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Special Issue
Successful Micronutrient Programs
Guest editors: John Mason, Megan Deitchler, Soekirman, and Reynaldo Martorell

The Food and Nutrition Bulletin *encourages letters to the editor regarding issues dealt with in its contents.*

Food and Nutrition Bulletin, vol. 25, no. 1

United Nations University Press
Published by the International Nutrition Foundation for The United Nations University
53-70 Jingumae 5-chome, Shibuya-ku, Tokyo 150-8925, Japan
Tel.: (03) 3499-2811 Fax: (03) 3406-7345
E-mail: mbox@hq.unu.edu
ISSN 0379-5721
Design and production by Digital Design Group, Newton, MA USA
Printed on acid-free paper by Webcom Ltd., Toronto, ON Canada

Preface: Lessons from successful micronutrient programs

Vitamin A, iodine, and iron deficiencies continue to affect large numbers of people in most parts of the developing world. More than 40% of women in developing countries are reported to be anemic, nearly 20% of people in the developing world suffer from iodine deficiency, and approximately 25% of children in low-income countries are estimated to have marginal deficiencies of vitamin A [1]. The prevalence rates for micronutrient – vitamin and mineral – deficiencies are highest for Asian countries. In South Asia alone, 36% of children are estimated to have subclinical deficiency in vitamin A, 25% are estimated to have iodine deficiency, and 53% of preschool children are estimated to be anemic. The extent of multiple deficiencies in preschool children is estimated at 27 to 36% (49–60 million) in South Asia [1, p.38]. While prevalence rates are lower in the East Asia and Pacific regions (in many cases half that of South Asia or less), the problem of micronutrient deficiencies is nevertheless still severe; in East Asia/Pacific 18% of children are estimated to be marginally deficient in vitamin A, another18% to have deficiencies in iodine, and 14% to be anemic.

The effects of these deficiencies of vitamins and minerals can be extensive, affecting health, fitness, cognitive development, and behavior in individuals, and reducing national productivity and socioeconomic development in many countries [2]. The UN in the Millennium Development Goals recently affirmed the importance of achieving elimination or accelerated progress in reducing these deficiencies.

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

The study focuses on programs in South and South East Asia—in Bangladesh, Cambodia, China, India, Indonesia, Laos, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam; in addition, South Africa participated. The project involved a preparatory workshop in Bangkok in June 2001, and a satellite meeting at the International Union of Nutritional Sciences (IUNS) International Congress of Nutrition, Vienna, August 2001. At these meetings, participants from the different countries gave presentations on national programs for control of deficiencies in vitamin A, iodine, and iron. The topics were organized into program initiation, implementation, and impact. These presentations form the case studies section of this publication; summaries are given on pages 79–88 of this issue, with the complete texts of the case studies available at inffoundation.org. No summaries or texts are available from India and Myanmar.

National policies for addressing micronutrient deficiencies have been widely adopted among countries participating in the study. This may be compared with experience in other regions of the world. An earlier review in 2001 [1] reported that 28 out of 99 developing countries (28%) 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. For the countries studied here, 9 out of the 12 participating countries (75%) had, in 2002, adopted national policies for control of vitamin A, iodine, and iron deficiencies – thus these are more advanced in this aspect 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 data are available for drawing some conclusions on program effectiveness, although rigorous evaluation is scarce. Survey data on clinical or biochemical indicators of vitamin A, iodine, 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, were suitable for evaluation purposes. But synthesizing across countries, some plausible conclusions as to impact could be sought.

Participating project countries were asked to prepare a paper describing various aspects of the ongoing micronutrient programs in the country; these aspects range 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 from all project countries in order to draw conclusions about common steps to program initiation, successful factors for 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. The findings across countries have thus been synthesized to propose lessons and conclusions from these programs.

Iodine deficiency is clearly decreasing dramatically, largely as a result of the unprecedented achievement of iodizing the world's salt supply. Clinical vitamin A deficiency is becoming a thing of the past, plausibly accelerated by vitamin A supplementation to a large proportion of the developing world's children. Anemia is the least well known and needs new approaches. The results show that there has been a rapid expansion of micronutrient deficiency control programs, and that most of these have gone to scale successfully.

The overall aim of these papers is to provide an analysis that can be applied to making future programs more effective. On behalf of the Micronutrient Initiative, as the major sponsor, and the Department of International Health and Development at Tulane University, as the lead research institution and convener of the meeting on "Successful Micronutrient Programs," we hope that this process will help worldwide efforts to reduce and finally eliminate micronutrient deficiencies.

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Acknowledgments

This work was supported by grants from the Micronutrient Initiative (MI File: 5600-0007-35-300), "Multi-Center Initiative for Evaluation Research and Capacity Building for Micronutrient Deficiency Control Programs," and from the Centers for Disease Control and Prevention (S1508-20/20), through ASPH/CDC, "Successful Micronutrient Programs."

We thank all the participants in the workshop (Bangkok, June 2001) and the IUNS meeting (Vienna, August 2001), and especially the presenters, authors of the country papers, and colleagues in the different collaborating institutions in the 12 countries involved. We particularly acknowledge the intellectual and practical encouragement and support of Dr. Venkatesh Mannar (MI) and Dr. Ibrahim Parvanta (CDC).

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.

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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 intersectoral 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

	National survey			National committee, plan, and/or legislation			External assistance		
Country	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	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)	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 *posyandu* (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: Year of program initiation	Children: Mechanism for capsule distribution	Mothers: Year of program initiation (time after delivery for supplement)	Mothers: 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 (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	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 (*continued*)

	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. 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. Signs of clinical deficiencies, however, 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

* 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.

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*]
Vietnam	1995	Breastmilk retinol	Lactating women (subnational)	41.1[c]
	1998	Breastmilk retinol	Lactating women (subnational)	58.3[c]
	1997	Breastmilk retinol	Lactating women (subnational)	48.5[c]
	1998	Breastmilk retinol	Lactating women (subnational)	56.3[c]
	2000	Breastmilk retinol	Lactating women (subnational)	43.1[c]
	1995	Serum retinol	Preschool children (subnational)	15.0[b]
	1997	Serum retinol	Preschool children (subnational)	12.0[b]
	1998	Serum retinol	Preschool children (subnational)	10.8[b]
	1999	Serum retinol	Preschool children (subnational)	10.5[b]
	2000	Serum retinol	Preschool children (subnational)	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.

countries, there is recognition of the need for diversified 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

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	Thriposha (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.

somewhat weaker and varied among studies [10–12]. 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.

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, 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 did not report 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, Thriposha, 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 study. 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 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.

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.

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, 84 cities, 1,525 municipalities, and 41,940 barangays

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

(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 organizations (particularly UNICEF) was almost universal

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 subnational 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.

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 strategies in the national plans of action provided a long-

TABLE 7. Clinical survey data on iodine deficiency

Country	Survey year	Indicator[a]	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	20.4
	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)	18.0*
	1994	VGR	Children 6–11 yr (national)	33.1
	1997	VGR	Children 6–11 yr (national)	25.1
	1999	VGR	Children 6–11 yr (national)	12.2
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)	14.4*
	1989	TGR	School-aged children (17 districts)	18.8
	2000	TGR	Not reported	21.0
Thailand	1989	TGR	School-aged children (15 provinces)	19.3*
	1990	TGR	School-aged children (15 provinces)	16.8
	1992	TGR	School-aged children (39 provinces)	12.2*
	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. 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 [2]; 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
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.

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

* 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.

rates in the 1950s in those areas of the country for 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 often (compared to 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-aged 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 in pilot projects 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 were 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 an additional 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

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		Yes	Not reported
Cambodia	No	Yes	Women of childbearing age (2000, phased out)	Yes	Two provinces (1997)	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	School-aged children (year not reported)	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	School-aged children (year not reported)	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		Not reported		Not reported	Not reported
Sri Lanka	Yes	Yes	High-risk groups (1950s, phased out)	No		Yes	Not reported
Thailand	Yes	Yes	Pregnant women, women of childbearing age, and School-aged children in areas with IDD prevalence > 20% (2001)	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 μg folate 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 250 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, 250 μg 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	69.5*
	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 [2]; 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.

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 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

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	Yes (fortification of wheat flour explored)	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 multimicronutient-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.

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 μg of folate) are usually provided, although there is some 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 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.

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 degree 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

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 reported.

a. In China, one survey was conducted at a subnational level.

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 documenting 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, for iron, 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.

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

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Introduction

This series of three papers, "Lessons from Successful Micronutrient Programs," describes the establishment 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 at www.inffoundation.org, 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—Indonesia, 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) also recommends distribution of high-dose vitamin A capsules 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

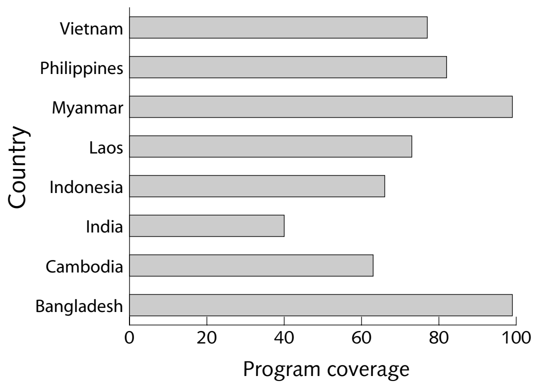

FIG. 1. Coverage of vitamin A programs for children according to country (most recent year for which data are available) Source: materials provided by study countries [2–15]. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients in India. 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	US$0.80/ capita/yr for VAC to children
Cambodia	Formerly VAC distribution with NIDs (now phased out); subsequently VAC distribution to children through routine EPI outreach; VAC distribution to women postpartum through health services and routine immunization outreach; home gardening; IEC activities	Coverage with NIDs for years 1995–96 reported as approximately 95%. Coverage with routine immunization outreach for March, July, and November 1999 and March 2000 reported as 70%, 69%, 63%, and 63%, respectively. Coverage of 47% shown by survey. Wide range of coverage reported among provinces (10%–55%) and within provinces (0%–100%). Coverage of postpartum women not reported	
China	No national vitamin A program implemented		
India	Vitamin A by liquid distributed to children 6–36 mo of age with UIP (1st dose with measles immunization, 2nd dose with diphtheria, pertussis, tetanus booster); subsequent doses to children < 5 yr of age provided by ICDS/health functionaries; home gardening; social marketing strategies	Low coverage of children reported for 1997. No state achieved more than 40% coverage for children receiving 1 dose of vitamin A	2,100 million Rs (US$ 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 Phabang 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 *Garantisadong Pambata*; 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 US$0.40/ 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 (Thriposha) 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; US$0.080/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.

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).

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 over 100 million capsules annually [14], 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.

* 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.

Insecure program sustainability

Some countries express concern about the sustainability 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 US$0.02 × total no. of children 0–5 years old × 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 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

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

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

Source: Poly O [3].

* 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.

days as a distribution system for vitamin A capsules, the challenge of maintaining high program coverage 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, 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 estimated 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 program coverage recorded during implementation.

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 Phabang 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 supply of 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 internationally. 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

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	US$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 multimicronutrient-fortified (iodine included) 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 *barangays* have passed local resolutions for iodized salt; IEC activities; supplementation to women of childbearing 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 57.7% in 1993, 85.7% in 1994, and 84.8% in 1995	Iodized salt, US$0.30/capita/yr; iodized oil capsules, US$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
Vietnam	Legislation for iodized salt since 1999; IEC activities; training of health, education, and salt personnel; monitoring and evaluation	Coverage of iodized salt program reported as 72.8% (≥ 20 ppm) in 1998 and 86.4% in 2000; 40%–90% (according to area) of households using iodized salt in 1996; 86% of salt produced was iodized	$0.05/capita/yr

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.

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 US$0.05 to US$0.50/capita/year 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%) were partially compensated for by the coverage of iodized oil capsules, in the early 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 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 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 carried out pilot projects or highly targeted small-scale projects for iodination of water. Thailand may be the only project country having an iodine-deficiency disorder program 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,

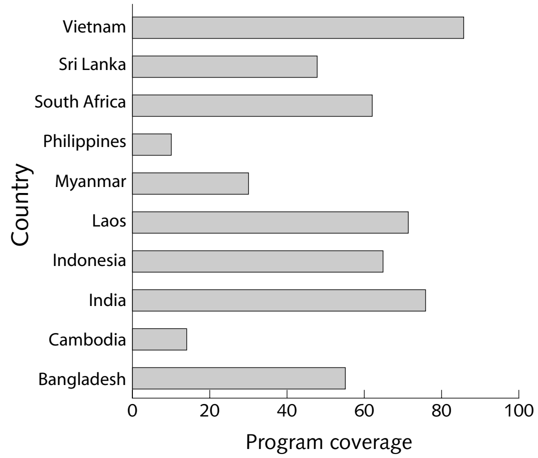

FIG. 2. Coverage of iodized salt programs according to country (for most recent year data are available)
Source: materials provided by study countries (refs. 2–12) and refs. 13–15. Also two unpublished country case studies: Vijayraghavan K (National Institute of Nutrition, Hyderabad). Micronutrients 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.

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

* 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.

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, 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 do not domestically produce 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].

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. 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

* 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.

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 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 [6]. 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-

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 μg folate) 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 350 μg 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 250 μg folate) 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

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 magnitude 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

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, 250 µg 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). US$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.

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 iron-supplementation 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—

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

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 countries 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 distribution 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. 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: 3 of the countries have collected nationally representative anemia data in pregnant women, and 8 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 (including 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 multinutrient 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 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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