Tracking Progress Towards Sustainable Elimination of Iodine Deficiency Disorders in Rajasthan

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Contents

1) Introduction to Iodine Deficiency Disorders

Iodine deficiency is the most common cause of preventable brain damage in the world today[1]. Studies conducted all over the world have revealed that 130 countries are affected by iodine deficiency, with a total population in excess of 2 billion at risk of of brain damage[2]. Since 1990, substantial progress in the elimination of brain damage has been made with two thirds of households all over the world having access to iodized salt by 2000. With the UN General Assembly Special Session for Children (UNGASS) (May 2002) adopting the goal of Virtual Elimination of IDD by 2005, it is imperative that all countries intensify efforts to eliminate it. The focus is shifting form iodine deficiency as a cause of goitre to iodine deficiency as the single most common cause of brain damage worldwide.

Iodine Deficiency and Brain Damage

Iodine Deficiency in humans occurs because people live in an environment where the soil has been leached of iodine due to flooding of river valleys or in hilly and mountainous areas by high rainfall or glaciation. The deficiency in the soil leads to deficiency in all forms of plant life, including all cereals grown in the deficient soil **(Fig 1)**. Therefore, populations living in systems of subsistence agriculture particularly in the developing countries, as in the great river valleys of Asia, suffer greatly from iodine deficiency[3].

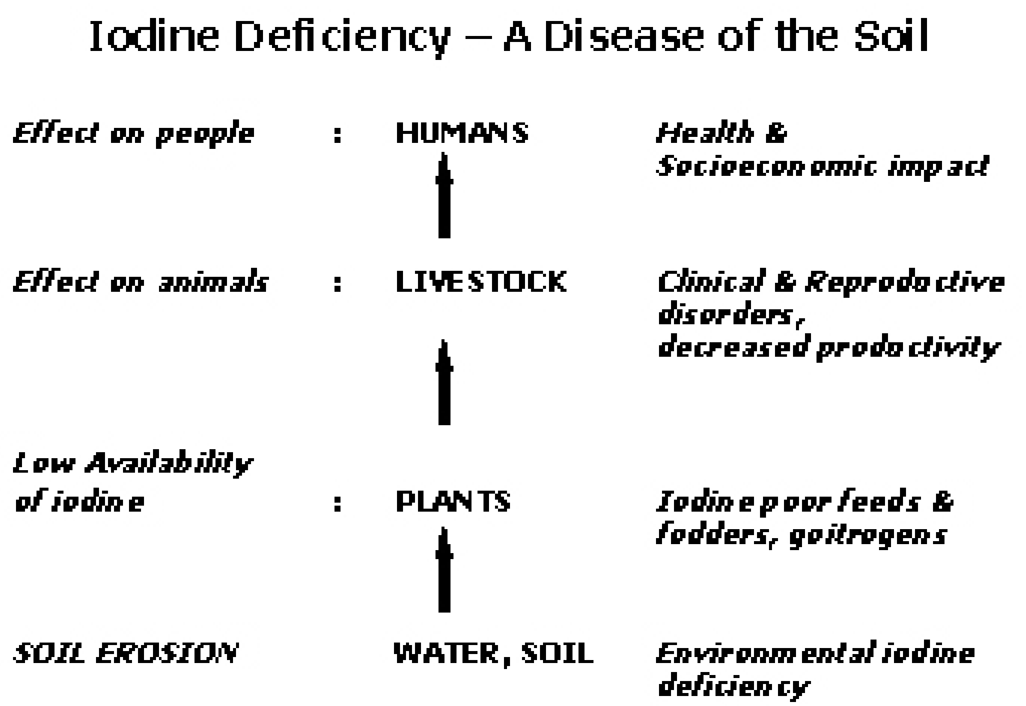


Fig. 1: In effect, Iodine Deficiency is a disease of the soil where the environmental deficiency results in the manifestation of the disease state in humans, perched on the top most level of the food chain.

Iodine is an essential element for human and animal development because it is a constituent of the thyroid hormones, thyroxine (T4) and triiodo-thyronine (T3). The significance of thyroid hormone in animals is best illustrated by the example of the frog. The metamorphosis of the larval tadpole into the adult frog will not occur without the thyroid hormones. In iodine deficiency, the thyroid gland enlarges to form a goitre, an enlargement of the thyroid gland to maintain the level of thyroid hormones in the blood but eventually the level falls with increasing effects on the development of the brain and other organs. The role of iodine deficiency as a cause of brain damage has been established by clinical and epidemiological studies and with the study of animal models.

The relation between iodine deficiency and brain damage was known since the medieval times, but it was in the 1960s that the problem was rediscovered in various parts of the world – in Latin America (Brazil); Africa (the then Zaire and now Republic of the Congo); The People's Republic of China and Papua New Guinea[4]. Endemic Cretinism is of two types – neurological and myxedematous. Neurological cretinism results from iodine deficiency in the first half of pregnancy, while the myxedematous type occurs with severe iodine deficiency in late pregnancy. Studies in Papua New Guinea showed that iodized oil (a preparation of iodine in poppyseed oil) could be used for correction of iodine deficiency[5, 6]. Subsequently the prevention of cretinism and stillbirths was demonstrated by the administration of iodized oil before pregnancy in a controlled trial in the Western Highlands of New Guinea[7], which was subsequently accepted worldwide[8]. To further establish the relation between iodine deficiency and foetal brain development, use of animal models in the sheep, the primate marmoset monkey and in the rat showed significant effects of iodine deficiency in slowing foetal brain development in all three species[3]. These studies established that the prevention of brain damage was possible by correction of the iodine deficiency before pregnancy.

This led to the coining of the term "iodine deficiency disorders (IDD)" to refer to all the effects of iodine deficiency on growth and development in a human and animal population, which can be prevented by correction of the iodine deficiency. The term IDD has now been adopted throughout the world, including adoption by the Chinese without translation! The effects of iodine deficiency are delineated in **Table 1**

Table 1: The Spectrum of the Iodine Deficiency Disorders (IDD)

FOETUS	Abortions Stillbirths Congenital anomalies Neurological cretinism: *mental deficiency,* *deaf mutism, spastic diplegia, squint* Myxoedematous cretinism – *Mental deficiency, dwarfism, hypothyroidism* Psychomotor defects
NEONATE	Increased perinatal mortality Neonatal hypothyroidism Retarded mental and physical development
CHILD & ADOLESCENT	Increased infant mortality Retarded mental and physical development
ADULT	Goitre with its complications Iodine-induced hyperthyroidism (IIH)
ALL AGES	Goitre Hypothyroidism Impaired mental function Increased susceptibility to nuclear radiation

Adapted from: Hetzel 1983[9]

The most common effect of iodine deficiency apart from goitre is the loss of mental and physical energy due to hypothyroidism. This condition sometimes called cerebral hypothyroidism can be reversed by correction of the iodine deficiency. This condition is associated with a reduction in the level of circulating thyroid hormone leading to the lethargy commonly observed in endemic populations. The correction of iodine deficiency produces a dramatic reversal of the condition of cerebral hypothyroidism due to restoration of brain thyroid hormone levels. This is a different effect from brain damage during pregnancy, which is not reversible but completely preventable.

A meta-analysis of 18 studies in which comparison was made between iodine deficient populations and a socio-culturally matched control population, revealed that the mean score for the iodine deficient group was 13.5 IQ points below that of the non-iodine deficient groups[10]. This data further indicate the major population dimension of the effect of iodine deficiency on neuropsychological development.

Social and economic effects result from iodine deficiency in both human and animal populations. In humans there is reduced school performance in children and reduced productivity in adults and reduction in goitre. There are also significant effects on all livestock with impaired reproduction in poultry, sheep, goats and cattle, with reduced wool growth and milk production and reduced rates of survival in offspring[11, 12]. Such effects indicate that correction of iodine deficiency has direct economic benefits for humans and livestock, that is critical for agrarian economies, the developing countries.

The Magnitude of IDD

In 1999, WHO estimated that, of its 191 Member States, 130 had a significant IDD problem, with a total of 741 million people affected by goitre – or 13 percent of the world's total population (**Table 2**). Given that goitre represents the tip of the IDD iceberg, it is likely that a much greater proportion of the population suffers from other aspects of IDD. While the struggle to conquer the IDD started in the early years of this century, it is the last decade that has seen the greatest progress. Progress has been particularly fast in Asia and Africa.

Table 2: Current Magnitude of IDD by goitre by *WHO Region (1999)**

WHO Region	Population**	Population affected by goitre	
	Million	Million	% Of the Region
Africa	612	124	20%
America	788	39	5%
South East Asia	1, 477	172	12%
Eastern Mediterranean	473	152	32%
Europe	869	130	15%
Western Pacific	1, 639	124	8%
Total	**5, 858**	**741**	**13%**

4) WHO Global IDD Database. To be published.
** Based on UN population Division (UN estimates 1997).

In 1999, WHO in collaboration with UNICEF and ICCIDD did a review of the IDD global situation[13]. Of the 130 countries with IDD, 98 (75%) now have legislation on salt iodisation in place, and additional 12 have it in draft form. The latest data from each of WHO's regions is summarized in **Table 3**.

Table 3: Current Status of Salt Iodisation Coverage by WHO Region (1999)*

WHO Region	Percentage of households with access to iodised salt
Africa	63%
Americas	90%
South East Asia	70%
Eastern Mediterranean	66%
Europe	27%
Western Pacific	76%
Overall	**68%**

4) Total population of each country multiplied by the % of households with access to iodised salt. Numbers then totalled for each Region and divided by the total Regional population.

In **Table 4**, the latest data on the status of monitoring programmes in the various WHO Regions are summarised[13].

Table 4: The Status of IDD, Legislation and Consumption of Adequately Iodised Salt in WHO-SEARO Member Countries

WHO Region	Countries with IDD (No)	Legislation in place	Households consuming iodised salt (%)	
			51-90%	> 90%
Africa	**44**	**34 (6*)**	**19**	**3**
Americas	**19**	**17**	**6**	**10**
South-East Asia	**9**	**7 (1*)**	**5**	**1**
Eastern Mediterranean	**17**	**14**	**6**	**3**
Europe	**32**	**20 (3*)**	**4**	**2**
Western Pacific	**9**	**6 (2*)**	**3**	**1**
Total	**130**	**98 (12*)**	**43**	**20**
Total %	**100%**	**75% (9% *)**		

Additional countries with legislation in draft form

As can be seen, 110 (84%) of the 130 countries in the WHO regions have legislation, either in force or in a draft form.

Therefore, the magnitude of IDD is immense, providing one of the major challenges in international health today.

Pregnancy and Iodine Metabolism

The main changes in thyroid function associated with the pregnant state are increased thyroid hormone requirements. These increased requirements can only be met by a proportional increase in hormone production that directly depends upon the availability of dietary iodine. When the iodine intake is adequate, normal "physiological" adaptation takes place. When the intake is restricted, physiological adaptation is progressively replaced by pathological alterations, in parallel with the degree of iodine deprivation, leading to excessive glandular stimulation, hypothyroxinemia, and goiter formation. Thus, pregnancy acts typically as a revelator of underlying iodine restriction and gestation results in an iodine deficient status, even in conditions with only a moderately restricted iodine intake, characteristic of many European regions[14].

There is now direct evidence that early maternal hypothyroxinemia alters histogenesis and cerebral cortex cytoarchitecture of the progeny[15]. Thyroid function is frequently altered during pregnancy, when three synergistic mechanisms stimulate the thyroid gland[16]:

a) Direct stimulation by the human chorionic gonadotropin
b) Stimulation by TSH which rises because the higher thyroxine-binding globulin concentration lowers the free thyroxine
c) The overall enhancing role of limited iodine availability

Due to these reasons the recommended daily intake of iodine has been set at 200 μg/day, as per the guidelines realeased by WHO/UNICEF/ICCIDD. Under conditions of borderline iodine intake, pregnancy is accompanied by a progressive decrease of serum free T4 and consequently by an increase of serum TSH. This state of chronic TSH hyperstimulation results in the development of goiter in about 10 % of the pregnant women and in a progressive increase in the serum concentration of thyroglobulin. Goiter can persist after pregnancy in an important number of women. Pregnancy, especially in conditions of borderline iodine intake, at least partly explains the higher frequency of thyroid problems in women than in men. The role played by iodine deficiency in causing elevated serum levels of TSH and thyroglobulin in cord blood than in the mothers and a slight enlargement of the thyroid gland is demonstrated by the fact that they are prevented by iodine supplementation of the mothers during pregnancy[17] and that they do not occur in iodine replete areas in Europe such as The Netherlands[18].

Iodine deficiency during pregnancy has important repercussions for both mother and fetus, namely thyroid underfunction and goitrogenesis. Furthermore, iodine deficiency may be associated with alterations of the psychoneuro-intellectual outcome in the progeny. The risk of an abnormal progeny's development is further enhanced because mother and offspring are exposed to iodine deficiency, both during gestation and the postnatal period. Because iodine deficiency is still prevalent in many European regions and remains a subject of great concern, investigators have proposed, since several years, that iodine prophylaxis be introduced systematically during pregnancy, in order to provide mothers with an adequate iodine supply[14]. There are concerns with salt intake in pregnancy, hence we have to look at additional means to ensure the iodine intake in pregnant women, and consequently their progeny, is optimal. One option is the administration of multi-vitamin tablets containing iodide supplements.

As long as USI is not systematically implemented in Europe, special attention has to be devoted to the protection of the two main target groups to the effects of iodine deficiency, i.e. pregnant and nursing women, neonates and young infants[19]. If iodine deficient, these age groups should be supplemented with physiological quantities of iodine, for example by including iodine to the multivitamins prepared for them. Moreover, the iodine content of formula milk should be increased in Europe above the classical recommendation of 5 μg/dl.

The main impact of iodine deficiency is on pregnant and lactating women and young infants due to the role of maternal, fetal and neonatal hypothyroxinemia in the development of brain damage resulting in irreversible mental retardation[20]. In addition to programs of salt iodization in iodine deficient populations, iodine supplementation to these target groups have to be considered temporarily in iodine deficient populations until programs of salt iodization have insured normal iodine stores within the thyroid of females during the child bearing age and consequently of the pregnant and lactating women and of their fetuses and young infants.

Assessment of the IDD Status of the Population

The three main indicators used for assessment of iodine status in a population are:

- Urinary iodine excretion
- Total Goitre Prevalence
- Coverage of Adequately Iodised Salt

Urinary Iodine excretion

Urinary iodine excretion is a good marker of the very recent dietary intake of iodine (over the past 48 hours) and, therefore, is the index of choice for evaluating the degree of iodine deficiency and of its correction. After careful study, it was decided that iodine concentrations in casual urine specimens of children or adults provide an adequate assessment of the population iodine nutrition, so the need for twenty-four hours urine samples, which are difficult to obtain, was obviated. For epidemiological studies, the distribution of urinary iodine is required rather than individual levels. Urinary iodine values fluctuate in an individual and within individuals, causing the frequency distribution of urinary iodine to be skewed towards elevated values. Hence, the median urinary iodine excretion is used, instead of the mean, as an indicator of the status of iodine nutrition.
Table 5 shows the epidemiological criteria presently recommended for assessing iodine nutrition based on median urinary iodine concentrations.

Table 5: Epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentrations in school-aged children

Median urinary iodine (μg/L)	Iodine Intake	Iodine Nutrition
< 20	Insufficient	Severe Iodine Deficiency
20-49	Insufficient	Moderate Iodine Deficiency
50-90	Insufficient	Mild Iodine Deficiency
100-199	Adequate	Optimal
200-299	More than adequate	Risk of iodine-induced Hyperthyroidism within 5-10 years following introduction of iodized salt in susceptible groups
>300	Excessive	Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease)

From WHO/UNICEF/ICCIDD (2001)

Urinary Iodine Excretion in Pregnancy

There have been many debates on the cut off for urinary iodine excretion in pregnancy. A recent paper by Delange[21] revaluates the iodine requirements during pregnancy, lactation and the neonatal period, and proposes new range of values for the urinary iodine cut offs. Based on a review of literature, he proposes that the median urinary iodine indicating optimal iodine nutrition during pregnancy, lactation and neonatal period should be in the range of 150 – 230 µg/L.

Total Goitre Prevalence

The size of the thyroid gland changes inversely in response to alterations in iodine intake, with a lag interval that varies from a few months to several years. The prevalence of goitre is an index of the degree of longstanding iodine deficiency and, therefore, is less sensitive than urinary iodine in the evaluation of a recent change in the status of iodine nutrition[1]. Thyroid size is traditionally determined by inspection and palpation. However, the evaluation of the prevalence of goitre based on palpation has been questioned because the reproducibility of assessment by palpation is low, especially with the size estimation of smaller glands, particularly in children[13]. **Table 6** shows the revised and simplified classification of goitre.

Table 6: Revised classification of goitre

Classification	**Description**
Grade 0	No palpable or visible goitre
Grade 1	A goitre that is palpable but not visible when the neck is in the normal position (ie the thyroid is not visibly enlarged). Thyroid nodules in a thyroid which is otherwise not enlarged fall into this category
Grade 2	A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated

From WHO/UNICEF/ICCIDD (2001)

The prevalence of goitre in an iodine replete population is below 5 percent.

Coverage of Adequately Iodised Salt

Coverage of Adequately Iodised Salt is an index of iodine nutrition that has to be evaluated in conjunction with the other two indicators. For IDD Elimination to be achieved, four conditions have to be met[1]:

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
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 general guidelines and need to be adapted to specific conditions in the countries. The government standards may vary depending upon the per capita consumption of salt. The emphasis is also 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, especially in small production units. They are also valuable as advocacy tools.

Correction of iodine deficiency

An iodine deficient environment requires the continued addition of iodine, which is most conveniently and cheaply achieved by the addition of iodine to the salt supply. Salt is consumed at approximately the same level every day, throughout the year by the population. It has been calculated that the average intake of salt in India is about 10 grams per person per day. With the addition of 15 milligram of iodine to one kilogram of salt (15 parts per million), the person receives a minimum of 150 µg of iodine. This is dependent on the efficiency of the mixing procedure, and the stability of iodine in salt during transportation and storage. Thus, a micronutrient like iodine can be introduced through salt at a uniform dosage every day. Most humans eat salt in roughly the same amount each day. A decrease in salt intake, as advised to people suffering from cardiac disease, can be readily met by increasing the iodine content. Where a significant amount of processed food is consumed, it is important that the salt used by the food industry in preparing such food is iodised as well.

Universal salt iodisation (USI), which ensures that all salt for human and animal consumption is adequately iodised, has been remarkably successful in many countries[22]. But sustainability of this successful correction of iodine deficiency is now a challenge.

In some remote regions of the world, like mountainous and hilly areas, the supply of salt may not be regular. In these cases, it may be difficult to ensure that the salt being consumed is adequately iodised. In such areas, other options for correction of IDD may have to be considered:

- Administration of iodised oil capsules every 6-18 months[23];
- Direct administration of iodine solutions, such as Lugol's iodine, at regular intervals (once a month is sufficient);
- Iodisation of water supplies by direct addition of iodine solution or via a special delivery mechanism.

With the changes in the administrative structure and policy makers, the process of education and awareness has to be a continuous process. Otherwise a successful programme will lapse as has occurred in India (Kangra Valley, Himachal Pradesh), Bolivia, Ecuador, and Guatemala [24, 25].

Universal Salt Iodisation

It is well recognised that the most effective way to eliminate IDD and sustain it thereafter is through Universal Salt Iodisation (USI). Adequate iodisation of all salt will deliver iodine in the required quantities to the population on a continuous and regular basis.

National salt iodisation programmes are now applied worldwide and have followed a common pattern of evolution:

- *Decision Phase:* Enable a decision supported by industry mobilisation, standards and regulation.

- *Implementation phase:* Ensure infrastructure for iodisation and packaging of all human and livestock salt. Support with quality assurance, communications, regulation and enforcement is ideal.

- *Consolidation phase*: Once the goal of universal iodisation is achieved, it needs to be sustained through monitoring and periodic evaluation; the latter may include international multidisciplinary teams.

A successful national salt iodisation programme depends on the implementation of a set of activities by various sectors, the stakeholders in the Iodine Deficiency Disorders Control Programme (IDDCP):

- Government ministries (legislative and justice, health, industry, agriculture, education, communication and finance);
- Salt producers, salt importers and distributors, food manufactures;
- Concerned civic groups;
- Nutrition, food and medical scientists and other key opinion makers.

Coordination and communication between these various groups needs to be established on a priority basis before the IDD elimination goal is reached and sustained forever.

The salt producers and distributors are important players in ensuring that IDD is eliminated. Protecting the consumers requires a framework to be in place that will ensure the distribution of adequately packaged, labelled, iodised salt and the setting of this framework is the main responsibility of the government. Ensuring a demand for the product and understanding the reason to insist on only iodised salt is a *shared responsibility* of the private salt marketing system, the government and civic society. The establishment and maintenance of such an alliance and all of the associated programme elements will determine the success and sustainability of the programme. A guideline has been developed as a useful tool to aid the review of all aspects of a salt iodisation programme[16]. This guideline, however, will need to be modified according to the particular country situation.

Criteria for Tracking Progress towards Sustainable Elimination of IDD

ICCIDD/UNICEF/WHO has set out criteria for tracking progress towards sustainable elimination of IDD. This is outlined in **Table 7** and **Table 8**. **Table 7** lists the biological indicators, while **Table 8** lists the programme indicators, which must be met for an area to be declared free of IDD.

Table 7: Impact Indicators for Tracking Progress Toward Sustainable Elimination of IDD

Indicator	Criteria
Urinary Iodine	
Median urinary iodine	>100 μg/L
Proportion below 100 μg/L	< 50 %
Proportion below 50 μg/L	< 20 %
Salt iodisation	
Proportion of Households consuming adequately iodised salt	> 90 %

Table 8: Programme Indicators for Tracking Progress Toward Sustainable Elimination of IDD

Programme Indicators
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

Sustainability

The remarkable progress of universal salt iodisation in the current decade poses the issue of sustainability. Indeed, sustainability is absolutely critical. IDD cannot be eradicated, only eliminated. IDD is a nutritional deficiency that is primarily the result of deficiency of iodine in soil and water. It can therefore reappear when the Iodine Deficiency Disorders Control Programmes are not monitoring the progress of the disease.

Communications are integral to all actions: to ensure understanding of the problem; to understand the role of each agency; to understand the need for constant quality control and assurance procedures, processes and products; to sustain the need for financial and other support once begun.

There are three major components to consolidate the elimination of IDD and to sustain forever:

- Sustained Political support
- Administrative infrastructure
- Assessment, Monitoring and Communication system

1) Political support

This refers primarily to support at governmental level through the Minister of Health and the Executive Group of Government (Cabinet or equivalent). Political support for the elimination of IDD depends on community awareness and understanding of the problem. Political support is essential for the passage of laws or regulations on salt iodisation through the legislature. Since governments change, the mechanism to ensure continuity must be in place.

2) Administrative Arrangements

The National Body responsible for the management of IDD control programme should operate within the ambit of a body dedicated to the optimal functioning of the program. The administrative body should comprise members from all the stakeholders, including the salt producers and salt traders. The body should meet at regular intervals to assess the progress made with the interventions in the national program, to make mid-course corrections in program implementation. The mandate of the national body is to set goals, advice the national government on policy matters, and devise and implement interventions to ensure that the set goals are met.

3) Assessment, Monitoring and Communication system

It is necessary to have adequate supply of the thyroid hormone, ensured through a regular intake of dietary iodine, to prevent brain damage in the foetus and in the young infant, when the brain is in the rapidly growing phase. Whether the effectiveness of a national programme is providing an adequate amount of iodine to the target population is reliably assessed by reference to measurements of salt iodine (at factory, retail and household level) and urine iodine (measured in casual samples from school age children either at school or at household level). Additional contributing measurements are estimation of thyroid size and blood tests. All these procedures require internal and external quality control in order to ensure reliability of the data collected.

In order to be effective, there needs to be a surveillance and monitoring system comprised of:

- **Laboratories** for measurement of salt iodine and urine iodine, which must be available at country and regional level with some support from international laboratories for quality control.

- **Production quality assurance charts and databases** at country level for recording the results of the regular monitoring procedures

The above must be backed up by the provision of adequate resources including money, trained manpower, materials and equipment that are required to support the implementation of salt iodisation and the establishment of monitoring systems.

2) Background and Rationale for the present study

Rajasthan Scenario

Rajasthan is located in the western part of the Indian subcontinent. With a large area of the state being covered by an arid desert, it was thought that the IDD situation in the state would be adequate. However, there has been no representative statewide study on iodine deficiency disorders, using objective established criteria, conducted in the state. The prevalence rates from the various districts is outlined in **Table – 9**.

The state has a IDD Cell managed by a Technical Officer deputed from the state Government. There is also a laboratory under the control of the Technical Officer. The IDD cell has among its staff an administrative assistant and a laboratory assistant.

Table 9: IDD in Rajasthan

No.	Name of the District	Survey conducted by	Base-line survey year	Goitre Prevalence (in%)
1	Kota	DGHS	1987	13.1
2	Udaipur	DGHS	1989	10.9
3	Bikaner	DGHS	1990	22.9
4	Bikaner	DGHS	1995	20.5

Apart from obtaining statewide estimates of IDD, it was also important to get data on the knowledge, attitudes, practices and behavior of the people about problem of IDD and use of iodised salt, by using qualitative methods. This would help us to understand the current situation with respect to IDD indicators and also the people's perception about IDD and iodised salt. This study was conducted with the idea that its results would also provide options in deciding the future course of action regarding IDD elimination in Rajasthan.

As an exploratory part, this study also looked at the distribution of urinary iodine among pregnant women in the state of Rajasthan.

3) Objectives and Methodology

Study Objectives

The primary objective of this study was to track progress towards elimination of IDD in the state of Rajasthan, quantitatively, using clinical and biochemical indicators. Additionally, the perception of various stakeholders regarding IDD was enquired about by using qualitative research methods.

The specific study questions were:

5.1) What is the current status of Iodine Deficiency Disorders in Rajasthan?

5.2) What is the current status of Iodine Deficiency Disorders among a sub-sample of pregnant women from the selected clusters?

5.3) What is the availability and cost of adequately iodised salt at the retail shops in Rajasthan?

5.4) What are the community's perception towards Iodine Deficiency Disorders, salt and iodised salt?

Methodology

The methodology followed for the study was the one recommended by WHO/UNICEF/ICCIDD and accepted internationally.

Study Design

The study was a cross-sectional community based field study. The Probability proportionate to size (PPS) 30 Cluster methodology was used for sample selection. The method of PPS selection is described in **Annexure – 1**. The clusters are listed in **Annexure – 2**. The study population was selected by house-to-house visit, the methodology of which is described in **Annexure – 3**.

Study Population

Forty school-age children in the age group of 6-12 years were selected from each cluster providing a total sample size of 1200 children in the 30 clusters surveyed.

Parameters studied

Clinical Parameters studied:

The enlargement of the thyroid gland was graded, as per the recommended WHO/UNICEF/ICCIDD Classification, as Grade 0, 1 and 2. A half-day demonstration workshop of the method of goitre examination was conducted. The teams were asked to examine children at the workshop so as to reduce intra-observer and inter-observer variability. In case there was uncertainty in grading of goitre, it was decided to record a lower grade.

Biochemical Parameters studied:

(i) Urinary Iodine:

Urinary iodine excretion is the best available indicator of iodine nutrition in a population. On-the-spot casual urine samples were collected in wide mouthed plastic bottles from all the study subjects at the households. The 1560 urine samples (from 1200 children and 360 pregnant women) were then transported to the Department of Health, Government of Rajasthan, Jaipur, and stored in a refrigerator. They were then transported to the ICCIDD Reference Laboratory in New Delhi for analysis by the simple microplate method for estimation of urinary iodine concentration[26].

(ii) Iodine in Salt

A total of 1153 salt samples were collected from the households of the study subjects. They were packed in sealed plastic bags and then transferred to the Department of Health, Government of Rajasthan, Jaipur.

They were then transported to the ICCIDD Reference Laboratory in New Delhi for analysis by titration. Similarly, 75 salt samples were also collected from retail shops in the 30 clusters. The iodine content of salt consumed at the household level was thus determined by the titrimetric method[27].

Qualitative Component:

Socio Economic Questionnaire:

A pre-tested household socioeconomic interview schedule, with components on knowledge, attitude, practices and beliefs about IDD and Iodised salt, was prepared. The interview schedule had both coded and open ended questions. The interview schedule was administered by the field survey physicians in the local dialect and the answers were translated into English and recorded into the boxes. A total of 1200 schedules were administered.

Sample size determination for the survey

The sample size was based on the following formula for cluster sampling:

$$\text{Sample size} = \frac{Z^2\ p\ q\ (DEFF)}{d^2}$$

q = (1-p)
DEFF = Design effect
d = Level of absolute precision

Therefore, with:

Estimated goitre prevalence	**:**	**20.5%**
Proportion of population consuming adequately iodized salt	**:**	**45.3%**
Confidence level	**:**	**95%**
Absolute precision	**:**	**± 5%**
Design effect	**:**	**3**
Total sample size	**:**	**1142**
No. of children to be examined	**:**	**~ 1200**
Number of clusters	**:**	**30**
Sample size (Number of children) per cluster	**:**	**40**

A sub-sample of 360 pregnant women from the 30 clusters was also selected to determine the distribution of urinary iodine in the population.

Selection of households & children, and pregnant women

After the selection of clusters, the households and the target population (children in the age group of 6-12 years and the pregnant women) were selected randomly using the standard techniques used in Expanded Programme on Immunization (EPI) surveys. Only one child was selected per household; If there were more than one eligible children in the household, then one child was randomly selected.

Household Sampling

Urine samples, were collected from all the subjects (children and pregnant women) examined for goiter prevalence. In addition, salt samples from these households were also collected.

Retail shops

The information on procurement, storage, re-packing and pricing of salt was collected from the retail shops using an interview schedule. In addition, storage and packing practices were also observed.

Laboratory Analysis

Iodine in salt:

Iodine content of salt samples from households and retail outlets were analyzed by *iodometric titration*[21].

Urinary iodine excretion:

Urinary iodine excretion in the urine samples from the study subjects was analysed by using the microplate method for determination of urinary iodine[20].

Internal Quality Assurance:

The analysis of iodine levels in salt and urine was done at the ICCIDD Reference Laboratory at the Centre For Community Medicine in the All India Institute of Medical Sciences in New Delhi. The Internal Quality Assurance (IQA) Protocol was followed throughout the salt sample analysis. Two batches of salt samples were analyzed on two different days, before the salt samples from the study areas were analyzed. This was kept as the known sample, to be analyzed with salt samples from the study areas as Internal Quality Assurance. Standardized Internal Quality Assurance protocols was also followed for urinary iodine estimation.

Data Entry And Data Analysis

The data entry and analysis was done at the ICCIDD Study Coordinating Centre in New Delhi.

Quality control in data analysis

The data was entered into an Microsoft Excel file and the data entry was double checked for errors. The data analysis was done using the Microsoft Excel and SPSS Version 11.0 statistical software programme.

Special Features Of The Rajasthan Study

Apart from being the first statewide study in Rajasthan, the present study had many special features.

1. This was the first statewide study where the field investigators were physicians. The data collected by the physicians ensured the quality, reliability and randomness of the data collected.

2. This study was the first to use three different indicators – Goitre prevalence, Urinary iodine excretion and iodine content of salt

3. This was also the first statewide community based study trying to assess the distribution of urinary iodine concentration among pregnant women in Rajasthan.

4. The study protocol was discussed together with the state investigators and agreed upon. The study was carried out, using uniform protocol, by various participants.

5. The coordination of the key agencies (Department of Health, UNICEF Rajasthan, the Micronutrient Initiative and ICCIDD) has highlighted the intersectoral coordination in this study.

6. Quality Assurance protocols followed in all aspects of the study ensured that data is reliable.

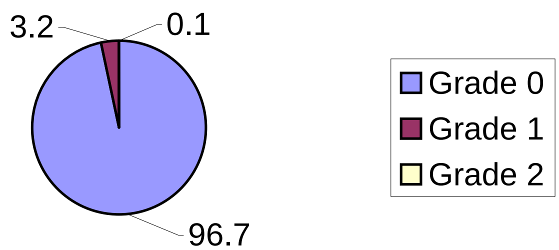
7. This study helped create a pool of trained resource persons for future IDD elimination activities.

4) Results

A total of 1200 children aged between 6 to 12 years (Mean ± SD: 8 ± 2 years) were studied.

The total goiter rate was 3.3% (95% CI: 2.3 – 4.3%). Of all the thyroid enlargements, only one was of Grade 2 goitre. (**Fig – 4**).

Fig – 4: Total Goitre Rate



Of the 1140 children for whose gender was recorded, there were 717 boys (62.8%) and 423 girls (37.1%) with a mean (± SD) age of 8.7 ± 1.9 years and 8.5 ± 1.9 years, respectively. The total goiter rate in boys and girls was found to be 2.8% (**Fig – 5**) and 4.0%(**Fig – 6**), respectively.

Fig – 5: Total Goitre Rate – Boys

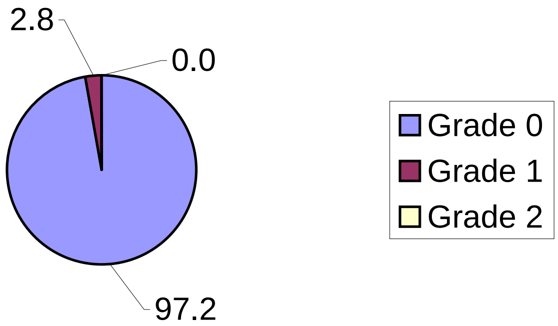
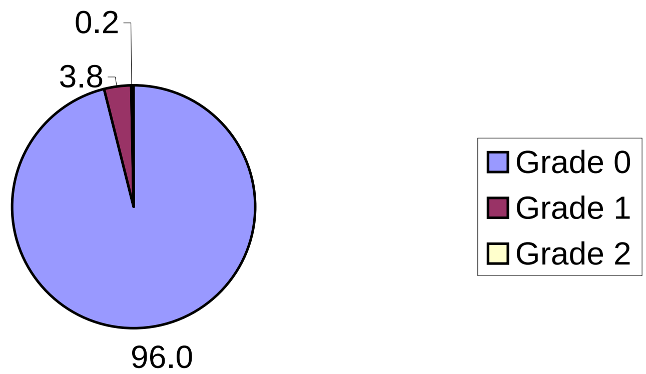


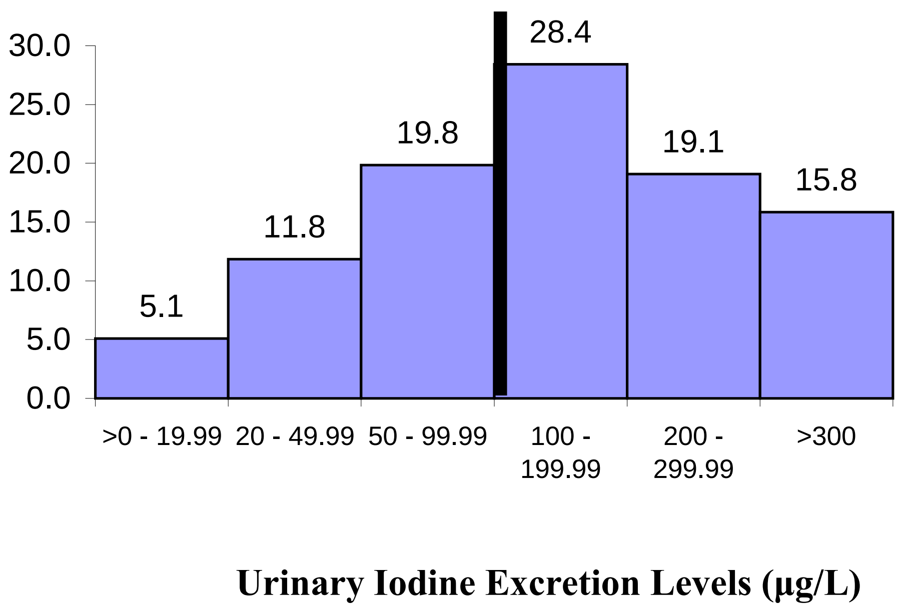
Fig – 6: Total Goitre Rate – Girls



Urinary Iodine Excretion

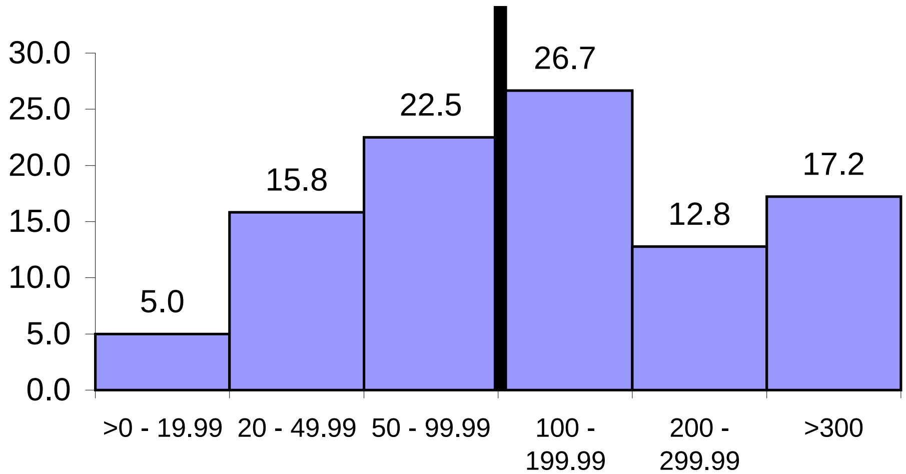
School Age Children
A total of 1200 urine samples were analyzed for iodine content. The median urinary iodine excretion was found to be 138.7 µg/L. The range of urinary iodine excretion values was 1.2 – 361.5 µg/L. 16.9% of the values were $\leq$ 50 µg/L and 36.7% of the values $\leq$ 100 µg/L. The distribution is shown in the **Fig – 7**. The dark line in the figure represents the cut off value of 100 µg/L, which has been recommended as the value to determine the adequacy of iodine nutrition in a population.

Fig – 7: Distribution of urinary iodine values in the population



Pregnant Women
A total of 360 urine samples were analyzed for iodine content. The median urinary iodine excretion was found to be 127.2 μg/L. The range of urinary iodine excretion values was 1.2 – 361.5 μg/L. 20.8% of the values were $\leq$ 50 μg/L and 43.3% of the values $\leq$ 100 μg/L. The distribution is shown in the **Fig – 8**. The dark line in the figure represents the cut off value of 100 μg/L, which has been recommended as the value to determine the adequacy of iodine nutrition. There are scientists who advocate higher cut off levels of 150 μg/L, to account for the physiological and metabolic changes in iodine metabolism in pregnancy.

Fig – 8: Distribution of urinary iodine values in the population of pregnant women



<u>Iodine Content Of Iodised Salt At The Household Level</u>

A total of 1153 salt samples were analyzed. The proportion of households consuming adequately iodised salt (salt with iodine levels of at least 15 parts per million – 15 milligrams of iodine per kilogram of common salt) was 42.1% (n=486). The range of iodine levels in salt in the samples from the households was 0 to 131.2 parts per million (PPM). The total number of salt samples with some iodine was 797 (69.1%). The distribution is outlined in the **Table – 10**

Table – 10: Iodine Content of Iodised Salt at Household Level

Iodine content (PPM)	Number of samples	Percentage	
0	356	30.9%	100%
5 – 6.9	104	9.0%	69.1%
7 - 14.9	207	18.0%	
15 - 30	252	21.9%	42.1%
> 30	234	20.2%	
TOTAL	1153	100.0%	

* Salt with iodine content less than 5 PPM is considered uniodised

Iodine Content Of Salt At The Retail Level

A total of 90 salt samples across different salt types (crystal, powdered, refined) were collected from the 30 clusters, out of which 75 samples were analyzed for their iodine content. Of the samples, 68 (75.6%) were branded varieties and, 22 samples (24.4%) were of the unpacked or loose variety. The range of iodine levels in salt in the samples from the retail shops was 0 to 88.9 parts per million (PPM). The range of cost of salt available at the retail level was Rs. 1 to Rs 7.50 for a kilogram of salt.

Overall Results

The overall results are briefly outlined in the **Table - 11** below:

Table – 11: Overview Of The Results

Variable	Value
Number of children studied	1200
Mean Age	8.0 ± 2.0
Goitre Grade I	3.2%
Total Goitre Rate	3.3% (95% CI – 2.3 – 4.3%)
Urinary Iodine - School Age Children	
Number of urine samples analysed	1200
UIE (Median)	138.7 µg/L
Proportion of values ≤ 100 µg/L	36.7%
Proportion of values ≤ 50 µg/L	16.9%
Number of salt samples analysed	1200
Urinary Iodine - Pregnant Women	
Number of urine samples analysed	360
UIE (Median)	127.2 µg/L
Proportion of values ≤ 100 µg/L	43.3%
Proportion of values ≤ 50 µg/L	20.8%
Proportion of households consuming adequately iodised salt	42.1%

5) Qualitative Component of the Rajasthan Study

In a national program trying to address a very important public health problem, a key component that is always ignored is the people's perception of the program activities. The availability, accessibility and affordability of the program can be regulatd by the implementing agency; but the acceptability of the program relies on the felt needs of the community. The qualitative component of the study was conducted with the goal of improving program activities by incorporating the views of the community on iodine deficiency disorders and also on the national program to eliminate IDD, and addressing any deficiencies in this regard.

Specific objectives:

1. To find out the community awareness about different types and brands of salts; its availability, quality and cost.

2. To understand the buying and storage practices of salt at the household and retail shop levels and find out the factors that influence the buying practices of salt by people.

3. To assess the knowledge among the people regarding the advantages and disadvantages of iodised salt and health impact of iodine deficiency.

4. To explore the perceptions of the community regarding a policy on universal salt iodisation and its promotion.

Methodology

Study Design: A pre-designed, pre-tested structured questionnaire, administered among subjects and retail shopkeepers in the study areas, was used for the collection of data.

Study Setting and Participants: The study was carried out in the thirty selected clusters (study areas) in twenty-two districts in Rajasthan.

Sampling: The household questionnaire was administered to a member of the household that the study team visited while conducting the sampling for the quantitative aspect of the study. Purposive sampling was carried out to select the retail shop to administer the retail shopkeeper questionnaire.

Tool for Data Collection: The household and retail shopkeeper questionnaires were prepared in advance. They were translated into Hindi, the local language, and field-tested in an urban slum in south Delhi. After minor changes, the questionnaire was printed in Hindi.

Data Collection: The questionnaires were administered by the physicians who conducted the quantitative IDD assessment, with the help of local coordinators. The study was carried out during the months of May and June 2004.

Data Processing and Analysis: The responses from the questionnaires were entered into n Excel worksheet. Numerical codes were entered for those questions which had pre-prepared codes. For the open ended questions the following steps were followed: the responses were freelisted, the main domains (or emerging themes) identified, the individual responses were categorized and coded as to which domains each of them would belong, and finally summarized using qualifiers and expressing the observations in semi-qualitative manner.

Results

At the Household Level:

The survey team members collected data from 1200 households. The gender of the respondents (1159) was primarily female, numbering 807 (69.6%). This was because the teams were asked to interview the person in the household who makes the decisions on salt purchases. On an average, the families had 6 members (with a standard deviation of 2).

Salt Purchase

Almost half the respondents were aware that they bought iodised salt. Most of them bought salt once a month, most often the one kilogram polypack. Over 60% of the respondents were currently buying branded packet salt. This clashed with their knowledge on identifying iodised salt. Close to 51% were ignorant of the means to identify iodised salt.

Salt Use

Nine tenths of the respondents used the salt bought in the market for home use in cooking and preserving foods. A tenth of them used the salt for more than one purpose, be it agriculture or livestock rearing. A small proportion (10%) of the respondents had changed from use of crystal salt to use of powdered salt at home. The reasons that were cited were the realization that iodised salt is beneficial, to only iodised salt was available and that the decision was made by the shopkeeper.

Salt Storage Practices

Two thirds of the respondents stored the salt on the kitchen floor. One fifth used the storeroom. A majority of the respondents stored the salt in a container with a lid.

Opinion on Iodised salt Use

When asked if they should take iodised salt, the respondents were equally divided. One half stating that they should and the other half that they were not sure or did not know much about iodine deficiency to take a stand. Even among those that agreed that iodised salt should be taken, a majority were influenced by the advertisements that are seen on the television. They were not really conversant with the health effects of iodine deficiency and the benefits of consuming iodised salt to prevent IDD.

At the Retail Level:

The survey team members collected data from 53 retail shops.

Salt Sales

More than half the shopkeepers (56%) claimed that they sold only iodised salt, while one fourth said that they sold both common and iodised salt. Most of them bought salt in bulk once a month. Refined iodised salt (43%), closely followed by common powdered salt (21%) had the maximum sales. Three fourth of the shopkeepers opined that these salt varieties, including the branded ones, sold that much more because the customers asked for it. Other reasons included promotional offers by the salt manufacturers and for health reasons.

Salt Storage Practices

Most of the respondents stored the salt inside the shop, on the floor. The polypacks were kept on the shelves. The salt packets were not placed where they could be easily seen.

Opinion on Iodised salt Use

When asked if they should take iodised salt, the 87% of the respondents stated that they should take iodised salt.

Conclusions

The following are the important conclusions drawn from the qualitative study

1) Most of the respondents were aware of iodised salt. However, they did not know how to distinguish non-iodised from iodised salt.

2) Most of them currently bought packed salt

3) Most of them used the salt for human consumption.

4) Most preferred powdered salt for ease of use.

5) Most of the respondents were aware of the precautions to be taken with the storage of iodised salt at home

6) Most do not know the health benefits of consuming iodised salt

7) Most of them were influenced by the commercial endorsements that focus on refined salt are heard or seen on the mass media. (The health system does not play a part in informing the community).

8) Inspite of the community not being aware of the benefits of iodised salt, the sales for refined salt is the maximum at the retail level. This is fueled by customer demand.

6) Discussion

The World Health Organization (WHO), United Nations Children's Fund (UNICEF), International Council for Control of Iodine Deficiency Disorders (ICCIDD) and the Micronutrient Initiative (MI), People Against Micronutrient Malnutrition (PAMM) are the main international agencies involved in IDD elimination programmes all over the world. These bodies have published several guidelines and indices to be used to track the progress of salt iodisation programmes (*Indicators for assessing IDD & their control through salt iodisation. WHO/UNICEF/ICCIDD; WHO/NUT/94.6*). The indicators used have been categorized into process indicators and outcome indicators. The process indicators include iodine content of salt at the production and consumer level while the outcome indicators are goitre grading (clinical), Neonatal TSH, Thyroglobulin in circulation and urinary iodine excretion (biochemical). These indicators are studies using Probability Proportionate to Size (PPS) cluster sampling technique among children of 6 to 12 years in the given population. In different parts of the world, several studies have been reported, using these indicators, where the iodine prophylaxis programme using iodised salt is in progress. These studies, outlined in the **Table 8**, were done in the regions of Delhi, Bhutan, Ceylon, Nepal, Bangladesh, Rajasthan and Thailand.

Table – 8: Total Goitre Rates and Median Urinary Iodine Values in Various Regions of the World

Area	**Year**	**Years Since Salt Iodisation**	**Goitre Prevalence Rates (%)**	**Median Urinary Iodine Excretion (µg / L)**
Delhi[28]	1994	10	20 .5	198.0
Bhutan[29]	1996	14	14.0	230.0
Nepal[30]	1998	27	Women - 50 SAC – 40.0	Women - 114.1 SAC – 143.8
Thailand[31]	1998	9	Range: 0.02 –6.63	149.8
Bangladesh[32]	1999	13	17.8	Hilly - 63.8 Flood Prone - 139.3 Plains - 147.7
Kerala[33]	2001	17	16.6	123.3
Rajasthan	2003	15	3.3	138.7

*SAC- School age children

Most of the studies above have reported that goitre rates are above 10% but urinary iodine is satisfactory, as per the criterion of median urinary iodine excretion levels.

The WHO/UNICEF/ICCIDD Joint Consultation has established fixed criteria for assessing the severity of iodine deficiency and tracking progress towards eliminating iodine deficiency. The indicators and criteria for classifying IDD as a public health problem are outlined in **Table 9**.

Table - 9: IDD Prevalence indicators and Criteria for classifying IDD as a significant public health problem*

	Severity of Public Health Problem		
Indicator	Mild	Moderate	Severe
Goitre grade > grade 0	5.0 – 19.9 %	20 – 29.9 %	≥30 %
Median UIE (μg/L)	50 - 99	20 - 49	< 20

****Indicators for assessing IDD & their control through salt iodisation. WHO/UNICEF/ICCIDD; WHO/NUT/94.6***

As per these criteria, Rajasthan has achieved optimal iodine nutrition.

The goals for eliminating IDD as a public health problem have also been outlined by WHO/ UNICEF / ICCIDD. On comparison of the progress made by Rajasthan, as shown in **Table - 10**, in terms of these goals it is seen that even though Rajasthan still has to achieve all the goals, the progress made has been tremendous. The key now is to sustain the success.

Table - 10: Criteria for tracking progress towards eliminating IDD as a public health problem

Indicator	Goal	Rajasthan
Thyroid size (age gp 6 – 12) proportion with enlarged thyroid	< 5 %	3.3 %
Urinary Iodine		
Median urinary iodine μg/L	>100 %	138.7 %
Proportion below 100 μg/L	< 50 %	36.7 %
Proportion below 50 μg/L	< 20 %	16.9 %
Salt iodisation		
Proportion of Households consuming adequately iodised salt	> 90 %	42.1 %

What does Rajasthan result mean?

Rajasthan has now achieved optimal iodine nutrition among the general population, in terms of the results of the objective indicators. However, with the focus now on pregnant and lactating women and the neonates, it can be seen that Rajasthan needs to increase efforts to see that they also achieve optimal iodine nutrition.

The main reason for the improved IDD status is iodised salt. The coverage of adequately iodised salt (adequately iodised salt at the household level is defined as salt with not less than 15 parts per million of iodine, i.e. 15 milligram of iodine per kilogram of salt) at the household level is 42.1%. In addition, 70% of all salt has some amount of iodine in it. This translates to some amount of iodine reaching the thyroid gland for synthesis of thyroxine. This, though, does not take away form the fact that every effort must be made to convert the coverage of adequately iodised salt at the household level from its present 42.1% to over 90%.

As shown by the qualitative study, the main reasons for the less than universal coverage of iodised salt is the ignorance of the problem of iodine deficiency and the need for continuous use of iodised salt. Hence, it can be inferred that the increase in iodised salt has been mainly due to the push given by the national iodine deficiency disorders control program, and not by increased demand from the people. Rajasthan serves as a model where the increasing coverage of iodised salt is a function of efforts at the production and program level, rather than at the community level.

In summary, Rajasthan is iodine replete, but there are population groups, like pregnant and lactating women, whose iodine nutrition needs to be addressed. The iodine in the salt contributes considerably to the iodine nutriture in Rajasthan. With improved reach and coverage of iodised salt, and sustained efforts to increase awareness, IDD can be virtually eliminated.

Comments by Dr. R. Sankar

This refers to our discussions on the interpretation of Rajasthan Study results.
My inference from the results will be:

It is important to bear in mind that this is a "*Tracking Progress*" exercise and more of a *Rapid Appraisal.*

The purpose of the study is to understand the status of the IDD elimination program using standard *process* and *impact* indicators.

Total of 42.1% of the households use adequately iodised salt. Additional 27% of the households use inadequately iodised salt. 30.9% of the households use salt with no iodine.

Median urinary iodine excretion is 138.7 μg/litre. Median urinary iodine in pregnant women is 127.2 μg/l. More than 20% of the pregnant women (20.8%) had urinary iodine values below 50 μg/l.

Looking only at median urinary iodine would suggest that the iodine nutrition of the population is normal. However, further analysis of the data shows that nearly 17 % of the population has urinary iodine values less than 50 μg/l and more than 20% of pregnant women have urinary iodine values less than 50 μg/l which suggests the existence of iodine deficiency in the population. The suggested cut-off is: less than 20% of the population should have UI values less than 20 μg/l. *(The recommended daily intake is 150* μg *in adults and is 200* μg *in pregnant women. Therefore the cut-offs for pregnant women need to be higher and is being looked into currently).*

The coverage of adequately iodised salt at household level is only 42% which is much less than the suggested cut-off which is 90%. However, nearly 70% of the households are using salt with some iodine. Contribution of this to the iodine nutrition of the population cannot be overemphasized.

To achieve a sustainable elimination of IDD the recommended criteria is to have at least 8 of the 10 programmatic indicators fulfilled, to have adequately iodised salt at 90% of households and median urinary iodine > 100 μg/l.

Of the above only urinary iodine in the Rajasthan study is found to be above the cut-off. When seen in isolation several interpretations are possible. This could be because the background iodine deficiency may not be severe in Rajasthan. The population could be getting iodine from iodised salt and also from their food.

The perfect positive correlation between urinary iodine and iodised salt is seen in situations of severe iodine deficiency and also in situations where iodised salt is the only or dominant source of dietary iodine. In situations where the deficiency is not severe or where iodine is available to the population from sources other than iodised salt, albeit in insufficient quantities to satisfy the physiological requirements, we will encounter varying degrees of discordance between the urinary iodine and household iodised salt coverage.

Therefore, it is important to look at more than one indicator and interpret the results. Achieving household coverage of 90% or more with adequately iodised salt will ensure that every individual in the population has adequate iodine intake. To sustain USI, it is essential to ensure that at least 8 of the 10 programmatic indicators are satisfactorily implemented.

In Rajasthan, we have only one indicator, i.e., median urinary iodine that is above the recommended cut-off. This has happened because of sustained efforts by the government in implementing the IDD elimination program. However, the efforts need to be accelerated and monitored so as to improve the availability and accessibility of adequately iodised salt at household level and achieve a coverage of 90%. This is absolutely essential if we want to give protection from iodine deficiency to all the population at all the times.

Let us look at the programmatic indicators in Rajasthan and try to recommend areas that need to be strengthened.

Let us also provide a clearly chalked out strategy for improving the household coverage of adequately iodised salt.

7) Conclusions & Recommendations

OVERVIEW OF THE RESULTS

Variable	Value
Number of children studied	1200
Mean Age	8.0 ± 2.0
Goitre Grade I	3.2%
Total Goitre Rate	3.3% (95% CI – 2.3 – 4.3%)
Urinary Iodine - School Age Children	
Number of urine samples analysed	1200
UIE (Median)	138.7 µg/L
Proportion of values ≤ 100 µg/L	36.7%
Proportion of values ≤ 50 µg/L	16.9%
Number of salt samples analysed	1200
Urinary Iodine - Pregnant Women	
Number of urine samples analysed	360
UIE (Median)	127.2 µg/L
Proportion of values ≤ 100 µg/L	43.3%
Proportion of values ≤ 50 µg/L	20.8%
Proportion of households consuming adequately iodised salt	42.1%

Criteria for tracking progress towards eliminating IDD as a public health problem

Indicator	Goal	Rajasthan
Thyroid size (age gp 6 – 12) proportion with enlarged thyroid	< 5 %	3.3 %
Urinary Iodine – school age children		
Median urinary iodine	>100 µg/L	138.7 µg/L
Proportion below 100 µg/L	< 50 %	36.7 %
Proportion below 50 µg/L	< 20 %	16.9 %
Salt iodisation Proportion of Households consuming adequately iodised salt	> 90 %	42.1 %

Conclusions:

1) As specified by WHO/UNICEF/ICCIDD, Rajasthan has achieved optimal iodine nutrition.
2) Given the lower urinary iodine levels in the pregnant women, as opposed to the general population, and added to the fact that the main target groups for iodine supplementation should be the pregnant and lactating women, there is a great need to focus on improving the salt iodine intake of pregnant women. This needs to be done from the pre-conceptional stages.
3) It is most likely that the adequately iodised salt contributes considerably to iodine intake of the population, as measured by median urinary iodine and urinary iodine distribution pattern.
4) Also, the increased coverage most likely comes from the efforts made by national IDD Control program pushing the salt into the market, rather than by public demand.
5) This underlines the need to make iodine in salt available on a regular and continuous basis for all time to come, with wide awareness of its benefits.
6) There is a need for continuous monitoring of the salt iodine levels and the urinary iodine excretion patterns, so that the success of the program is sustained.

Recommendations:

1) As a population measure, the most cost effective, physiological time tested and universally accepted method is making adequately iodised salt available, accessible and affordable to all population for all time to come.

2) All efforts should be made to consolidate the coverage achieved of having 42.1% of salt samples that are adequately iodised.

3) Accelerated efforts should be made to increase the coverage of adequately iodised salt from 42.1 % to 100% and sustain it thereafter.

4) To achieve Universal Salt Iodisation i.e. 100% coverage of adequately iodised salt, affordable to the population, for all times to come, requires a combination of legislation and education. In view of the fact that most of the people in Rajasthan are not aware of the problem of iodine deficiency and the benefits of consumption of iodised salt, focus should be on educational efforts. The expected outcome of the educational campaign should be such that consumption of adequately iodised salt becomes the norm in the family and an integral part of "Good Nutritional Practice" and a "Healthy Habit".

5) In face of the results that have been obtained, we must stress the importance of IEC (Information, Education, Communication) in the efforts to eliminate IDD. This aspect has been neglected since the beginning of the programme. **Table – 11** below lists the complimentary roles played of legislation (Prescriptive

approach) and IEC & Social mobilization (participatory approach) in our efforts to educate the people about IDD.

Table 11: Complementary roles of Legislation and IEC / Social Mobilization

S. No	VARIABLES & PHASES	LEGISLATION	IEC / SOCIAL MOBILIZATION
1.	Stakeholders involved in formulation	- Few - Legislative / Executive	- Many - Interaction of researchers with community & other stakeholders
2.	Preparatory Phase	- Advocacy with political leadership	- Social Science research methodology – KAPB survey, Focus Group Discussions etc
3.	Implementation phase	- Difficult – especially with respect to enforcement - May lead to social & economic harassment	- Relatively easy if the medium of mass communication well developed
4.	Resource Requirement	- Few	- Large
5.	Time required	- Require less time in formulation and adoption	- Takes time for the development of message and the desired impact to take place
6.	Indicators of measurement	- Legislation in place: Yes / No - Being enforced: Yes / No - Number of cases filed per year and decisions taken thereof	- Complex - Process indicators: Increase in knowledge - Impact indicators: Change in behavioral practices

* - A general perception is that when USI is referred to, it is linked to legislation and consequent compulsory salt iodisation

6) Universal Salt Iodization is summed up by the five As: **A**wareness, **A**vailability, **A**ccessibility, **A**cceptability, **A**ffordability for all time to come!

At the Policy Level

7) A state level IDD Control Task Force should be constituted. It may be chaired by the Commissioner, Health. The Task Force should constitute members from the Departments of Health, Social Welfare, Medical Education, Food and Civil Supplies, Education, and Women and Child Development, of the Government of Rajasthan. Key participants are representatives of salt traders and distributors in Rajasthan. Other members may include representatives from UNICEF Rajasthan, the Micronutrient Initiative and ICCIDD for technical and resource inputs. Non-governmental organizations and women Self Help Groups (SHG) may be invited to suggest means to improve program implementation. This Task Force has to meet once every six months to track the progress of IDD elimination activities.

Dissemination of Results of the Study

8) A time bound plan should be prepared to widely share the results of the survey with medical, nutrition and agricultural colleges and health institutions of the Department of Medical Education, branches of Indian Medical Associations, and professionals involved as stakeholders in the solution to the IDD problem

9) Associations of salt traders and distributors in Rajasthan must be informed of the government's efforts to improve IDD coverage and their cooperation and suggestions must be sought.

10) The Chief Minister and Minister of Health may write to all the Panchayat Raj members seeking their support for the IDD Control program and ensuring the only iodised salt is sold in their villages.

11) The Commissioner, Health may write to all the District Magistrates and Chief Medical Officers of a District, telling them that ensuring IDD elimination is a top priority of the Government of Rajasthan, and they should ensure that quality iodised salt is reached to all the population of their district.

At the Program Level

12) All unloading stations must have a representative of the Government of Rajasthan, along with the officials from the Salt Department, conducting random checks on the salt samples to ensure that their iodine levels are adequate.

13) The laboratory facilities of the Salt Commissioners Office in Jaipur and its branches may be coopted for monitoring so that they can help conduct all sample analysis for the state.

14) All district laboratories must have facilities for conducting analysis of salt samples by the titrimetric method

15) A demonstration of the use of Salt Testing Kit to check the presence of iodine can be conducted for all the Panchayat members of each district. Each Panchayat Institution may be supplied with a box of test kits, so that they can conduct tests at the retail level in their villages

16) Quality assurance procedures should be in place to ensure "Good Manufacturing Practices", for transport and storage facilities for iodised salt. An option present before us, which has been successful in 11 states and Union Territories, is to make iodised salt available through the Public Distribution System.

17) Almost 70% of the samples examined at household level had some iodine. However, of these, only 42.1 % was found to be adequately iodised. It is likely that inadequately iodised salt is being labeled and marketed as iodised salt. It is vital to have stringent monitoring mechanism in place, by which random representative samples of salt collected from the district, can provide information on the trend in the iodised salt coverage. Coupled with strict enforcement of the regulation, this would ensure that the people are not misled and they get the product of their choice and also "value for money" spent to buy the product.

Program Evaluation and Research

18) A system of annual cyclic monitoring should be developed so that in a five-year monitoring cycle all the districts are covered for ensuring availability of adequately iodised salt to the people. The monitoring system should be linked to the decision making process so that required corrective actions are taken to ensure availability of adequately iodised salt to the people.

Challenges for future - Consolidating the achievement

It is clear that despite the great success in many countries challenges for the future include:

- Continued and strong government commitment and motivation to eliminate IDD, with appropriate annual budgetary allocations to maintain the process.

- The salt industry should have the mandate and the access to resources to ensure effective iodisation. Producer compliance, quality assurance, logistical problems and bottlenecks need to be addressed through effective advocacy and social communications.

- Monitoring systems should be in place to ensure specified salt iodine content and coordinated with effective regulation and enforcement.

- In some countries salt for animal consumption has not been included in the iodisation programme and is not covered by legislation. The animal productivity is also enhanced by elimination of IDD. Ensuring this salt is iodised means that there is also no leakage of non-iodised salt into the market and consumption by general population.

- There are still numerous places in the world where iodised salt is not available. Identifying these areas and developing a market for iodised salt in these places is critical to successful IDD elimination. This process includes creating consumer awareness and demand.

In Summary…

Ensuring a normal daily intake of iodine to maintain normal brain function is as important as the provision of clean water. There is adequate knowledge and expertise to ensure the sustained elimination of IDD from the entire world. Thus, an ancient scourge of mankind can be eliminated with the application of existing technology. The achievement of the sustained elimination of IDD will constitute one of the major public health triumphs of our time.

8) Annexure

Annexure – 1
Selection of Sample Communities by PPS Technique

This has been done and the list of the clusters is attached as **Annexure -2**

The following are the steps that are followed for the selection of communities by the PPS technique.

First stage:

In order to generate a PPS selection of clusters, the following steps need to be taken:

a) Listing of all clusters [villages (rural) / wards (urban) areas] in the study State along with their respective population
b) The cumulative population will be detailed in a separate column
c) Selection of 30 clusters in the state using the standard PPS technique.

Make four columns; the first column contains the names of all clusters in the State, the second column the population of each cluster, and the third column the cumulative population. A fourth column is used for identifying which communities will have one or more clusters selected.

Step 1: Calculate the sampling interval by dividing the total population by the number of clusters.
Step 2: Choose a random starting point between 1 and the sampling interval by using the random number table.

Step 3: The first cluster will be where the random number is found in the cumulative population column.
Step 4: Continue to select clusters by adding the sampling interval to the random start and each successive number cumulatively. In communities with large populations, more than one cluster will probably be selected. Note that if two clusters were selected in one community, when the survey is performed, the survey team would divide the area into two sections of approximately equal population size and treat each area as independent clusters. Similarly, if three or more clusters were selected in a community, the community would be divided into three or more sections of approximately equal population size. In situations where cluster selected has less than 500 populations, the adjacent cluster will be included to obtain the sample

ANNEXURE - 2 : List of clusters for IDD survey in Rajasthan

Cluster No	District	Tehsil / Town	Village / Ward	Population
1	Ganganagar	Suratgarh	15 Shpd	1139
2	Bikaner	Bikaner	Napasar	19550
3	Churu	Rajgarh	Bairasar Gumana	751
4	Jhunjhunun	Jhunjhunun	Dheva Ka Bas	905
5	Alwar	Behror	Jainpurwas	3399
6	Alwar	Thanagazi	Garh Basai	2358
7	Bharatpur	Kumher (M)	Kumher (M) - Ward No.19	1019
8	Dhaulpur	Dhaulpur (M+OG)	Dhaulpur (M) - Ward No.34	2014
9	Sawai Madhopur	Bonli	Borda	1808
10	Dausa	Lalsot (M)	Lalsot (M) - Ward No.3	2374
11	Jaipur	Sanganer	Mohanpura	1249
12	Jaipur	Jaipur (M Corp)	Jaipur (M Corp.) (Part) - Ward No.52	44479
13	Sikar	Lachhmangarh	Kalwa	748
14	Sikar	Neem-Ka-Thana (M)	Neem-Ka-Thana (M) - Ward No.1	1426
15	Nagaur	Degana	Luniyas	1311
16	Jodhpur	Bhopalgarh	Rajlani	4848
17	Jodhpur	Pipar City (M)	Pipar City (M) - Ward No.22	1021
18	Barmer	Barmer	Utarlai	4188
19	Jalor	Sanchore	Teetop	2468
20	Pali	Pali (MCI)	Pali (MCI) - Ward No.6	3168
21	Ajmer	Ajmer (M Cl)	Ajmer (M Cl) - Ward No.44	11197
22	Tonk	Tonk	Sankhana	1778
23	Bhilwara	Gulabpura (M)	Gulabpura (M) - Ward No.11	1106
24	Rajsamand	Deogarh	Daulpura	1623
25	Udaipur	Girwa	Gudli	3198
26	Dungarpur	Dungarpur	Khara	328
27	Banswara	Bagidora	Itauwa	2142
28	Chittaurgarh	Pratapgarh	Peepli Khera	593
29	Kota	Sangod (M)	Sangod (M) - Ward No.18	842
30	Jhalawar	Pirawa	Kanwari	773

Annexure – 3
Selection of households and the target population

When a team visits a survey site, they will first need to select individuals to be in the study. It is important that the team perform the selection of individuals.

The ideal method would be to select households at random from throughout the community. If a map or listing of all households is available, households could be randomly selected to be in the survey.

Note that with a household-based survey where information on individuals is to be collected (e.g., blood specimen collected), the exact number of households that will need to be visited is not known. Generally households are visited until the appropriate numbers of eligible individuals are surveyed.

While random selection of households is the best method for selecting households, this may be impractical in some situations and the method used in EPI surveys generally provides a reasonable approach to household selection and is described below.

If a household is selected for the sample, every attempt should be made to locate the individuals in that household. Finding residents at home can be facilitated by doing the survey during hours when people are most likely to be at home or by working with local leaders to request that people remain near their houses until the sampling is completed.

Selecting households involves two steps:

1. The selection of the first household to visit
2. The selection of subsequent households to visit.

The selection of the first household can be done using different methods depending upon the size of the village and whether a listing or Map of households is available.

Selecting the first household:

Method 1: Small village where a list or map of the households is available: Some villages may have a reasonably complete listing or map of households from census records or tax lists. In small villages it might be feasible to quickly map the village and number the households (if there are fewer than 100). The steps for selecting households are:

Step 1: Number all the households
Step 2: Randomly select a number from 1 to the highest numbered household. The number can be selected using a random number table or from a currency note.
Step 3: Go to the selected household and determine if there is someone eligible to be in the survey. If there is someone eligible, then collect the survey information.

Method 2: Smaller village where a list or map of households is not available: If there are more than 100 households and no list or map, it may not be practical to develop such a list. The steps to take in this situation are:

Step 1: Select a central area of the village, such as a market, temple or mosque.
Step 2: Randomly select a direction to walk towards the outer part of the village. Spinning a bottle or pen on the ground can do this. Whichever way the bottle or pen points to move in that direction.
Step 3: count all the household from the central area to the edge of the village.
Step 4: Randomly select a number from 1 to the total number of households counted. The number selected will be the first household to visit.

Selecting subsequent households:

Once the first household is selected, the second household is the one whose front door is closest to the first household (the direction of the second and subsequent households is not important). The third household to visit would be the closest front door of the next household (excluding any households already visited). This is repeated until the appropriate number of households is selected.

Larger areas are likely to have more than one cluster that has been selected in the sample. When a team arrives to the area, an attempt should be made to divide the city into approximately equal population size sections. If two cluster surveys are to be performed, divide the city into two areas; if there are three clusters, divide the city into three sections, etc.

For the present study, only households with school-age children in the age group of 6 – 12 years will be considered eligible for enumeration and will be included in the sample. A total of 35 eligible children need to be studied in each cluster. It is recommended that only one child be enrolled from one household. If there are more than I eligible children in any household, use the lottery method to select the study subject.
The lottery method: Write the names of all the children on separate slips of paper and place the slips on the floor. At random, select one of the slips and the child whose name is written on that slip of paper is enrolled in the study.

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