Section IX

Sustaining Optimal Iodine Nutrition

John T Dunn

1. Introduction

Optimal iodine nutrition everywhere is the overall goal of the efforts described in this book. The initial attainment of iodine sufficiency is a satisfying milepost, but its value is greatly diluted if the achievement is not maintained. This lesson is underscored by the many countries that at some point made outstanding initial progress against iodine deficiency, only to have it re-emerge later.

Other chapters have focussed on the consequences of iodine deficiency, its extent, and current efforts to correct it. Here we address sustainability, including the criteria for assessing it (especially monitoring), country examples, national activities needed to achieve it, and the contributions of international partners. The chapter closes with a summary of current iodine nutrition in countries and future prospects.

2. Criteria for Monitoring Progress towards Sustainable Elimination

First, we need to assess whether a country has achieved iodine sufficiency, and then gauge its likely sustainability. The ICCIDD/UNICEF/WHO Report (2001) offered definitions and guidelines **(Tables 1 and 2)**. The three key features are satisfactory iodine nutrition, availability of adequately iodized salt, and evidence for their sustainability.

Nutritional iodine deficiency is defined principally by the median urinary iodine concentration in the population. Section IV, Table 2, lists levels of daily iodine intake recommended by the 2001 Joint Report. These are close to those of the Food and Nutrition Board (FNB), US National Academy of Sciences, and of other national and international expert groups (Thomson, 2002). The recommended tolerable upper limit of iodine ingestion has been put at 1100µg per day by the FNB, and 1000µg by WHO. Many people consume higher amounts without apparent ill effect.

Table 1. *Summary of criteria for monitoring progress towards sustainable elimination of IDD*

Indicators		**Goals**
Urinary Iodine	Proportion below 100µg/L	< 50%
	Proportion below 50µg/L	< 20%
Salt Iodization	Proportion of households using adequately iodized salt	> 90%

Programmatic indicators (see Table 2) at least 8 of the 10

Table 2. *Programmatic indicators for sustainable IDD elimination*

1.	An effective, functional national body (council or committee) responsible to the government for the national program for the elimination of IDD (this council should be multidisciplinary, involving the relevant fields of nutrition, medicine, education, the salt industry, the media, and consumers, with a chairman appointed by the Minister of Health.
2.	Evidence of political commitment to universal salt iodization and the elimination of IDD.
3.	Appointment of a responsible executive officer for the IDD elimination program.
4.	Legislation or regulations on universal salt iodization (while ideally regulations should cover both human and agricultural salt, if the latter is not covered this does not necessarily preclude a country from being certified as IDD-free).
5.	Commitment to assessment and reassessment of progress in the elimination of IDD, with access to laboratories able to provide accurate data on salt and urinary iodine.
6.	A program of public education and social mobilization on the importance of IDD and the consumption of iodized salt.
7.	Regular data on salt iodine at the factory, retail, and household levels.
8.	Regular laboratory data on urinary iodine in school-aged children, with appropriate sampling for higher risk areas.
9.	Cooperation from the salt industry in maintenance of quality control.
10.	A database for recording of results or regular monitoring procedures, particularly for salt iodine, urinary iodine and, if available, neonatal TSH, with mandatory public reporting.

Source: ICCIDD/UNICEF/WHO, 2001

Means for assessing iodine nutrition also appear in Section IV. Briefly, the median urinary iodine concentration in a representative segment of the population is currently the most practical assessment tool. Goitre palpation is occasionally useful especially with large thyroids, but is too crude for first-line evaluation. Field ultrasonography for thyroid size is precise, reliable, and recently standardized, so it is an acceptable alternative to urinary iodine concentration under some circumstances. Also, neonatal screening with TSH provides valuable information when collected as part of universal screening of newborns in a population. For most countries,

however, the urinary iodine concentration is the best marker, and has the added advantage of recognizing iodine excess as well as deficiency. (see Table 3 in Section IV for a classification of iodine nutrition status by median urinary iodine concentration).

2.1 Satisfactory use of Iodized Salt

The ICCIDD/UNICEF/WHO Report (2001) offers four 'preconditions:'

i) local production and/or importation of iodized salt in a quantity that is sufficient to satisfy the potential human demand (about 4-5kg/ person/year);

ii) 95% of salt for human consumption must be iodized according to government standards for iodine content, at the production or importation levels;

iii) at least 90% of food-grade salt from a representative sample of households should have an iodine content of at least 15mg/kg; and

iv) iodine estimation at the point of production or importation, and at the wholesale and retail levels, must be determined by titration; at the household level, it may be determined by either titration or certified kits.

These are, of course, general guidelines and need to be adapted to specific conditions. The recommendations about following the government standards imply that these standards are optimal, while, in fact, they are occasionally too high or too low. The figure of at least 15mg/kg at the household level will be inadequate for some people who consume low amounts of salt. The emphasis on titration as the better method for assessing the iodine content of salt is sound, but the kits as a qualitative indicator still have a place, specially in small production units.

Despite their necessarily arbitrary nature, these preconditions emphasize that the successful application of iodized salt requires adequate supplies and regular monitoring at production and consumption levels.

3. Programmatic Indicators for Sustainability

The 2001 Report listed 10 factors **(Table 2)** and suggested that at least 8 should be present to conclude that adequate iodine nutrition was sustainable. Not all will be applicable to each country, but they provide a useful checklist. The requirement of 8 is arbitrary and some can be waived if found inappropriate for a specific country. We discuss these below.

3.1 An Effective National Multidisciplinary Body Responsible for the IDD Elimination Program

The 2001 Report envisioned chiefly a group responsible to the government, and its chair appointed by the Minister of Health. Such a group exists in many countries, with varying degrees of effectiveness. Recently there has been considerable interest in an alternative model, a coalition or alliance of concerned citizens that exist independent (partly or completely) of the government. Several examples are given later in this chapter. They illustrate how unique features in each country determine a structure that will be successful. The overriding effort should be to have a multisectoral group that will provide permanent oversight and advocacy for optimal iodine nutrition.

3.2 Political Commitment to Elimination of Iodine Deficiency and USI

Because iodine nutrition, like other issues of public health, is ultimately its responsibility, the government must be involved. This requires not only endorsement of the goals of iodine sufficiency, but provision of the resources to support it. Unfortunately, the initial enthusiasm in many successful programs is followed by complacency and then neglect (Dunn 2000). Numerous examples attest to this statement (see later in this chapter). A national coalition can be invaluable in constantly urging the government and its oft- changing political leaders to keep iodine nutrition in constant view.

3.3 Appointment of a Responsible Executive Officer for the Iodine Nutrition Program

Someone in the government needs to be held accountable. A great danger is the diffusion of responsibility among several individuals or departments, until no one has it as a major concern. The frequent reorganizations within governments, especially in Ministries of Health, often cannibalize individual units and leave the IDD Program as a lifeless and quickly forgotten cipher. This is less likely with an appointed executive whose career is judged by his performance with the IDD Program.

3.4 Legislation and Regulations on USI

Most countries have laws and regulations for iodized salt, and many have additional legal instruments for other aspects of the IDD program

and its monitoring. Often they stem from existing food or product regulations covering additives or industry standards, and their application is not smoothly tailored to iodization. Laws for salt iodization should not be too narrow, such as in designating a particular level of iodine in salt, because they may make adjustments on technical issues more cumbersome. Better to have a broad law mandating iodized salt for human and animal consumption, and leave technical details to later enabling regulations by the Minister of Health or other functionary, without a new Parliamentary act. The legislation should designate responsibility for the program and require periodic reporting of its status. The law should also provide means for its enforcement.

3.5 Commitment to Assessment and Reassessment of Progress, with Access to Appropriate Laboratories

Like the previous three Indicators, this guideline demands governmental commitment, here to monitoring. As such, it is an extension to Indicator #3.2 above. Assessment requires access to adequate technical means for measuring iodine in salt and urine, and periodic surveys and analyses of their data.

3.6 A program of Public Education

Section VI has described the importance of education and communication in successful campaigns against iodine deficiency. Several countries, e.g., the United States, Japan, and Great Britain, have achieved iodine sufficiency through "silent prophylaxis," chiefly from the unregulated content of iodine in dairy products, meat, and other sources. For many other countries, iodized salt is the major source of iodine, and strong consistent measures must be taken to ensure its acceptance and use. Target groups for education include governmental policy makers, the health sector, the salt industry, educational authorities, and members of the community at large. Sustainability is best achieved if all these sectors understand the consequences of iodine deficiency and the importance of its correction with iodized salt. The communication messages should be tailored to the particular target and be appropriate for the culture. Periodic assessment for level of understanding helps refine the message and re-invigorate its application.

3.7 Regular Data on Salt Iodine at Various Levels

This indicator deals further with monitoring, here of iodine in salt. Two techniques are available. The "titration method" is the standard for quantitative assessment. Details of the technique differ depending on whether iodate or iodide is used for salt iodization. In either, free iodine is liberated from the salt, and its reaction with starch produces a blue color. On titration with thiosulfate, the blue color disappears, and the amount of iodine in salt can be calculated from the amount of thiosulfate required to produce the color change. This method requires only chemicals, no special instruments, and provides a quantitative number. Each sample must be treated individually.

A simpler alternative is the use of qualitative kits. These also rely on the blue color produced by the reaction of iodine with starch, by treating a small amount of salt with several drops of a testing solution of starch and other reagents. Many versions of these kits have been used around the world. Some provide semi-quantitation, but most are reliable only for indicating the presence or absence of iodine in salt. This information is satisfactory for many applications, but should be backed up by titration. In salt plants and testing laboratories, the titration method should be used. For advocacy purposes, such as children bringing salt samples in from home, the kits are effective.

The iodine content of salt should be monitored at several levels, most importantly at production and at consumption. Producers should regularly check the iodine content of their salt as an ongoing quality assurance measure during processing. This is routine with large producers but more difficult for small producing units, frequently only a single family on a small farm. Results should be recorded and available to inspectors.

The government should also monitor the levels of iodine in salt. Typically salt inspectors visit plants, review records of internal quality control, take random samples and send them for analysis by titration in a government laboratory. Inspectors can also carry the qualitative kits for on-the-spot checks.

Salt inspectors should also routinely collect samples in the market place, and if possible, in homes. Collection should be regular and random, and samples submitted promptly for analysis. The government program responsible for iodine nutrition should oversee the analysis of samples and review the findings, inform producers of the results, and investigate any deviations from the prescribed standards for iodine content. Many countries have penalties for samples that do not meet specifications, and these should be enforced.

Countries that import iodized salt should check its iodine content at their borders, and refuse entry to batches that do not meet specification. Strong enforcement of these regulations has proven highly effective.

3.8 Regular Laboratory Data on Urinary Iodine Levels in School-Aged Children, Pregnant Women and Infants

The median urinary iodine concentration is the most valuable indicator of iodine nutrition. Current methods require less than 1 ml of urine, and samples are stable in tightly sealed tubes for couple of months, even at ambient temperature. Techniques for measurement vary from sophisticated research instruments to simple manual and semiautomatic methods that can be carried out in routine chemistry laboratories.

Surveys should use the simplest and most practical means to obtain enough information to delineate the current status and make appropriate decisions. School children have usually been studied (see Section IV).

Recent work suggests that urinary iodine data from school children may underestimate the iodine nutrition of pregnant women in the same community. Because iodine deficiency produces its gravest impact during pregnancy, this possibility is of great concern. In the NHANES study from the United States (Soldin 2003) the mean urinary iodine concentration in pregnant women was about 50µg/L lower than that in 6-11 year olds and a large survey from China showed a similar difference (Yan Yuquin, personal communication). Iodine nutrition in pregnancy is complicated by the increased needs of both mother and foetus, a lower renal threshold for iodine (Smyth 1997) and occasional medical restriction of salt intake, so the minimal median values for urinary iodine of 100µg/L for iodine-sufficiency in adults should be increased to at least 150µg/L for pregnancy. In addition to these measures, data on urine iodine in breastfed infants, as well as on the iodine content of breast milk, would also provide information during the further period of brain vulnerability in the first year of life.

Occasionally, survey teams visit households to obtain data for several health and socioeconomic conditions. When these take place, urine and salt samples can easily be collected and used for assessing iodine nutrition as well.

The selection of schools or households to visit requires careful attention to ensure that those surveyed represent the population being studied. Epidemiologic techniques for proper selection are available and

should be carefully considered. Iodine deficiency is typically more prevalent in females in poor rural remote communities and they must be adequately represented in surveys. Children from such communities may have lower school attendance and thus may be overlooked. Pockets of iodine deficiency may also be obscured if surrounded by large areas of relative iodine sufficiency. A standard technique is cluster sampling, often applied to other health surveys. It typically includes 30 clusters, selected by appropriate statistical conditions of randomness, to be representative of the community (see further 2001 Joint Report).

An additional approach is designation of sentinel sites, to be followed serially for changes in iodine nutrition. These should be chosen to be representative of the area or situation being monitored.

3.9 Cooperation from the Salt Industry in Maintenance of Quality Control

The business of the industry is to make and sell salt. Public health issues such as salt iodization are not its primary responsibility. However, most salt producers are quite willing, and often eager, to advance a national goal like elimination of iodine deficiency, as long as it does not damage their business. Common problems, real or potential are:

i) increased cost for the producer, especially in technology upgrade and cost of iodine;
ii) unfair competition from non-iodized salt;
iii) onerous inspections and regulations; and
iv) lack of consumer support. These concerns must be recognized and dealt with.

The added cost of iodization varies greatly. Iodine itself is fairly cheap. The major expenses occur with upgrading the quality of salt as part of the iodization step, and with changes in distribution networks. Some countries have only a few producers, with sophisticated technology at large sites, or import all their salt; for them, insertion of an iodization step is simple and inexpensive, and their product can be sold with minimum increase in price.

Other countries have many small salt production sites, occasionally with only one or a few workers, where the technology is primitive and the crude product is sold locally at low cost. Introducing iodization is a major challenge in such an industry, and predictably, these countries have the most difficulty in implementing the use of iodized salt. The government

and international donors can help by providing training, forming cooperatives for iodization, and offering upgraded technology.

Salt producers feel penalized if they obey an iodization law while their competitors provide less expensive non-iodized salt. The government must enforce its iodization laws for all producers, to make the playing field level. The law should stipulate iodization of salt for domestic animals as well as for humans, both because the animals also need adequate iodine and because the presence of cheaper non-iodized salt in the market, ostensibly for animals, offers a tempting alternative for inappropriate human use.

The national regulations must be reasonable and not burdensome for the producers. The government should patiently explain the purpose and procedures of the program, address their concerns, and work with them towards a true partnership that will be mutually satisfactory. Many programs have failed because the government imposed laws without considering the interests of the producers, who then resisted and made the program ineffective.

Industries, including the salt trade, respond to the demands of consumers. If the consumer wants iodized salt, the producer will supply it, or else his competitor will. Thus, a key component of a governmental program is to educate the consumer and create a market for iodized salt. This follows from Indicator # 3.6 above.

Obtaining the cooperation of the industry, as is now being facilitated by the recently established Network for the Sustainable Elimination of Iodine Deficiency, is important (Section III). It is also necessary to see that the product meets quality control standards, as already discussed with Indicator #3.7 above.

3.10 Databases for Monitoring, and Mandatory Public Reporting

This topic follows from Indicators #3.7 (iodized salt) and #3.8 (urinary iodine) discussed above. A regular system of data gathering and analysis is critical for any public health issue, including iodine nutrition. The data on salt can be gathered from producers as part of their quality control procedure and from sampling by health inspectors. Routine analysis will enable early recognition of products that deviate from the accepted standards of iodine content, and lead to prompt remedial action. Often working with the producer to solve technical issues will be satisfactory; otherwise enforcement measures may be necessary.

Data on urinary iodine concentrations should be collected as detailed above, at least every several years from representative groups of the population, with special attention to those from poor, remote, and rural regions, where iodine deficiency is most likely to persist. If neonatal TSH screening is already being used nationally to detect congenital hypothyroidism, analysis of its data for the appearance of transient hypothyroidism can provide valuable information about iodine nutrition, with little added cost (see further Section IV).

Mandatory public reporting of these data is extremely important. Statistics moldering in a government office have no value unless they assist evaluation of programs. Public release of information reminds the government and citizens about iodine nutrition and how their country is progressing. National coalitions should constantly demand these reports to keep the issue in view. The 'wheel model' is fully discussed in Sections II, VII and in the ICCIDD/UNICEF/WHO Report (2001).

4. National Coalitions: Some Examples

We have mentioned National Coalitions above under Programmatic Indicator #1 of the Joint 2001 Report **(Table 2)**. Their formation is one of the best ways to achieve sustainability. This importance and the many ways, in which they can evolve, justifies further discussion and some examples.

Health issues such as iodine nutrition are the responsibility of the individual country, so success in dealing with them depends on local factors. International agencies and aid organizations can offer advice and seed money, but maintaining optimal iodine nutrition must ultimately be overseen by the country and its government. However, governments and their personnel change, occasionally violently, and these conditions make it easy for a country's iodine nutrition to sink out of sight and thus severely threaten its sustainability.

National coalitions can direct continued attention to iodine nutrition and the means for making it optimal, usually iodized salt. The structure of coalitions can vary to complement the individual circumstances of a particular country. The principal point of variation will be the level of government involvement. Because public health (and therefore iodine nutrition) is its responsibility, the government must be involved to some extent. However, the government has many other issues and priorities to face, with the inherent danger that iodine nutrition may be lost to official view unless some group keeps it constantly in focus.

In one format, the national coalition consists of prominent citizens from involved sectors who have sustainable optimal iodine nutrition as their major goal. Ideally, the coalition should include all relevant sectors– health, industry, education, the media, the affected communities, mothers, human rights advocates, civic organizations, and others. The specific make-up depends on the strengths and interests of the various available groups. The most important element is the commitment and concern of coalition members. In some countries, it works most effectively as an independent adviser to the government. In this form, it can withstand the inevitable changes in governments and their policies. Such a coalition must work with the government, because the government has the ultimate responsibility.

In another format, the government is a principal member of the coalition, and may even take the lead. This is acceptable as long as changes in governmental policy and personnel do not bring the work of the coalition to an abrupt halt.

Examples of national coalitions are as varied as the countries they represent.

South Africa developed a Network with representatives of the Directorate of Nutrition and the Directorate of Food Control of the National Department of Health, UNICEF South Africa, and the Nutritional Intervention Research Unit of the Medical Research Council (Jooste 2002). While other members, such as salt producers and the general public, may soon be included, their interest in the IDD problem must first be gained. The South African network is coordinating IDD activities and mutual exchange of information among members to jointly strengthen the national salt iodization program. It has developed a plan of action, and its activities are particularly focused on supporting the salt industry towards optimal iodization of salt, by developing training activities, education, and information.

Switzerland has a Fluorine-Iodine Commission of the Swiss Academy of Medical Sciences, a nongovernmental body whose ten members represent a wide spectrum of prominent public health officials, dentists, thyroidologists, food chemists, pharmacologists, and salt manufacturers (Delange et al 2002). The Commission meets regularly, reviews new data on developments in iodine nutrition and iodized salt production, and makes proposals to the Federal Commission of Nutrition (a government entity), which in turn writes a Swiss Nutrition Report about every four years, including a section on iodine. From this, proposals are made to the government with recommendations for any necessary legislation.

The Russian Federation held a large national conference of iodized salt producers and distributors late in 2002, organized by the National Salt Producers Association in collaboration with the Ministry of Health, and the Russian Academy of Medical Sciences, with support from UNICEF, and attended by salt producers, distributors, and representatives of government ministries, academia, NGO's, and the media (Gerasimov 2002). One outcome was a public council consisting of representatives of the salt industry, government agencies, and public organizations, to coordinate joint efforts towards IDD elimination.

In ***Croatia***, the Ministry of Health in 1992 established a National Committee for Eradication of Goitre and Control of Iodine Prophylaxis (Kusic 2003). The Committee is chaired by a leading thyroidologist, who directs the Department of Nuclear Medicine at the University Hospital in Zagreb. Other members are the Head of the Department of Sanitary Inspection at the Ministry of Health, a legal assistant from the Ministry of Health, a representative of the Public Health Institute, a representative of the veterinary faculty, and a director of the largest salt plant in the country. The Committee's charge was to "control iodine prophylaxis in the territory of the Republic of Croatia, propose necessary measures to eradicate goitre, issue recommendations for health workers and other involved professionals, and participate in the preparation of relevant regulations." The Committee has conducted surveys resulting in new compulsory regulations for salt iodization at 25mg/kg for both human and animal consumption.

An interesting historical example comes from ***Uruguay***, where a National Committee, composed of four professors (Pediatrics, Endocrinology, Preventive Medicine, and Epidemiology) was appointed in 1953 (Salveraglio 1974). Its formation sprang from a visit by the Health Minister to the country's north, where be noted goitres in schoolchildren as they sang the national anthem. This experience led him to create the Committee, whose members donated their time. They conducted surveys, developed a program for use of potassium iodide pills and iodized salt, and organized explanatory meetings for health authorities, teachers, civic groups, religious leaders, industrial organizations, salt dealers, service organizations, the press, and other media. The Committee members also noted other health problems including poor environmental hygiene, inadequate housing, lack of milk, poor child nutrition, and avoidable dental caries. They urged that these problems be addressed by epidemiologic, medical, and social measures, and by establishing additional health centers throughout the country to obtain public health action and gain

cooperation of communities interested in solving their own problems. Their efforts led to a bill passed in 1963 on compulsory iodization of salt, which was easily accepted by the public because the Committee had provided proper health education for the community.

In ***Argentina***, the Federated Endocrine Societies, a professional organization of clinicians and academicians interested in the thyroid and other endocrine organs, has formed a Committee for IDD Control that has systematically evaluated the status of iodine nutrition in the country's provinces (Niepomniszcze 2003). This organization operates entirely independently of the government, but publishes its findings and discusses them with national and provincial health authorities. The Committee also plans education for students and the general public, and is exploring neonatal screening to monitor iodine nutrition. Some support for its activities comes from a manufacturer of thyroid medicines.

A common feature of these various forms of national coalitions is the dedication and commitment of important citizens. The ICCIDD seeks out such individuals, appoints them as National Representatives, and encourages them to form national alliances with appropriate partners. This approach re-enforces the primary responsibility of the country for its optimal iodine nutrition rather than depending on international agencies, and offers the best hope for long-range success.

5. Country Examples of Sustainability Issues

Each country is unique, and so, too, are the conditions that affect its attainment of permanent optimal iodine nutrition. Here are examples that show some of the issues involved and offer lessons for other countries.

5.1 Guatemala

The country had longstanding severe iodine deficiency, especially in the mountains, with a national goitre prevalence of 38% in 1952 (Dunn 2002). A highly effective salt iodization program initiated in the 1950s brought the prevalence down to 5% by 1965. By 1973, the country declared that goitre (i.e. iodine deficiency) had been eliminated. Monitoring relaxed, and by 1987 the goitre prevalence rose to 21% and the urinary iodine fell to 42µg/L. The government regained interest, salt iodization improved, and by 1995, the median urinary iodine range was back at an acceptable level, 220µg/L. However, control of salt iodization once more became lax in the late 1990s, and by 1999, the median urinary iodine was 72µg/L, and cretinism re-appeared.

5.2 China

As described in Section VIII of this book, many parts of the country had severe iodine deficiency (Delange et al 2002). Several surveys in the early 1990s showed its extent, leading to a National Advocacy Meeting organized by the State Council in 1993, attended by top leaders, governors, and different sectors from the national and provincial levels as well as by international organizations. Next, the Chinese government and all provinces pledged the elimination of IDD by the year 2000. It established a Central Coordination and Leading Group, with a National IDD Advisory Committee for technical support and scientific consultation. The National IDD Advisory Committee and the Chinese Center for Endemic Diseases Control led efforts for technical training and scientific consultation. Each year they conduct a national re-advocacy meeting, reviewing survey data and making any necessary adjustments. Guidelines for the next decade are developed at these meetings.

5.3 Bolivia

The entire country had severe iodine deficiency with goitre prevalence in the 60% range and frequent cretinism. An impressive program with iodized salt and iodized oil led to iodine sufficiency by 1996, with median urinary iodine of 252µg/L and household consumption of iodized salt reached 92%. An external review committee then concluded that the country was iodine sufficient. Subsequently the situation deteriorated. Changes in government and personnel led to decreased monitoring and a general loss of interest. By 2000, household use of iodized salt was down to 62%, and the median urinary iodine was in the deficient range (ICCIDD 2001).

5.4 Iran

Iodine deficiency was severe in many parts of the country (Azizi 2001). Surveys by university groups and the government in the 1980's led to a decision in 1989 to accept IDD as a priority health problem, and salt iodization began in 1990. National surveys have taken place regularly; the most recent in 2001, showed a median urinary iodine of 165µg/L and more than 95% of households consuming adequately iodized salt. The program meets all the indicators for sustainability set by ICCIDD/UNICEF/WHO Report 2001. It has an effective and functional national body that

is responsible to the government for the elimination of IDD. This multidisciplinary council involves the fields of nutrition, medicine, industry, education, and others. The government's political commitment continues. A responsible executive officer is in charge, legislation on salt iodization has been enforced, and an active education program is integrated into the health network with full participation of rural health workers. Data on iodized salt are collected regularly at the factory, retail, and household levels in each province and analyzed by the National Committee. Surveys of urinary iodine concentration are conducted in each province yearly and every five years nationally. All results are kept in a database in the Ministry of Health. A major feature of this highly successful program has been the longstanding collaboration between dedicated leaders in the Ministry of Health and a University Endocrine Unit in Teheran (see Section VIII).

5.5 United States of America

Iodine deficiency was probably never severe, but endemic goitre was frequent in inner parts of the country, especially the Midwest and Northern Pacific region (ICCIDD 2001). Goitre among adolescent girls and during pregnancy was common enough to be considered normal. Goitre from iodine deficiency was reportedly the most frequent cause for military service rejection in the First World War among young men in northern Michigan. Iodized salt was introduced on a voluntary basis in the 1920s, while it became mandatory in neighboring Canada. In the 1950s, iodate was introduced as a bread conditioner in the baking industry and the mean daily iodine intake in the country rose (this practice has since been largely discontinued). A large national survey in the 1970s showed the median urinary iodine concentration to be 321µg/L, but a repeat study in the early 1990s showed a decrease, to 145µg/L (Hollowell et al 1998). The most recent data, from 2001, report a median urinary iodine of 162µg/L. About 70% of table salt is iodized, but the bulk of daily salt intake comes from prepared foods, which are typically not iodized. Most ingested iodine comes from dairy products and other sources, and is unrecognized and unregulated. The country is currently iodine sufficient, but the contribution of iodized salt is minor. There is no national program, although regular monitoring is currently being done by the Center for Disease Control, a government unit.

5.6 Comments on Examples

The program in Iran is one of the world's most successful at this time, and has provided optimal iodine nutrition for over five years. Its cardinal feature is the commitment of the government and dedicated individuals to keep it effective. China is another success story that has emphasized the role of monitoring, with regular review of the results and appropriate action taken afterwards. Guatemala and Bolivia are developing countries that created impressive initial successes in achieving iodine sufficiency, only to slip backwards later, due in part to absence of monitoring and political will. The United States has achieved iodine sufficiency but by "silent prophylaxis"; its iodine nutrition is unregulated and largely unknown. No national program exists and occasionally medical and other groups comment on iodine nutrition, but there is no national coalition, nor much interest in the issue. The dramatic changes in iodine nutrition over two decades show the effects of market and cultural forces, and emphasize the need for regular monitoring to avoid return of deficiency.

6. What is needed for Sustainability? : Country, Regional and Global

6.1 At the Country Level

The key elements are described above. Iodine nutrition is essentially a country issue, and must be solved at the national level.

6.2 At the Regional Level

Factors beyond a country's borders influence its iodine nutrition. Salt is traded extensively across national and provincial boundaries, and its regulation, especially its iodization, profoundly affects iodine nutrition. If salt is iodized before importation, the levels must comply with national laws, which may be different from those in the country of origin. Thus, a major regional goal is agreement among neighboring countries on the amounts of iodine to be added to salt, so that uniformly iodized salt can move freely across national borders. At the present time, the iodine levels in salt specified by various countries range from 0 to 100mg/kg. Europe is a hodgepodge of national regulations governing the amount and type of iodine added to salt. Some countries in East Africa iodize at 100mg/kg iodine, while most others are around 30mg/kg. As trade barriers

lower, the regulations among neighboring countries should be harmonized. For most purposes, iodization at 30mg/kilo is reasonable and can be taken as a baseline for further refinement.

Another variable is the salt used for food processing. It is not typically iodized in most countries in North America and Western Europe, but is in many countries in Eastern Europe. In countries such as the United States, most daily salt intake comes from processed foods, not from what is added in the kitchen or at the table, so harmonization of practices regarding iodized salt in food processing should also be addressed. Economic partnerships such as the European Union and ECOWAS are appropriate bodies to address consistency of these regulations.

Regions can also pool resources for monitoring and other cooperative activities. Full-scale national iodine monitoring laboratories are not always practical for many countries, especially smaller ones. The International Resource Laboratory for Iodine (IRLI) Network, created by the US Center for Disease Control, WHO, UNICEF, the Micronutrient Initiative, and ICCIDD, has designated 12 regional laboratories for measuring iodine in urine and salt. These can provide service and training for countries in their regions and form the basis for a network for quality control in monitoring. Countries can also share educational material in specific languages and exploit other common opportunities to promote effective iodine control programs.

6.3 At the Global Level

Activities at the global level should support countries in their efforts to achieve optimal iodine nutrition. Areas include monitoring, advocacy, education, communication, and research.

6.3.1 Monitoring

Global databases of progress in countries keep track of where the overall effort stands, identify countries that need more help, and track progress towards the stated goals of the UN on the virtual elimination of iodine deficiency. ICCIDD has one such database on its website, with individual listing for each country (www.iccidd.org). Both WHO and the Micronutrient Initiative are also developing databases to appear on their respective websites. UNICEF has collected data on iodized salt use, also available on the web. The ICCIDD website includes summaries of the

current status of each country with frequent updates. Its tables and maps summarize current knowledge of global iodine nutrition from currently available information, and emphasize gaps in knowledge about many countries. The global community including ICCIDD, WHO and UNICEF can urge countries to implement effective monitoring systems, and can support their development.

6.3.2 Advocacy

Country programs need advocacy both nationally and internationally. The global community can urge governments to give proper emphasis to iodine nutrition and iodized salt, and ask international donors and NGO's to encourage country efforts.

6.3.3 Research

The fields of iodine nutrition and its implementation are advanced, relative to many other health issues, but much remains to be learned and improved. Examples are simpler, less expensive ways to assess iodine nutrition, additional means for iodine supplementation, association of iodine nutrition with other health issues, such as HIV, and documentation of socioeconomic consequences. Research on issues such as these can advance knowledge and improve program efficiency, and also foster valuable investigative experience in developing countries.

6.3.4 Education

Iodine deficiency and its correction need to be understood in order to motivate people towards effective programs. Targets should include all who may be involved–high government officials, government technical people, health workers, agriculturists, schoolteachers, students in schools, the media, and the general public. Education must be individualized to suit the characteristics of a particular country, but common principles, materials, and support can be provided by the global community. Education can also be directed at the international community itself, to improve understanding of iodine nutrition and its correction and to make it more supportive of efforts in affected countries.

6.3.5 Communication

Members of the global community should communicate with each other, to improve efficiency and promote effective collaborations. As this book shows, many international organizations are involved in the

global effort to promote optimal iodine nutrition. These include UN agencies, especially WHO, UNICEF, and the World Bank; bilateral donors, especially CIDA, AusAID, the Dutch Foreign Ministry, USAID; non-government organizations, like ICCIDD, the Micronutrient Initiative, Kiwanis International, and the Network for Sustained Elimination of Iodine Deficiency; and professional groups, such as salt producers, medical associations, and various others. Each of these organizations has its own mandates, areas of interest, and priorities. Communication among them is essential to avoid duplication and to apply resources in the most effective way. Several fora for communication exist, such as the UN Standing Committee on Nutrition and the Global Network. Linkages among organizational websites and publications such as the *IDD Newsletter* also promote coordination. These efforts should be institutional in nature, because personnel and priorities change.

7. Role of International Partners in Sustainability

Section III details activities of major members of the global partnership for iodine sufficiency. More can be found on their websites. Here we emphasize their role in promoting sustainability.

7.1 United Nations and Bilateral Aid Agencies

The major UN partners have been UNICEF, WHO, and the World Bank. The United Nations and member governments have pledged the virtual elimination of iodine deficiency by the year 2005. UNICEF has been charged with taking the lead in this for the UN. Both UNICEF and WHO have representatives and staff in each country, with units that cover health and nutrition, and both have made correction of iodine deficiency a high priority. It will be important that they sustain their efforts by promoting appropriate monitoring and encouraging national coalitions, so that the impressive achievements so far will not be lost.

The aid programs of many countries have contributed to various phases of the IDD elimination effort, especially Australia, Canada, Japan, the Netherlands, Sweden, and the United States. Aid has taken different forms, such as fortification projects, training, publications, and support for implementing organizations, like UNICEF, WHO, the Micronutrient Initiative, and ICCIDD. Support from some (e.g., AusAID, CIDA, the Netherlands) has been consistent for more than a decade. International aid agencies are subject to the policies of the governments they represent, and their resources, priorities, and personnel change over time.

Donors prefer to support projects for fixed periods. As they look for new areas to support, iodine nutrition runs the danger of being downgraded in importance. Donors also like to support projects that become self-sustaining. While some foreign aid will continue to be available, countries must adopt approaches that will eventually support themselves. For example, to be sustainable, a salt iodization program must be acceptable to producers and consumers, and have appropriate enforcement and monitoring. A program may reasonably receive external support for its initiation, but it must eventually run by itself without dependence on foreign aid. This requires the development of practical policies and attitudes that ingrain iodized salt use into the national way of life.

7.2 Nongovernmental Organizations

7.2.1 ICCIDD

Consisting largely of volunteers from many different disciplines and counties, ICCIDD has the single purpose of achieving optimal iodine nutrition for the world. Its goal and personnel have been fairly stable since 1985. With national representatives and members in most countries, ICCIDD has a flexibility and singleness of purpose not found in the larger organizations. However, its resources are limited and its major activities will be to offer technical advice, advocacy, and information, and to encourage countries and larger agencies to remain vigilant against iodine deficiency. Its databases and publications should help to keep iodine nutrition in constant view.

7.2.2 Micronutrient Initiative

It has made major contributions in the fight against iodine deficiency, especially in the area of fortification, which continues to be an important priority. Current efforts are directed more towards vitamin A and iron, but iodine is still an interest. It also maintains databases, and these should help draw attention to countries where the IDD control program becomes threatened.

7.2.3 Kiwanis International

IDD elimination was its first worldwide service project, for which it raised over $75 million, mostly channeled through UNICEF. While the major part of that fundraising project is now completed, Kiwanis will retain an interest in the impact of its donations, and its continued involvement should be strongly encouraged.

7.3 Professional Groups

7.3.1 Salt producer

Associations of salt producers, both national and international, have been strong partners in efforts so far. At the 8th World Salt Symposium in 2000, industry leaders recognized their responsibility for delivering the product and services necessary for achieving and sustaining the elimination of iodine deficiency. That meeting led to the formation of the Network for the Sustained Elimination of Iodine Deficiency, whose members include three groups of salt producers (the European Salt Producers Association, the Salt Institute, USA, and the China Salt Company) as well as other partners like UNICEF, WHO, ICCIDD, the Micronutrient Initiative, Kiwanis, Emory University, and the US Centers for Disease Control. This interest on the part of the salt industry must be strengthened and maintained in order to assure sustainability. The importance of iodized salt should appear regularly at meetings of producers to keep the issue constantly in view.

7.3.2 Medical associations

Endocrinologists and thyroid specialists have had a longstanding interest in iodine nutrition, because they see its effects on the thyroid daily in their clinical practice. In many countries, physicians have been among the first to point out the presence and severity of iodine nutrition and to call for its correction. Some international meetings, such as the International Thyroid Congresses, have noted the continuing presence of IDD and called on their members to encourage governments and others to work towards its elimination. ICCIDD and its partners have sponsored symposia at regional and international thyroid meetings to review IDD status and urge further corrective measures. Efforts are being made within some of the Regional Thyroid Associations to embed iodine nutrition as a routine agenda item requiring regular review and reporting. Continued awareness in this professional group is key to recognizing and correcting deviant iodine nutrition in countries and regions.

Other medical groups should also remain aware of iodine nutrition and consider ways they can improve it. Examples are nutritionists, public health workers, maternal and child health professionals and primary care physicians. Iodine deficiency affects individuals seen in all of these specialties and an awareness of it and of the necessary corrective measures can contribute greatly to the overall effort.

7.4 Networks

Several alliances of organizations dealing with iodine nutrition exist, for example, the Network for the Sustained Elimination of Iodine Deficiency, the International Resource Laboratories for Iodine (IRLI) Network, and the UN Standing Committee on Nutrition. Each of these provides a forum for reviewing current progress and problems in combating iodine deficiency, and they need to remain vigorous to advance sustainability.

8. Current Status and Prospects for Sustainability

The world has made great inroads against its iodine deficiency in the past two decades. For example, a 1987 review of Africa found that the status was unknown in 15 countries and that 97% of the rest were deficient. Fifteen years later, 53% were still deficient, but now 45% were sufficient and the status of only one was uncertain.

Table 3 summarize, available information on the world's iodine nutrition (details by geographical area at www.iccidd.org). It classifies countries following the scheme recommended by ICCIDD/UNICEF/WHO (2001), based on median urinary iodine concentration. Countries are labeled "deficient" when a substantial fraction (not necessarily a majority) of the population lives in areas of iodine deficiency and risks its consequences. Correspondingly, a country is called "sufficient" if most people are getting enough iodine, although certain areas may still be deficient. Data for many countries are incomplete and occasionally absent; among other things, this table emphasizes the need for more detailed information.

Table 3. *Global Iodine Nutrition*

	Population (in millions)	**Countries**
Deficient	3,034 (50%)	84 (53%)
Sufficient	2,839 (47%)	72 (45%)
Excess	210 (3%)	3 (2%)
Unknown	6 (<1%)	1 (<1%)

Countries and their population are assigned to specific categories if a substantial segment (not necessarily a majority) have, or are likely to have, deficient or excessive iodine nutrition, usually based on UI data.
Source: ICCIDD, 2003; www.iccidd.org

The table suggests that about one-half of the world's population still lives in countries that have a substantial degree of iodine deficiency. Most countries do not have effective monitoring systems, and educational efforts have been insufficient. As stated earlier, monitoring and education are two of the crucial elements for sustainability, so the world needs to greatly accelerate its efforts. This becomes a race against time, both to meet the goal of 2005 as pledged by the United Nations General Assembly, and also to develop mechanisms for sustainability in countries while iodine nutrition still has the attention of governments and international agencies.

Successes in some countries, e.g., Iran, China, Cameroon, Peru, show that sustainable optimal iodine nutrition is possible. The three greatest threats to sustainability are inadequate monitoring, changing personnel and priorities, and failure to embed IDD control (usually through iodized salt) into the country's way of life. These challenges can be met, as shown by these examples, but they demand accelerated efforts on the part of all, especially the countries themselves.

9. Summary

Once iodine sufficiency is obtained, its sustainability depends on monitoring of iodine nutrition and iodized salt, education, national coalitions, designated responsibility, and reporting of data. The urinary iodine concentration is the most useful monitoring tool. Country examples of sustainability issues include Guatemala and Bolivia, where initially impressive achievements subsequently declined, China, which has periodic re-advocacy meetings and a strong national committee, Iran, where an effective partnership between academic endocrinologists and the Ministry of Health has produced a carefully monitored and highly successful program, and the United States, whose silent prophylaxis is largely uncontrolled. In addition to the key elements listed above at the country level, sustainability at the regional level needs harmonization of iodized salt regulations, and pooling of resources for monitoring and education. Important activities at the global level are country databases, advocacy, research, education, and communication. Partners include UN agencies, bilateral donors, non-governmental organizations, professional groups such as salt producers and health associations, and networks.

Currently, about one-half of the world's countries have significant degrees of iodine deficiency, although the majority within each country

may not be deficient. For these countries, the first priority is to achieve iodine sufficiency. In addition, all countries should look to the sustainability of their efforts so that the achievements are not lost in the future. Recurrence of iodine deficiency has occurred in many countries in the past. It is avoidable, but only if countries and their partners take the necessary measures to ensure sustained iodine sufficiency.

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