water included as an activity.

Some fortification activities additional to iodized salt have been tested in certain project countries. The efforts are mostly multinutrient fortification activities, and although iodine is included among the fortificants, the projects are likely to have been initiated to provide for increased availability of nutrients that are less easy to provide as fortificants than iodine (e.g. iron and vitamin A). Table 3 provides details on the characteristics of country programs for controlling iodine deficiency.

Constraints to program implementation

Lack of legislation

All project countries have programs for iodized salt, yet the degree to which the programs are developed varies across countries. Although most project countries have a law banning the production, sale, and importing of noniodized salt, Cambodia, India, and Vietnam all have a less stringent policy environment. Cambodia, for example, has not yet issued a law requiring that salt be iodized [3], and India has rescinded legislation requiring salt iodization across the country.* Despite national legislation for salt iodization in Vietnam, the country was lacking complete legislation for regulation of the production and distribution of iodized salt [12]. The successful development, implementation, and enforcement of legislation rests upon advocacy and awareness-raising among government, academic, and industrial stakeholders. In decentralized administrations, subnational ordinances have to be formulated as well; for example, this is needed in the Philippines.

Number of salt producers

Constraints to implementation of iodized salt programs include both controllable factors and those factors that can be mitigated but not controlled (e.g., geography, size of country, and vulnerability to disasters). Experience shows that iodized salt programs are often easier to implement and enforce in smaller countries. In small countries, such as Laos or Myanmar, there are typically fewer salt producers than in larger countries. In Laos, for example, there were only eight large-scale salt producers, and given the small number of producers,

* Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001.

overseeing compliance with protocols for iodized salt is easier than it might be otherwise [6]. Thailand, on the other hand, has more than 145 identified salt producers. Although all of the producers were registered with the Ministry of Public Health as of 1997, overseeing the compliance of 145 salt producers (through iodine levels at production and retail) would require more resources than doing so for 8 producers [11].

Insufficient salt production

Many countries experience difficulties in domestically producing the quantity of iodized salt needed annually. Laos is one of the few project countries that can nearly meet the full quantity of salt needed with its domestic production. Salt producers in Laos are able to meet 90% of the country's need for salt, thereby making importation of salt minimal and providing less opportunity for noniodized salt to enter the country [6]. Most other countries have to import much more than 10% of their total salt. In Cambodia, for example, all salt is produced in Kampot Province, where seven machines have the capacity to produce a total of 100,000 tons of iodized salt per annum [3]. The annual need for iodized salt in Cambodia is 80,000 tons (40,000 tons for human consumption and 40,000 tons for industrial use). However, Cambodia rarely meets the need of iodized salt in the country, because equipment problems and natural disasters reduce the actual production capacity of factories. In 2000 Cambodia produced only 11,000 tons, falling short of its need by nearly 86%.

Countries with production shortfalls often experience problems with importation of noniodized salt into the country. Enforcement of salt legislation at border sites is lacking in many countries, and the entry of noniodized salt at border sites constrains the potential success of national iodized salt programs. In Bangladesh, noniodized salt is regularly imported illegally from India [2]. Already, a substantial decrease (from 78% to 55%) in household use of iodized salt is evident from the coverage rates reported in 2000 and 2001 [2, 18, 19]. Moreover, with the recent rescinding of legislation for iodized salt in India, the amount of noniodized salt imported into Bangladesh may increase, causing an additional decline in the availability of iodized salt in the country.

Price of iodized salt

In addition to constraints on the availability of iodized salt, there are constraints related to the accessibility of iodized salt. In many project countries where noniodized salt is available (either legally or illegally), the price at which it is sold is substantially lower than that of iodized salt. Bangladesh, India, the Philippines, and Vietnam all cite a higher price of iodized salt in comparison to that of noniodized salt. Although the price of iodized salt is subsidized in Vietnam, the price at which iodized salt is sold is still higher than that of

noniodized salt. In the future, more subsidies may be provided so that the subsidized rate will encourage a wider population to purchase iodized salt in lieu of noniodized salt [12].

Monitoring of program implementation

Monitoring of iodized salt programs can occur at three levels: producer, retailer, and consumer. Countries usually prescribe minimum standards for the iodine content of salt at the producer and consumer level, but less frequently establish standards for the retail level. The recommended standards for iodine content are normally established in order to provide 150 µg/day of iodine via iodized salt [20]. To do so, the recommended iodine concentration at production is usually between 20 and 40 mg of iodine per kilogram of salt, which takes into account an expected 20% loss in iodine from the production site to the household and another 20% loss from cooking prior to salt consumption.

The iodine concentration recommended for salt varies somewhat by country, depending on the particular climatic conditions of the country and the dietary habits of the population [20]. In countries where, for example, the quality of available salt is poor, or in areas where salt may be exposed to excessive moisture, heat, or light, the loss of iodine from the salt can be as much as 50% from production site to household. When these circumstances are known to exist, higher levels of iodine concentration are generally implemented.

Quality control: producer level

Quality control at the factory level is most often monitored by the salt producer at an on-site laboratory. In Laos, a factory in Vientiane Province monitors a random salt sample by rapid color test every hour, and monitors the iodine content of random salt samples by titration two times per day (once in the morning and once in the afternoon) (S. Naphayvong, personal communication, June 2001). In Myanmar, the Salt and Marine Enterprise monitors the iodine content of salt by titration.* Across countries, program staff or other authorities may perform random checks of salt producers and monitor the compliance with salt iodization regulations; however, it seems that most iodized salt programs do not collect regular data at the production level. Instead, the salt producer is given responsibility for monitoring its own production, with little enforcement of accountability. Thailand, however, is an exception; in Thailand, provincial health personnel and staff from the Ministry of Education have responsibility for quality control of iodized salt at the production level in high-prevalence areas [12].

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

Quality control: retail level

Regular monitoring of salt quality at the retail level is also uncommon. In most iodized salt programs, a recommended level of iodine content is not clearly established for the wholesale and retail levels. Although the iodine content should be above the minimum prescribed for household salt, the content can be expected to be less than the level found at the production site. Some countries have conducted studies on the quality of salt sold at the retail level. In Myanmar, for example, a study was conducted to examine the variation in the quality of salt available. The results showed a variation in the iodine content of salt at the factories and a difference in the brands of salt available in the markets.* Similarly, as noted above, a recent study in Sri Lanka also showed widely varying levels of iodine in salt at the retail level (5.3 to 418 ppm) [10].

Coverage of program: household level

Most countries have national data on coverage of their iodized salt programs. Many countries conduct regular surveys to assess iodized salt coverage. Data on iodized salt from salt testing are often collected as piggyback indicators to broader-based health and nutrition surveys (e.g., demographic and health surveys, multiple indicator cluster surveys [MICS]). In addition to data obtained from these annual surveys, health workers are also sometimes given responsibility for monitoring the quality of household salt. In Myanmar, for example, midwives are provided with test kits, and each midwife visits 30 households per month to monitor the iodine content of salt.**

Gaps in monitoring

Many countries express a need to improve the monitoring of the iodized salt program. The greatest need may be to improve monitoring at production and market sites as well as at border crossings where salt is imported. Several countries have plans to establish a more developed monitoring process. Laos, for example, aims to improve the enforcement of proper salt iodization at the production or import and retail levels and to increase the capability of laboratories at the central and provincial levels, as well as at salt factories themselves, while implementing a wider system of feedback and reporting [6].

In addition to large-scale producers, countries aim to improve the monitoring of small-scale salt producers.

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

** Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

In most project countries, there is a large number of small-scale producers scattered throughout the country, often in relatively isolated and inaccessible areas. The wide dispersion of the small-scale producers makes monitoring of their production difficult. Moreover, the small-scale producers, due to a lack of awareness and incentive, are often more reluctant than large-scale producers to follow iodized salt regulations. Thailand and Laos are among the many countries experiencing challenges in encouraging small-scale producers to implement procedures for adequately iodized salt [6, 11].

Lessons learned**Advocacy and awareness**

A successful salt iodization program requires awareness of government authorities, health personnel, and communities of the consequences of iodine deficiency and the benefits of consuming iodized salt. Enforcement of legislation for iodized salt requires the commitment of government authorities at all levels. Laos has, in its implementation of salt iodization, demonstrated how the involvement of knowledgeable government workers can facilitate a successful program. The governmental ministries are responsible for monitoring the implementation of the program in Laos. The Ministry of Health workers are knowledgeable about the issues and challenges related to the production, importation, and distribution of iodized salt in the country. The knowledge and capability of the Ministry of Health facilitate effective monitoring of the program and better enforcement of the iodized salt legislation.

Cambodia, in its effort to increase the level of knowledge among government workers, is providing training for provincial authorities. Of particular focus for the training sessions are customs officers and trade officers in bordered provinces. It is anticipated that training of these officers at border sites will help to encourage salt testing along the border and will eventually decrease the quantity of noniodized salt imported into the country.

Just as a successful salt program requires awareness among those enforcing the law supporting the program, it also requires a level of awareness among the consumers buying salt. Most countries have multiple IEC activities focusing on efforts to eliminate iodine-deficiency disorders. Myanmar, for example, has a National Iodine Deficiency Elimination Day.* In Bangladesh, advertisements promoting iodized salt are telecast [2]. Health centers, schools, and

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

nongovernmental organizations all participate in the campaign for increasing iodized salt consumption in Thailand [11]. Cambodia promotes the benefits of iodized salt by means of television, radio, posters, and leaflets [3]. In select provinces, local nongovernmental organizations contact people directly to provide education about iodine deficiency in an effort to increase demand for iodized salt. In Sri Lanka, communication activities have been implemented in three phases. The first phase focused on increasing awareness of iodine-deficiency disorders, the need to iodize edible salt, and proper methods for storage of iodized salt. The second phase of activities aimed to further promote awareness of iodine-deficiency disorders, focusing specifically on goiter and emphasizing the need to consume iodized salt. The third phase of activities provided education about potential irreversible consequences of iodine deficiency, such as motor and cognitive impairment [10]. In Indonesia, a television commercial by a famous actress promotes iodized salt.

Collaboration between government and the private sector

Engaging the private sector in efforts for salt iodization is essential to the success of an iodized salt program. Successful iodized salt programs require good working relations with and strong cooperation from the salt industry. Involvement of the private sector in program activities is most beneficial when collaboration is initiated as early as possible; early involvement in the problem helps to increase producers' level of knowledge of iodine deficiency as well as encourage a sense of ownership for the program among the producers themselves. For example, efforts to control iodine deficiency in Cambodia have involved 8 government ministries, 12 international agencies, and several local nongovernmental organizations [3].

Salt producers cite common disincentives to producing iodized salt, such as low demand for iodized salt, the expense of producing it, equipment necessary for its production, and high transportation costs. Successful programs might mitigate some of the disincentives by providing producers with information on iodine-deficiency disorders and offering certain incentives for production of iodized salt, as well as designing fortification programs to ensure financial sustainability and profitability over the long term.

Incentives for producers to iodize salt have been offered across most countries and have, in many cases, been critical for motivating the producers' cooperation. Among the incentives commonly offered are those provided by UNICEF and the country governments. Across countries, UNICEF usually provides the equipment for salt iodization to both small- and large-scale producers. In addition, UNICEF also supplies potassium iodate to them. Tax exemptions are further incentives often allowed to producers of iodized salt. In Thailand, the Ministry of Public Health supplies the potassium iodate

to add to salt, and iodized salt producers are exempted from the 7% tax [13]. In both Thailand and the Philippines, producers of iodized salt receive a national seal of recognition to incorporate in their salt packaging and to use as part of their marketing strategy.

Accessibility and availability of iodized salt

The accessibility and availability of iodized salt are critical factors in the success of an iodized salt program. Many project countries still struggle to achieve wide availability of iodized salt. In the Philippines, the Department of Health Field Epidemiology Training Program conducted a survey in 1998 to assess the public's awareness of iodized salt [8]. The results showed an 81% rate of awareness of iodized salt, whereas the rate of consumption of iodized salt was 21%. The discrepancy between awareness and consumption was attributed to the lack of availability and accessibility of iodized salt. Despite legislation requiring that all salt for human consumption be iodized, noniodized salt is still widely available in Filipino markets. Moreover, in areas where both iodized and noniodized salt are available, the price of iodized salt has been reported to be two to three times higher than that of noniodized salt. In some areas of the Philippines, iodized salt may not be available at all.

Given the known problem of the availability of iodized salt, alternative systems for the distribution of iodized salt have been explored in the Philippines. A recent project exploring the feasibility of alternative distribution methods was conducted in Amadeo, Cavite Municipality, 45 km from Manila. The objective of the project was to develop a system at the local level for increasing the purchase and consumption of iodized salt at the household level, with specific emphasis on improved availability and affordability of iodized salt [8]. A 1991 baseline survey for the project showed a 17.6% goiter prevalence among schoolchildren. Ninety-one percent of households in Amadeo were aware of the importance of iodized salt, but utilization of iodized salt remained low at 61%. Assessment of the availability of iodized salt showed that two groceries in the area were selling both iodized and noniodized salt; only 5 of the 178 *sari-sari* (traditional shops) stores in the area were selling iodized salt; and of the 11 market vendors in Amadeo, none was selling iodized salt.

Implementation of the project included various advocacy and awareness activities directed to local chief executives, market vendors, salt producers, and stakeholders. An intensified IEC campaign involving billboards, posters, and radio messages was launched, and a municipal ordinance requiring all suppliers or retailers to sell only iodized salt was passed [8]. Of particular importance were networking activities between market vendors and salt producers. Collaboration between the salt producers and market vendors allowed for an alternative system for distribution of iodized salt

to be established. Market vendors were provided with a regular supply of iodized salt packaged in 50-kg sacks, sold at a price comparable to that of noniodized salt. Upon receiving the iodized salt, the markets and *sari-sari* stores repackaged the iodized salt in smaller sacks appropriate for sale to household consumers. Selling and repackaging the iodized salt by this system ensured the availability of iodized salt in the markets and *sari-sari* stores at a low price.

Three months after project implementation, utilization of iodized salt was measured as 92% (up from 61% at the beginning), and the awareness level of iodized salt increased to 100% (from 91%) [8]. Moreover, the availability of iodized salt markedly increased. Although at the end of three months the two groceries continued to sell both iodized and noniodized salt, all 178 *sari-sari* stores were reported to have begun to sell iodized salt. Ten of the 11 market vendors previously selling only noniodized salt were, at the end of three months, selling only iodized salt. In addition, as a result of the project, consumers and retail outlets in the Amadeo area were reported to begin to demand iodized salt.

Monitoring and sustainability of program

Sustainability of national iodized salt programs requires strong enforcement of iodized salt legislation. To strengthen enforcement at the local level, some countries have transferred responsibility for monitoring local program implementation to local governments or subnational committees. In the case of the Philippines, several local government units have adopted municipal ordinances for iodized salt [8]. One such example is in Amadeo, where a local ordinance was adopted to support local efforts for implementation and enforcement of the national iodized salt program. Monitoring would also serve to reduce the large variation in salt iodine levels at the consumer level. In Indonesia, adulteration of iodized salt in the market is still frequently found.

Other strategies to enhance the sustainability of iodized salt programs include phasing out of donor contributions of potassium iodate and parts of iodization equipment. Laos, for example, plans to transfer responsibility for the purchase of potassium iodate to salt producers in the near future. Phasing out has so far been delayed because of the effect of the regional economic crisis on salt prices. Over the next three years, however, it is planned that the costs of potassium iodate, maintenance of production equipment, and replacement of broken parts will be absorbed by the salt-producing factories. The government may provide financial support to the transition process, as necessary, but an increase in the cost to consumers from the purchase of iodized salt will be avoided as much as possible [8]. In Indonesia, responsibility for the purchase of potassium iodate has been transferred to the producers. Phasing out of donor assistance should

be deliberately balanced with phasing in of assistance from local sources, such as the private sector and civic organizations.

Iron

Summary of Iron Program Implementation

Control of iron-deficiency anemia is most often targeted to pregnant women and is usually approached by daily supplementation of pregnant women with iron/folate tablets. Although policies have been adopted by all project countries, national programs for iron supplementation are typically less well developed than those for the control of vitamin A deficiency or iodine deficiency. The characteristics of the programs are shown in table 4. Preventing iron deficiency by supplementation is inherently much more difficult than preventing vitamin A or iodine deficiency by supplementation, since iron supplements need to be taken daily or perhaps weekly [21].

Iron-supplementation programs commonly encounter difficulties in achieving wide and consistent coverage. Distribution systems for iron programs, unlike those for vitamin A supplementation, are not usually linked with already existing programs, such as national immunization days. Instead, iron supplementation often relies on regular visits by pregnant women to antenatal health centers, which have relatively low accessibility and utilization rates in most project countries.

Few countries have reported the estimated coverage rates for the iron-supplementation programs implemented. More than for other micronutrient programs, a lack of a well-developed monitoring system for iron programs is common. Often no data on coverage are available, or in cases where coverage has been estimated, the figure is derived indirectly and typically assumes full compliance. Given the lack of capacity for monitoring and evaluation of iron programs, few outcome data (anemia) are available from project countries. Thailand and Vietnam are the only two project countries reporting such data periodically.

Thailand and Vietnam both have fairly comprehensive strategies implemented for the control of iron deficiency. In both countries the programs target not only pregnant women, but also other women of childbearing age and some young children. (In Vietnam, targeting of nonpregnant women and children is still in the testing phase and has been implemented only in select areas of the country.) Moreover, complementary strategies such as nutrition education, IEC, improvement of water and sanitation, and helminth control are implemented to varying extents. Perhaps in part because of the life-cycle approach to the control of anemia in these countries, the data available for Thailand and Vietnam suggest a significantly improving trend in the prevalence of anemia. However, the extent to which the improve-

ment demonstrated is actually linked to the programs implemented is not clear. These data are described in more detail in the third paper in this issue [16].

Thailand and Vietnam may be among the exceptions. Of project countries, only Bangladesh has also shown an improving trend in anemia prevalence of such mag-

TABLE 4. Characteristics of programs addressing iron-deficiency anemia

Country	Type and content	Coverage, target groups, pilot programs (if any)	Issues, resources
Bangladesh	Iron/folate tablets (60 mg iron, 250 mg folic acid) to pregnant women twice daily from pregnancy through first 6 mo of lactation; distribution of tablets is through ANC and BINP/NNP; IEC activities; some deworming	Pregnant women with BMI < 18.5 particularly targeted; coverage rates > 80% reported for pregnant and lactating women; compliance not known	Established independent iron tablet procurement and supply system
Cambodia	Iron/folate tablets available for pregnant women in health centers (60 tablets distributed at 1st visit, 30 tablets at 2nd visit); use probably low	Pilot program for iron distribution is expanding target group to include nonpregnant women; pilot program gives weekly dose of 60 mg elemental iron and 3.5 mg folate to women of reproductive age working in garment factories, attending secondary schools, or living in rural communities	Through social marketing and health education, pilot program encourages women of childbearing age to purchase iron tablets in the future
China	National policy for iron/folate supplementation to pregnant women, but program not yet implemented	Pilot program to evaluate the efficacy of iron (NaFeEDTA)-fortified soy sauce; efficacy trial is a randomized, double-blind study implemented in Bijie City of Guizhou Province (where anemia prevalence is approximately 30%).	
India	Iron/folate tablets to pregnant and lactating women; diet promotion; rehabilitation	Low coverage and inadequate supply of tablets reported for pregnant and lactating women; pilot program for iron supplementation to adolescents implemented in Orissa; effectiveness of double-fortified (iron and iodine) salt is being tested	1,700 million Rs (US\$38 m) invested for iron/folate supplements to pregnant women
Indonesia	Iron/folate, sugar, and vitamin C tablets distributed to pregnant and newly married women; iron syrup provided for undernourished children; mandatory fortification of wheat flour with iron and other nutrients	Coverage of pregnant women reported as 70%; voluntary fortification of noodles with iron; efficacy trial to test multimicronutrient-(iron included)fortified biscuit to evaluate effect on pregnancy weight gain	
Laos	Iron/folate tablets (60 mg elemental iron and up to 0.25 mg folic acid) distributed through ANC to pregnant women from first presentation at health center until 3 mo after delivery; IEC activities	Low coverage of pregnant women reported. Of women who had a child in the 5 yr preceding a 2000 survey, 93% took no iron tablets during pregnancy, 6% took fewer than 90 tablets, and almost none took more than 90 tablets	Laos government requested 21,600,000 tablets (US\$36,288) containing 200 mg ferrous sulfate to supply all MCH facilities for 2001–02
Myanmar	Iron/folate tablets distributed to pregnant women during last trimester of pregnancy (2 tablets daily) through ANC; nutrition education on food-preparation methods	Not reported	Not reported

continued

TABLE 4. Characteristics of programs addressing iron-deficiency anemia (*continued*)

Country	Type and content	Coverage, target groups, pilot programs (if any)	Issues, resources
South Africa	Iron/folate tablets distributed to pregnant women through ANC; policy for high-dose iron supplementation to children 6–24 mo of age; no program for children yet implemented	Availability of iron tablets reported to be a problem	Not reported
Sri Lanka	Iron/folate tablets distributed to pregnant women through ANC; training and IEC activities; Thriposha mineral-fortified food supplement (9 mg iron and 20 mg ascorbic acid) to mothers and children; antihelminthic therapy for pregnant women after 1st trimester, preschool children, and schoolchildren; malaria chemoprophylaxis for pregnant women after 1st trimester; nutrition education for dietary diversification	ANC covers most pregnant women; 1997 efficacy study on fortification of wheat flour; no program for fortification of wheat flour established	Not reported
Thailand	Iron/folate tablets distributed to pregnant women through ANC (facilitated by VHVs); nutrition education for promotion of iron-rich foods; targeted weekly iron supplementation to schoolchildren and women of childbearing age in the workplace; triple-fortified (iron, iodine, vitamin A) instant noodle seasoning available in markets	High use of ANC services (> 95% for 1 visit, > 80% for 4 or more visits) and high coverage of pregnant women expected; double-fortified fish sauce (iron and iodine) to be marketed; wheat flour, complementary foods, and cooking oil considered as additional vehicles for iron fortification; considering iron supplementation to infants and preschool children	National supply of iron tablets is purchased from fiscal budget or by funds available at each health-service unit
Vietnam	Iron/folate tablets (60 mg iron, 0.25 mg folate) distributed to pregnant women until 1 mo postpartum through ANC; IEC activities for breastfeeding, complementary feeding practices, and dietary diversification; deworming; water and sanitation activities; fortification planned	Iron-supplementation project covered 15%–20% of the country; weekly iron supplementation to children 6–15 yr of age through school system and iron supplementation to women of childbearing age (15–35 yr) through large organizations are in pilot phase; iron and multimicronutrient supplementation to infants and children is being tested in certain areas; iron-fortified biscuits are in pilot study phase; iron-fortified (NaFeEDTA) fish sauce is in pilot phase	Estimated price for supply of iron tablets for 1 pregnant woman, 7,680 VND (US\$0.50); 200 commune workers (1 worker/10,000 women). \$0.55/pregnant woman/yr

ANC, Antenatal care; BINP, Bangladesh Integrated Nutrition Project; NNP, National Nutrition Programme; IEC, information, education, communication; BMI, body mass index; MCH, Maternal and Child Health; VHV, village health volunteer; VND, Vietnam Dollar.

Source: materials provided by study countries (refs. 2–12) and refs. 13–15. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Paper presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001. Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

nitude in recent years. In general, most countries report constraints and challenges to the successful implementation of iron-supplementation programs. In an effort to identify alternative methods for the control of iron-deficiency anemia, complementary pilot projects are being pursued by many project countries. Six of

the 12 project countries, for instance, were exploring or already implementing iron-fortification projects. Although most countries are in the pilot or testing stage of product development, Indonesia has already adopted and implemented a law for mandatory fortification of wheat flour with iron (among other nutrients).

Constraints to program implementation

Although all countries have a policy for providing iron supplementation to pregnant women, not every country has yet implemented a program on the national scale. Still fewer countries have a program with the capacity to supply regular supplements to the target population. Rarely have iron programs achieved high coverage rates in areas where the program has been implemented.

Lack of a well-developed distribution system

Across countries, iron programs have faced many constraints to achieving effective implementation. To begin with, the system for the distribution of iron tablets is generally not well developed. Although vitamin A programs have achieved high coverage by utilizing national immunization days as a system for capsule distribution, such a distribution method is not yet feasible for iron programs, because tablets must be taken daily or weekly. Most iron programs distribute tablets through antenatal-care clinics, and distribution is usually dependent upon a pregnant woman's visit to the center. Proper supplementation, however, requires that pregnant women make multiple visits to the antenatal-care center to obtain the recommended number of tablets. Access to health centers is therefore a critical determinant of program coverage. Given the typically low accessibility and utilization rates of health centers in project countries, the distribution system established for iron programs is a factor constraining successful program implementation.

Laos, for example, has adopted a national policy for iron supplementation to pregnant women. However, no comprehensive strategy for achieving goals of high coverage and effective program implementation has yet been developed, and only a minority of women attend antenatal-care clinics. As an indicator of utilization of antenatal-care facilities, only about 50% of women in developing countries overall are immunized against tetanus [19]. Given the low utilization of antenatal centers, it is unlikely that most women in Laos receive iron supplementation during pregnancy.

Inadequate tablet availability

Many countries report difficulties with adequate tablet supply. South Africa, among other project countries, reports problems with the availability of iron tablets [9]. Some countries have taken measures to avoid the problem of shortage of iron tablets. Bangladesh and Thailand, for example, established independent iron tablet procurement systems in order to ensure adequate tablet supply [2, 11]. With this system, Thailand reports never having a problem of undersupply of iron tablets; not only is money available in the budget for purchase of tablets, but at the local level, health-service units can

purchase additional tablets by income generated at the health-service unit.

Noncompliance

Compliance with the full regimen of iron tablets is a further program constraint. Most countries (e.g., Laos, South Africa, Myanmar, Bangladesh, Thailand, and Indonesia) report that women rarely comply with the full iron tablet-supplementation regimen recommended. Forgetfulness, fear of difficult delivery, and side effects have been cited as some of the reasons for poor compliance among women.

Lack of integrated strategy for anemia control

In most project countries, poor iron status, malaria, and helminth infection are all important causes of anemia. Because the causes of anemia are multiple, the most effective programs will use an integrated approach for the control of anemia. Although many countries do implement interventions for helminth and malaria control, few countries have an integrated program in which interventions for helminth and malaria control are incorporated as part of the iron-supplementation program. In fact, in many cases when helminth or malaria interventions are implemented in the country, they are in a pilot study phase or implemented only in select areas of the country. Moreover, interventions such as helminth control are often directed to schoolchildren and do not include pregnant women as a specific target group. For example, in Cambodia, the helminth-control program is implemented only in some areas of the country, and the activities are not incorporated into the national iron-supplementation program [3]. Likewise, malaria control in Cambodia is administered by the national malaria center, and interventions are implemented separately from the iron program as well as from the helminth-control program. Iron-supplementation programs could have a better chance of effectiveness if complementary interventions, such as helminth and malaria control, were integrated with supplementation distribution, and if deworming activities were targeted to pregnant women when not included already.

Lack of suitable methods for fortifying staple foods with iron

Although some approaches have been tested, no widely applicable procedure has been reported for fortifying rice, the main staple in Asian countries, with iron. This, perhaps more than anything, would contribute to improving the iron status of the population in Asia. More success has been achieved in Indonesia with fortification of wheat with iron and other micronutrients; although a minority of the population consume wheat regularly, this intervention nonetheless should impact a considerable number of people. Overall, certainly until recently, the investment in research and development

of iron fortification has been too limited to lead to rapid progress. The technical problems are probably not insuperable but have not yet been solved at a cost realistic for wide application.

Lack of research

More research is needed on several aspects of iron programs, including fortification of rice and other widely consumed foods. Some countries have not yet conducted studies to assess the main causes of anemia in the country or to examine how the issue of compliance may influence program effectiveness. In addition, small-scale efficacy studies to explore the potential impact of a life-cycle approach to iron supplementation are needed. Indonesia is one of the few project countries that have conducted several iron-related studies and also has explored alternative strategies, such as weekly supplementation to pregnant women. Although China, Thailand, Vietnam, and India are conducting research on iron-fortified products, in general most countries have a gap in applying research to program implementation. Biofortification programs (breeding for high-iron, high-vitamin A, and high-zinc rice) using traditional plant-breeding methods, as well as transgenic methods, require more support for research that could give important dividends.

Monitoring of program implementation

Compared with programs of vitamin A supplementation or iodized salt, iron-supplementation programs are considerably more difficult to monitor. Not only are distribution systems for iron programs less well established, but monitoring systems for iron-supplementation programs are also less well developed. Moreover, in the case of iron supplementation, it is difficult to monitor the actual number of tablets consumed throughout pregnancy.

Iron tablet coverage achieved

Of the project countries, Vietnam has a fairly comprehensive program approach to controlling anemia and a relatively good monitoring system for the program established. In Vietnam, the iron-supplementation program is targeted to pregnant women and, in select localities, to girls 15 years old or older [12]. In addition to supplementation, food diversification, fortification (in the pilot phase), and safe water activities are provided as part of the program. Iron and multimicronutrient supplementation to infants and children was being tested in several areas. In addition, during yearly campaigns, deworming activities are targeted to children and nonpregnant women. The monitoring system at the commune level is reported to be weak, but Vietnam has some of the most comprehensive data available. Vietnam has established a fairly good system for antenatal-care services, with over 90% of

births attended by trained health personnel [12]. However, the iron-supplementation program in Vietnam was covering only approximately 15% to 20% of the country [12].

Thailand also has relatively strong data available on iron supplementation. The data available, however, again do not include the number of women receiving tablets or the actual number of tablets consumed. The reporting system does not yet have the capacity for such monitoring. Coverage of the program is therefore estimated indirectly, mainly by estimating the coverage of antenatal-care clinics (examples of indicators are percentages of women with attendance ≥ 4 times at antenatal-care clinics, or percentage of births with hospital delivery) [11]. The method of estimating program coverage therefore assumes universal supplementation to those attending health facilities and, as in the case of Vietnam, is recognized as somewhat imprecise. Still, the coverage figures reported by Vietnam and Thailand provide more information about program effectiveness than those available for most other iron-supplementation programs.

Lessons learned

Successful management design for program implementation

A management design incorporating local-level government and community participation is important for ensuring uninterrupted program implementation and for achieving good program coverage. Advocacy among government stakeholders, in particular the Ministry of Health or the Ministry of Public Health, is important to creating appropriate health protocols and promoting program monitoring.

In Vietnam, for example, the management structure of the program is vertical, organized by hierarchical level, with different institutes given responsibility for each level of program implementation. The structure of the program is based on the preventive health and the Maternal and Child Health/Family Planning system. At the central level, a national steering committee consisting of nine members has been established; the responsible organizations at this level are the National Institute of Nutrition and the Ministry of Health, with the collaboration of other institutes, such as the Institute of Malariology, Parasitology, and Entomology and the Institute of Protection of Children's Health. At the provincial levels, the preventive health center, the Maternal and Child Health/Family Planning Centers, and social organizations have management responsibility. At the district level, the district health centers, specifically the hygiene-epidemiology and Maternal and Child Development/Family Planning teams, are responsible for the program, and at the commune level, Commune Health Committees have program responsibility [12]. In this way, the distribution and management system of the iron program relies on the collaboration of various

institutions across levels and community participation at the local levels. Schoolteachers, youth unions, and representatives from population and family planning services all have active roles in managing the program as key members of the management board under the coordination of the local people's committees.

Community participation

In addition to integration at the local level, community acceptance of and community participation in iron-supplementation programs are essential factors for smooth implementation. In Thailand, village health volunteers help make the iron program work. They have an important role in encouraging increased participation in the iron program and in distribution of supplements where access to health centers is difficult. The village health volunteers have responsibility for identifying pregnant women in the community and, upon identification, encouraging them to receive antenatal-care services [11]. Iron supplementation is then provided to the women upon presentation at the center. The work of village health volunteers in this regard has been cited as an important factor in the increased number of pregnant women attending antenatal centers since the 1980s.

High coverage has also been reported for the iron-supplementation program in Bangladesh. Among pregnant and lactating women living in the national nutrition program areas, coverage of the iron program has been reported to be greater than 80% [2]. As in Thailand, the high coverage rates achieved in Bangladesh are due largely to activities at the community level that support, promote, and facilitate program implementation. The program in Bangladesh is supported by a strong partnership between the central and local levels. The Government of Bangladesh works closely with nongovernmental organizations at the community level to implement the program activities. As in Thailand, community nutrition promoters in Bangladesh have an important role in motivating participation in the program. Pregnant women are identified, registered, and encouraged to attend antenatal centers. The center has monthly weight-monitoring sessions, at which time monthly iron/folate distribution also takes place.

Life-cycle approach to controlling iron-deficiency anemia

Some countries are beginning to adopt a life-cycle approach to iron supplementation. As it becomes increasingly recognized that anemia is prevalent among groups other than pregnant women, countries are beginning to consider additional target groups for iron supplementation. Implementing an effective life-cycle strategy can help to reduce the prevalence of anemia, both among pregnant women and in newly targeted groups. Countries such as Indonesia, Thailand, and Vietnam, for example, provide iron supplementation

not only to pregnant women, but also to nonpregnant women of childbearing age. Prepregnancy supplementation helps to build iron stores and places women in a more healthy position when they become pregnant. Iron supplementation during pregnancy theoretically would then become more effective because women would not be as much in need of making up a deficit of iron, but would be able to maintain the iron stores necessary by counteracting the losses that occur during normal pregnancy. However, although some countries are now beginning to consider including infants, preschool children, women of reproductive age, and lactating mothers among the potential groups to be targeted for iron tablet supplementation, few countries have yet adopted policies or implemented programs incorporating such a comprehensive strategy.

Monitoring and evaluation

Of the three nutritional deficiencies, iron deficiency is the most poorly researched in terms of national population-based or program-based data. Facility-level data are limited in utility by low levels of compliance with supplementation regimens. The incorporation of program utilization indicators into national survey instruments would help to elucidate national trends in anemia relative to program exposure, as well as highlight programmatic factors that increase beneficiary compliance.

Synthesis of lessons learned on micronutrient-deficiency control program implementation and associated recommendations

In reviewing the experience of micronutrient program implementation, attention is directed both to the overall principles (e.g., the potential for fortification of salt with iodine and for intermittent massive doses of vitamin A) and the myriad of details involved in sustainable implementation of national-scale interventions. In the summary below, wider adoption of effective features and fixing the problems that are identified are recommended. (This approach is used rather than making particular recommendations, which would become repetitive.)

In most of the countries, projects were successfully launched, implemented, and sustained (fig. 3). Of the five principal programs included in this study—vitamin A capsule distribution to children, vitamin A capsule distribution to women postpartum, salt iodization, iron tablet distribution to women, and iron tablet distribution to children—10 of the 12 project countries have at least three national programs in place. Salt iodization is the most widely implemented program (all countries); despite challenges to achieving national coverage and monitoring program quality, most (10) project coun-



FIG. 3. National-level micronutrient-deficiency control policies and programs. VAC, Vitamin A capsule; pp, postpartum

tries have established the legislative foundations for its success. Vitamin A capsule distribution programs for children and women have been implemented in fewer countries (8 of 12), with 2 others having policies in place for vitamin A capsule to children and 1 other having policies for vitamin A capsule distribution to women. Iron tablet distribution programs for pregnant women are being implemented in most countries, but with varying coverage and limited evidence of effectiveness.

Most countries implement national programs without up-to-date (e.g., within the previous five years), nationally representative, population-level biochemical, clinical, or functional deficiency data. Formerly, national surveys were commonly performed before implementing programs [1], although these were done as much to establish the problem as to obtain a baseline. However, regular follow-up surveys to track progress and/or to identify new problems are less common. Within the past 10 years, almost all countries have collected at least subnational data on clinical or functional vitamin A deficiency (11 have collected data on xerophthalmia or night-blindness) and subclinical vitamin A deficiency (serum retinol) in preschool children; fewer (5 countries) have recent national-level clinical or functional deficiency data, and only 2 have recent national-level subclinical data. Data on iron deficiency are the least available: three of the countries have collected nationally representative anemia data in pregnant women, and eight have collected anemia data for other population groups in the past 10 years. The lack of nationally representative population-level data precludes effective population surveillance or impact evaluation. Micronutrient-deficiency indicators could be better integrated into existing large-scale population survey instruments to measure both the prevalence of deficiencies and program coverage.

A number of program design and management principles associated with apparently effective program implementation can be identified.

- » Interagency collaboration between national, local, and international partners is vital to ensure comprehensive planning, resource procurement and distribution, and information dissemination.
- » Particularly for facility-based programs such as supplementation with iron and vitamin A capsules, strong program management and motivation by program staff at the local level are imperative.
- » The social mobilization and community participation that effective management brings about is reported to result in a higher demand for services by target groups.
- » Finally, project countries emphasized the importance of a well-developed institutional capacity for program monitoring and evaluation, although this was frequently cited as an area for future growth.

Some barriers to program implementation stood out as priorities for correction.

- » Increasing public knowledge of program services, as well as promoting public motivation to use the services, continues to be of high importance. This is particularly true with iron and vitamin A capsule supplementation of women (in pregnancy and postpartum, respectively), where participation is linked to the use of existing services. In the case of iron, low compliance with pill regimens is a particular problem, which has been linked in project countries to forgetfulness, fear of difficult delivery, and side effects of the supplement.
- » Knowledge and motivation of health-care workers were seen as important intermediate factors in achieving community-level demand for nutritional supplements by the target groups.

There is too much reliance on single interventions: multifaceted strategies for micronutrient-deficiency control are needed. Particularly for vitamin A and iron, the sustainability or even effectiveness of supplementation alone in permanently reducing the deficiency is open to some doubt. Ideally, sustainable reduction of deficiency is seen to depend on improved nutrient intakes through diet, which requires promotion of dietary change. Often, this may require increasing dietary nutrient content by fortification. Of the project countries, seven reported an IEC program, six reported a home-gardening program, and one reported a mandatory fortification program to improve vitamin A status. In addition, six countries reported deworming programs. Expanding and sustaining coverage of proven deficiency-control strategies remains important, but broader and integrated approaches addressing problems, taking account of differing needs through the life cycle, should be a long-term vision.

Supplementation has shown greater success using campaign-based models (i.e., vitamin A) than facility-based models (e.g. iron, which, however, is much less suited to intermittent intervention).

- » *A campaign model has proven to be the most effective mechanism to date for achieving wide population coverage of children with vitamin A capsules.* Of the eight countries implementing national vitamin A capsule programs for children, six work through national or subnational immunization days. Vitamin A capsule programs implemented through outreach or facility-based immunization services (in Cambodia and India, respectively) exhibit the lowest coverage rates of all project countries (47% to 70% and <40%, respectively), and coverage rates decreased with the transition away from national immunization days (in Cambodia). The phasing out of national immunization days with the eventual eradication of polio signals the need for operational research to clarify how the coverage of routine outreach or facility-

based services might be augmented. This also calls for strengthening of supply management systems to avoid interruption of services.

- » *Vitamin A capsule distribution programs for postpartum women are in general less well established than child supplementation programs.* Having been launched more recently, their coverage rates tend to be lower than those for child supplementation in countries for which data are available, rarely exceeding 50%. Additionally, as with iron supplementation to pregnant women, vitamin A capsule distribution to women postpartum is constrained by obstacles to utilization of antenatal-care services.
- » *Iron supplementation remains the least well implemented or documented program of the principal strategies investigated here.* The distribution of iron tablets through routine antenatal-care services has not generally led to national coverage. The main constraints to participation include low access to and utilization of antenatal-care services by rural women in project countries, inadequate availability of iron tablets on the local level, and reluctance to take daily iron supplements. Half of the project countries are experimenting with iron-fortification projects, and finding successful methods would be a major advance.

With the exception of salt iodization, fortification is an underexploited strategy for sustainably reducing the prevalence of micronutrient deficiencies.

- » *Salt iodization is the most widely implemented micronutrient-deficiency control program in project countries, but several operational factors continue to constrain full program effectiveness.* These factors include inadequate environment to mandate or enforce iodization; reliance upon inadequately iodized imported salt; lack of government capacity to monitor salt iodization by producers, particularly small-scale producers; and higher prices for iodized salt in the market. Consumer knowledge and attitudes regarding the value of consuming iodized salt are important determinants of salt-purchasing behavior.
- » *Fortification of food with vitamin A is mandatory in only one country, and fortification with iron is mandatory in only one other country; fortification of foods*

with micronutrients should have higher priority for research and investment. The development of feasible, culturally acceptable vitamin A-fortification strategies for the Asian setting (particularly fortification of rice) is essential, as is continued investment in cross-national collaborative networks to promote fortification. The technology for iron fortification of staple commodities, particularly flours, is available but has not yet been widely implemented or legislated at the national level. It seems crucial to increase investment into alternative mechanisms for increasing micronutrient intake in affected populations, particularly via multivitamin fortification.

One way forward in enhancing national program implementation is to focus on capacity development for national governmental, academic, and research institutions. Focal areas needing increased capacity include population assessment and surveillance, program design and management, program monitoring, evaluation design and implementation, and technology development. Multiagency initiatives need sustained support. Nutritional surveillance systems could be further developed, integrating program performance data (collected by government and industry partners) and population health and nutrition status data (collected at the facility and population levels) to better monitor and evaluate population trends in micronutrient deficiencies. Increasing the rigor and comparability of information systems would assist enormously in improving the capacity to improve national program design based upon sound evaluations.

Project countries report concern regarding the sustainability of programs. Medium-term planning should incorporate mechanisms to promote the technical, financial, and organizational sustainability of programs. Most project countries reported dependence upon external donors and partners (e.g., the Canadian International Development Agency, UNICEF) for vitamin A capsules, iodine, and other fortificants. Additionally, the inability to produce the national salt requirement results in the availability of noniodized (and often insufficiently regulated) salt on the market. The building of national governmental, industrial, and academic capacity for program implementation and management, as well as the national production of program inputs, should have top priority.

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Lessons from successful micronutrient programs

Part III: Program impact

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Abstract

Micronutrient-deficiency control programs have been greatly extended at the national level in the last 10 to 15 years. However, rigorous evaluations of these are scarce, so that conclusions on impact are tentative and based mainly on indirect evidence. The coverage of vitamin A capsule distribution programs has exceeded 70% in most study countries. In countries implementing national iodized salt programs, the coverage reaches 60% to 90% of households with adequately iodized salt. Of the three micronutrients, coverage of iron tablet supplementation is the least well documented due to inadequate program monitoring systems and population survey data. Supplementation of preschool children 6 to 59 months of age with vitamin A capsules has plausibly contributed to the reduction in clinical vitamin A deficiency and its near-elimination in many countries. The impact of vitamin A capsule supplementation on children's biochemical vitamin A status (serum retinol) in national programs may be less. National data on salt iodization show a consistent relation to reduced prevalence of iodine-deficiency disorder symptoms (goiter); the rates of cretinism and other results of iodine deficiency are almost certainly falling too. The evaluation of the impact of salt iodization programs on biochemical iodine status is limited by a lack of data. Although trials have demonstrated the efficacy of iron supplementation in reducing the prevalence of anemia, the interpretation of national-level data is not so clear. Given the substantial financial and technical commitment required to implement national micronutrient-

deficiency control programs, it is vital that investment enable the evaluation of the impact of these programs. It is becoming increasingly important to collect data on subclinical deficiency (e.g., biochemical data) to assess program impact.

Introduction

This paper, the third in the series entitled "Lessons from Successful Micronutrient Programs," takes up the question of the evidence for the impact of micronutrient-deficiency control interventions, examining how far it is known whether national programs are associated with improvement in indicators of nutritional status, and by how much. This is based on a project involving 12 countries, all but one in Asia: Bangladesh, Cambodia, China, India, Indonesia, Laos, Myanmar, Philippines, South Africa, Sri Lanka, Thailand, and Vietnam.

Numerous efficacy trials starting decades ago have been conducted to assess the effects expected from large-scale micronutrient-deficiency control programs. Iodine provides a good model of systematic development of intervention. Thus, the importance of iodine along with the efficacy of supplementation was shown in the 1960s to the 1980s [1], leading to some well-documented national programs that greatly reduced iodine-deficiency disorders, notably in Latin America [2]. Understanding vitamin A interventions has been more complicated, with the focus shifting from preventing eye damage to reducing mortality and more limited testing of the efficacy of different approaches; this is discussed in the next section in some detail. Iron deficiency and anemia have been concerns for many years, but here there is a crucial gap between the efficacy of approaches at the pilot level (such as ferrous sulfate supplementation) and the limited known success (lack of data is a major problem) of these approaches in routine programs.

The research needed to move from efficacy at the pilot level to broad effectiveness has been limited. Hence the size and rate of reduction of deficiency

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to be expected from large-scale programs are not always clear. With most developing countries now implementing at least one (and in many cases three) nationwide micronutrient-deficiency control program or programs, it has become increasingly important to estimate the actual effects of these interventions on large populations in order to fine-tune their utility and support their continuation. This requires specific and carefully designed evaluations. However, these are very scarce for national (or large-scale) programs.

The extent of the impact of micronutrient-deficiency control programs in Asia can nonetheless be assessed to some degree. Most countries providing case studies have some outcome data on micronutrient status and on program implementation. However, almost all available outcome data are for clinical measures of micronutrient deficiencies. For vitamin A, the clinical prevalences are so low that this measure is not very suitable for evaluation, requiring huge samples to estimate effects. On the other hand, few survey results are available on subclinical measurements among less severely affected populations, even though subclinical prevalences are higher and thus potentially more suitable for evaluation. Although some project countries have multiple rounds of data on clinical indicators of vitamin A deficiency, only the Philippines has two rounds of national data on serum retinol. (China, Indonesia, South Africa, and Vietnam also have multiple rounds of serum retinol data available, but the survey coverage in all cases is subnational, and for many of these countries, information on the comparability of the serum retinol surveys was not available.) Likewise, almost all countries have at least two rounds of goiter data; however, only three countries reported multiple rounds of national data on urinary iodine excretion (China also has multiple rounds of urinary iodine excretion data available; however, only data on median urinary iodine values could be obtained.) At the same time, process data on implementation may be available, but these data are not often linked (except perhaps at the provincial levels) to the outcome, thus precluding much useful evaluation. The prevalence of anemia among pregnant women is assessed, but program coverage data are scarce for iron too. Few of the anemia prevalence data can therefore be linked to iron-supplementation programs.

The results on the prevalence of deficiencies from project countries have been compiled here to assess their trends and to shed some light on program impact achieved to date, as best as possible from the available data. The trends for clinical vitamin A deficiency are reasonably clear both for individual project countries and across countries in Asia. Most countries have considerable coverage data on vitamin A programs, so that some linkage can be attempted. The prevalence trends assessed by biochemical data on vitamin A deficiency are not as clear. For iodine deficiency, most

country data indicate a decrease in prevalence with implementation of the national iodized salt program. This trend is observed for both clinical (goiter detected by palpation) and biochemical (urinary iodine excretion) indicators. In the case of iron-deficiency anemia, not as many conclusions can be drawn. Few countries have anemia data that can be linked to programs; only Thailand and Vietnam have prevalence and coverage data that allow for some crude assessment of program effectiveness.

For all three deficiencies, as a first step we have reviewed what results might be expected from effective implementation—mainly based on efficacy trials—as guidance to what to look for. The observed results are then related to the expected results, with focus on the situations with the most promising data.

Vitamin A

What is known from efficacy trials

A literature search was done to explore the extent of the effect to be expected by supplementation of children with massive doses (200,000 IU) of vitamin A. A number of both controlled efficacy trials and uncontrolled community trials of periodic dosing were identified. Most efficacy trials observing the effects of supplementation used data on clinical signs of vitamin A deficiency that had been obtained prior to the wide-scale adoption of vitamin A-supplementation programs. Although much less in number, some trials to date have observed the effects of supplementation on biochemical indicators of vitamin A deficiency, such as low serum retinol; these trials are discussed later.

Range of efficacy demonstrated by clinical data on vitamin A deficiency

Most efficacy trials used high-dose (200,000 IU) vitamin A capsules at approximately six-month intervals. The results of 25 trials of vitamin A capsules (19 in Asia; 20 measuring clinical vitamin A deficiency) analyzed in a previous review [3] were largely consistent in showing a significant impact on clinical indicators of vitamin A deficiency, often bringing the prevalence to nearly zero. Examples are studies conducted in India [4, 5],* Indonesia [6–9], and the Philippines [10].

The size of the impact varied considerably. For Bitot's spots (X1B), the decrease in prevalence at 12-month follow-up ranged from 4.4 to 1.1 percentage points (4.7% to 0.3% in the study of Tarwotjo and co-workers [7]; 1.1% to 0.1% in other Indonesian studies [8–11]). Keratomalacia was observed as an outcome measure in

* Gujral, Gopaldas T. USAID assisted ICDS impact evaluation project in Panchmahals (Gujarat) and Chandrapur (Maharashtra), 1984–1990, 1991.

one study; the results showed an odds ratio of 12.5 for keratomalacia and receipt of dose [4]. The effect of supplementation on active xerophthalmia ranged from 4.7 to 1.6 percentage points of decrease in prevalence (from 6% to 1.3% in Vijayaraghavan and colleagues [5], and from 1.9% to 0.3% in Sommer and co-authors [6]).

Longer follow-up periods demonstrated sustained effects on clinical signs. In Vietnam, a two-year trial was conducted in which a vitamin A dose (200,000 IU) was provided twice yearly. The results of the trial indicated no cases of xerophthalmia among the experimental group at the end of the follow-up period [12]. In the Philippines, 200,000 IU vitamin A capsule supplementation was provided to children with xerophthalmia. The results showed a 2.7 percentage points decrease in xerophthalmia at 24 months of follow-up.* A study in India with a six-year follow-up also showed a beneficial impact of vitamin A supplementation: among those groups receiving twice-yearly vitamin A doses, the prevalence of active xerophthalmia decreased from 4% to 1% in one intervention area and from 12% to 1% in the second intervention area studied.**

A few other trials have shown a lesser impact of vitamin A supplementation on clinical signs of deficiency. A trial in Sudan [13] showed little difference in the number of new cases of xerophthalmia after three doses of vitamin A were administered at six-month intervals. The prevalence of xerophthalmia was reported as 2.9% at baseline; after 18 months, it was 0.013% in the treated group and 0.015% in the control group, results that are hard to interpret. In the Philippines, no substantial difference in the frequency of xerophthalmia cases was found with the provision of vitamin A supplement (200,000 IU) to malnourished children (second and third degree underweight) every six months [14]. These results may indicate that under some conditions—possibly with other forms of malnutrition or underlying changes—the impact is reduced.

Some guidance as to the expected impact on clinical vitamin A deficiency from supplementation can be taken from these intervention trials. Overall, the results may be interpreted as showing that, whatever the starting prevalence, administration of vitamin A capsules in high doses every four to six months largely prevents new cases of eye signs and brings their prevalences down to nearly zero. Cautions in the interpretation of these results may be that existing Bitot's spots may persist and that the effect of vitamin A supplementa-

tion may be curtailed with concurrent protein–energy malnutrition. At the same time, since the starting prevalences of clinical vitamin A deficiency are very low (almost always less than 5%, and often only 1%), this indicator is not ideal for detecting change.

Range of efficacy demonstrated by biochemical data on vitamin A deficiency

Much less is known about the effect to be expected on serum retinol from supplementation. This is important, since subclinical vitamin A deficiency is far more prevalent and, moreover, it is thought that the mortality-reducing effects of vitamin A interventions are gained by reducing subclinical deficiency [15]. A number of studies on the effect of supplementation (to children) on serum retinol were extracted from the literature; the results are summarized in table 1, as no such compilation was identified. The time over which the effect of supplementation persisted became of concern with results from the Philippines presented in this project. Therefore the efficacy trials were reexamined to look into this aspect. The serum retinol studies available are relatively few in number, and the findings across these studies are not always consistent. The extent of impact ranged from a 12 percentage points decrease in vitamin A deficiency as indicated by low serum retinol (< 20 µg/dl) [16] to no biochemical improvement indicated among a group supplemented with vitamin A capsules [10].

The largest decrease in the prevalence of subclinical vitamin A deficiency was demonstrated in a trial conducted in Brazil by Araujo and co-workers [16], where the prevalence of serum retinol levels < 20 µg/dl dropped from 16.3% to 4.3% among preschool children after supplementation with vitamin A. However, because the study did not include a control group, the extent of the decrease in prevalence cannot be distinguished from the underlying trend in vitamin A deficiency. Ramakrishnan and co-workers [20] found a significantly higher mean serum retinol value among the experimental group receiving 200,000 IU vitamin A capsules three times a year compared with the control group receiving a placebo. The size of the difference between groups was not reported. Tilden et al.,*** on the other hand, conducted a study in Nepal and showed an effect of vitamin A capsules on Bitot's spots, but a much weaker impact on serum retinol. Likewise, although Solon and co-authors [10] documented an effect on clinical signs of vitamin A deficiency (the prevalence of xerophthalmia dropped from 3.1% to

* Klemm RDW, Villate E, Mendoza O. Integration of vitamin A supplementation and nutrition education into DOH community health services: a case study of impacts and processes. Presented at the 15th International Vitamin A Consultative Group meeting in Ecuador, 1992.

** Gujral, Gopaldas T. USAID assisted ICDS impact evaluation project in Panchmahals (Gujarat) and Chandrapur (Maharashtra), 1984–1990, 1991.

*** Tilden RL, Curtale F, Pokhrel RP, Muhilal, Pant CR, Pak S, Gorstein J, Pokhrel GP, Atmarita, Lepkowski J, Grosse RN, and the Vitamin A Child Survival Project Team (1993). Cost, coverage, and changes of several measures of health status associated with alternative approaches to the control of vitamin A deficiency in Nepal. Presented at the 15th International Vitamin A Consultative Group meeting, March 1993.

TABLE 1. Reported results of trials of the effect of periodic massive vitamin A doses on serum retinol

Country	Age, dose, frequency, and type of study	Effect on serum retinol ^a		
		Reported	At 2–3 mo	At 6 mo
Brazil [16]	0–5 yr 200,000 IU every 6 mo No comparison group	Substantial at 6 mo	+	+
Ghana, India, and Peru [17]	Infants 25,000 IU 3 times between 6 wk and 5 mo of age Randomized, double-blind, placebo-controlled	Effect at 2–3 mo, none at 6 mo	+	–
India [18]	2–5 yr 180,000 IU, once Comparison group	Effect at 10 wk, none at 25 wk	(+)	–
India [19]	2–6 yr 90,000 IU, once Comparison group	Effect at 8 wk, none at 18 wk	+	–
India ^b	Newborns 50,000 IU, Comparison group	Effect at 42 wk	+	+
India [20]	6–36 mo 200,000 IU every 4 mo Randomized, double-blind, placebo-controlled	Effect at 12 mo	?	+
Indonesia ^c	1–5 yr 300,000 IU, once Comparison group	No effect	–	–
Indonesia [21]	1–5 yr 100,000 or 200,000 IU, once Comparison group	Effect of 200,000 IU greater at 6 mo	(+)	+
Nepal ^d	6 mo–5 yr 200,000 IU every 6 mo Comparison group	Small effect only	?	–
Philippines [10]	6 mo 200,000 IU, once Comparison group	No effect	–	–
Philippines [22]	1–5 yr 200,000 IU, once Randomized, double-blind, placebo-controlled	Effect at 2 mo, probably not at 6 mo	+	–
Thailand ^e	Infants 100,000 or 200,000 IU, once No comparison group	No effect	–	–

a. +, Increased serum retinol; (+), minor or doubtful effect; –, no effect; ?, effect unclear.

b. Thanangkul O, Promkutkaew C, Waniyaopong T, Damrongsak D. Comparison of the effects of a single high dose of vitamin A given to mother and infant upon plasma levels of vitamin A in the infant. Presented at a Joint WHO/USAID Meeting for the Control of Vitamin A Deficiency, NUT/WP/74.14. WHO, Jakarta, Indonesia, November 25–29, 1974.

c. Kusin JA, Sinaga HSRP, Smith EM. Vitamin A Status of preschool children in Suka Village, North Sumatra, after an oral massive dose. Presented at the 5th International Vitamin A Consultative Group meeting, NUT/80. WHO, Jakarta, Indonesia, October 13–17, 1980.

d. Tilden RL, Curtale F, Pokhrel RP, Muhilal, Pant CR, Pak S, Gorstein J, Pokhrel GP, Atmarita, Lepkowski J, Grosse RN, and the Vitamin A Child Survival Project Team. Cost, coverage, and changes of several measures of health status associated with alternative approaches to the control of vitamin A deficiency in Nepal. Presented at the 15th International Vitamin A Consultative Group meeting, March 1993.

e. Dhanamitta S, Stoecker B, Vallyasevi A. Community approaches to prevention of vitamin A deficiency. Presented at a Joint World Health Organization/UNICEF/US Agency for International Development/Helen Keller International/International Vitamin A Consultative Group meeting on Vitamin A Deficiency and Xerophthalmia, Jakarta, Indonesia, October 13–17, 1980.

0.6% among the group supplemented with vitamin A), the study showed no biochemical improvement from capsule supplementation alone; only the intervention group provided with a weekly supply (two packets per family per day) of monosodium glutamate (MSG) fortified with vitamin A showed an increase in serum retinol (from 21.0 to 28.5 µg/100 ml).

Few biochemical data exist to assess the potential protective period of the recommended dose of vitamin A supplementation. Only two such efficacy studies could be identified. One of these trials [21] showed that children supplemented with 200,000 IU retained significantly higher serum retinol values three and six months following supplementation than did children supplemented with 100,000 IU (the serum retinol values at baseline, three months, and sixth months for the 100,000 IU vs. the 200,000 IU group were 0.55 vs. 0.54, 0.53 vs. 0.63, and 0.81 vs. 0.89 µmol/L, respectively). A second study, conducted by Perlas et al. [22] in the Philippines, showed an effect of vitamin A supplementation on serum retinol, with a protective effect of the capsules that seemed to last up to about four months. The results of the Perlas study are described in more detail below, under General Evaluation Findings.

In addition to the above trials, some studies have explored the effect of supplementation on serum retinol among women postpartum. Studies by Roy et al. [23], Stoltzfus et al. [24], Rice et al. [25], and Tanumihardjo et al. [26] have shown that, in general, vitamin A supplementation to women postpartum is an efficacious strategy for controlling vitamin A deficiency among lactating women. This was indicated in the study of Rice et al. [25] by differences in mean milk vitamin A concentration among mothers and by differences in serum retinol and modified retinol dose response (MRDR) values among infants in different intervention groups; as in the study of Roy et al. [23], among women less effect was observed on serum retinol than among infants. In fact, in the study of Rice et al., a significant difference in serum retinol values was not demonstrated between any of the three groups of lactating women at any time during data collection.

In a controlled trial by Stoltzfus et al. [24], lactating women were supplemented with vitamin A (300,000 IU) or placebo shortly after delivery. The results showed that the mean serum retinol concentration for the intervention group was higher than that for the placebo group, and this finding was observed at both three and six months postpartum. The extent of the impact demonstrated, however, was relatively small: a difference of 0.15 µmol/L between the intervention and control groups (1.39 vs. 1.24 µmol/L) at three months. The same range of effect (0.15 µmol/L difference) was observed between the intervention and control groups (1.23 vs. 1.08 µmol/L) at six months of follow-up. The findings suggest that the extent of the

effect to be expected by vitamin A supplementation on serum retinol among lactating women should be considered. If consistent across studies, the observed results could have wider implications for indicators to include in future evaluations of postpartum vitamin A-supplementation programs.

Changes in serum retinol after administration of vitamin A capsules appear to be more dependent on the length of time after the dose than are changes in clinical signs. In more than half the trials assessed (table 1), the serum retinol levels had returned to predose values by six months after the dose, and probably earlier. Thus, the efficacy data suggest that vitamin A capsule supplementation may not have a persistent effect on the subclinical deficiency, as measured by serum retinol. Therefore we are unsure about what to expect when serum retinol is used to evaluate large-scale programs involving administration of vitamin A capsules.

Methods applied to country-level prevalence data

Evaluation of programs by clinical data on vitamin A deficiency is possible, although using biochemical data in addition would be valuable because the prevalences of clinical signs are so low. In the case of most project countries, the prevalence of night-blindness is low enough that the number of people actually affected by night-blindness is very small. This makes it somewhat difficult to use clinical indicators of vitamin A deficiency to relate data to population estimates. Still, clinical data are what most countries have available, and therefore they remain the most available means of assessing program effectiveness in these countries.

Baseline and follow-up data as reported are listed in table 2. The calculation of the rate of change in prevalence in percentage points for a 10-year period (percentage points/10 years) for clinical vitamin A deficiency was as follows:

$$\frac{\text{follow up prevalence} - \text{baseline prevalence}}{\text{follow up year} - \text{baseline year}} \times 10 \text{ years}$$

Caution must guide the interpretation of the results both within and across countries. Very few countries (if any) have yet conducted rigorous evaluations of their national vitamin A-supplementation programs, with valid comparisons over time and with and without the program. Furthermore, in some cases different age groups have been used for surveys in different years. In others, baseline data (i.e., obtained prior to program implementation) could not be found for a country program. For these countries, the earliest known prevalence data were used.

Coverage data on the percentage of members of the age group reported to receive vitamin A capsules for the (normally twice yearly) distribution are shown in figure 1. Coverage data were used for the closest

TABLE 2. Large scale vitamin A-supplementation programs: distribution methods, coverage, and vitamin A deficiency indicators

A	B	C	D	E	F	G	H
Country	Intervention	Period of supplementation	Target group	Baseline VAD prevalence (group, year)	VAD prevalence during intervention (group, year)	Program coverage (year)	Percentage point change/10 yr (time period)
Bangladesh	VAC distribution on NIDs	1973-current (1995 began with NIDs)	Children < 5 yr	XN 3.6% (children 6-59 mo, 1982)	XN 0.6% (children 6-59 mo, 1999)	99%+ (1999)	XN -1.76 (1982-99)
Cambodia	VAC distribution through routine immunization outreach	1993-current (1993-95 small scale, 1996 program began)	Children < 5 yr	XN 5.6% (children 1-6 yr, 1993)	XN 0.2%-2% (children 18-59 mo, 2000)	63% (Mar 2000)	XN -7.7 to -5.1 (1993-2000)
China	No national vitamin A-supplementation program; No program impact data available						
India	VAC distribution with UIP	1970-current	Children 6-36 mo	XIB 1.8% (1975-79) ^a	XIB 0.7% (1996-97) ^{a,b}	< 40% (year not reported) ^{a,c}	XIB -0.56 (1975/9-1996/7)
Indonesia	VAC distribution to children by <i>posyandus</i> (village weighing posts)	1974-current	Children 12-59 mo	XN + XIB 1.3% (preschool children, 1978)	XN + XIB 0.33% (preschool children, 1995)	66% (not reported)	XN + XIB -0.53 (1978-95)
Laos	VAC distribution to children on SNIDs	1996-current	Children 12-59 mo	XN 0.7% (children 24-71 mo, 1995)	XN 0.47% (children 6-59 mo, 2000)	73% (2nd round distribution, 1999)	XN -0.46 (1995-2000)
Myanmar	VAC distribution to children on NIDs	1993-current?	Children 6-59 mo	XIB 0.6% (children 0-5 yr, 1991)	XIB 0.38% (children 0-5 yr, 1994) XIB 0.23% (children 0-5 yr, 1997) ^d	> 90% (1997)	XIB -0.73 (1991-94); -0.62 (1991-97)
Philippines	VAC distribution to children on NIDs	1993-current	Children 12-72 mo	35.3% serum retinol < 20 µg/dl (children 6 mo-5 yr, 1993)	38% serum retinol < 20 µg/dl (children 6 mo-5 yr, 1998)	> 80% (1995); 80% (2000)	Low serum retinol +5.40 (1993-98)
Philippines	VAC distributed to women postpartum	1998-current	Women shortly after delivery	16.4% serum retinol < 20 µg/dl (lactating women, 1993)	16.5% serum retinol < 20 µg/dl (lactating women, 1998)	Coverage of women postpartum not available	Low serum retinol +0.20 (1993-98)
South Africa	No program for supplementation to children yet implemented; no program impact data available						
Sri Lanka	No program for supplementation to children yet implemented; no program impact data available						
Thailand	No national vitamin A-supplementation program; no program impact data available						

Vietnam	VAC distribution to children on NIDs	1988–current (1988–92 small scale) (1993–1997 program not linked with NIDs)	Children 6 mo–3 yr	XN 0.37% (children 0–5 yr, 1985–88) ^e	XN 0.05% (children 0–5 yr, 1994) XN 0.20% (children 0–5 yr, 1998)	77% (2000)	XN –0.43 (1985/8–94); –0.15 (1985/8–98)
Vietnam	VAC distribution to lactating women	1993–current	Lactating women	XN 0.58% (pregnant and lactating women, 1994)	0.90% XN (pregnant and women, 1998)	52.2% (2000)	XN +0.80 (1994–98)

VAD, Vitamin A deficiency; VAC, vitamin A capsule; NID, national immunization day; XN, night-blindness; UIP, Universal Immunization Programme; XIB, Bitot's spots; SNID, subnational immunization day. a. Data presented by K. Vijayraghavan, Bangkok, June 2001 [36], from NNMB, National Nutrition Monitoring Board Second Repeat Surveys, 2000.

b. 2001 data are also available for Bitot's spots but are not included here, as comparability with other surveys is not known.

c. It is unclear which areas the XIB data represent, but no data for any area reported show higher than 40% coverage for children receiving two doses of vitamin A.

d. Data presented by government representative, Bangkok, June 2001; prevalence of XIB also available for rural (0.1%) and urban (0.03%) areas for children 0 to 5 years of age.

e. Vietnamese data on prevalence of other clinical signs are also available: e.g. from 1988 to 1994, the prevalence of XIB decreased from 0.16% to 0.045%, and the prevalence of X2/X3A/X3B decreased from 0.07% to 0.005%.

Source: refs. 27–37. Also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001. Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Presented at a workshop on "Successful Micronutrient Programs" held at the International Union of Nutritional Sciences, Vienna, August 2001.

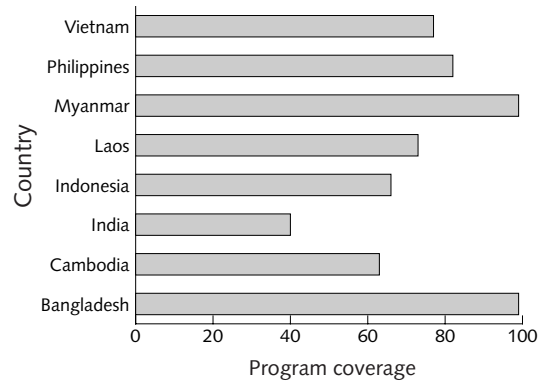


FIG. 1. Coverage of vitamin A capsule programs for children by country (data are for the most recent year available; see table 2).

year possible to that of the follow-up prevalence data point, normally for the most recent year available. As discussed later, reported coverage based on administrative records from the vitamin A capsule distributions—usually the number of capsules compared with local data on population in the target age group—was generally higher than estimates derived (when available) from sample surveys of households; however, there was no way of correcting this, so the data in figure 1 should be viewed as probably a high estimate of the actual coverage.

Evaluation findings

Impact of programs on clinical indicators of vitamin A deficiency

The characteristics and clinical outcomes of the large-scale programs reviewed here are compiled in table 2, drawing on the country studies [27–37].* Comparing the results of repeated national surveys shows the prevalence of clinical vitamin A deficiency to be decreasing (column H). Across project countries in Asia, the rates of change in the clinical prevalence of vitamin A deficiency (night-blindness or Bitot's spots) nationally range from –0.15 to –0.43 (Vietnam) to –1.76 (Bangladesh) percentage points/10 years; Cambodia reports rates of –5.1 to –7.7 percentage points/10 years by regions. (Only the Philippines reported a slight increase in prevalence in subclinical indicators, as discussed in the next section.)

* Also the following unpublished studies:

Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Presented at a workshop on "Successful Micronutrient Programs" held at the International Union of Nutritional Sciences, Vienna, August 2001.

TABLE 3. Iodine-deficiency control Programs: types, timing, coverage, clinical indicators (total goiter rate)

A	B	C	D	E	F	G
Country	Intervention	Period of program legislation	Baseline goiter prevalence (year) ^a	Goiter prevalence during intervention (year)	Program coverage (year)	Percentage point change/yr (time period)
Bangladesh	Iodized salt (current)	1995–current	11.3% (1981) 47.1% (1993)	NA	70% (1999) 55% (2000)	Not available
Cambodia	No program outcome data available. Iodized salt coverage estimated as 14% in 2000					
China	Iodized salt (current); iodized oil capsules (2000); iodine containers in wells (1997)	1994–current (testing of iodized salt began in 1956, with iodized salt in some areas in 1966)	20.4% (1995)	9.6% (1997) 8.0% (1999)	76% (1995) 91% (1999)	-5.4 (1995–97) -3.1 (1995–99)
India	No program outcome data available. Iodized salt coverage estimated as 70% (1995–2000)					
Indonesia	Iodized salt (current); iodized oil capsules to schoolchildren and young married couples (1987–current)	1986–current	27.2% (1980)	9.8% (1996)	58% (1996) 65% (2000)	-1.1 (1980–96)
Laos	Iodized salt (current); iodized oil capsules (1990–93)	1995–current (universal salt iodization program initiated in 1994)	24.9% (1993, North) 14.9% (1993, South)	9.1% (2000, North) 11.5% (2000, South)	71% (2000)	-2.3 (1993–2000, North) -0.5 (1993–2000, South)
Myanmar	Iodized salt (current)	1998–current (pilot program for iodized salt began in 1969, with acceleration of iodized salt program in 1996)	33.1% (1994) 25.1% (1997)	12.2% (1999)	53% (1999)	-4.2 (1994–99) -6.5 (1997–99)
Philippines	Iodized salt (current); iodized oil capsules to women of childbearing age (1993–95)	1993–current	0.8% (1987, boys) 0.6% (1993, boys) 6.4% (1987, girls) 4.8% (1993, girls)	Only urinary iodine excretion data available postprogram initiation [15% (1992–96) 22% (1999) ^b	-0.03 (boys, 1987–93) -0.27 (girls, 1987–93)
South Africa	No program outcome data available. Iodized salt coverage estimated as 62% (1998)					
Sri Lanka	Iodized salt (current)	1993–current (program for iodized salt came into operation in 1995)	18.8% (1989)	21% (2000)	48% (1995) 87% (2000)	+0.2 (1989–2000)

Thailand	Iodized salt (current); targeted iodinated water (current); targeted iodized oil capsules to pregnant women, women of childbearing age, and schoolchildren (current)	1994–current (pilot projects for iodized salt began in 1965 with expansion into national program in 1968)	9.8% (1993)	7.9% (1994) 5.7% (1995) 4.3% (1996) 3.3% (1997) 2.6% (1998) 2.2% (1999)	50% (1992–96) 74% (1999)	-1.9 (1993–94) -2.1 (1993–95) -1.8 (1993–96) -1.6 (1993–97) -1.4 (1993–98) -1.3 (1993–99)
Vietnam	Iodized salt (current)	1999–current	27.1% (1993–95) 14.9% (1998 ^c)	10.1% (2000)	72.8% (1998) 86.4% (2000)	-3.1 (1994–2000) -2.8 (1998–2000)

a. Goiter prevalence reported for Myanmar is for visible goiter rate, whereas for all other countries indicator reported is total goiter rate

b. Data source is Mason et al. [38].

Source: refs. 27–37; Mason et al. [38]; global micronutrient survey [39]; UNICEF [40]; Also Aung P, Thein A (Ministry of Health, Myanmar), Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001. Vijayaghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001.

The decrease observed in clinical eye signs of vitamin A deficiency is, across project countries, in line with the trend demonstrated by a global assessment of trends in vitamin A deficiency (the prevalence of xerophthalmia, calculated by the sum of night-blindness and Bitot’s spots, was the indicator used for assessing trends in vitamin A deficiency [38]), which compared the results of repeated national surveys available from 8 countries with a total of 35 data points across time (13 national surveys and 22 subnational surveys, irrespective of intervention programs). The trend was estimated as -0.84 percentage point/10 years for South Asia and -0.18 percentage point/10 years for East Asia and the Pacific region; the global average was -0.43 percentage point/10 years [38, table 6]. The results available here from the country reports are thus generally in the same range as the previous estimates. (Add ref to table 3?)

Although the trend of observed improvement in clinical vitamin A deficiency is anticipated, the rate of change shown by project countries might be smaller than expected from the range of effect typically demonstrated by efficacy trials. A 1.6 to 4.7 percentage point decrease in the prevalence of xerophthalmia was demonstrated across efficacy studies at one year of follow-up. For night-blindness, the trials in Indonesia [8–11] showed a decrease of 0.87 percentage points over *one year* in the prevalence of night-blindness among the group supplemented with vitamin A, as compared with a decrease in the prevalence of night-blindness ranging from 0.17 to 1.76 percentage points per *10 years* for national vitamin A supplementation programs implemented. (The rate of change indicated by Cambodia is not included in the range stated here, as the values shown are extreme outliers and represent subnational estimates.)

Of the project countries having outcome data, Bangladesh shows a particularly strong decrease in the prevalence of vitamin A deficiency across time. The vitamin A-supplementation program appears likely to have contributed to this, with very high reported coverage. Vitamin A supplementation to children in Bangladesh began in 1973, but coverage at this time was not reported. The earliest data point that could be identified for the prevalence of night-blindness was 1982. At that time, 3.6% of children 6 to 59 months of age were reported to have clinical signs of night-blindness. A second data point for night-blindness was collected in 1999 and showed a prevalence of 0.6% for children 12 to 59 months of age. The rate of change is calculated as a decrease of 1.76 percentage points in prevalence per 10 years.

Bangladesh has achieved coverage of greater than 80% since the integration of supplementation with national immunization days. For the most recent year for which prevalence data are available (1999), coverage of 99% was reported. However, the full extent of the decrease in deficiency is probably related not solely to

supplementation, but also to the underlying decreasing trend in prevalence seen in other countries without programs (or with lower coverage).

In Cambodia, small-scale implementation of vitamin A supplementation began in 1993. In 1995, distribution of capsules through national immunization days was pilot tested in eight communes, and by 1996, capsule distribution was fully integrated with national immunization days. During years in which the vitamin A supplementation was integrated with national immunization days, high coverage rates were achieved. From 1995 to 1998, more than 95% of the target coverage was reached for every year, with the exception of the year 1997, for which coverage rates reaching 90% of the target were reported. The high prevalence reported at baseline, together with the high rate of coverage obtained by the program twice yearly, supports the reported dramatic improvement in prevalence of vitamin A deficiency (table 2).

More common across project countries is a decrease in prevalence of around 0.5 percentage points per 10 years. Countries such as Indonesia and Vietnam (for 1988–1994) show rates of decrease of about this order. Although each of these countries has a fairly high program coverage, these are not as high as those achieved in Cambodia and Bangladesh. Indonesia, for example, reported coverage for the supplementation program as 66%. In 2000, Vietnam reported a coverage of 77% for the vitamin A program. Nonparticipants are likely to be the most remote and vulnerable.

India and Myanmar also show rates of decrease in clinical signs of vitamin A deficiency similar to those achieved in Indonesia and Vietnam, although in both of these countries, Bitot's spots is the indicator reported. Although Myanmar has reported especially high rates of program coverage (> 90% prior to integration with national immunization days and 99% in January 2000, when supplement distribution was integrated with national immunization days), the supplementation program in India has not achieved coverage rates of this magnitude. Although national program coverage data are not available for India, it appears, for example, that there was no state in which more than 40% of children received one dose of vitamin A in 1997. Given the marked difference in coverage between these programs, it is therefore interesting that a similar rate of decrease in Bitot's spots is indicated for the two countries. The similarity in the decrease in prevalence, despite the differences in program coverage, may again suggest that not all of the decrease in prevalence is attributable to program impact, but that an underlying improving trend is also present.

An interpretation of the efficacy data could be that when vitamin A capsules are provided under supervision, clinical vitamin A deficiency essentially disappears, and thus the rate of improvement is less

important than the final prevalence. It is hard to judge with such low prevalences, but it seems plausible that clinical vitamin A deficiency was at significant levels in the baseline measurements (table 2, column E) and had reached lower levels, approaching zero, postintervention. What is less clear is how much of this was due to the underlying trend and how much to intervention. But given the combination of the high coverage data (fig. 1) and the known efficacy, at least in terms of clinical vitamin A deficiency, it seems plausible that, at a minimum, the vitamin A capsule programs hastened the improvement in clinical vitamin A status.

Impact of programs on biochemical indicators of vitamin A deficiency

The Philippines is the only project country for which the effectiveness of the national vitamin A-supplementation program can be assessed from biochemical data. In other countries for which two rounds of serum retinol data are available (China, Indonesia, South Africa, and Vietnam), the data are for subnational areas and, although useful for assessing program impact for those areas, do not provide a complete picture of the effectiveness of the national program. The national vitamin A-supplementation program consists of twice-yearly distribution to children one to five years of age. The program began in 1993 and was reported to reach high coverage (> 80%) by 1995 (when it was known as ASAP (Arawa ng Sangkap Pinoy, or national micronutrient day in Tagalog)). For children one to five years of age, the 1993 and 1998 data both showed a shift upwards in the distribution of serum retinol levels, when data from the no-dose group were compared with the pooled data from children one to six months after dosing. Thus, some program impact was apparent [32]. On the other hand, the estimated national prevalence of low serum retinol actually increased slightly, from 35% to 38%, over the period [41]. This presented a dilemma that required more complex analysis to unravel.

The data available come from the Food and Nutrition Research Institute, which implemented National Nutrition Surveys in 1993 and 1998, collecting serum retinol data [41]. Additional variables included the age and sex of the child, participation in the national supplementation program, the month when the vitamin A dose (200,000 IU) was received, the month of data collection, and child anthropometric measurements, as well as information on other health-related variables. Although the data were not originally intended for program evaluation, their availability provided an unusual opportunity to investigate the effectiveness of the vitamin A-supplementation program for children both marginally and severely affected by vitamin A deficiency. The results drawn on here include those presented at the International Union of Nutritional Sciences in 2001 [32] and the results of further analyses

presented at the International Vitamin A Consultative Group in 2003.*

Some key results are shown in figure 2. Improvement in the prevalence of low (< 20 µg/dl) serum retinol levels was evident for the first two months after dosing, as compared with those in the survey who (for whatever reason) did not get a vitamin A capsule dose, shown by the top two lines in figure 2. The data also showed an increase in the mean serum retinol level from 22 to 25 µg/dl one month after dosing (3 µg/dl, a 14% increase); this was the only significant difference. The improvements in the prevalence of low serum retinol were comparable to the results seen in efficacy trials at two months (lower line in fig. 2, from Perlas et al. [22]). However, from about two months after dosing, the prevalence levels nearly returned to either the predose or the nondosed levels. The effects of supplementation on increasing serum retinol appeared more transient in the national results than in the efficacy trial. One possible explanation is the difference in the prevalence of deficiency prior to supplementation. Seasonality effects were also evident.

The national Food and Nutrition Research Institute data thus suggest a smaller effect of supplementation on serum retinol levels than that expected from the efficacy trial [22]. The protective period following dosage appears to be shorter-lived, with most of the effect disappearing one to three months after supplementation. Additionally, analysis according to age group showed that children under one year of age had the highest prevalence of deficient serum retinol and the lowest mean value of serum retinol. This difference was greater in 1998 than in 1993. This suggests that the increasing numbers of babies with serum retinol deficiency meant that the supplementation program for children one to five years old had a rising tide to stem.

Overall, the vitamin A capsule program in the Philippines may be effective in preventing a recurrence of clinical vitamin A deficiency, which is said to have virtually disappeared; but it is not apparently affecting the overall prevalence of subclinical vitamin A deficiency measured by serum retinol. These results are uncommon, since very few surveys of serum retinol have been repeated. The one other case identified in Asia, from Orissa and Andhra Pradesh in India (E. Boy, personal communication, 2002), showed similar transient effects of vitamin A capsules on serum retinol: in Orissa a similar temporary fall in prevalence was observed one month after dosing, and in Andhra Pradesh there was no reduction.

* Madriaga JR, Pedro MRA, Barba CVC, Habito RCF, Deitchler M, Mason JB. The impact of the national vitamin A supplementation program on mean serum retinol and prevalence of subclinical vitamin A deficiency in Luzon, Visayas and Mindanao, Philippines. Poster presentation at International Vitamin A Consultative Group meeting, 2003.

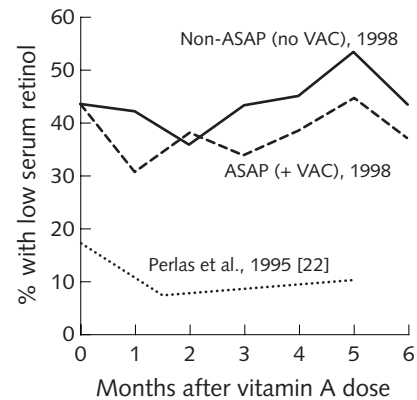


FIG. 2. Prevalence rates of low serum retinol (< 20 µg/dl), according to month after dose of vitamin A (200,000 IU), from the 1995 efficacy trial and the 1998 national ASAP (Arawa ng Sangkap Pinoy; National Micronutrient Day) program in the Philippines, with and without dose [22, 32].

Conclusions

The only data presented that allowed any comparison between groups receiving and not receiving vitamin A capsules were those from the Philippines on subclinical vitamin A deficiency. The clinical data from all other countries were obtained before and during supplementation, with no comparison group, so evaluation conclusions are tentative.

The clinical data showed that, in the most recent measurements, eye signs of vitamin A deficiency (night-blindness and Bitot's spots) were reaching very low prevalences of 0.1% to 0.7% (average, 0.6%), as compared with 0.4% to 5.6% (average, 1.8%) presupplementation (table 3, columns E and F). We do not know whether there is an underlying trend toward a decrease in clinical vitamin A deficiency, which has been observed both prior to and during the supplementation programs in other studies [3, 23]. The question is: What values would the clinical vitamin A deficiency prevalences have reached without supplementation?

Since coverage of vitamin A capsules was consistently reported as above at least 60%, it is clear that supplementation was successfully launched and sustained, even if some vulnerable groups remained to be reached. The efficacy data show that when vitamin A capsules are provided, usually twice yearly (under some supervision in trials), clinical vitamin A deficiency is almost abolished. Therefore it is reasonable on this basis to ascribe the very low levels of clinical vitamin A deficiency now observed in these countries at least in part to the vitamin A capsule programs. On balance, vitamin A capsule supplementation can plausibly be credited with helping in the near-elimination of clinical vitamin A deficiency in these countries; but no doubt pockets of clinical deficiency persist.

The efficacy of vitamin A capsule distribution in raising serum retinol levels appears more variable

(table 1). In the one case in which effectiveness could be studied in large-scale programs, in the Philippines, the effect of six-monthly doses of 200,000 IU of vitamin A to children one to five years of age at one to two months after the dose was modest, amounting to an increase in serum retinol of about 3 µg/dl (about 15%) and a reduction of 5 to 10 percentage points in the prevalence of serum retinol values below 20 µg/dl, from a prevalence of around 40% (fig. 2). The effect persisted for around one to three months, after which the serum retinol returned to predose levels. This means that over several rounds of repeated six-monthly doses, no established downward trend is to be expected, but rather fluctuations returning to predose levels each time. This is in line with the findings of an actual small *increase* in the prevalence over the period of program implementation [41].

It is uncertain whether the reduction of clinical and subclinical vitamin A deficiency resulting from the use of vitamin A capsules will be paralleled by a reduction in mortality, although the prevention of subclinical deficiency has been invoked as a mechanism for reducing mortality [15]. These results raise a question as to whether more frequent dosing (or another adaptation, such as targeting) would be advisable to ensure the intended impact on mortality (which has not been monitored). Modifications that could be considered include:

- » Giving top priority to supplementation to the mother shortly after delivery, and promoting breastfeeding;
- » Providing the supplement every three or four months to children one to five years of age;
- » Reexamining whether children 6 to 12 months of age can be supplemented, directly or through blended food or sprinkles;
- » Timing the mass supplementation program carefully in the light of seasonal effects;
- » Providing other supplements.

Iodine

What is known from efficacy trials

The efficacy of iodine interventions (by lipiodol injection, oral supplement, or iodized salt) for the prevention of deficiency has well established by the results of numerous controlled trials [42–53]. In these, iodine has been shown to prevent the various health consequences of iodine deficiency by a reduction in the frequency of irreversible outcomes and/or by an improvement among those populations having reversible consequences. The range of impact observed varies, in part, with the severity of deficiency among the population. In those areas with endemic and more severe levels of iodine deficiency, provision of iodine would be expected to have a greater benefit in both

efficacy trials and large-scale programs. In most cases, goiter prevalence has been a key indicator, and there is no doubt that iodine is efficacious in reducing the goiter prevalence in iodine-deficient populations.

However, the rate at which goiter—as the usual measure of iodine-deficiency disorders—is expected to decline with an effective salt iodization program is less well known. The World Health Organization (WHO) has established criteria for assessing the severity of the problem of iodine-deficiency disorders and monitoring progress [54]. A goiter prevalence of less than 5% would be regarded as indicating the absence of an iodine-deficiency disorder problem, and clearly this is the eventual goal. What is unsure is the rate at which this can be expected to be achieved by universal salt iodization.

Methods applied to country-level evaluation data

Clinical and biochemical data on iodine deficiency, along with data on program coverage, have been compiled for the 12 project countries (tables 3 and 4). As for vitamin A, iodine-deficiency data were selected to measure baseline and during-intervention prevalence, as best as possible. For these purposes, the year of adoption of iodized salt legislation was selected to mark the time of program initiation, although some countries already had efforts for iodized salt or other iodine-supplementation intervention efforts under way prior to program legislation. Although the year of adoption of legislation of iodized salt was fairly recent for countries such as Myanmar (1998), China (1994), Thailand (1994), and Vietnam (1999), all of these countries have had relatively longstanding efforts devoted to the control of iodine-deficiency disorders. Thailand, for example, launched its first pilot project on salt iodization in 1965, and Myanmar launched its first pilot program for the control of iodine-deficiency disorders (by means of iodized salt) in 1969. In China, iodized salt was tested at selected sites from 1956 onward. In addition, in Sinjiang, China, over 700,000 injections of iodized oil were provided between 1978 and 1981, and an additional 300,000 to 400,000 injections were provided in 1982 [1]. In the case of Vietnam, the date of initiation of iodized salt implementation could not be identified. However, it is clear from the coverage rates reported (table 2, column G, and table 3, column F) that large efforts for iodized salt were already under way before legislation was adopted.

For the prevalence data, goiter detected by palpation was the indicator used in almost all cases. Only for Bangladesh, China, Laos, and Vietnam were repeat surveys of urinary iodine excretion also available. Coverage data for iodized salt programs were available for nearly all countries and were used for the year of “during-intervention” outcome data whenever possible. In most cases, the coverage data reported reflect the

percentage of households using adequately iodized salt (as established by individual country standards for the iodine content of salt, usually > 15 ppm); the coverage data in tables 3 and 4 were shown graphically in the second paper in this series [55].

The rate of change in prevalence in percentage points per year was derived as follows:

$$\frac{\text{follow up prevalence} - \text{baseline prevalence}}{\text{follow up year} - \text{baseline year}}$$

Although the rate of change in prevalence (tables 3 and 4, column G) provides useful information about iodized salt programs at the country level, some caution should be taken before drawing conclusions about the impact of programs. First, as for other interventions, generally only data obtained before and during the intervention are available, without negative comparison groups.

Second, in most countries, only goiter rates are available (with the exception of Bangladesh, Laos, and Vietnam, in which urinary iodine is used also; China also has multiple rounds of urinary iodine excretion data available, but only data on median urinary iodine excretion values could be identified). Goiter has some drawbacks in terms of responsiveness to intervention and is a less preferred method of assessment of population iodine status [53, 56]. Moreover, assessment of goiter by palpation is regarded as a subjective means of assessing iodine deficiency. Low interobserver reliability is known to affect the results of goiter surveys, and the extent to which goiter is detected can be largely related to the level of training provided to the enumerators. An increase in goiter prevalence across time therefore may not reflect an actual trend in prevalence, but rather may be a consequence of improved training and more skilled detection of the manifestation of goiter.

The results of a recent national micronutrient survey in Nepal, in which palpation was compared with ultrasound of a subsample, highlight the questionable reliability of assessing goiter by palpation as a method of identifying iodine-deficient individuals [57]. The survey showed assessments of goiter by palpation and by ultrasound to be poorly correlated: for example, palpation showed a goiter prevalence of 57% and ultrasound a prevalence of 23% (although the cutoffs may not have been fully comparable).

Prevalence data from Bangladesh also illustrate the potential inconsistency in measurements of goiter by palpation. The increase in goiter prevalence rates reported for Bangladesh from 1981 (11.3%) to 1993 (47.1%) seems implausible. In this case, biochemical data are also available for trend assessment (see table 4), which seem to give more likely results, with an improving trend from 69% (urinary iodine < 10 µg/dl) in 1993 to 43% in 1999.

TABLE 4. Iodine-deficiency control programs: types, timing, coverage, and biochemical indicators (urinary iodine excretion)

A	B	C	D	E	F	G
Country ^a	Intervention	Period of program legislation	Baseline prevalence of subclinical iodine deficiency ^b (year)	Prevalence of subclinical iodine deficiency during intervention	Program coverage (year)	Percentage point change/yr (time period)
Bangladesh	Iodized salt (current)	1995–current	68.9% (1993)	43% (1999)	70% (1999) 55% (2000)	-4.3 (1993–99)
Laos	Iodized salt (current); iodized oil capsules (1990–1993)	1995–current (universal salt iodization program initiated in 1994)	95% (1993)	26.9% (2000)	75.4% (2000)	-9.7 (1993–2000)
Vietnam	Iodized salt (current)	1999–current	84% (1993–95) 32.9% (1998)	31.2% (2000)	72.8% (1998) 86.4% (2000)	-12.8 (1993–95 to 1998) -0.9 (1998–2000)

a. China also has multiple rounds of urinary iodine excretion data available; however, only data on median urinary iodine excretion values could be identified.

b. Subclinical iodine deficiency is defined as urinary iodine < 10 µg/dl.

Source: ref. 29.

Evaluation findings

Impact of programs on clinical indicators of iodine deficiency

Given the established efficacy of salt iodization, a rapid improvement in the prevalence of iodine deficiency would be expected for those iodized salt programs successfully implemented at the country level. In a global review of progress in the control of micronutrient deficiencies [38], we observed substantial declines in the prevalence of iodine deficiency in several countries that had achieved improved rates of household utilization of iodized salt over the same time period. Bolivia, Peru, and Cameroon, for example, all demonstrated a rapid improvement in goiter prevalence, with wider consumption of iodized salt reported. Across the three countries, the rates of change were calculated to range from a 2.0 to 5.5 percentage point improvement in goiter prevalence per year of program implementation; the average for seven countries with time-series data showing improvement was 2.3 percentage points per year. The rates of change, as shown in column G of table 3, are generally in this range for countries with widespread and sustained iodized salt coverage.

The estimated rates of improvement in goiter prevalence vary from a decrease of 0.5 percentage point per year (Southern region of Laos) to a decrease of 6.5 percentage points per year (Myanmar) from national data. Vietnam, China, and Myanmar show the greatest impact. The rate of change for each of these countries is estimated as greater than a 2.5 percentage point decrease in goiter per year. Although both China and Vietnam showed rates of program coverage reaching around 90% (86.4% for Vietnam in 2000 and 91% for China in 1999), Myanmar reported a somewhat low rate of program coverage, with only 53% of households reported to have adequately iodized salt (> 15 ppm) in 1999. The rapid improvement in prevalence in Vietnam and China can therefore probably be explained by the wide program coverage achieved. Although the coverage rate reported for the iodized salt program in Myanmar seems somewhat low, the rapidly decreasing trend in prevalence for Myanmar could be attributed to complementary efforts that Myanmar has implemented for the control of iodine deficiency; these include control of iodine deficiency among schoolchildren by the use of iodinated drinking water.*

Sri Lanka is the only country reporting a possible increase in the prevalence of goiter since the adoption of legislation for iodized salt, from 18.8% in 1989 to 21% in 2000. Legislation for iodized salt was adopted in 1993, and the program for iodized salt came into effect in 1995. The rate of change of goiter prevalence

is calculated as a slight increase of 0.2 percentage point per year. This can be attributed to several possible factors. As discussed earlier, increased effort on the part of enumerators to identify goiter is a possible explanation for the finding. In addition, Sri Lanka has relatively low program coverage; less than 50% of households in Sri Lanka are reported to use iodized salt [35]. Further, among those households consuming iodized salt, Sri Lanka, more than many project countries, reports difficulties with the quality of iodized salt. Although the minimum iodine content for salt is established by legislation, lack of strict quality-control measures has caused the iodine content of the salt available to vary over a wide range. A survey in 2000 was reported to give the iodine content of salt available in markets as varying from 5.3 to 418 ppm.

Impact of programs on biochemical indicators of iodine deficiency

Trends in urinary iodine excretion can be estimated from survey results in Bangladesh, Laos, and Vietnam (table 4). China has biochemical urinary iodine excretion data, but only median values of were reported, preventing calculation of changes in prevalence. In addition to the urinary iodine data, each of these countries also has multiple rounds of national goiter data available.

In Bangladesh, data on goiter are available for 1981 and 1993, and on urinary iodine for 1993 and 1999. Legislation for iodized salt was adopted in 1995, although production of iodized salt had been initiated earlier. As mentioned before, the changes in goiter rate are considered implausible. The urinary iodine excretion data suggest marked improvements in iodine deficiency since legislation for iodized salt was adopted. The 1993 survey showed 68.9% of the population to have urinary iodine levels below 10 µg/dl, falling to 43% in 1999. Over the same time period, coverage of iodized salt increased from 20% in 1994 to 70% in 1999. It seems highly plausible that the salt iodization led to the decrease in low urinary iodine excretion and the improvement in iodine status.

The data available for Laos and Vietnam further suggest that impact was achieved with a successfully implemented iodized salt program. In Laos, there are seven major salt manufacturers and many small-scale producers. The primary salt manufacturers have the capacity to produce 90% of the salt required for the country, making importation of noniodized salt less of a problem than in other project countries. The program is well coordinated among ministerial sectors and international organizations, includes information, education, and communication (IEC) activities as important program components, and implements routine monitoring to ensure the quality of iodized salt at the household level. Moreover, all data available for the program indicate high program coverage.

* Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

Repeat data from two districts reported household utilization of iodized salt as 72% in 1996 and 96% in 1997–98. National program coverage for 2000 showed 94.3% of households to use iodized salt; 75.4% of these households had adequately iodized salt (> 15 ppm) when tested.

Data from Laos show a substantial decrease in the prevalence of iodine deficiency, as indicated by both goiter and urinary iodine data. In 1988, the baseline goiter prevalence was 25%; in 1993, it was 24.9% in the North and 14.9% in the South. The prevalence of urinary iodine less than 10 µg/dl in 1993 was 95%. The second round of national iodine-deficiency data was collected in 2000, five years after legislation for iodized salt had been adopted. The 2000 data showed goiter rates down to 9.1% in the North and 11.5% in the South; urinary iodine data indicated a marked improvement in the iodine status of the population, with 26.9% having urinary iodine less than 10 µg/dl. Iodized salt coverage for 2000 was reported as 75.4%.

In Vietnam, a high coverage of iodized salt was again related to an improving trend in iodine deficiency by both biochemical and clinical indicators. The most dramatic improvement appears to have occurred upon the first efforts to iodize salt widely. Two periods were assessed: from 1993–5 to 1998, then 1998 to 2000. Goiter prevalence decreased from 27% to 15%, then 15% to 10% over this time. The prevalence of suboptimal urinary iodine excretion (< 10 µg/dl) decreased from 84% to 33%, then 33% to 31%. The rate of iodized salt coverage in 1998 was already high compared to that achieved by other countries: for 1998 it was reported as 72.8%, increasing to 86.4% in 2000.

Conclusions

From the country case studies and data available, it would seem that marked improvement in iodine deficiency occurs with programs that are well implemented. However, there are still examples of countries in which programs are not yet demonstrating a rapid improvement in signs of goiter, such as the Philippines, and no doubt some underserved areas in other countries are lagging. But overall, iodized salt is a resounding success story, bringing improved health and nutrition to millions of people

The rate at which goiter prevalence is reduced can be as high as 5 percentage points per year; the improvement seems fairly steady where repeated data are seen (e.g., Myanmar and Thailand), and the scarcer urinary iodine data support this. By the time iodized salt distribution reaches and remains at high coverage, goiter rates usually reach prevalences of 10% or less; but it may be that the last few percent reduction is indeed turning out harder to achieve.

Problems remain with coverage and quality control of iodized salt and the outreach to remoter and (usually) poorer areas.

Certain implications emerge for future monitoring and evaluation. Salt iodization is so easy to test, and so widely used, that it succeeds in giving a key indicator. Goiter prevalences are perhaps better than expected as a general measure in terms of responsiveness, and they have the important advantage of being widely available for baseline (or early in implementation) reference. They are, however, clearly very inaccurately assessed, and this needs to be improved either with better technology (e.g., ultrasound) or more standardized training. Measurement of urinary iodine is not as widely available and also has the drawback that it assesses current intake; in this respect, the value that it adds to salt iodine testing may not be so great.

None of these tests measure the functional consequences of the deficiency; goiter itself can be innocuous. This argues for wider application of testing for thyrotropin in newborns (usually performed on cord blood, for which rapid immunoassay methods are now available). Perhaps more stress should be on this approach, complementing salt iodine testing.

Finally, in countries with low program coverage, there are likely to be large pockets of individuals particularly vulnerable to iodine-deficiency disorders. Because of the serious risk to damage in utero, in some instances complementary measures for the control of iodine-deficiency disorders may need to be considered until higher program coverage of iodized salt can be achieved. Targeting women of childbearing age or pregnant women with oral iodine supplementation, either as a single large dose of iodized oil, or in multiple micronutrient supplements provided as part of antenatal care, may be warranted in places where iodized salt may not yet be readily available or utilized.

Iron

What is known from efficacy trials

The results from a number of recent iron-supplementation trials were compiled by Beaton and McCabe [58], in which data from eight controlled trials providing iron supplementation to pregnant women were reanalyzed to study the efficacy of weekly vs. daily supplementation. For all of the trials, there were two treatment groups: one receiving weekly and one receiving daily iron tablet supplementation (except for the trial in China, which had a third study group that received a higher dose of iron). The results of the studies (table 5) are interesting here for consideration of the possible sizes of effects with supervised iron supplementation.

In all eight studies, daily iron supplementation to pregnant women resulted in an improvement in anemia prevalence from baseline to post-intervention. The extent of the impact demonstrated varied widely

TABLE 5. Effects of iron supplementation on anemia in pregnant women

Location of study	Target group	Anemia criterion (blood hemoglobin concentration in g/L)	Dosing schedule	<i>n</i>	Baseline prevalence (%)	Final prevalence (%)
Korea	Pregnant women	110	Weekly	13	38.5	15.4
			Daily	10	70.0	10.0
Malawi	Pregnant women	100	Weekly	102	63.7	62.7
			Daily	112	62.5	51.7
Maluku	Pregnant women	110	Weekly	199	25.6	24.1
			Daily	200	29.5	15.0
Bangladesh	Pregnant women	110	Weekly	74	50.0	20.0
			Daily	66	42.0	14
China	Pregnant women	110	Weekly	117	41.0	18.0
			Daily	64	39.0	22.0
			Daily, high-dose	56	45.0	28.0
Guatemala	Pregnant women	110	Weekly	54	27.0	24.7
			Daily	54	27.0	16.1
Mexico	Pregnant women	120	Weekly	39	10.3	20.5
			Daily	36	22.2	2.8
West Java	Pregnant women	110	Weekly	71	76.1	56.3
			Daily	68	66.1	45.6

Source: reprinted from Beaton and McCabe [58], p. 52.

across studies. The decrease in anemia prevalence from baseline to follow-up ranged from 10.8 percentage points (Malawi) to 60 percentage points (Korea). The criterion of anemia in all studies on pregnant women was defined as hemoglobin 110 g/L, with exception of the study in Mexico, which used 120 g/L as the criterion. The 60 percentage point improvement in anemia observed in Korea was exceptional; no other study included in the review showed an improvement in anemia prevalence by more than 30 percentage points. In general, the more controlled studies showed a higher rate of improvement in anemia from baseline to post-intervention. The trials conducted in Maluku, China, and Mexico, for example, were all tightly controlled; high compliance for the regimented dosing schedule among the participants would therefore be expected. In the case of the Malawi study, very few controls were implemented in the study design, and likewise, the difference in anemia prevalence from baseline to follow-up was the lowest (10.8 percentage points) for all the intervention trials reviewed. A consistent pattern of improvement in anemia was clearly observed in all studies for those groups provided with iron supplementation. Among the groups treated with daily supplementation, the median and mean decreases in anemia prevalence were 17 and 19.7 percentage points (excluding Korea, with a mean 60 percentage point decrease, regarded as an outlier).

From these and many earlier studies (reviewed extensively by Viteri [59]), substantial improvement in anemia prevalence is expected from daily (or weekly)

ingestion of iron supplements by pregnant women, and probably greater improvement from ingestion of iron supplements by nonpregnant women. In theory, similar decreases could be achieved from a wide-scale program, although it is likely that under less controlled conditions a slower rate of improvement would be seen, even for those programs generally successfully implemented. In fact, much less is known about the extent to which large-scale iron-supplementation programs demonstrate effectiveness. Among countries, lack of data and limited capacity for program monitoring often preclude drawing firm conclusions about the effectiveness of iron-supplementation programs. In many cases, prevalence data cannot be linked to programs implemented, and it is often difficult to assess program participation. In countries located in subtropical areas, there are complications in assessing the prevalence of anemia caused by iron deficiency. Recent analysis of anemia data concluded that there was little evidence for overall change in the populations of developing countries, although direct trend estimates from surveys are very scarce [38, 60].

Iron-supplementation programs have the added problem of monitoring tablet compliance among program participants. Because these programs are designed to provide regular supplementation (usually daily) to women throughout pregnancy, the extent of the impact achieved would be expected to be related, in part, to the number of tablets a woman takes during pregnancy. There is, however, no easy or routine way to monitor daily consumption of iron tablets by pregnant

women participating in a program of national scale.

Of the project countries, Vietnam and Thailand have the most comprehensive data on iron-supplementation programs. Although several other project countries have at least two rounds of anemia data available, the prevalence data cannot usually be linked to the programs implemented. Lack of process data and of knowledge of the underlying trends limits the possibility for evaluation analysis across countries. Even in the case of Thailand and Vietnam, complete data are not available. Given, however, that both countries have some process data available, various sources of data on anemia prevalence, and some information on program coverage, an assessment of program effectiveness for these countries has therefore been undertaken. The preliminary findings for each of these countries are discussed below.

Evaluation findings

Assessment of program effectiveness in Thailand

In Thailand, the main strategy implemented for the control of anemia among pregnant women is daily supplementation with iron/folate tablets [36]. The policy for supplementation recommends that pregnant women be provided with iron tablets from their first appearance at the antenatal clinic through four to six weeks postpartum. The main mechanism for program delivery is through the health-care system, with community health workers (village health communicators and village health volunteers) playing an important role in encouraging pregnant women to visit health centers for antenatal care and prophylactic iron supplementation. Although limited attention has so far been given to assessing the effectiveness of the iron-

supplementation program, data on anemia and access to health services are available from various sources and can provide useful information about program effectiveness. Data on the prevalence of anemia are available from nationally representative surveys (1986 and 1996–97) and from surveillance data collected at health centers. However, the data available do have limitations for assessing program effectiveness. It is possible, for example, that the sampling design of the surveys may have influenced by an over- or underestimation of the prevalence reported for anemia. For the national survey, the hemoglobin of pregnant women was measured in sampled households, which were defined by the presence of children under five years of age; in the case of surveillance data, hemoglobin was measured in areas with more sophisticated health services available, therefore probably resulting in an underestimation of the prevalence of anemia. In addition, none of the anemia prevalence available data could be disaggregated by gestational age. It is therefore unclear how accurately the prevalences reported reflect the extent of the problem.

Data on coverage of antenatal care are also available, but limited. Due to inadequate capacity for monitoring of program coverage, a proxy indicator of antenatal-care coverage is used, defined as the number of antenatal-care visits made during pregnancy, with four or more visits throughout pregnancy recommended as optimal. Using antenatal visits as a proxy for program coverage assumes, however, universal supplementation to all women receiving antenatal care during pregnancy and, therefore, could to some extent result in an overestimation of coverage achieved.

An improving trend in prevalence among pregnant women is evident from the available data (table 6). The

TABLE 6. Time-series data on anemia prevalence among pregnant women

Country	Iron-supplementation program implemented	% Prevalence of anemia (year)		Percentage point change in prevalence
		Time 1	Time 2	
Bangladesh	Iron/folate tablets to pregnant women twice daily and through 1st 6 mo of lactation	77 (1981)	49.2 (1997)	-27.8
Indonesia	Iron, folate, sugar, and vitamin C tablets to pregnant women	50.1 (1991)	50.9 (2000–01)	+0.8
Myanmar	Iron/folate tablets to pregnant women twice daily during 3rd trimester	58.1 (1993)	58.0 (1995)	-0.1
Philippines	Iron/folate tablets to pregnant women	43.6 (1993)	50.7 (1998)	+7.1
Thailand	Iron/folate tablets to pregnant women	27 (1988) ^a NE: 39 (1986) ^b SE: 48 (1986) ^b	17 (1999) ^a NE: 27 (1996–97) ^b SE: 13 (1996–97) ^b	-10 -12 -33
Vietnam	Iron/folate tablets to pregnant women	53 (1995)	32 (2000)	-21

a. Data from national nutritional surveillance system.

b. Data from national surveys, with illustrative results by region (NE, Northeast; SE, Southeast) shown.

Source: refs. [27,30, 36, 41 and Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001.

two most recent national surveys (1986 and 1996–97), for example, show a decline in the prevalence of anemia among pregnant women.

Over the period of 10 years, a substantial and important decline in anemia prevalence was estimated for each region. Anemia prevalence among pregnant women in the Central/East, North, Northeast, and Southern regions of the country declined from 32% to 12%, 42% to 8%, 39% to 27%, and 48% to 13%, respectively. Other data support the conclusion of a decrease in prevalence indicated by the national data. Surveillance data show a decline of about 10 percentage points, from 27 percent to 17 percent, between 1988 and 1999. In addition, small research studies have shown that the severity of anemia among pregnant women has also declined. Moreover, an improving trend in attendance at antenatal clinics is also evident over time, with a high rate of antenatal coverage achieved in recent years. It is reasonable to suggest, although this is not proven, that part of the improvement may indeed be due to the iron-supplementation program.

The trend in anemia prevalence can be determined from data available on other demographic groups. Data on anemia prevalence among men and young children should indicate the underlying trend in anemia status, since no programs for these groups are yet implemented in Thailand. For men, two rounds of Health Examination Surveys (1991 and 1996–97) are available. For each region, the prevalence of anemia decreased across time; for two of the five regions, the decrease was substantial, amounting, for example to 20 percentage points in the Center East region. The decreases for these groups (not targeted for iron supplementation) are in the same range as those for pregnant women. This casts some doubt on the effect achieved by the iron-supplementation program alone.

Assessment of program effectiveness in Vietnam

As in Thailand, the main strategy for the control of iron-deficiency anemia in Vietnam is providing daily iron tablet supplementation to pregnant women [37]. The program for iron supplementation was implemented in 15% to 20% of the country in 1995 to 2000. Programs for weekly supplementation to groups such as children and adolescents 6 to 15 years old, non-pregnant women 15 to 35 years old, and infants and children are also implemented in selected areas, but these interventions are still in the pilot testing phase. The protocol for the iron-supplementation program recommends daily iron tablets to be taken by pregnant women from first presentation at the antenatal clinic to one month after delivery. Although the capacity for program monitoring and supervision is reported to be limited, some data are available for crude assessment of the extent of the impact that may have been so far achieved.

Nationally representative data on anemia prevalence

are available from a 1995 national anemia and nutrition risk survey and a national survey launched in 2000. As seen in Thailand, a strong improving trend in anemia prevalence is observed among pregnant women. In Vietnam, anemia prevalence rates of 52.7% and 32.2% were reported for pregnant women for the years 1995 and 2000, respectively, a 20.5 percentage point decrease in five years. Although other demographic groups also show a decrease in anemia prevalence across years, in this case for no other groups is the decrease as substantial. For nonpregnant women, children 0 to 60 months of age, and men, the respective decreases in anemia prevalence from 1995 to 2000 were reported to be 15.9, 11.2, and 6.3 percentage points. From this perspective, the more substantial decrease in anemia among those groups for which supplementation programs are implemented might indicate some program impact. Unfortunately, the program coverage data do not support this conclusion. From 1995 to 2000, a substantial decrease in program coverage was observed. Whereas 425,000 women were targeted for iron supplementation in 1995, less than 10% of that number (40,000) was targeted in 1996. Likewise, the number of provinces, districts, and communes to benefit from the program showed a pattern of similar decline between the years 1995, 1996, and 2000.

The conclusion for Vietnam (as for Thailand) has therefore to be that the decrease in anemia was probably real, but without better evaluation it is not possible to ascribe this to the supplementation program. Certainly part was due to a nonprogrammatic underlying trend.

Results from other countries

The limitations of the data available for evaluation of the iron-supplementation program in Thailand and Vietnam are common to most countries with national programs. In fact, other countries with programs for iron supplementation to pregnant women often have substantially fewer data available for assessment of program effectiveness. Of the project countries, Bangladesh, Myanmar, Indonesia, and the Philippines have data on anemia among pregnant women available for recent years (table 6), but few other data on the program.

Bangladesh shows a substantial decrease in anemia prevalence; an improvement of more than 27 percentage points among pregnant women, from 77% to 49%, was reported from 1981 to 1997. In Myanmar, Indonesia, and the Philippines, on the other hand, the rate of anemia among pregnant women appeared stagnant across time, despite implementation of national iron-supplementation programs. In Myanmar the rate of anemia remained at about 58% from 1993 to 1995; in Indonesia it remained at roughly 50% from 1991 to 2001; and in the Philippines it increased from 43.6% in 1993 to 50.7% in 1998. The lack of improvement

probably stems from difficulties common to program implementation, as well as lack of change in the underlying prevalence of anemia.

Conclusions

The rate of improvement demonstrated by the efficacy studies compiled for the Beaton and McCabe [58] review thus appear larger than those seen at the program level, even when some improving trends are seen (as in Bangladesh, Thailand, and Vietnam). Improvements of the magnitude of 20 percentage points are rarely observed, and in those cases when such change across time is indicated, the effect can rarely be confidently attributed to program intervention. The lack of firm conclusions that can be drawn about program effectiveness highlights the importance of increased efforts to improve capacity for program monitoring and evaluation. Comparable surveys on anemia prevalence among supplemented groups in program and nonprogram areas, and data on program coverage across time and use of antenatal services, are essential for strong conclusions to be made about the effectiveness of programs. Information about the time of gestation on the date of blood collection and about tablet compliance would further help to elucidate the extent to which iron-supplementation programs are benefiting targeted populations, although such data are more difficult to obtain.

Summary of lessons learned on micronutrient-deficiency control program effectiveness and associated recommendations

Program evaluation

Micronutrient-deficiency control programs have been greatly extended at the national level in the last 10 to 15 years. However, rigorous evaluation of these is scarce, so that conclusions on impact are tentative and based mainly on indirect evidence.

The effects of programs need to be distinguished from underlying trends of improvement in population nutritional status. This underlying improvement is probably occurring for clinical vitamin A deficiency, but probably not for iodine and iron deficiencies (i.e., in the absence of intervention). Nonetheless (see below), taking account of this, it is plausible that twice-yearly distribution of vitamin A capsules, which has attained high coverage in most of the countries studied, has contributed to the near-elimination of clinical vitamin A deficiency in children, and that the use of iodized salt has brought goiter rates steadily down in the general population. For anemia, however, where significant improvement over time is seen (which is uncommon but may be occurring in Bangladesh, Thai-

land, and Vietnam), the existing information is insufficient to allow the trend to be ascribed to intervention, and there is evidence of improving trends in Thailand and Vietnam that are not due to iron programs. For all deficiencies systematic prospective evaluation is urgently needed.

Intervention efficacy

Efficacy trials have demonstrated that high-dose vitamin A supplementation of children results in significant reductions in the prevalence of clinical vitamin A deficiency.

Studies in India, Indonesia, the Philippines, and elsewhere have demonstrated that vitamin A supplementation is effective for the prevention and treatment of xerophthalmia: twice-yearly supplementation has resulted in a reduction of clinical vitamin A deficiency to nearly zero (down by 1 to 5 percentage points). The results for subclinical vitamin A deficiency are uncommon; and those available give equivocal results.

Many trials have demonstrated the efficacy of iodine supplementation in reducing the prevalence of goiter and other signs of iodine-deficiency disorders and improving population iodine status.

Mechanisms of supplementation tested include lipidol injections, oral iodized oil supplementation, and iodization of salt. The results of the studies indicate efficacy for the prevention of cretinism, improvement of psychomotor skills and cognitive development, and prevention and treatment of goiter. Study countries in Asia include China, India, Indonesia, and Papua New Guinea.

Trials have demonstrated the efficacy of iron tablet supplementation in reducing anemia prevalence.

The mean reduction of anemia prevalence was roughly 20 percentage points with daily supplementation. The study countries included Indonesia, Malawi, China, and Korea. The magnitude of improvement appears to be associated with the extent of supervision of adherence to dosing regimes in the studies, indicating that efficacy is linked to the degree of participant compliance with the dosing regime.

Coverage of national programs

The coverage of vitamin A capsule distribution programs has exceeded 70% in most study countries (Bangladesh, Myanmar, Philippines, Vietnam, and Laos).

Only India (40%), Indonesia (66%), and Cambodia (63%) were estimated to have lower rates of coverage of vitamin A capsules. The utilization of national immunization days as the foundation for campaign-style programs accounts to a significant degree for the high coverage rates achieved. Coverage estimates derive in large part from program-monitoring data.

In countries implementing national iodized salt programs, the coverage reaches 60% to 90% of households with adequately iodized salt.

Quality control, maintaining coverage, and further measures to reach underserved populations should become the current priorities. Coverage estimates are normally based on testing for the level of salt iodization in households in sample surveys.

Of the three micronutrients, coverage of iron tablet supplementation is the least well documented due to inadequate program-monitoring systems, lack of population survey data, and lack of accurate estimates of adherence to the dosing regimen.

Only two countries have reasonable monitoring systems. Vietnam indicates a coverage level of 15% to 20% of the country, and coverage is reported to be quite high in Thailand based upon estimates of antenatal-care attendance.

National program effectiveness

Vitamin A capsule supplementation of children 6 to 59 months of age has plausibly contributed to the reduction in clinical vitamin A deficiency and its near-elimination in many countries (fig. 3).

The national rate of decline in measured night-blindness in project countries in Asia ranges from -0.15 percentage point per 10 years (Vietnam) to -1.76 percentage points per 10 years (Bangladesh). Although the level of impact appears to be less than in controlled trials, it is in the range of 0.5 percentage point per 10 years. This rate depends on contextual and program factors such as high baseline prevalence and high program coverage. Both of these factors may account for the exceptionally high impact seen in Cambodia (-7.7 percentage points per 10 years) and Bangladesh (-1.76 percentage points per 10 years). Most countries have multiple programs implemented (see the previous article in this issue on Implementation), so the synergistic effects of multiple intervention strategies (combined with the usage of national immunization days as the mechanism for delivery of vitamin A capsule) may account in part for the impact seen.

The impact of vitamin A capsule supplementation on children's biochemical vitamin A status (serum retinol) in national programs may be lower than the impact on clinical vitamin A deficiency.

Limited research from national programs in the Philippines indicates that the impact of supplementation on serum retinol levels is of shorter duration than the impact on clinical signs of deficiency. This would in part explain the slight increase in subclinical vitamin A deficiency in the Philippines during implementation of vitamin A capsule programs. The collection of biochemical and clinical data in the same subjects

would contribute to the clarification of the nature and extent of impact to be expected from supplementation. Additionally, more research is needed to evaluate the relative benefits of alternative dosing regimens (e.g., two times vs. three times a year).

National data on salt iodization show a consistent reduction in the prevalence of iodine-deficiency disorder symptoms (e.g., prevention and treatment of goiter); the rates of cretinism and other results of iodine deficiency are almost certainly falling too (fig. 4).

At the population level, the most common mechanism for providing iodine is salt iodization. This has largely superseded the use of iodized oil, given orally or by injection. The data for study countries indicate a steadily improving trend in the prevalence of clinical iodine-deficiency disorders, consistent with a dramatic global trend of decreased prevalence of iodine-deficiency disorders with the implementation of national salt iodization programs (reductions in goiter prevalence of 20 to 54.5 percentage points per 10 years). There is enormous variation in the improvement in the prevalence of iodine-deficiency disorders among study countries, from 0.5 percentage point per year (Southern region of Laos) to 6.5 percentage points per year (Myanmar). Vietnam, China, and Myanmar showed improvement of greater than 2.5 percentage points per year. Variation in prevalence estimates is likely to result in part from measurement error: increased awareness of the value of monitoring of goiter is known to result in higher estimates, leading to spurious conclusions of increased goiter prevalence.

The evaluation of the impact of salt iodization programs on biochemical iodine status is limited by a lack of data (and a lack of urinary iodine data linked to program data).

The impact of salt iodization on both clinical and biochemical indicators (urinary iodine excretion) can be measured only for Bangladesh, Laos and Vietnam. The prevalence of low urinary iodine has declined at a rate of 4.3 percentage points per year in Bangladesh and 10.2 percentage points per year in Vietnam. Laos has also exhibited a very sharp decline of 9.7 percentage points per year. In the case of Bangladesh, the data suggest an encouraging trend in the prevalence of iodine-deficiency disorders, in contrast to a worsening, and quite possibly spurious, trend shown by the goiter data.

Although trials have demonstrated the efficacy of iron supplementation in reducing the prevalence of anemia, the interpretation of national-level data is not so clear.

The rate of improvement would be expected to be less in national programs than in controlled trials because of reduced adherence to daily (or weekly) dosing protocols in the community setting. In terms



FIG. 3. Impact on vitamin A deficiency of national-level distribution of vitamin A capsules (VAC) to children. HG, Home gardening; IEC, information, education, and communication; XN, night-blindness; X1B, Bitot's spots; NID, national immunization day. Data for subclinical vitamin A deficiency are provided for the Philippines. Source: refs. 27–37. Also Aung P, Thein A (Ministry of Health, Myanmar). Myanmar. Case studies on nutrition intervention programmes of Myanmar. Presentation on Micronutrient Programs, INMU, Bangkok, June 2001. Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. Presented at a workshop on "Successful Micronutrient Programs" held at the International Union of Nutritional Sciences, Vienna, August 2001



FIG. 4. Impact on iodine-deficiency disorders (IDD) of national-level iodization of salt. Coverage refers to the percentage of households using iodized salt. Prevalence refers to the percentage of the population with goiter. UIE, urinary iodine excretion. Source: see table 3.

of evaluating national program effectiveness in reducing anemia, only Thailand and Vietnam have anemia prevalence and program coverage data available. In Thailand, daily supplementation of pregnant and postpartum women appears to have been associated with a substantial decline in anemia prevalence (of 1 to 3.5 percentage points per year in different regions of the country). However, data from men and from children under five years of age suggest a comparable trend in anemia improvement. This calls into question the degree to which improvement among pregnant and lactating women can be attributed to program impact. In Vietnam, the data suggest that populations (pregnant women, nonpregnant women, and children under five) showed lower prevalence rates of anemia. However, the data available do not allow the conclusion to be drawn that the differences result from program impact. Anemia data across all study countries suggest that anemia—unlike clinical vitamin A deficiency and clinical iodine-deficiency disorders—is not showing marked improvements, but remains high. This may be due to common constraints to program initiation (see Part I in this issue) and implementation (see Part II in this issue), or to changes in other determinants of anemia. Perhaps even more than vitamin A deficiency and iodine-deficiency disorders, priority is needed on monitoring and evaluation of national iron-deficiency control, to better understand how anemia may be reduced in vulnerable population groups.

Next steps in evaluation

Given the substantial financial and technical commitment required to implement national micronutrient-deficiency control programs, it is vital that investment enable the evaluation of the impact of these programs.

Although further development of systems for monitoring program coverage is necessary in the study countries, even coverage data are inadequate to monitor program impact. Collection of process and outcome data, particularly through representative sample surveys and program-monitoring systems, is required for the assessment of a program's effects. Research on noninvasive methods of assessment (for anemia and subclinical vitamin A deficiency) for use in routine surveys would be helpful for this.

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The prevalence of clinical manifestations of micronutrient deficiencies—including vitamin A deficiency (xerophthalmia) and iodine-deficiency disorders (goiter)—is in sharp decline in many countries. As a result, it is becoming increasingly important to collect data on subclinical deficiency (e.g., biochemical data) to assess program impact.

The collection of multiple rounds of national serum retinol or urinary iodine data is infrequent. These indicators will increase in importance for evaluation as the nutritional status of populations improves and the effects of deficiency are largely preclinical. More research is required to clarify the utility and interpretation of biochemical indicators for impact assessment.

Global trends in micronutrient deficiency data indicate possible secular trends of improvement.

The widespread reduction in the prevalence of clinical vitamin A deficiency, as well as the reduction of anemia in program and nonprogram groups in Thailand (and probably Bangladesh and Vietnam), highlights the importance of differentiating secular (non-program-related) trends from program impact. Because such trends may coincide with program implementation, the design of evaluation studies needs to make comparisons of groups before and after intervention, and with and without intervention, to estimate the effect attributable to program participation.

In conclusion, the clearest evidence of program effectiveness is found with salt iodization.

The national-level implementation of salt iodization programs, with adequate provision for salt accessibility and consumption, is associated in study countries with an often sharp reduction in the prevalence of iodine-deficiency disorders. The effectiveness of vitamin A supplementation in the reduction of clinical vitamin A deficiency is likely, but its effectiveness on biochemical indicators of vitamin A is unclear. Additionally, the anticipated phaseout of national immunization days following the virtual eradication of polio calls for more targeted research on alternative and effective intervention models. Finally, evidence on the effectiveness of iron-deficiency programs, specifically iron tablet distribution, is inconclusive because of lack of accurate coverage data and evidence that improvements in iron status may be due to improved living conditions where data are available (Vietnam and Thailand).

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Summaries of country case studies

The following are summaries of country case studies that were presented at a workshop on “Successful Micronutrient Programs” held at the International Union of Nutritional Sciences, Vienna, August 2001.

The complete texts of the case studies are available at www.inffoundation.org. No summaries or texts are available for the case studies from India and Myanmar.

1. Bangladesh

Fighting micronutrient malnutrition in Bangladesh: Progress made over the past decade

M. Hossain and T. Hussain

In the past decade, Bangladesh has made substantial improvement in food production. However, people still suffer from imbalance in nutrient intake, characterized by protein and micronutrient deficiencies. From 1991 to 1999, among children under five years of age, the prevalence of stunting decreased from 71% to 55%, and the prevalence of underweight decreased from 72% to 61%. Women had, in 1991–1999, an average pregnancy weight gain of less than 6 kg. Over half of the adult population was undernourished during this time, with 10% suffering from severe malnutrition.

The government operates nationwide programs for the control of vitamin A deficiency, iodine-deficiency disorders, and iron-deficiency anemia. However, control of iron-deficiency anemia is still unsatisfactory. Vitamin A deficiency was a huge problem, with 3.6% of children six to nine months of age having nutritional blindness during 1982–83. In 1999, the prevalence of nutritional blindness was 0.3%, and vitamin A capsule distribution coverage was almost 100%. However, some children (22%) still have low (< 20 µg/dl) serum retinol concentrations, and 2.7% of lactating moth-

ers and 1.7% of nonpregnant, nonlactating women have night-blindness. The rate of usage of iodized salt is satisfactory (> 85%). However, a substantial number of poor and uninformed people still use cheaper noniodized salt, which comes through illegal importation from neighboring India. Iron-deficiency anemia in Bangladesh is estimated to cause an annual loss equivalent to 2% of the gross domestic product. Although recent nationally representative data on iron-deficiency anemia control programs are not available, a 1997 report concluded that 49% of pregnant women and 53% of preschool children were anemic. Because of programmatic difficulties in the current methods of iron distribution and patient compliance, the emerging food-fortification technology may be a good alternative. However, wheat flour as a food vehicle will not be a universal choice here; the possibilities for rice or potato need to be investigated.

Bangladesh has positive cultures, policies, programs, and institutions to support breastfeeding. Prolonged breastfeeding up to the second year of life is common (97%); but both early and late starting of complementary feeding are still problems. The rate of exclusive breastfeeding rate in the first six months is 55%; some infants (22%) are given only liquids or rice water in addition to breastmilk, while 6% receive no comple-

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mentary food at all. Despite reasonable achievements to solve various nutritional problems, Bangladesh still shows the highest level of malnutrition in the world. Therefore, the country needs large-scale studies to get a clear picture of the dimension and nature of the

nutritional problems. Capacity building of the existing nutrition institutions of the country is urgently needed. There is an opportunity for the whole world to learn from Bangladesh through working with the local institutions.

2. Cambodia

The micronutrient-deficiency control program in Cambodia

O. Poly

Interventions to address micronutrient deficiencies are somewhat recent in Cambodia, with broad application of micronutrient interventions dating from the mid-1990s. Experience is still being gained from implementation of iodized salt, vitamin A, and iron supplementation interventions in Cambodia. Some data are available for assessment of program coverage or impact.

Efforts to establish a national program to address iodine deficiency began largely in response to documentation of the extent of the problem. The results from the first national goiter survey (1996–97) indicated that 17% of children 8 to 12 years of age were iodine deficient. Shortly thereafter, a national subcommittee consisting of 8 governmental ministries, 12 international agencies, and several local nongovernmental organizations was formed. The national program for salt iodization began in 1999, with the subcommittee participating in program areas related to legislation, monitoring, and quality control, as well as in the development of educational and training materials to promote the use of iodized salt. A Demographic and Health Survey in 2001 showed only 13% of households using iodized salt, a finding that contributed to a new thrust (with UNICEF support) to promote its use.

Development of the national vitamin A–supplementation program was also catalyzed largely by the results of a national survey that documented the extent of the problem. Soon after the prevalence findings from a 1993 vitamin A survey were reported, the first national vitamin A policy and implementation document was adopted by the government. This early policy

document recommended universal vitamin A capsule supplementation to children between the ages of six months and six years two times per year. More recently, the national policy has changed to include vitamin A supplementation to women during their first few weeks postpartum. Over the course of program implementation, the distribution system for vitamin A capsules has also transitioned. With the phaseout of national immunization days, capsule distribution began to be linked more strongly with routine immunization outreach and routine health services, including immunization and maternal health services, as well as during supplemental distribution campaigns such as school health days and bed net distribution interventions.

Cambodia's policy for addressing iron deficiency is iron supplementation to pregnant women, with delivery through the antenatal system for health care. However, recent initiatives demonstrate government concern for addressing anemia among demographic groups wider than pregnant women. In 2001, the Ministry of Health, in cooperation with the Ministry of Social Affairs and with the support of the World Health Organization (WHO) and UNICEF, launched a one-year study in select communities to introduce a program of preventative iron supplementation to women of reproductive age and to secondary-school girls, complemented by social marketing and health-education campaigns. The objectives of the study include assessing the effectiveness of weekly iron supplementation in improving the knowledge, attitudes, and practices as well as the hemoglobin status of women of reproductive age and secondary-school girls. On the basis of this study, it is planned to extend the iron supplementation program.

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3. China

The status of micronutrients and the efficiency of intervention in China

Y. Shi-an

In the last 20 years, the nutritional status of the Chinese population has greatly improved, in association with economic development and increased income. At present, malnutrition in the form of severe protein-energy malnutrition, vitamin A deficiency, or thiamine deficiency is not common. However, marginal deficiencies in micronutrients such as iron, vitamin A, iodine, calcium, zinc, and vitamin B₁ are rather common among children, adolescents, and women of childbearing age in urban and rural areas. Despite substantial progress in health and economic indicators over the last two decades, nutritional anemia, rickets, vitamin A deficiency, and zinc deficiency remain public health problems in China. These deficiencies have potentially adverse consequences for the growth and development of children and the health of women.

The extent of iron-deficiency anemia and its causes among men, women, and children were studied as part of the 1992 National Nutrition Survey. The data showed anemia to be most prevalent among children under three years of age, with a prevalence of 11% to 23% in urban areas and 16% to 29% in rural areas. The prevalence of anemia among children 3 to 5 years of age was lower, less than 12% for both girls and boys, but it showed an increase among children aged 6 to 10 years. Among young adults, anemia prevalence was estimated at around 10%, and the difference in prevalence between males and females was more marked than for children. The anemia rate for young adult females was much higher than for young adult males. Among the middle-aged and aged population, the prevalence of anemia was higher than that among young adults; there was no difference in prevalence between males and females.

On the basis of results from the 1992 National Nutrition Survey, the estimated iron intake by the Chinese population is adequate. Nevertheless, iron deficiency and iron-deficiency anemia are the most common nutritional deficiency problems, particularly among women and children. Because of poor absorption of iron from plant foods, the iron absorbed from plants fails to meet the requirements of the body. To improve the iron status of the population, it therefore seems necessary to increase dietary diversification as well as to explore the possibility of enriching food with iron.

In order to promote the use of an iron-fortified food

as a national strategy for the control of iron-deficiency anemia, a two-year soy sauce fortification study, supported by the International Life Sciences Institute and the Micronutrient Initiative, was conducted to test the efficacy of NaFeEDTA-fortified soy sauce in combating iron deficiency and anemia linked with low hemoglobin levels. The study also evaluated the effects on vitamin A and anthropometric status. The prevalence of anemia among the group receiving fortified soy sauce decreased significantly after six months of intervention. Given the impact on anemia, the next step is to make the fortified soy sauce widely available to consumers. This process involves working with national authorities to promulgate regulations and standards for the control of NaFeEDTA-fortified soy sauce, and with the national soy sauce association to gradually expand the production and distribution of NaFeEDTA-fortified soy sauce.

Vitamin A deficiency remains a major public health problem among preschool children in China. In China, plant provitamin A carotenoids account for about 70% of dietary vitamin A. As in many developing countries, seasonal variations in the availability of plant foods may result in fluctuations in provitamin A intake, and thus vitamin A status generally declines during the fall and winter seasons. Data on the prevalence of vitamin A deficiency are available from multiple sources and, in each case, indicate a high rate of marginal vitamin A deficiency among preschool children. A survey in 1999–2000 collected measures of vitamin A deficiency among 8,669 children zero to five years of age from 14 provinces. The survey found that 1,018 children (11.7%) had serum retinol levels below 20 µg/dl, and 3,396 (39.2%) had serum retinol levels between 20 and 30 µg/dl. Clinical indicators of vitamin A deficiency were also prevalent: 8 children (about 0.14% $8/8669 = 0.09\%$) were found to suffer from night-blindness, 7 children (about 0.12% $7/8669 = 0.08\%$) were diagnosed as having signs of xeroma, and 61 mothers were reported to have night-blindness.

Recent studies have confirmed the efficacy of high doses of vitamin A in reducing the incidence of diarrhea and respiratory diseases among children. The serum vitamin A level among those receiving one capsule containing 50,000 IU vitamin A every three months was significantly higher than that in the control group. However, these studies had yet to lead to national vitamin A-supplementation programs.

More than 425 million people in China live in areas of endemic iodine deficiency; this figure accounts for close to 40% of the affected world population and 66%

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of the affected Asian population. Iodine deficiency has a wide distribution in China, occurring to varying degrees in 29 provinces, municipalities, and autonomous regions, except Shanghai and Taiwan Province.

The use of iodized salt increased on average from 40% of households to over 90% between 1995 and 1999, in association with a drop in goiter rates from

20% to 8%. The use of adequately iodized salt was greater than 80% in most provinces. Increased use of iodized salt can be seen to parallel substantial reductions in goiter and increases in urinary iodine. Such results attest to the effective and rapid prevention of iodine-deficiency disorders by the use of iodized salt in much of China.

4. Indonesia

Micronutrient programs in Indonesia

Hardinsyah and Suroso

Policy and programs for controlling micronutrient problems have been developed in Indonesia since the 1980s, starting with distribution of iron tablets and vitamin A capsules, followed by iodization of salt. Nutrition- and health-related policy also includes immunization and sanitation programs and antenatal care. The first Indonesian dietary guidelines, called a guide to a balanced diet, were formulated and published in 1994. In 1998, the Indonesian Government adopted the formulation of a Food and Nutrition Plan of Action (FNPA).

The prevalence of clinical iodine-deficiency disorders in schoolchildren was 28% in 1988 and 10% in 1999. In previous surveys, goiter prevalence ranged between 2% and 38%. The prevalence of iodized salt intake was stagnant at around 64% in 1998 and 2000, respectively. Since the 1980s, the Government of Indonesia and the private sector have received significant funding for reducing the problem of iodine-deficiency disorders through salt iodization programs. Although the problem of iodine-deficiency disorders still exists, the prevalence of iodine-deficiency disorders has decreased very significantly during the last 20 years, mainly because of salt iodization.

Iron-deficiency anemia is still prevalent, especially in pregnant women and young children. The most current (2002) estimates of prevalence are 63% in pregnant women, 65% to 85% in children under two years of age, 40% in children under five years of age (2000), 40% in women of reproductive age, and 60% among the elderly. From 1985 to 2002, the prevalence of iron-deficiency anemia among pregnant women decreased by only about 10% to 15%.

In 1998, Ministry of Health Decree 632/1998 estab-

lished the mandatory fortification of wheat flour. Wheat flour produced and distributed in Indonesia must be fortified with iron, zinc, thiamine, riboflavin, and folic acid. With support from UNICEF and the United States Agency for International Development (USAID), fortification of wheat with iron was initiated in Indonesia. From January 1999 to January 2000, a grant of US\$850,000 from USAID through UNICEF was given to the Indonesian Government to purchase 340 metric tons of iron premix, which has been distributed to Bogasari, Berdikari Sari Utama, Citra, and Sri Boga Ratu Raya Flour Mills for fortification of wheat flour (60 ppm of iron). In 2001, the wheat flour industry received 240 metric tons of premix from the Canadian International Development Agency.

In addition to the above decree, in May 2001 the Ministry of Industry and Trade issued Decree 153/2001 on the Mandatory Application of the National Standard of Indonesia (SNI) for Fortified Wheat Flour. Both imported wheat flour and domestically produced wheat flour must follow this SNI. According to the SNI, the wheat flour must be fortified with 50 ppm iron, 30 ppm zinc, 2.5 ppm thiamine, 4 ppm riboflavin, and 2 ppm folic acid.

A decreasing trend in the prevalence of clinical vitamin A deficiency is evident, but for lack of data, trends could not be assessed for sub-clinical vitamin A deficiency. Regarding vitamin A supplementation, twice per year, infants between 6 to 12 months of age should receive vitamin A supplementation in the amount of 100,000 IU and children between 1 to 5 years should receive 200,000 IU.

Mass campaigns for distribution of vitamin A capsules are held every February and August. Village midwives or health center personnel should provide vitamin A supplements of 200,000 IU to every mother within the first 30 days after she gives birth.

Fortification of complementary foods is a current

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priority. The following are some challenges faced by the complementary food industry in fortifying foods for young children: The current available national capacity cannot fulfill more than 25% to 30% of the total requirement; the duration of usage of complementary

food is shorter than that of usage of milk; the perceived image of complementary food is still low among mothers; regulations need to be revised and established; and there is a lack of long-term strategic nutritional plans and programs at the regional level.

5. Laos People's Democratic Republic

Programs for micronutrient-deficiency control in the Lao People's Democratic Republic

S. Naphayvong, P. Vongvichit, and M. Deitchler

This paper addresses iodized salt and vitamin A-supplementation programs. The case study aims to describe these programs, document the story leading to program initiation, describe the challenges and successes met in program implementation, and provide data on the extent of the impact achieved.

High rates of micronutrient deficiencies have been documented in recent years in Laos. Prior to adoption of national micronutrient-deficiency control programs in the country, approximately 95% of school-age children were reported to have suboptimal iodine status (urinary iodine < 100 µg/L), and 65% of children were reported to have severe deficiencies in iodine (urinary iodine < 20 µg/L). The prevalence of night-blindness was estimated as 0.7%, among children 24 to 71 months of age and 5.7% among lactating women.

The Laotian Government responded to reports of widespread micronutrient deficiencies in the country by adopting national programs for iodized salt and vitamin A supplementation. Both the iodized salt program and the vitamin A-supplementation program have been consistently implemented since initiation, and although they have faced various constraints and challenges in program implementation, they have both achieved notable success in program delivery.

The iodized salt program has already achieved a high level of impact nationwide. All recent coverage

and prevalence data available show high use of iodized salt (> 75% of households using adequately iodized salt in 2000) and low rates of iodine deficiency (27% with urinary iodine < 100 µg/L). Data on vitamin A supplementation are more difficult to interpret; most coverage data available show the program to be achieving high rates of capsule coverage to children (> 70% for almost all rounds and years of capsule distribution). However, a national survey in 2000 showed that among children under five years of age, 44.7% had marginal deficiencies in vitamin A (serum retinol < 20 µg/dl) and more than 7% had deficient vitamin A status (serum retinol < 10 µg/dl).

The consistent implementation of the iodized salt and vitamin A-supplementation programs is evidence of the Laotian Government's commitment to controlling micronutrient deficiencies in the country. The national government's collaboration with international and bilateral agencies, as well as with foreign governments, in the design and implementation of the program has facilitated program delivery. The various successes already achieved by the programs are due largely to the collaborative efforts of the bodies to establish appropriate systems for enhanced program delivery, monitoring, and evaluation. However, some aspects of both the iodized salt and the vitamin A-supplementation programs still need further development. Increased capacity for improved program delivery and enhanced systems for monitoring and evaluation of each of the programs are desired. Ensured sustainability of currently implemented programs and identification of a longer-term strategy for the control of vitamin A deficiency are additional program concerns.

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6. Philippines

Impact, policy, and program implications of the Philippines vitamin A-supplementation program

M. R. A. Pedro, R. L. Cheong, J. R. Madriaga, and C. V. C. Barba

The Philippine Government addresses vitamin A deficiency with the implementation of a universal twice-yearly high-dose (200,000 IU) vitamin A-supplementation program for children 1 to 5 years of age. The program, which started in 1993, has been a centerpiece in the country's nutrition efforts. The paper reviews the vitamin A-supplementation policies and program in the Philippines on the basis of the general guidelines, administrative documents, and records of implementing and cooperating agencies, such as the Department of Health and Helen Keller International, and a cost-effectiveness analysis by a Philippine Cost-Effectiveness Study Team; it also examines the program impact on the basis of the results of the 1993 and 1998 National Nutrition Surveys. The results of the review had significant program and policy implications. Among the programmatic changes was the shift from being centrally managed by the Department of Health to being a program devolved to local government units. A declining coverage of target children after the early

years reflected the lack of a smooth transfer of program ownership to local government units. On the other hand, a preferential access to the program by children from poor households was apparent in some provinces. The 1993 and 1998 National Nutrition Survey results revealed indications of positive impact of the vitamin A-supplementation program: a shift to the right in the distribution of plasma retinol among children 1 to 5 years of age between 1993 and 1998, and between children without and with vitamin A supplementation in both years. This was despite the overall increase in the prevalence of low serum retinol from 35% to 38% over this same time [1]. In further studies [2], the main impact was shown to be in the most deficient areas, but possibly persisting for only four months after the dose.* This suggested that thrice-yearly vitamin A capsule distribution might be advisable.

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* Madriaga JR, Pedro MRA, Barba CVC, Habito RCF, Deitchler M, Mason JB. The impact of the national vitamin A supplementation program on subclinical vitamin A deficiency in pre-school children in the Philippines. Presented at XXI International Vitamin A Consultative Group (IVACG) Meeting, February 2003.

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7. Philippines

The National Salt Iodization Program of the Philippines

M. A. Tuazon and R. C. F. Habito

Iodine-deficiency disorders remain a public health problem in the Philippines. From 1987, the prevalence of goiter has been on the rise, and the latest National Nutrition Survey conducted by the Food and Nutrition Research Institute of the Department of Science and Technology in 1998 revealed that 36 of every 100 children 6 to 12 years of age were suffering from moderate

to severe iodine-deficiency disorders, based on urinary iodine excretion levels.

As a response to this problem, the Government of the Philippines enacted a law on December 20, 1995, known as Republic Act 8172, II entitled "An act promoting salt iodization nationwide and for other purposes." Also known as the ASIN Law, it mandates that all salt producers and traders make iodized salt available to all Filipinos.

For the nationwide implementation of the National Salt Iodization Program, intersectoral organizational machinery was created, with the main responsibility

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vested in the Department of Health. The program has four main components: production, marketing and distribution, promotion and advocacy, and management and coordination.

An in-depth assessment of the National Salt Iodization Program showed the following strengths: strong political commitment of national leadership in addressing iodine-deficiency disorders; availability of local technology for salt iodization; responsive participation of private industry, nongovernmental organizations, and other relevant sectors; promotional and advocacy efforts that have contributed to the generation of much-needed resources and political will and support; and regular consultation and dialogues that have effectively contributed to issue resolution and have forged alliances.

However, there are still a number of weaknesses that need to be addressed: the availability of iodized salt is still a bottleneck; nationwide compliance and

enforcement of the ASIN Law need to be strengthened, particularly the implementation of the regulation and monitoring scheme; the personnel and testing facilities of Bureau of Food and Drugs (BFAD) as the primary agency responsible, should be upgraded; and information dissemination targeting consumers should be intensified to bridge the gap between awareness and utilization of iodized salt. Furthermore, the government can consider utilizing existing networks such as the National Food Authority (NFA) system for importation and distribution of iodized salt nationwide, while at the local level, the *takal* system (repackaging salt sold loose) of selling iodized salt provides a workable and acceptable system for marketing iodized salt. It is also evident that a stronger government-private sector-nongovernmental organization partnership has to be forged, where sharing of resources and expertise can take place, if the National Salt Iodization Program is to be sustainable.

8. South Africa

Micronutrient programs in South Africa

C. Witten, P. Jooste, D. Sanders, and M. Chopra

lthough South Africa is a middle-income country, persistent social and economic inequalities have resulted in large numbers of people living in poverty. National surveys consistently found that more than a quarter of children were stunted in 1994, rising to over 40% in many rural areas. Marginal vitamin A deficiency (serum retinol < 20 µg/dl) was prevalent in 33% of preschool children (6 to 72 months of age) [1]. Even after a universal salt iodization program, over 10% of schoolchildren were iodine deficient. The South African Government has recognized malnutrition as a key priority issue and developed an Integrated Nutrition Programme. Micronutrient malnutrition control is one of the focus areas of the Integrated Nutrition Programme, which addresses micronutrient deficiencies in the population through a combination of strategies, namely, supplementation, food fortification, the promotion of dietary diversification, and related public health measures [2–4].

In order to support the implementation of the focus areas of the Integrated Nutrition Programme (on micronutrient and other deficiencies), the Department of Health placed considerable emphasis on the

development of a coordinated intersectoral approach to solving nutrition problems in South Africa through community-based nutrition projects. A number of general management aspects were identified as constraints to the implementation of community-based nutrition projects: complex financial procedures and delays in funding, lack of staff, inadequate staff training, and inadequate technical support. This highlights the crucial gap between policy and successful implementation [5].

The Department of Health has had relative success with mandatory salt iodization since 1995. However, small weaknesses still exist in the national salt iodization program, such as domestic use of noniodated agricultural salt in 6.5% of households [6]. The 1999 National Food Consumption Survey (NFCS) findings indicated that one of every two children had a dietary vitamin A intake less than half the recommended level. The Department of Health set out a policy for a supplementation program as a primary prevention strategy, to form part of routine mother and child health services. This program targets all children aged between 6 and 60 months and postpartum women in the period six to eight weeks after delivery [7]. Based on the findings of the NFCS, it was recommended that maize and wheat flour be fortified with vitamin A and iron, among other nutrients, to provide a person 10 years old or older with 25% of his or her RDA of both micronutrients from 200 g of raw maize or wheat flour [8].

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9. Sri Lanka

Case studies of successful micronutrient programs: The Sri Lankan experience

C. Piyasena

Sri Lanka has achieved considerable successes in the sphere of community health services owing to the well-established network of primary health-care workers. Immunization coverage of over 90% has been achieved, while growth monitoring is successfully implemented even at the remote village level. Advances have also been made in related sectors. For example, approximately 75% of the Sri Lankan population has a safe drinking water supply. The food authority has implemented a wide range of regulations by the food act ensuring food safety and hygiene. Food and agriculture policy has taken different dimensions during the last few decades, moving from the objective of self-sufficiency toward a free-market economy and liberalization of foreign exchange transactions, thereby increasing private sector participation and privatization of state enterprises.

Although low food acquisition power is a key factor exposing the poor sections of the community to a greater risk of micronutrient deficiencies, wrong beliefs and lack of knowledge have contributed to the present pattern of food consumption. Addressing issues of food quality, in line with goals set up by the World Health Organization and UNICEF, national policy makers endorsed and adopted a declaration and plan of action for the virtual elimination of vitamin A deficiency, the virtual elimination of iodine deficiency, and reduction of iron deficiency in women by one-third.

Clinical vitamin A deficiency is not commonly seen in Sri Lankan children. The latest survey in 1995-96 revealed that 36% of Sri Lankan preschool children had

suboptimal serum vitamin A levels, with the prevalence of night-blindness (0.8%) and Bitot's spots (0.8%) indicating vitamin A deficiency as a moderate public health problem in the country. Control measures have been implemented for some years, such as free distribution of milk, vitamin A supplementation, diagnosis and treatment of vitamin A deficiency at school medical inspections and hospitals, and provision of supplementary food fortified with vitamin A. Following the 1995-96 survey, vitamin A policy was reformulated, and the provision of vitamin A megadoses routinely to children and postpartum mothers was introduced. Achieved coverage rates have not been reported.

Iodine-deficiency disorders have long been recognized as an endemic problem in the southwest wet zone of Sri Lanka. Provision of potassium iodide to pregnant women and adolescent girls in high-risk areas was among the early interventions initiated in the 1950s. Surveys at that time revealed an increased prevalence of goiter in spite of interventions, which indicated that the increased prevalence of goiter was not due to iodine deficiency or was due to ineffective intervention.

Studies showed that the prevalence of goiter remained high in schoolchildren (19%) and pregnant women (63%). Based on these findings, a national program on salt iodization was adopted, and a universal salt iodization law was enacted from 1995. A follow-up national survey of iodine-deficiency disorders (2000) indicated a reduction in prevalence in one district (Kalutara) where the iodine-deficiency disorders control program had been implemented for more than five years, although the national data showed an increase in the prevalence of iodine-deficiency disorders from 19% to 21%. Moreover, the highest prevalence was

observed in the North-central province, previously a nonendemic area. The same study led to estimates of the prevalence of iodine-deficiency disorders from urinary iodine assays showing that the prevalences of mild, moderate, and severe iodine deficiency were 22%, 7%, and 1.4%, respectively. In pursuing improvement of the situation, Sri Lanka has identified the need to determine thyrotropin levels of newborns and to develop a database on the iodine content of foods, goitrogens in local foods, and the effects of fertilizer, pesticides, and insecticides on the bioavailability of iodine in food.

Anemia is a major public health problem in Sri Lanka, affecting all segments of the population and contributing to increased morbidity and mortality rates. Anemia prevalence in 1973 was estimated as 38% among men, 68% among women, 70% among primary schoolchildren, and 52% among preschool children. The prevalence was 60% among pregnant women in 1988–89. In 2001 the prevalence was estimated as 32% among nonpregnant women, 30% among pregnant

women, 22% among adolescents, 21% among primary schoolchildren, and 30% among preschool children. Operational studies on the iron-supplementation program have indicated that further strengthening is required to achieve optimal results. A comprehensive national strategy was formulated, including iron/folate supplementation to all pregnant women; antihelminthic use and malaria control; promotion of dietary diversification; information, education, and communication (IEC) campaigns to improve compliance; provision of safe drinking water and sanitation; and proper monitoring and further research to improve efficiency and effectiveness. Additional target groups to be included were infants, preschool children, schoolchildren, nonpregnant women, and displaced persons. The possibility of iron fortification as a strategy has been looked into. Challenges ahead for optimal control are proper monitoring and evaluation, securing adequate human resources, improving the bioavailability of micronutrients in foods, promoting food-based methods, and issues related to iron fortification.

10. Thailand

Current situation and status of micronutrient policies and programs in Thailand

P. Winichagoon, T. Pongcharoen, and J. Yhoung-aree

Thailand has set goals for alleviating three major micronutrient deficiencies that since the early 1980s have been regarded as major public health problems. The prevalence of vitamin A deficiency has decreased, along with the reduction of protein–energy malnutrition among young children and mothers. Iodine and iron deficiency, however, have required additional efforts through salt iodization and iron-supplementation programs during the past two decades. Currently, clinical micronutrient deficiencies have become rare, and the severity of persisting deficiencies has declined to the subclinical level. These remain a significant challenge.

Iron supplementation is the major program addressing anemia during pregnancy. The anemia surveillance system has been an integral part of the efforts to alleviate anemia among school-aged children and pregnant women. Village health volunteers provide the major resource for identifying pregnant women and advising them to attend antenatal care, as well as promoting safe delivery in the hospital. Daily iron supplementation has been provided throughout pregnancy, but adherence

to supplementation is not monitored. Severe anemia among pregnant women has substantially declined as a result of improving the referral system and ensuring compliance to iron therapy. There have been no specific programs for anemia in infants, preschool children, or adolescent girls. Meanwhile, weekly supplementation in primary schools has been piloted but not yet expanded nationwide.

Legislation for iodization of salt has been a major step forward as a nationwide strategy to alleviate iodine deficiency. Continued attention is still needed to ensure the sustainability of salt iodization and household consumption of iodized salt. Cyclic monitoring of the iodine-deficiency situation has been launched, and data on urinary iodine from pregnant women and school children are being used to monitor the situation. Fortification of various foods to address multiple micronutrient deficiencies has been studied, and some products have been commercialized. Partnerships among government, the private sector, and academics have been established since the early stage of the program. The private sector and academic institutions have worked together to formulate the products, and government sectors assist in promoting the use of fortified foods. Systematic evaluation of these programs will be useful in elucidating lessons learned from Thailand.

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11. Vietnam

Successful micronutrient programs: Micronutrient-deficiency control strategies in Vietnam

N. X. Ninh, N. C. Khan, N. D. Vinh, and H. H. Khoi

Vitamin A deficiency, iron-deficiency anemia, and iodine-deficiency disorders have been reduced during the past decade but still remain issues in Vietnam. Since the early 1990s, the Ministry of Health has implemented a nationwide program for the control of vitamin A deficiency. An implementation network has been set up from the commune to the central level by a strong preventive health structure with the active participation of mass organizations. A comprehensive strategy has been developed, including nutrition education; universal distribution of vitamin A capsules to target children, in combination with national immunization days, and to lactating mothers in the community; and promotion of the production and consumption of vitamin A-rich foods at the household level. The data in 1994 and in 2000 showed that the prevalence of clinical xerophthalmia was lower than the cutoff point established by the World Health Organization for a public health problem; however, the prevalence of subclinical vitamin A deficiency was still high in 2000 (11% in children and 50% in lactating mothers).

The groups highly vulnerable to iron-deficiency anemia are women of childbearing age and children (53% of pregnant women, 40% of nonpregnant women, and 60% of children under 24 months old suffered from iron-deficiency anemia in 1994). The iron-deficiency anemia control program has consisted

of supplementation of women with iron/folic acid tablets while providing them with nutrition education, together with the prevention of intestinal parasites, especially hookworm. However, the program has been implemented in only 1,282 out of more than 10,000 communes in the whole country so far; moreover, there is no policy for iron supplementation of children under two years of age.

Iodine-deficiency disorders are also very widespread in Vietnam. More than one-quarter (27%) of school-aged children had goiter in 1995; the prevalence was reduced to 14.9% in 1998. There is geographic and ecologic variation in goiter prevalence. Since 1999, universal salt iodization has been adopted by government legislation. By 2001, at the country level, 61% of households used iodized salt; however, the rate of usage was rather low in the Mekong River Delta, and about 30% of people in this region were reported to have low levels of urinary iodine ($< 10 \mu\text{g}/\text{dl}$).

In the coming years, greater attention should be paid to more sustainable measures. Food fortification with micronutrients may be an important approach. Iron-fortified fish sauce, which was proved to have both efficacy and effectiveness in community-based trials, will be developed on a larger scale, while other vehicles, such as sugar, instant noodles, and processed complementary foods, should be considered for micronutrient fortification. As committed by the National Nutrition Strategy, ratified by the government, we are making ongoing efforts to combine different strategies to maintain success and sustain further achievements.

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International Workshop on Food Aid

Contributions and Risks to Sustainable Food Security—Berlin Statement

Preface

Since decades, food aid is a contentious instrument for addressing hunger and food insecurity. The workshop carefully considered the pros and cons of food aid on the basis of past and current evidence, including practitioners' experiences. In particular, the workshop re-visited food aid in view of the perspectives of the ongoing WTO trade negotiations, the experience gained with the Food Aid Convention, the initiatives related to the human right to adequate food resulting from the World Food Summit, and the challenges of health crises, i.e. HIV/AIDS.

The "Statement" results from an open and participatory process of working groups, and from more comprehensive plenary presentations by main actors in food aid (recipient governments, bilateral and multilateral donors, international agencies, NGOs). While reflecting a fair amount of consensus, the individual workshop participants and delegates cannot be held responsible for the "Statement". It is meant to serve stimulation of further discussion for innovation and improvement of key aspects of food aid for sustainable food security.

General Issues and Recommendations

1. The *Millennium Development Goal* to cut hunger in half by 2015 will not be achieved with business as usual. A massive scaling up of food security actions globally, and by the countries with high prevalence of food insecurity is needed. Simply meeting aggregate food needs or GDP growth targets at national level will not suffice. Too many countries are currently regressing on the measures used to define the food security objective as stated by the FAO Food Summit. Taking responsibility for the persistence of world hunger, at international and government levels has to be more than words.
2. The *definition of 'food aid'* should not just be focused on its source of funding, or by specific transactions, such as "items donated from external donors to recipient", but should include consideration of a) all related international and domestic actions and programs, and b) the role of non-food resources brought to bear jointly with food to address key elements of hunger problems. As such, food aid can be understood as all food supported interventions aimed at improving the food security of poor people in the short and long term, whether funded via international, national, public and private resources.
3. *Food aid is only one of a multitude of instruments* in the fight against hunger. Food aided food security interventions should not be planned in isolation of other key food security policies. Food aid policy should be consistent and coherent with agriculture and trade policy. Food aid must be assessed in the broader context of food security policy, as one element of an insurance policy for the poor, which means to an exceptional measure, rather than the usual. The impact of food aid on food security of people depends on national government policies, international policies, the acuteness of local conditions, the country context, and the appropriateness of food aid management modalities.
4. Food aid policies and deliveries should *respect and promote the human right to food*. International food aid should assist countries in need, but only after they have exhausted their own related food resources. The use of food aid can contribute to the realization of the right to adequate food if it is a reliable source of support in emergencies. Such a source should be provided by the donor community, rather than individual donors be held accountable. The management of food aid must also not work counter the human right to food by undermining the capacity of people to feed themselves.
5. *Good governance of the whole food system* in developing countries will contribute over time to a decreased need for food aid. Food aid should be provided only when it is the most effective and appropriate means of assistance, compared with real, which means immediately available, alternatives including forms of financial assistance.

- Corruption in the food system must be countered as in any other public domain. As it affects the poorest, it requires particular attention.
6. *Civil society organizations* incl. national and international NGOs should play key roles in facilitating good governance of the food aid systems, and in grass roots needs assessment and as donors in food aid delivery.
 7. *Food aid must address well-defined problems* involving immediate food shortage in flexible ways, with the aim of:
 - » saving lives
 - » protecting livelihoods and assets of the poor affected by natural and manmade disasters;
 - » protect livelihoods of chronically vulnerable social groups, including refugees, internally displaced persons, the disabled, AIDS orphans and the destitute;
 - » support complementary and synergistic efforts to improve the human resources of vulnerable people where food shortage is a major constraint.
 8. Food aid allocation should be based on *sound 'needs' assessment*, involving both recipient and donors, and optimally targeted to the needy and vulnerable groups. Optimal targeting entails due consideration of the costs of targeting, and utilization of accessible timely information.
 9. A "*do no harm*" approach to food aid delivery is called for. Food aid, which involves commodities provided directly to the recipient government or its agent for sales on local markets, has often been driven by surplus disposal intentions or market stabilization policies of donor countries. The cutting back of food aid on the one hand, and its expansion on the other hand driven by international food ups and downs of prices is unacceptable. Multi-lateral food aid adds to independent response capabilities. Further strengthening of multi-lateral, undirected, food aid is therefore called for.
 10. *The international governance of food aid* requires reform and streamlining in order to achieve predictability, accountability of appropriate volumes, and timely delivery of food aid. This calls for due consideration of food aid policy in the WTO Development round and re-assessment of the Food Aid Convention.
- effects of natural disasters and conflicts indicates that food aid has a continuing role in emergency relief, post-crisis rehabilitation, and potentially in pre-next-crisis mitigation which can contribute to the transition between relief, rehabilitation and long-term development.
2. Maintain and enhance famine *early warning systems*, and couple early warnings with timely response by donors and governments. Systems to predict climate-related humanitarian crisis are used nowadays to anticipate and prepare food aid deliveries. Efforts to improve these systems should continue, with a focus on enhancing the international community's ability to conduct rapid emergency needs assessment that pay closer attention to a) non-food needs (in addition to food), and b) times when food is not needed. This facilitates appropriate exit strategies from food aid and avoids dependencies.
 3. Food aid in emergencies should be *restricted to situations where it is the most appropriate means* to solve the underlying problem, i.e.:
 - » to provide relief in cases of protracted crisis;
 - » as a contribution to strategic reserves and safety nets;
 - » for operations linking relief, rehabilitation and development
 4. Poor targeting, including that due to mistiming of deliveries, often reveals itself through price adjustments on local food markets as supply increases at a faster rate than demand. Food Aid should be *timely delivered in emergencies*. In this case, local purchases may have the advantage of providing food aid on time. National food policy capacities must be strengthened in developing countries to appropriately deal with food (and other development) aid instabilities.
 5. While emergency relief facilitates future development, it also should be *linked with long term development action*. The provision of food aid in emergency situations should take particular account of longer-term rehabilitation objectives.

Food aid for development

1. Food based activities are indicated in regions and under circumstances only, *where the envisaged developmental objectives cannot be met more cost-effectively or in a more sustainable way by non-food activities*. More resources need to be made available for effective 'development needs assessments' (compared with emergency needs assessments) so that those regions and circumstances can be appropriately determined and the food-versus-other-resource decisions can be more empirically informed.
2. Food aid has been shown to be useful in supporting development where it has *protected assets and*

Specific issues and recommendations

Emergency Food Aid in the context of natural disasters, armed conflict and population displacement

1. *Adequate attention should be put to natural disasters as well as conflicts*. Success in mitigating the

prevented vulnerable people from falling into destitution.

Where food aid is the appropriate intervention in this sense, it should focus on

- » *infrastructure* development and reconstruction (by food for work),
 - » *human capital* (e.g. by food for education or school meals) health and nutrition (e.g. by maternal and child health programs).
3. *School feeding* program providing large coverage but adjusted to local needs and where needed, supported by food aid should be considered. Where possible these should draw on local food production, but only with government buy-in assured.
 4. The role of food aid in *poverty reduction strategies (PRSPs)* as part of food security actions warrants further attention.

Food aid in the context of health crises, including HIV/AIDS

1. For poor households, *HIV/AIDS* represents a *massive and irreversible shock* that seriously affects their ability to sustain their livelihoods and remain food security. They are faced with significantly reduced income, fewer people available to work and an unrelenting need for food and medicine. Special attention needs to be given to orphans.
2. In areas of high food insecurity and high HIV prevalence, food assistance can provide a *safety net to catch families before they become destitute*, and thus even more vulnerable to the risk of infection, and they can support the needs of orphans and foster families in the aftermath of family dissolution due to AIDS.
3. Food Aid Project design should generally target people on the *basis of food insecurity rather than on the basis of their HIV/AIDS status*. As there are serious stigma issues involved, many people with HIV do not yet know that they are infected, and other non-affected households may be equally vulnerable for other reasons. The complex issue of scaling up many pilot programs needs due attention and learning from shared experiences.

Food aid management and delivery

1. Food aid has to *avoid disrupting markets, investment, and production*, whether it is delivered from overseas or purchased within the region. In order to promote local agricultural development, strengthen regional and local markets, and ensure sustained food security, consideration shall be given to using direct cash contribution for the purchase of food within the recipient country, or region. While local purchases have many benefits they too must

be guided by careful assessments of availability, potential price effects, food safety, and comparative costs.

2. Food aid should be culturally acceptable and respect *nutritional needs* and eating habits, and adhere to food safety standards. Food aid must adhere to *food and bio-safety standards*. In view of limited capacities of recipient countries, donors must only deliver food aid, which meets safety standards accepted by the Codex Alimentarius. The capacities of food and bio-safety standard assessment in recipient countries need strengthening so that countries can make informed choices, including on genetically modified organisms.
3. *Strengthening the role of civil society organizations and of the private sector* (in market and retail business) should be explored to facilitate effectiveness and efficiency of food aid delivery.
4. Food Aid may be a suitable instrument under certain conditions such as inefficiency of local markets or administrative structures. Because of *high transaction costs*, it is often less efficient than cash based interventions. Sustainable impact can only be reached when combined with other developmental interventions.
5. *Shared analytical frameworks are needed* in a rapidly changing domestic and international context, and increased dialogue is needed for coordinated analyses of food aid, including participatory approaches at local levels.

Toward reforming the food aid regimes at global and national levels

1. Food aid should be *clearly separated from commercial trade*. The provision of food aid should not be tied directly or indirectly, formally or informally, to commercial exports of agricultural products or other goods and services to recipient countries. The WTO negotiations should lead in this direction.
2. Food aid to LDCs should be provided *exclusively in grant form* in order not to increase the debt burden of vulnerable countries.
3. Neither the *Food Aid Convention* nor the *WTO Marrakech Agreement* (of the Uruguay Round) has acted as an effective coordination mechanism for global food aid nor as an effective safety net for the poor.
4. The *Food Aid Convention* has had *limited and unsatisfactory impact* in reducing fluctuations or setting minimum levels of food aid needs. This raises serious questions about the credibility of the Convention in establishing a safety net and the most appropriate form of international commitments for protecting the food security of developing countries. The Food Aid Convention should arguably be discontinued in its current form after 2005.
5. Consideration should be given to replace the Food

- Aid Convention by a *new type of Food Aid Compact* that could be brought for example under the WTO as an element of the WTO Development Round.
6. The reform of food aid regimes at *international* and at *national* level should be accompanied by an international *Code of Conduct* strengthening accountability, effectiveness, fairness, and transparency, and monitored by an appropriate independent body under the auspices of for example the WTO. A participatory process toward developing such Code of Conduct, building on existing components, should be designed.
 7. A reformed global food aid governance system must *not entail dominance* of global organizations in the food aid system, given the complexities of the national food security problem, regional diversity, and comparative advantages of organizational strengths.

Note: The Statement was tabled in closing of the International Workshop on Food Aid—Contributions and

Risks to Sustainable Food Security upon invitation by the organizers by Joachim von Braun, Director General of the International Food Policy Research Institute (IFPRI), Washington D.C. (<http://www.ifpri.org/>).

The workshop was hosted by the Federal Ministry of Consumer Protection, Food and Agriculture (BMVEL), the Federal Ministry for Economic Cooperation and Development (BMZ), the Federal Foreign Office (AA) and the Deutsche Welthungerhilfe / German Agro Action (DWHH). It was organized by the German Technical Cooperation (GTZ) and InWEnt—Capacity Building International, Germany. Presentations and other workshop results are available for download at <http://www.foodaid-berlin2003.de/>, where also an electronic discussion group is set up.

Joachim von Braun, "Berlin Statement on Food Aid for Sustainable Food Security," presented at the International Workshop "Policies against Hunger II, Food Aid Contributions and Risks to Sustainable Food Security," September 2–4, 2003, Berlin, Germany.

Book reviews

Handbook of clinical nutrition and aging. Edited by Connie Watkins Bales and Christine Seel Ritchie. Humana Press, Totowa, N.J., USA, 2003 (ISBN 1-58829-055-7) 698 pages, hardcover. US\$145.00.

To create a context for a review of the *Handbook of Clinical Nutrition*, the most recent book to discuss nutrition and aging, it is useful to revisit some previous books dealing with the same topic. Until well into the 1970s, books and articles on aging tended to be pessimistic litanies of degenerative changes. Neither the 1976 book by Winick [1] nor the 1984 treatise by Arbrecht et al. [2] go far beyond this tradition, although a final chapter in the latter emphasizes a relationship between the intake of specific nutrients and mental function.

By 1986 a book edited by Eleanor Young [3] on nutrition, aging, and health states in its preface that we are only beginning to appreciate that specific disease states more commonly associated with the aged probably have their origin early in life. Another chapter concludes that when we view the intimately interwoven aspects of aging we are beginning to realize that “it is continually influenced by a multitude of environmental, biosocial, biocultural, economic and physiological factors.” The similarity of some of the signs of aging to those of nutritional deficiencies is noted in another chapter, with the suggestion that prolonged, subtle deficiencies of single or multiple nutrients over time may be a factor. There is also mention of dietary modification to reduce the risk of atherosclerosis.

In the 1989 book by Horwitz et al. [4], the opening chapter on the epidemiology of nutrition of the aged reviews factors responsible for individual variation in the aging process; these are discussed in more detail in subsequent chapters. The 1995 book by Morley et al. [5] has a chapter on the interaction of the decline in immune function with specific nutrients, but is mainly descriptive of the decline in various other systems with age and nutrition management and support. The chapter on physical activity focuses only on the factors con-

tributing to reduced physical activity in the elderly.

In 1991 the book by Evans and Rosenberg [6], *Biomarkers: the 10 determinants of aging you can control*, broke new ground by describing how the aging process could be slowed and renewed strength and vitality acquired at any age. The findings were based largely on the studies of nutrition and aging at the USDA Human Nutrition Research Center on Aging at Tufts University. This was followed in 1998 by the MacArthur Foundation Study on Successful Aging [7], whose findings demonstrated that lifestyle choices “more than heredity, determine your health and vitality.” The results of these two studies exploded the myths about aging that had long shaped individual and institutional attitudes toward growing older. These books outline the vital lifestyle choices, including diet, type of exercise, mental stimulation, and self-reliance, that make a difference no matter how early or late in life they are made.

The *Handbook*, with 31 chapters, provides an excellent summary of trends in nutrition and health in older adults; the fundamentals of geriatric nutrition; geriatric syndromes related to nutrition, such as diminished sense of taste and smell; and the impact of specific disorders on nutrition. The handbook provides detailed and up-to-date nutrition information for health workers responsible for the care of the elderly and can also be used for their training. However, it is designed only to provide guidance on the management of nutrition-related problems that are common in the elderly, and does not address their causes. It is a serious defect that this latest book on nutrition and aging virtually ignores the role of lifestyle and environmental factors from conception onward in the nutrition and health problems of the elderly. Any modern book on nutrition and aging should include emphasis on ways of preventing or delaying many of the changes that have been attributed entirely to biological aging. The messages in the preceding two books [5, 6] should be included in the training of all health professionals concerned with aging, and should influence national health policy and legislation.

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Fish to 2020: Supply and demand in changing global markets. Christopher L. Delgado, Nikolas Wada, Mark W. Rosengrant, and Siet Meijer Mahfuzuddin Ahmed. International Food Policy Research Institute, Washington, D.C., and World Fish Center, Malaysia, 2003 (ISBN 0-89629-725-X) 226 pages, softcover. US\$19.95.

Captures of wild fish have leveled off since the mid-1980s, and many stocks of fish are threatened by over-fishing. Meanwhile, increasing demand has been met by fish farming. This book explores the limitations of aquaculture by using computer modeling and explores the environmental problems that aquaculture will face as it expands. The model shows that developing countries will consume and produce a much greater share of the world's fish and that trade in fisheries commodities will increase. The causes and implications of these changes are discussed, and specific actions and policies that can improve outcomes for the poor and the environment. are proposed.

The book concludes that global fish consumption will increase by about 1.5% per year through 2020, driven primarily by developing countries. Almost all of this increase will come from aquaculture, and prices will continue to rise. The demand for fish meal as feed for fish requires that its use for feeding nonruminant animals must be replaced to a greater degree by vegetable protein sources such as oilseed meals. Milk and meat are likely to become cheaper relative to fish. The effects on poverty will be mixed. Entry points for policy actions are identified and priorities suggested for further policy research. Supplementary tables give detailed information on the production and consumption of food fish. This book does not deal with the technical aspects of aquaculture, but it is the most authoritative treatise currently available on its economic and policy implications.

Food Inc.: Mendel to Monsanto: The promises and perils of the biotech harvest. Peter Pringle. Simon & Schuster, New York, 2003 (ISBN 0-7432-2611-9) 356 pages, hardcover. US\$24.00.

Food and Nutrition Bulletin readers are aware of the raging controversy over the introduction of genetically modified (GM) foods. All of our foods today are the result of genetic modification through years and sometimes centuries of plant breeding, but the ability to insert genes from unrelated species is new, and for some, frightening. This book is one more effort, this time by a journalist, to provide an impartial summary of the pros and cons of this inflammatory issue. In general he succeeds, and he has produced a readable and balanced book that explores the key issues in depth.

Unfortunately, in such a book it is necessary to devote many pages to comment on the statements and policies against GM foods that are not science based. Some large multinational companies and other advocates of genetically modified organisms (GMOs) have made unwise, foolish, or arrogant claims. Companies that tried to introduce their products into the market without telling people about them made a serious mistake, but the activists who indulge in unsubstantiated scare-mongering are doing a great disservice. The author notes that "transgenic foods have been eaten by contented and discerning consumers in America for a decade" and concludes that "biotech agriculture is another step in the evolution of human foods" and that the promise of producing more food in African deserts or the wetlands of Asia is worth the time and money spent on the research.

The author presents evidence that genetic engineering has practical value for developing countries, but "only if it is properly integrated into their agricultural systems." He concludes that GM foods are "here to stay and full of promise but also represent a potential hazard." This leads him to call for more caution from those who regulate and grow these foods and close study by those who eat them. Although this caution is appropriate, it must be accompanied by a willingness on the part of regulators to accept reasonable scientific evidence. Readers interested in the agricultural implementation of these considerations should refer to the small book by Pinstrup-Anderson and Schiøler, reviewed in the September 2002 issue of the *Bulletin* (vol. 23, no. 3) [1].

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Modern aspects of nutrition: Present knowledge and future perspectives. Edited by Ibrahim Elmadfa, Elke Anklam, and Jurgen Konog. Proceedings of the 17th International Congress of Nutrition, Vienna, 2001. S. Karger Publishers, New York, 2003 (ISBN 3-8055-381-2) 434 pages, hardcover. US\$198.25.

These are the full-text plenary lectures, symposia, and workshop presentations of the 17th International Congress of Nutrition of the International Union of Nutrition Sciences (IUNS) held in Vienna, Austria, August 26–31, 2001. The 180 papers cover the full range of topics in modern nutrition. This large and well-presented volume has 306 authors, 179 figures, 165 tables, and 434 pages. Author and subject indexes and organization by theme make the papers accessible. The volume is useful not only for the wide range of topics presented, but also for identifying contemporary nutrition leaders throughout the world.

Nutritional biochemistry of the vitamins. 2nd edition. David A. Bender. Cambridge University Press, Cambridge, U.K., 2003 (ISBN 0-521-80388-8) 512 pages, hardcover. US\$100.00.

As knowledge of the vitamins continues to expand, it is useful for nutrition and health workers to have available authoritative and comprehensive reviews of current available information. This is the second edition of a book that explores the biochemical function of each vitamin, including the effects of deficiency and excess and their role in optimum health and well-being. It provides a compact and authoritative reference volume of value to students and specialists in nutrition. Its value is enhanced by its coverage of gaps in knowledge and of areas where more research is required. Written by a single author, it has an admirably uniform approach and coverage in each chapter.

The final chapter covers a series of marginal compounds and phytonutrients, including carnitine, choline, creatine, inositol, taurine, ubiquinone, and phytochemicals in plant foods of potential biological significance. The chapters are well organized, with multiple subheads, and the many tables and figures are well conceived. In addition to references in the text gathered in a single bibliography at the end, each chapter has suggestions for further reading. This up-to-date review is a convenient reference for clinicians and nutritionists and an appropriate advanced text in nutritional biochemistry.

Physical activity epidemiology. Rod K. Dishman, Richard A Washburn, and Gregory W. Heath. Human Kinetics, Champaign, Ill., USA, 2004 (ISBN 0-88011-605-6) 488 pages, hardcover. US\$59.00.

A global epidemic of overweight and obesity is affecting most industrialized and developing countries. A major factor is steadily decreasing physical activity due to the changing lifestyles associated with the development process. Several good books give guidelines for exercise and strength training for the general public [1, 2]. However, the book under review here, written for students in nutrition, health, and related fields, is the first to take a comprehensive epidemiological approach to understanding the significance and importance of physical activity. It will help these readers to understand the risks of the diminishing physical activity associated with worldwide economic and social change.

It was not until 1980 that the US Public Health Service identified physical fitness and exercise as a means for improving human health. The first International Conference on Exercise, Fitness, and Health was held in 1988 and the second in 1992. In the same year (1992), the American Heart Association recognized activity to be an independent risk factor for atherosclerosis. The American Medical Association followed with a similar recognition in 1995. A report from the US Surgeon General in 1998 introduced the concept of physical activity epidemiology. Since then the field has developed rapidly, and physical activity has become recognized as an important means for improving health, whereas a sedentary lifestyle has been demonstrated to contribute to poor health.

This book provides an introduction to physical activity epidemiology, including origin, concepts, methods, measurement, and surveillance, as well as physical activity and disease mortality, risk factors, obesity, hypertension, cardiovascular disease, diabetes, osteoporosis, cancer, and the immune system. Each chapter has a good bibliography and a list of relevant Web sites. The book is intended "as a textbook for upper level undergraduates and master's degree students who are being introduced to activity epidemiology for the first time and as a reference text in courses in public health." It is well suited to these purposes.

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The epidemiology and treatment of childhood anemia in Western Kenya. Meghan Desai. Ph.D. Dissertation, University of Amsterdam, Netherlands, 2003 (ISBN 90-8170-745-2) 147 pages, softcover.

This Ph.D. dissertation consists of seven separate studies, each of interest to nutrition and health workers among populations in which malaria is an important factor. One study demonstrates the high overlapping of malaria, malnutrition, and diarrhea that is responsible for severe anemia among children 3 to 24 months of age and, therefore, the importance of starting preven-

tion in early infancy. Another shows that primary caregivers can be trained to recognize severe anemia (hemoglobin < 5 g/dl), although with only moderate accuracy. One of the studies finds that in this hyperendemic malaria area, daily administration of iron to preschool children for six weeks gives better hematological results than twice-weekly administration. In a final study, the author found no evidence for clinically relevant modifications by hemoglobin S phenotype in the results of iron supplementation of young children with anemia.

—Nevin S. Scrimshaw

5th Report on the World Nutrition Situation

This report makes the argument that nutrition has a crucial role to play as a key strategy in attaining many of the Millennium Development Goals (MDGs). Conventionally, nutrition is seen as integral to the first MDG, on hunger and poverty; however, nutrition is also instrumental in the achievement of goals for primary education enrollment, improved gender equity, reduced risk of child mortality, improved maternal health, and improved ability to combat disease. The report also provides examples of how to engage nutrition within existing development policies.

This report will be launched at the 31st Session of the Standing Committee on Nutrition at the United Nations on March 22–26, 2004. Copies of the report can be obtained from the SCN Secretariat (e-mail: scn@who.int) or downloaded from <http://www.unsystem.org/scn/Publications/html/RWNS.html>.

WHO update on global guidance in the area of HIV and infant feeding

To minimize vertical transmission of HIV infection from mothers to their infants through breastfeeding, the Interagency Task Team on Prevention of Mother-to-Child Transmission of HIV recommends for mothers who are known to be HIV positive*:

- » When replacement feeding is acceptable, feasible, affordable, sustainable, and safe, avoidance of all breastfeeding by HIV-infected mothers is recommended. Otherwise, exclusive breastfeeding is recommended during the first months of life.
- » To minimize HIV transmission risk, breastfeeding

should be discontinued as soon as feasible, taking into account local circumstances, the individual woman's feeding situation, and risks of replacement feeding (including malnutrition and infections other than HIV).

- » When HIV-infected mothers choose not to breastfeed from birth, or stop breastfeeding later, they should be provided with specific guidance and support for at least the first two years of the child's life to ensure adequate replacement feeding.
- » Programs should strive to improve conditions that will make replacement feeding safer for HIV-infected mothers and families.

While clear guidance is available for complementary feeding of breast-fed infants after 6 months of age, there have been requests for better information regarding feeding of infants of HIV-positive mothers who stop breastfeeding early. In response, WHO's Department for Child and Adolescent Health and Development, in coordination with the Departments of Nutrition for Health and Development, HIV/AIDS Prevention and UNICEF Headquarters, conducted informal consultations with experts and commissioned a technical review of alternative feeding options considering various scenarios (including where other milks and animal source foods are available and where they are not). The review forms the basis of an informal meeting to discuss practical generic guidelines for feeding infants 6 to 24 months of age who are not breastfed and a process for their application in countries, 8–10 March 2004, in Geneva, Switzerland. As an outcome of the meeting, WHO is hoping to develop a new set of guidelines, complementary to the Guiding Principles for Complementary Feeding of the Breastfed Child**, that can guide program managers in identifying adequate feeding recommendations that are affordable and feasible for caregivers, families, and communities to implement.

* WHO. New data on the prevention of mother-to-child transmission of HIV and their policy implications. Conclusions and recommendations. WHO technical consultation on behalf of UNFPA/UNICEF/UNAIDS/ Interagency Task team on mother-to-child prevention of HIV. WHO/RHR/01.28, Geneva: World Health Organization, 2000.

** Pan American Health Organization. Guiding Principles for Complementary Feeding of the Breastfed Child. Washington, DC: Pan American Health Organization, World Health Organization, 2002.

For more information on the outcomes of the meeting, please consult the Child and Adolescent Health website at http://www.who.int/child-adolescent-health/NUTRITION/HIV_infant.htm or contact Dr. Peggy Henderson (hendersonp@who.int) or Dr. Bernadette Daelmans (daelmansb@who.int).

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Iron-deficiency anemia

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4. American Medical Association, Department of Drugs. AMA drug evaluations, 3rd ed. Littleton, Mass, USA: Publishing Sciences Group, 1977.

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IDPAS: *Iron World V* CD

Accompanying this issue of the *Food and Nutrition Bulletin* is the compact disk *Iron World V*. The CD includes “captures” of the Iron Deficiency Project Advisory Service (IDPAS) web pages as of 1 January 2004.

The CD is intended primarily for professionals working in developing countries who do not have high-speed access to the Internet. Content focuses on iron nutrition, including more than 2,000 references for research reports, peer-reviewed articles from more than 30 mainly international journals, guidelines, and reports from UNICEF, WHO, FAO and other international organizations, bilateral agencies, technical groups, and professionals. Activities in more than 110 countries are included, along with many full-text articles based on generous agreement for use of copyrighted materials on this CD by many authors, publishers, and organizations.

The CD was produced by IDPAS, a project of the International Nutrition Foundation, with offices in the Friedman School of Nutrition Science and Policy at Tufts University in Boston Massachusetts, USA. Production of this CD and its distribution in the *Food and Nutrition Bulletin* are supported by the Micronutrient Initiative of Canada.

For further information, please go to the IDPAS web pages at www.micronutrient.org/idpas or contact IDPAS directly at idpas@inffoundation.org.