Executive Summary

Iodine is one of the essential micronutrient required for the normal mental and physical growth and development of man.

On a worldwide basis, iodine deficiency is the single most important preventable cause of mental handicap. Children living in areas affected by severe iodine deficiency have an intelligence quotient (IQ) of up to about 13.5 points below that of those from comparable communities in areas where there is no iodine deficiency. Iodine deficient children suffer from tardy concentration, impaired co-ordination, sluggishness and learning disabilities, which result in poor school performance, absenteeism and dropouts. In addition, their energy and productivity are also adversely affected. This has an effect on health, the quality of life of communities, and economic productivity.

Since 1990 there has been tremendous progress in household consumption of adequately iodised salt - the most simple, physiological and cost-effective method for supplementing iodine in the diet. As a result, many countries are now on the threshold of achieving Iodine Deficiency Disorder elimination. In these countries, the emphasis is now focussed on ensuring that the achievements are sustained for all time to come.

Kerala Scenario

Kerala is a small state in the south-west corner of India. It represents 1.18% of the total area (38,863 sq. km) of India with 3.43% (31 million) of the total population of the country.

Most of the studies on IDD in Kerala have been district based. The information is available district-wise. So far, there have been no statewide surveys where all the three indicators, namely, goitre prevalence, urinary iodine excretion and iodine content of salt at the consumption level were measured.

The studies in Kerala trace their origins mainly from four sources:

1. Directorate of Health Services, under the auspices of the National IDD Control Programme (NIDDCP)

2. Independent research scientists

3. Individuals from Institutions

4. National Nutrition Monitoring Bureau (NNMB) from the National Institute of Nutrition, Hyderabad

Based on a report to the Indian Council of Medical Research (ICMR) in 1967, Kochupillai et al in 1976[1], conducted the initial study.They studied the overall prevalence of thyroid nodules in the coastal areas of Kerala. Subsequent studies have been restricted to districts or have been hospital based studies. Between 1989 and 1994 the Goitre Control Cell of the Directorate of Health Services Government of India conducted district wise surveys all over the state and reported the prevalence of goitre. It ranged from 4.7% to 27.3%. These studies have helped researchers and public health officials to assess the status of iodine nutrition in Kerala.

The available studies from the state have shown the existence of Iodine Deficiency Disorders (IDD) as

a public health problem in 11 of the 14 districts surveyed so far. Also, Kerala is the only state in the country that has not banned the sale of non-iodised salt.

With this in view, it was important to study the current status of IDD and also the knowledge, attitudes, practices and behaviour of the people about problem of IDD and use of iodised salt, by qualitative research methodology. This would help to understand the current situation with respect to IDD indicators and people's perception about IDD and iodised salt. It would also help in deciding the future course of action regarding IDD elimination and its sustainability in Kerala.

Methodology

The methodology followed for the study was the one recommended by WHO / UNICEF / ICCIDD in the year 2000 and accepted internationally *(WHO / UNICEF / ICCIDD. WHO / Nut / 94.4).*

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 study population was selected by a house-to-house visit.

Study Population

Thirty-five school age children in the age group of 6-12 years were selected from each cluster providing a total sample size of 1050 children and households in the 30 clusters surveyed.

Parameters studied

Clinical Parameters

The enlargement of thyroid, as recommended by the WHO/UNICEF/ICCIDD Classification was graded as Grade 0,1 or 2. Even though physicians constituted the study teams, a half-day demonstration workshop on the method of goitre examination was conducted. The teams were asked to examine the 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 the lower grade.

Biochemical Parameters

(i) Urinary Iodine

Urinary iodine excretion is one of the markers 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. They were transported to Medical College, Thiruvananthapuram and kept under refrigeration. They were then transported to the ICCIDD Reference Laboratory in New Delhi for analysis by the simple microplate method as developed by Ohashi et al.

(ii) Iodine in Salt

Salt samples were collected from households in the study sample. They were packed in sealed plastic bags and then transported to the State Nutrition Laboratory at Thiruvananthapuram for analysis of the iodine content. Similarly, salt samples were also collected from retail shops, sealed and sent to the State Nutrition Laboratory. The iodine content of salt samples thus collected was determined by the titrimetric method.

Qualitative Component:

(i) Socio Economic Questionnaire

A pre-tested household socioeconomic questionnaire, with components on knowledge, attitude, practices and beliefs about IDD and Iodised Salt, was prepared. The questionnaires had both close and open ended questions. During the initial orientation workshop, the participants were asked to translate it into Malayalam and translate it back to English independently. The questionnaire was administered by the physicians in the local dialect. The answers were then translated into English, recorded, and analysed.

ii) Focus Group Discussion

A series of six Focus Group Discussions (FGD) were held all over the state to determine the community perceptions about iodine deficiency and iodised salt. The FGDs were carried out in two districts of Kerala, in Thiruvananthapuram and Calicut. Two categories of stakeholders were identified: buyers and shopowners (vendors). Five F.G.Ds. were conducted among the buyers and one among the vendors.

Sample size determination for the survey

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

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

z = Desired level of certainity (1.96 for 95% confidence interval)
p = Estimate of expected proportion
q = (1-p)
DEFF = Design effect
d = Level of absolute precision

The number of children to be examined per cluster was calculated on the basis of the following assumptions.

Estimated goitre prevalence	**30%**
Proportion of population consuming iodised salt	$\geq$ 70%
Population with urinary iodine excretion $\geq$ 100 μg/l	$\geq$ 70%
Confidence level	95%
Absolute precision	$\pm$ 5%
Design effect	3
Total sample size	969
No. of children to be examined	~ 1,050
Number of clusters	30
Sample size (number of children) per cluster	35

Selection of households & children

After the selection of clusters, the households and the target population (children in the age group of 6-12 years) were selected randomly using the standard techniques used in EPI "30 Cluster" surveys. Only one child was selected per household. If there was more than one eligible child in the household, then one child was randomly selected.

Household Sampling

Urine samples from all the subjects examined were collected. Salt samples from the respective households of the children examined were collected for iodine analysis.

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. One sample from each of the available salt varieties was collected from the shops and sent to the State Nutrition Laboratory, Thiruvananthapuram for analysis by iodometric titration.

Laboratory Analysis

Iodine in salt

Iodine content of salt samples from households and retail outlets were analyzed by the method of *iodometric titration*. The iodine content of salt can be determined by liberating iodine from salt and titrating iodine with sodium thiosulphate using starch as an external indicator.

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 as devised by Ohashi T, Yamaki M, Pandav CS, Karmarkar MG and Irie M.

Internal Quality Assurance

The Internal Quality Assurance 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 clusters were analyzed. The mean and two standard deviation values were calculated. This was kept as the known sample, to be analyzed with the other salt samples as Internal Quality Control.

ICCIDD provided the technical assistance and training for the laboratory technicians conducting the salt analysis in State Nutrition Laboratory Thiruvananthapuram, Kerala.

The urinary iodine excretion estimation was done at the ICCIDD Reference Laboratory in New Delhi. Internal Quality Assurance was also followed in the Reference Laboratory in ICCIDD. As part of the Internal Quality Assurance protocol, a total of 210 urine samples were analyzed on different days to establish the reliability and validity of the process in the laboratory.

Data Entry And Data Analysis

The data entry and analysis was done at the Medical College, Thiruvananthapuram.

Quality control in data analysis

The data was entered into a DBASE file and the data entry was double checked for errors. The data analysis was done using the EPIINFO 6.04 statistical software programme.

Special Features of the Kerala Study

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

1. This was the first statewide study where the field investigators were physicians. The training of physicians ensured the quality and reliability 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 as the outcome variables.

3. The study protocol was discussed together with the state investigators and a concurrence reached. The study was carried out, using the uniform protocol, by the various participants.

4. There was a regular communication and feedback from the state coordinators, which helped to complete the study within the stipulated timeline.

5. The involvement of key institutions, at the State level [Directorate of Health Services (DHS) and Directorate of Medical Education (DME)] NGOs, National Institutions (AIIMS and INMAS, New Delhi), International agencies (UNICEF, India,) ICCIDD has helped in highlighting the intersectoral collaboration that is integral to the success of any health care programme.

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

7. As part of capacity building, the study helped to create a pool of trained resource persons at the state level for future activities.

8. The concept of annual cyclical monitoring and sentinel surveillance has evolved from this study. The programme manager can review the change in the iodine status of the population by dividing the state in five zones and covering them turn by turn every year for the next five years.

Iodine Deficiency Disorders in "Hard To Reach Clusters"

In addition to providing state level representative data for Kerala, it was decided to survey three "Hard-to Reach" clusters. The clusters were selected by purposive sampling by the field investigators in Kerala. These areas were identified based on:

1. *a priori* knowledge of "hard to reach" areas

2. Distance from the nearest urban area

3. Health infrastructure

4. Other health indicators like Infant Mortality Rate, Neonatal Mortality Rate, Maternal Mortality Rate, etc.

The three areas selected were Ponmudi, Iritty and Agaly.

Results

There were 1067 children examined in the age group of 6-12 years.

Total Goitre Rate

The total goitre rate was 16.6% (95% CI : 14.4% to 18.8%), prevalence of Grade I goitre being 14.0% and Grade II goitre being 2.6%.

Urinary Iodine Excretion

A total of 990 urine samples were analyzed for iodine content. The median urinary iodine excretion was found to be 123.3 μg/L. The proportion of the population with a urinary iodine excretion below 100 μg/L was 32.5% and the proportion of the population with a urinary iodine excretion below 50 μg/L was 8.2%.

Iodine Content Of Salt at the Household Level

A total of 1066 salt samples were analyzed by titration. The proportion of households consuming adequately iodised salt i.e. iodine content of ≥15 parts per million [ppm] (15 mg of iodine/kg of salt) was 48.9% (95% C.I. : 45.9% to 51.9%).

Iodine Content of Salt at the Retail Level

A total of 59 salt samples were analyzed. The proportion of retail shops storing adequately iodised salt i.e. iodine content of ≥15 parts per million (15 mg of iodine/kg of salt) was 61% (95% C.I. : 48.6% to 73.4%).

Qualitative Study

A qualitative study was also conducted as a part of this survey to assess the community's perception towards IDD and iodised salt. This included a semi structured interview schedule and focus group discussions.

Results of the Qualitative Study:

The following are the important conclusions drawn from the qualitative study:

Knowledge about Salt and Iodised Salt

- **Most** of the women who participated in FGDs knew about the different types of salt and at least one or two brands of iodised salt.
- **Most** of them were knowledgeable about the difference in price and quality of different types of salt.

Buying practices

- **Almost all** respondents in urban areas buy powdered salt and most of them prefer to buy iodised salt with brand names.
- In rural areas too, the **majority** of respondents buy powdered salt, but they are not concerned about iodised or non-iodised or specific brand products.
- Quality of product and considerations of price are the prime factors influencing the buying practice.

- Health benefits are not a criterion for buying a specific variety even by majority of those who buy iodised salt.
- Advertisements and incentives are the motivation factors influencing the decision – making for buying the salt.

Awareness of IDD and Benefits of Iodised Salt

- **Nearly half of the respondents** were ignorant about the advantages and disadvantages of iodised salt.
- **Few** were aware about IDDs other than goitre.
- People were confused and not convinced about the health benefits of iodisation as it is not projected adequately.
- **Majority** perceived a favorable response from the people if they are made aware of the health benefits of salt iodisation.

Programme Supportive Measures

- **Majority** would opt for health, if a choice were to be made between health benefits and price of salt.
- **Majority** of the respondents did not favour a complete ban on non-iodised salt.
- **Educational campaign** through mass media especially electronic media, advertisement of iodised salt focusing on health issues, reducing the price of iodised salt and targeting student population in educational campaign were suggested by respondents as measures for promoting iodised salt.

Overview of the Results of the Kerala Study

Variable	Value
Number of children studied	1067
Mean Age (Years)	8.8 ± 1.9
Goitre Grade I	14.0%
Goitre Grade II	2.6%
Total Goitre Rate	16.6% (95%CI: 14.4%-18.8%)
Median UIE μg/L (990 samples)	123.3
Proportion ≤ 100 μg/L	32.5%
Proportion ≤ 50 μg/L	8.2%
Proportion of households consuming adequately iodised salt (1066 samples)	48.9% (95% CI: 45.9%-51.9%)

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

Indicator	Goal	Kerala
Thyroid size (age gp 6 - 12 years) proportion with enlarged thyroid	<5%	16.6%
Urinary Iodine		
Median urinary iodine (μg/L)	> 100	123.3
Proportion below 100 μg/L	< 50 %	32.5%
Proportion below 50 μg/L	< 20%	8.2%
Salt iodisation Proportion of households consuming adequately iodised salt	> 90%	48.9%

Conclusions

1) As recommended by WHO/UNICEF/ICCIDD, the total goitre prevalence rate of 16.6% suggests the presence of endemic goitre as a public health problem in Kerala.

2) The prevalence of endemic goitre in a population is a historic marker of iodine deficiency.

3) As demonstrated by median urinary iodine (123 μg/L) and proportion of urinary iodine samples below 100 μg/L (32.5%) and proportion of urinary iodine samples below 50 μg/L (8.2%), currently, the iodine nutritive status is possibly adequate in Kerala.

4) A total of 49% of salt samples at household level as analysed by titrimetric procedure of iodine estimation contain adequate iodine levels in them. The iodine content in these samples is more than 15 parts per million (ppm) of iodine or 15 mg of iodine / Kg of salt.

5) Taking into consideration the contribution of sea fish to the iodine intake of population, 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.

6) This underlines the need to make iodine available on a regular and continuous basis.

Recommendations

1) In view of IDD being a public health problem in Kerala, as a population measure, the most cost-effective, physiologically time tested and universally accepted method is making adequately iodised salt available, accessible and affordable to the whole population for all time to come.

2) All efforts should be made to consolidate the coverage achieved of having 49% adequately iodised salt usage.

3) Accelerated efforts should be made to increase the coverage of adequately iodised salt from 49% to 100% and sustain it thereafter.

4) 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!

5) To achieve Universal Salt Iodisation i.e. more than 90% coverage of adequately iodised salt affordable to all population for all times to come requires a combination of legislation and education.

6) Role of legislation : Legislation and / or appropriate regulatory mechanism facilitates and accelerates accessibility and availability of iodised salt, possibly through Public Distribution System (PDS), specially to lower socio-economic groups and disadvantaged communities, at a price they can afford. In view of the high literacy status in Kerala, they should focus attention on educational efforts so that people consume adequately iodised salt

for all time to come. 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".

7) In view of the results obtained, serious efforts must be made to focus on Information, Education, Communication to eliminate IDD. This aspect has not received due attention since the beginning of the programme.

8) Almost 100% of the samples examined at household level had some iodine. However, of these, only 49% was found to be adequately iodised. It is likely that inadequately iodised salt is being labelled and marketed as iodised salt. In the absence of legislation banning the sale of non-iodised salt, it becomes vital to have a stringent regulatory mechanism in place to ensure that the labelling is appropriate and the iodised salt logo is appropriately used. 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.

9) Quality assurance procedures should be in place to ensure "Good Manufacturing Practices", as well as transport and storage facilities for iodised salt, so that adequately iodised salt is available to the population on a regular basis.

10) 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 Directorate of Health Services,

Directorate of Medical Education branches of Indian Medical Associations and professionals involved in the solution to the IDD problem and associations of salt traders and distributors in Kerala.

11) 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.

12) A state level IDD Committee chaired by Secretary (Health) should be constituted with representatives of all the stake holders. The state IDD programme Manager should be the Member-Secretary. The progress of IDD elimination activities should be tracked, at least once every six months as a mandate of an established public health committee.

1.

Introduction

Iodine is one of the essential micronutrient required for the normal mental and physical well being of mankind. The human body requires around 150 μg of iodine every day, which works out to be a teaspoonful (5 gm) over a life span of seventy years.

On a worldwide basis, iodine deficiency is the single most important preventable cause of brain damage. Children living in areas affected by severe Iodine Deficiency Disorders (IDD) have an intelligence quotient (IQ) of up to about 13.5 points below that of those from comparable communities in areas where there is no iodine deficiency[1]. Iodine deficient children suffer from tardy concentration, impaired co-ordination and sluggishness, which result in poor school performance. In addition, their energy and productivity are also adversely affected. This has an effect on health, the quality of life, and economic productivity of communities.

On the other hand, IDD are amongst the easiest and cheapest of all disorders to prevent. The addition of a small, constant amount of iodine to the salt that people consume everyday is all that is needed. The elimination of IDD is a critical national development issue and should be given the highest priority by governments and international agencies.

Recognizing the importance of preventing IDD, the World Health Assembly in 1990 adopted the goal of

the elimination of iodine deficiency as a public health problem by the year 2000[2] . In the same year the world's leaders endorsed this goal when they met at the World Summit for Children at the United Nations[3], New York and it was re-affirmed by the International Conference on Nutrition in 1992[4] held in Rome. In 1993, WHO and UNICEF recommended Universal Salt Iodisation (USI) as the main strategy to achieve elimination of IDD. Universal Salt Iodisation is defined as iodization of all human and livestock salt, including the salt that is used by the food industry.

Since 1990 there has been tremendous progress in the production and availability adequately iodised salt. As a result, many countries are now on the threshold of achieving IDD elimination. In these countries, the emphasis should now shift to ensuring that the achievements are sustained for all time to come.

2

Iodine Deficiency Disorders

Iodine deficiency in humans and animals occurs when iodine intake falls below recommended levels. Iodine deficiency is a naturally occurring ecological phenomenon that is present in many parts of the world. The erosion of soils as a result of glaciation, frequent flooding, rivers changing course over a period of time, heavy rainfall, widescale deforestation etc, leads to a continued and increasing loss of iodine from the soil[5]. Thus, groundwater and locally grown vegetation in these areas lack iodine. In point of fact Iodine Deficiency is a disease of the soil (Fig -1) where the environmental deficiency results in the manifestation of the disease state in humans, perched on the top most level of the food chain.

Fig. 1: Iodine Deficiency : A Disease of the Soil

Cause	**Who Affected ?**	**How Afffected?**
Effect on People:	HUMANS	Health & Socio-economic impact
Effect on Animals:	LIVESTOCK	Clinical & Reproductive Disorders, Decreased Productivity
Low Availability of Iodine:	PLANTS	Iodine poor feeds and fodder, goitrogens
Soil Erosion:	WATER, SOIL	Environmental Iodine Deficiency

The ideal iodine intake as recommended by WHO/ UNICEF/ICCIDD[6] is shown in **Table 1**.

Table 1: Recommended Iodine intake in human beings (WHO/UNICEF/ICCIDD)

Age Group	**Iodine Requirement (in μg)**
Infants (0-11 months)	50
Children (12 months to 59 months)	90
School age children (6-12 years)	120
Adults (above 12 years)	150
Pregnant and lactating women	200

When iodine intake falls below the recommended levels, the thyroid gland is no longer able to synthesise sufficient amounts of thyroid hormone. The resulting low level of thyroid hormones in the blood (hypothyroidism) is the principal factor responsible for the damage done to the developing brain and the other harmful effects known collectively as Iodine Deficiency Disorders[7]. The adoption of this term was significant as it emphasized that the problem extended far beyond goitre and cretinism (**Table 2**).

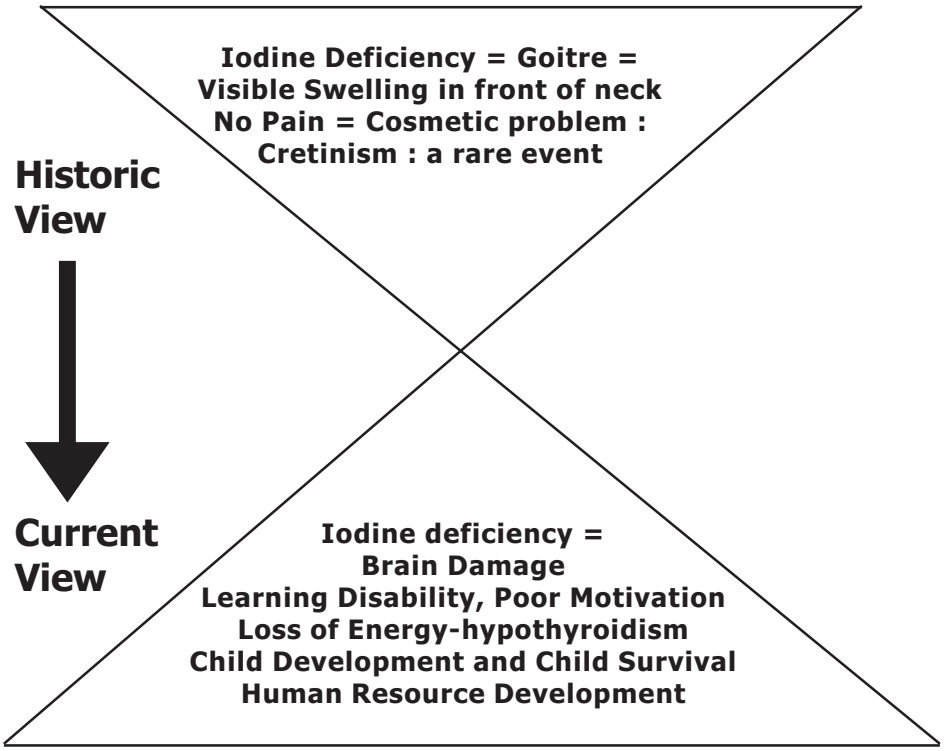
The understanding of the spectrum of iodine deficiency disorders has lead to a gradual realization of the insidious effects of iodine deficiency. This is represented by the hourglass concept of the people's perception of iodine deficiency disorders (Fig - 2). Previously it was thought that since iodine deficiency only leads to goitre, which was a visible swelling with no pain, it was thus only considered to be a cosmetic problem.

Table 2: The Spectrum of the Iodine Deficiency Disorders (IDD)

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

With an understanding of the overall effects of iodine deficiency, the current view stresses on the less than optimum development of the brain in areas of iodine deficiency. The loss of energy due to the resultant hypothyroidism and the learning disabilities leading on to poor motivation have serious consequences on child survival and development. In fact, iodine deficiency can be termed as a problem of human resource development.

Fig. 2: The Hourglass Concept of Perception of IDD



The most critical period of human brain growth and development is from the second trimester of pregnancy to the third year after birth. It is during this period that 90% of adult human brain development is completed[8,9]. Normal levels of thyroid hormones are required for optimal development of the brain. In areas of iodine deficiency, where thyroid hormone levels are low, brain development is impaired. In its most extreme form this results in cretinism. However, the greater impact on public health are the more subtle degrees of

brain damage and reduced cognitive capacity, which affects the entire population. As a result, the mental ability of apparently normal children and adults living in areas of iodine deficiency is reduced compared to what it would otherwise be. Thus, the potential capability of a whole community is reduced by iodine deficiency. Even the domestic animals such as poultry, goats, pigs, cows and buffaloes are affected and as a result the livestock productivity is dramatically reduced[10].

Correction of iodine deficiency

An iodine deficient environment requires the continued addition of iodine. This is most conveniently and cheaply achieved by the addition of iodine to the salt. Salt is consumed in the same quantity every day, throughout the year, by the entire population groups. The average intake of salt in India is about 10 grams per person per day. Thus, a micronutrient like iodine, introduced through salt, will ensure average requirement of 150 μg of iodine every day, throughout the year when salt with 15 parts per million of iodine (15 mg of Iodine per kg of Salt) is available at consumption level. ***A decrease in salt intake 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 is iodised as well.

Universal Salt Iodisation (USI) which ensures that all the salt for human and animal consumption is adequately iodised has been remarkably successful in many countries[11]. But sustainability of this successful correction of iodine deficiency is now the biggest challenge because iodine deficiency may recur at any time.

There is enough evidence that correction of iodine deficiency in a community has been followed by a "coming to life" of a community suffering from the effects of hypothyroidism due to the deficiency of iodine supply to the brain. Such an increase in vitality is responsible for improved learning among school children, improved work performance of adults, and a better quality of life. The economic significance of the prevention of iodine deficiency disorders needs to be clearly understood[12].

Education about these basic facts has to be a continuous process repeated with the inevitable changes over time in Ministries of Health and Industry (responsible for iodised salt production) and technocrats. Otherwise a successful programme will lapse as has occurred in a number of countries including India (Kangra Valley in Himachal Pradesh) Bolivia, Ecuador and Gautemala[11].

Universal Salt Iodisation

In nearly all countries where iodine deficiency occurs, it is now well recognised that the most effective way to achieve the elimination of IDD and sustain it thereafter is through Universal Salt Iodisation (USI), that is, the iodisation of all human and livestock salt, including the salt that is used by the food industry. 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 implemented worldwide and have followed a common pattern of evolution:

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

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

- *Consolidation phase*: Once the goal of universal iodisation is achieved, it needs to be sustained through ongoing external evaluation monitoring and periodic evaluation. The latter may include evaluation by international interdisciplinary 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) are:

- Elected representatives;

- Government ministries (health, industry, legislative and justice, agriculture, education, communication and finance);

- Salt producers, salt importers and distributors, food manufactures;

- Concerned civic groups, professional organisations; other key opinion makers; and

- Nutrition, food and medical scientists.

Opening the channels of communication and maintaining commitment and co-operation across these various groups on a regular continuous basis is perhaps the greatest challenge to reach the IDD elimination goal and sustain it thereafter.

The salt producers and distributors are instrumental to ensure that IDD is eliminated. Protecting the consumer requires a framework to be in place that will ensure the distribution of adeqately iodised salt that is appropriately labelled and packaged. 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 comprehensive salt iodisation programme[13]. This guideline, however, will need to be modified according to the situation of a particular country.

Sustainability

The remarkable progress of Universal Salt Iodisation in the current decade raises the issue of sustainability. Indeed, sustainability is absolutely critical. IDD cannot be eradicated in one great global effort like smallpox and, hopefully, poliomyelitis. Smallpox and poliomyelitis are infectious diseases with only one host – man. Once eliminated, they cannot come back. In contrast, IDD is a nutritional deficiency that is primarily the result of deficiency of iodine in soil and water. It can therefore return at any time after elimination if Iodine Deficiency Disorders Control Programmes fail. Indeed, there is evidence that iodine deficiency has re-occured in India (Kangra Valley, Himachal Pradesh) and some countries like Guatemala, Ecuador, Bolivia where it had been eliminated in the past[14].

Communications is an integral part of 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; and 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 it forever:

- Sustained Political support
- Effective Administrative infrastructure
- On-going Assessment and monitoring
- Regular Communication

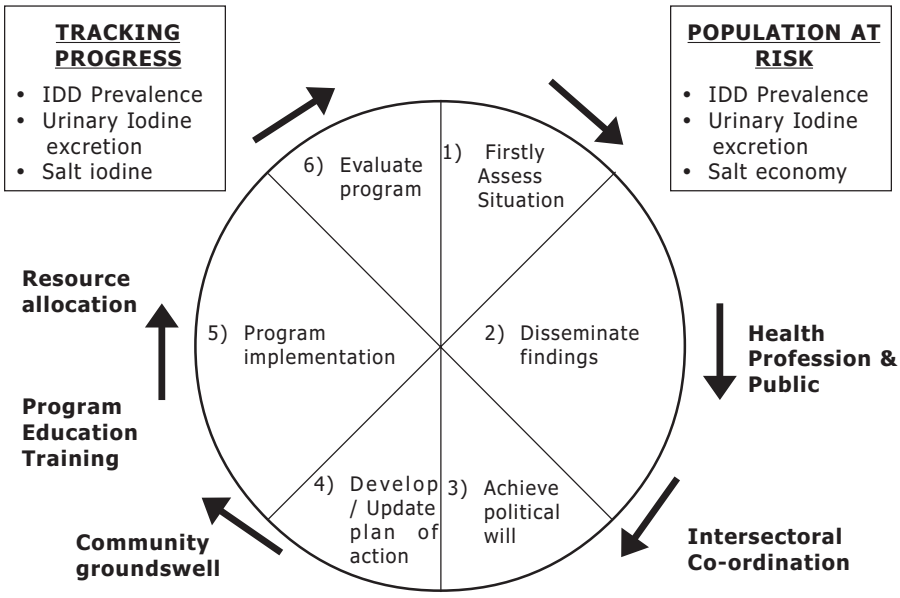
1) Sustained Political Support

This refers primarily to support at governmental level through the Minister of Health and the Executive Group of the 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) Effective Administrative Infrastructure

The National Body responsible for the management of IDD control programme should operate with a process model. A useful example of such a process model is known as the social process model[15] or the "wheel" described by Hetzel et al. (**Fig - 3**).

Fig. 3: Social Process Model for Health Care Programmes (The Wheel)



The Social Process model ("The Wheel") above describes the iterative cycle of IDD elimination. The key lies in the sustainability of IDD elimination, not just its elimination.

In order to adequately implement a health care programme, a variety of components are necessary. Some of these components may appear to be peripheral to the actual implementation process. For this reason, it is useful to take a holistic perspective.

The social process model for health care programmes may be represented by a six element circular model:

a) Firstly, assess/reassess the situation epidemiologically

Initially, epidemiological assessment is used to identify a health problem, to develop a situation analysis, and to conduct further exploration of the severity and extent of the problem in the country. This information is crucial for programme development and for assessment of programme success.

b) Increase awareness of the situation through communication and dissemination of findings

To develop more general awareness of the health problem, information must be disseminated and exchanged through various levels. This process usually begins in the medical/scientific community, travels to the Health Ministry and then to other arms of the government and the people at large.

c) Develop and achieve political resolve and agreement at all levels (from national level to community level)

The political resolve and agreement must be achieved before the development of a plan and establishment of collaborative linkages for its implementation. National level political will is expressed through legislation, adequate financial allocation, and by support to community based actions to promote the programme.

d) Create and update plans for infrastructure development and plan of action

The development of a plan is by the Ministry of Health and establishment of infrastructure and collaborative linkages between the Ministry of Health, Ministry of Trade and Industry and other sectors, for its implementation.

e) Vigorously implement the programme

Successful execution of the programme is dependent on effective organization and management of personnel and material. Adequate training of staff is an essential requirement.

f) Assess / Reassess the programme progress (viz. monitoring and evaluation)

Programme assessment may be considered in various ways: Internal versus External; Ongoing versus Occasional; Continuous versus Periodical; Process versus Impact; Formal versus Informal

The multi and inter-disciplinary orientation required for a successful programme poses special difficulties in implementation.

3. On-going Assessment, Monitoring

It is necessary to have adequate iodine content in the diet to prevent brain damage in the foetus and in the young infant when the brain is growing rapidly. The effectiveness of a national programme is providing an adequate amount of iodine to the target population. This is reflected in measurements of salt

iodine (at factory, retail and household level) and urine iodine (measured in casual samples from school children or households). Additional measures that would help in the assessment 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, the assessment and monitoring system needs :

- **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 which includes money, trained manpower, equipment and materials to support the implementation of salt iodisation and the establishment of monitoring systems.

4. Regular Communication

An important aspect of sustaining the success of the eliminatin of iodine deficiency disorders is to open channels of communication with the various stakeholders, to reaffirm their commitment and dedicationto the cause of sustainable IDD elimination.

3

Progress Towards IDD Elimination

Global Scenario

In 1999, WHO estimated that , of its 191 Member States, 130 had a significant IDD problem, with a total of 741 million (13%) of the world's total population which is affected by goitre (**Table 3**). Given that goitre represents the "tip of the IDD iceberg", it is likely that a much greater proportion of the population suffers from IDD and, in particular, from some degree of mental retardation. While the struggle to

Table 3 : 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%**

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

conquer the IDD started in the early years of the twentieth century, it is only the last decade that has seen the most remarkable progress, which has been particularly laudable in Asia and Africa.

In spite of this progress, the estimated total affected population at the global level has not changed substantially compared to the figure previously published in 1993[16]. The reason is that in 1993 the magnitude of the problem was underestimated because part of the information was not available then.

In 1999, WHO in collaboration with UNICEF and ICCIDD did a review of the IDD global situation[17]. Of the 130 countries with IDD, 98 (75%) now have legislation on salt iodisation and a further 12 have it in draft form. Following the promulgation of legislation on salt, and the sensitization of the salt industry, there has been an enormous increase in the consumption of iodised salt. The latest data for each of WHO's regions are summarized in **Table 4**.

Table 4 : 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%**

‡ Ref: Adapted from reference (18). 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.

This report emphasises the importance of monitoring for ensuring the sustainability of IDD control programmes.

In **Table 5**, the latest data on the status of legislation and monitoring programmes in the various WHO Regions are summarised[18].

Table 5: The Status of IDD, Legislation and Consumption of Adequately Iodised Salt in WHO-SEARO Member Countries

WHO Region	Countries with IDD (Number)	Legislation 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
Grand Total %	100%	75% (9%*)	-	-

*Additional countries with legislation in draft form

As can be seen, 110 countries (84%) of the 130 countries in the WHO region have a legislation either in force or in draft form. **Table 17** also compares the roles played by llegislation and social mobilization in the national programs to eliminate IDD. In the current scenario, a judicious mix of legislation, social mobilization and education is the key to success.

Indian Scenario

India is the second most populous country in the world with a population of 1027 million (2001 census). There is a high prevalence of goitre and cretinism in the Himalayan and sub-Himalayan belt, from Jammu and Kashmir in the west, to Arunchal Pradesh in the East and, along this entire length, extending at least 500 kms south of the Himalayas into the flat sub-Himalayan terai (plains).

In addition to the well-known "Himalayan endemic belt", iodine deficiency has been reported from many other states in the country. In 1984-86, the Indian Council of Medical Research (ICMR) carried out a multicentric IDD prevalence study. Nine states outside the traditional "Himalayan goitre belt" were studied for the prevalence of goitre and cretinism. A total of 409,923 individuals were examined. Overall goitre prevalence observed was 21.1 percent and the overall cretinism prevalence was 0.7 percent[19].

Results of sample surveys conducted by different agencies in 283 districts of 29 states and 4 Union Territories of India have shown a high prevalence of IDD in 247 districts[20]. This shows that no state or union territory is free of iodine deficiency.

Table 6 shows the IDD status in the various states and union territories. As can be seen, *no State and Union territory in the country is free from IDD as a public health problem*. In 1997, the Government of India introduced a promulgation banning the sale and storage of common salt in the country. All states and union territories, with the exception of Kerala (which did not implement the ban a the state level), Andhra Pradesh and Maharashtra (which implemented the ban partially, i.e. in some districts only), also implemented the ban order in their respective states. The ban order was lifted by the Central Government and in its wake, only Gujarat

Table 6: IDD Program Status in India

State /UT	Total Districts	Total surveyed	Endemic Status	Ban Cell	IDD
Andhra Pradesh	23	10	9	Partial	Yes
Arunachal Pradesh	10	10	10	Complete	Yes
Assam	23	18	18	Complete	Yes
Bihar	37	13	13	Complete	Yes
Chhatisgarh	16	2	2	Complete	No
Goa	2	2	2	Complete	Yes
Gujarat	25	16	8	No Ban	Yes
Haryana	19	10	9	Complete	Yes
Himachal Pradesh	12	10	10	Complete	Yes
Jammu & Kashmir	15	14	11	Complete	Yes
Jharkhand	18	9	8	Complete	No
Karnataka	27	17	6	Complete	Yes
Kerala	14	14	11	No Ban	Yes
Madhya Pradesh	45	14	14	Complete	Yes
Maharashtra	35	29	21	Partial	Yes
Manipur	9	8	8	Complete	Yes
Meghalaya	7	2	2	Complete	Yes
Mizoram	8	4	4	Complete	Yes
Nagaland	8	7	7	Complete	Yes
Orissa	30	4	4	Complete	Yes
Punjab	17	3	3	Complete	Yes
Rajasthan	31	3	3	Complete	Yes
Sikkim	4	4	4	Complete	Yes
Tamil Nadu	29	12	12	Complete	Yes
Tripura	4	3	3	Complete	Yes
Uttar Pradesh	71	25	20	Complete	Yes
Uttaranchal	13	9	9	Complete	Yes
West Bengal	18	5	5	Complete	Yes
A & N Islands	2	2	2	Complete	Yes
Chandigarh	1	1	1	Complete	Yes
Daman & Diu	1	1	1	Complete	Yes
D & N Haveli	1	1	1	Complete	Yes
NCT Delhi	1	1	1	Complete	Yes
Lakshwadeep	1	1	1	Complete	No
Pondicherry	4	4	4	Complete	No
Total	587	283	247		

Source: Directorate General of Health Services, Ministry of Health & Family Welfare, 2000

has revoked the ban order. Other states have maintained a status quo. Under the NIDDCP, there were provisions made for the setting up of an **IDD Cell.** The Central Nutrition and Iodine Deficiency Disorders (IDD) Cell at Directorate General of Health Services (DGHS) is responsible for implementation of NIDDCP in the country.

This places India among the major endemic iodine deficiency countries of the world. Immediate steps are therefore required to ensure that iodine supplementation, in the form, of iodised salt reaches the entire afflicted population, at the earliest.

Kerala Scenario

Kerala is a small state in the south-west corner of India. It represents only 1.18% of the total area of India but 3.43% of the total population of the country is in Kerala.

Kerala may be divided into three geographical regions:

1) Highlands
2) Midlands
3) Lowlands

The highlands slope down from the Western Ghats which rise to an average height of 900 metres, with a number of peaks well over 1,800 metres in height. This is the area of major plantations like tea, coffee, rubber, cardamon and other spices.

The midlands, lying between the mountains and the lowlands, are made up of undulating hills and valleys. This is an area of intensive cultivation. Cashew, coconut, arecanut, cassava (tapioca), banana, paddy, ginger, pepper, sugarcane and vegetables of different varieties are grown in this area.

The lowlands or the coastal area, which is made up of the river deltas, backwaters and shore of Arabian sea, is essentially a land of coconuts and paddy. Fisheries and the coir industry constitute the major industries of this area.

Most of the studies on IDD in Kerala have been district based. Thus the information is available district-wise. So far, there has been no statewide survey carried out using all the three indicators, namely, goitre prevalence, urinary iodine excretion and iodine content of salt at the consumption level.

The studies in Kerala trace their origins mainly from four sources:

1. Directorate of Health Services, under the auspices of the National IDD Control Programme (NIDDCP)
2. Independent research scientists
3. Individuals from Institutions
4. National Nutrition Monitoring Bureau (NNMB) from the National Institute of Nutrition, Hyderabad

Based on a report to the Indian Council of Medical Research (ICMR) in 1967, Kochupillai et al in 1976 conducted the initial study[21]. They studied the overall prevalence of thyroid nodules in the coastal areas of Kerala. Subsequent studies have been restricted to districts or hospital based studies. Between 1989 and 1994 the Goitre Control Cell of the Directorate of Health Services conducted district wise surveys all over the state and reported the prevalence of goitre. It ranged from 4.7% to 27.3%. These studies have helped researchers and public health officials to assess the status of iodine nutrition in Kerala.

The studies have been listed in the **Table - 7** in chronological order.

Table 7 : District wise Goitre Surveys - I

S.No.	Author & Study Questions	District	Period of Survey	Goitre Prevalence Rate (%)	Other Parameters	Remarks
1.	Kochupillai N et al[21] Prevalence of thyroid nodules	Limited to coastal areas	1979	Overall prevalence not done	Prevalence of thyroid nodules - 13% Solitary - 68% MNG - 20%	Only looked at thyroid nodules
2.	Ramachandran M[22] Prevalence of thyroid swelling in hospital setting	Thyroid Clinic in Medical College Hospital (MCH)	1990	Adenoma - 16% Multi Nodular Goitre - 61% Carcinoma - 6.5%	Low levels of iodine in the subsoil water of midland and highland areas	Hospital based study
3.	K.P. Paulose[23] Goiter prevalence in villages of Kottayam, Medical College Kottayam Inpatient and Outpatient Clinics and School Camps	Kottayam	1992	Kottayam District - 6 - 28% MCH Outpatient - 30.0% MCH Inpatient - 3.7% Peripheral - 9 to 17 % School campus - 16 to 39%	Low levels of iodine in the water of highland areas - $^{1}/_{3^{rd}}$ of that of lowland areas	Regionalized Need further analysis

Table 7 : District wise Goitre Surveys - II

S.No.	Author & Study Questions	District	Period of Survey	Goitre Prevalence Rate (%)	Other parameters	Remarks
4.	Goitre Control Cell, Directorate of Health Services (DHS)[24] Goitre Prevalence	Trivandrum	1989-1992	17.3-27.3	Not done	Only goitre prevalence assessed
5.	Goitre Control Cell, DHS[24] Goitre Prevalence	Kollam	1992	5.8-12.9	Not done	Only goitre prevalence assessed
6.	Goitre Control Cell, DHS[24] Goitre Prevalence	Ernakulam	1992	9.1	Not done	Only goitre prevalence assessed
7.	Goitre Control Cell, DHS[24] Goitre Prevalence	Alappuzha	1992	4.7	Not done	Only goitre prevalence assessed
8.	Goitre Control Cell, DHS[24] Goitre Prevalence	Pathanamthitta	1992	12.6	Not done	Only goitre prevalence assessed
9.	Goitre Control Cell, DHS[24] Goitre Prevalence	Idukki	1992	17.8	Not done	Only goitre prevalence assessed
10.	Goitre Control Cell, DHS[24] Goitre Prevalence	Kottayam	1994	21.0	Not done	Only goitre prevalence assessed
11.	Goitre Control Cell, DHS[24] Goitre Prevalence	Thrissur	1994	14.0	Not done	Only goitre prevalence assessed
12.	Goitre Control Cell, DHS[24] Goitre Prevalence	Palakkad	1994	6.0	Not done	Only goitre prevalence assessed

Table 7 : District wise Goitre Surveys - III

S.No.	Author & Study Questions	District	Period of Survey	Goitre Prevalence Rate (%)	Other parameters	Remarks
13.	Goitre Control Cell, DHS[24] Goitre Prevalence	Manjeri	1994	11.0	Not done	Only goitre prevalence assessed
14.	Goitre Control Cell, DHS[24] Goitre Prevalence	Calicut	1994	13.0	Not done	Only one indicator assessed
15.	Goitre Control Cell, DHS[24] Goitre Prevalence	Wayanad	1994	21.0	Not done	Only one indicator assessed
16.	Goitre Control Cell, DHS[24] Goitre Prevalence	Kannur	1994	11.0	Not done	Only one indicator assessed
17.	Goitre Control Cell, DHS[24] Goitre Prevalence	Kasargode	1994	10.0	Not done	Only one indicator assessed
18.	National Nutrition, Monitoring Bureau (NNMB) Goitre Prevalence	Rural survey	1996	Boys <18 years- 6.8% Girls <18 years- 8.8%	Not done	Physiological effect
19.	U. Kapil[25] Goitre Prevalence Urinary Iodine	Ernakulam School survey	1998	Goitre - 1% Median UIE-200 µg/L	Not done	District study

4

Background and Rationale for the Present Study

Geographically, Kerala lies in peninsular India. A significant proportion of the population in the state lives in the coastal areas. The State of Kerala has achieved near 100 percent literacy and is known to be a better performing State with respect to health indicators.

The population of Kerala has traditionally consumed sea fish and tapioca on a regular basis. Sea fish is rich in iodine while the thiocyanate present in tapioca interferes with iodine utilization by the thyroid gland. Thus, sea fish and tapioca consumption have had a significant effect on the iodine nutrition of Kerala over the years. Over a period of time the tapioca cultivation and consumption has declined. Fish, however, remains an important food item consumed by the population.

In this context, the available studies from the state have shown the existence of Iodine Deficiency Disorders (IDD) as a public health problem in 11 of the 14 districts surveyed so far.

Most of the studies on IDD in Kerala have been district based. Thus, the information is available district-wise. So far, there has been no statewide survey carried out using all the three indicators, namely, goitre prevalence, urinary iodine excretion and iodine content of salt at the consumption level.

With this in view, it was important to study the current status of IDD and also the knowledge, attitudes, practices and behaviour of the people about the problem of IDD and the use of iodised salt, by using qualitative methods. This would help us to understand the current situation with respect to IDD indicators and people's perception about IDD and iodised salt. It would also help in deciding the future course of action regarding IDD elimination and its sustainability in Kerala.

5

Objectives

Objectives of the Study

Due to the lacunae of statewide data on Iodine Deficiency Disorders (IDD) in Kerala, it was decided to determine the status of IDD quantitatively, using clinical and biochemical indicators, throughout the State. Also, as an important component of the social process model, the perceptions of the people of Kerala about IDD and iodised salt were also looked into in detail.

The specific study questions were:

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

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

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

6

Methodology

The methodology followed for the study was the one recommended by WHO/UNICEF/ICCIDD in the year 2000 and accepted internationally *(WHO / UNICEF / ICCIDD. WHO / Nut / 94.4).*

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 a house-to-house visit, the methodology of which is described in **Annexure - 3**.

Study Population

Thirty-five school age children in the age group of 6-12 years were selected from each cluster providing a total sample size of 1050 children and households in the 30 clusters surveyed.

Parameters Studied

Clinical Parameters

The enlargement of thyroid, as recommended by the WHO / UNICEF / ICCIDD Classification was graded

as Grade 0,1 or 2. Even though physicians constituted the study teams, a half-day demonstration workshop on the method of goitre examination was conducted. The teams were asked to examine the 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 the lower grade.

Biochemical Parameters

(i) Urinary Iodine

Urinary iodine excretion is one of the markers 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 990 urine samples were transported to Medical College, Thiruvananthapuram and kept under refrigeration. They were then transported to the ICCIDD Reference Laboratory in New Delhi for analysis by the simple microplate method as developed by Ohashi et al[26].

(ii) Iodine in Salt

Total of 1066 salt samples were collected from all the households in the study sample. They were packed in sealed plastic bags and then transported to the State Nutrition Laboratory at Thiruvananthapuram for analysis of the iodine content. Similarly, salt samples were also collected from retail shops, sealed and sent to the State Nutrition Laboratory. The iodine content of salt samples thus collected was determined by the titrimetric method[27].

Qualitative Components

(i) Socioeconomic Questionnaire

A pre-tested household socioeconomic questionnaire, with components on knowledge, attitude, practices and beliefs about IDD and Iodised Salt, was prepared. The questionnaires had both close and open ended questions. During the initial orientation workshop, the participants were asked to translate it into Malayalam and translate it back to English independently. The questionnaire was administered by the physicians in the local dialect. The answers were then translated into English, recorded, and analysed.

ii) Focus Group Discussion

A series of six Focus Group Discussions (FGD) were held all over the state to determine the community perceptions about iodine deficiency and iodised salt. The FGDs were carried out in two districts of Kerala, in Thiruvananthapuram and Calicut. Two categories of stakeholders were identified: buyers and shopowners (vendors). Five FGDs. were conducted among the buyers and one among the vendors.

Sample Size Determination for the Survey

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

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

z = Desired level of certainty (1.96 for 95% confidence interval)
p = Estimate of expected proportion
q = (1-p)
DEFF = Design effect
d = Level of absolute precision

The number of children to be examined per cluster was caclulated on the basis of the following assumptions.

Estimated goitre prevalence	**30%**
Proportion of population consuming iodised salt	$\geq$ 70%
Population with urinary iodine excretion $\geq$ 100 μg/l	$\geq$ 70%
Confidence level	95%
Absolute precision	$\pm$ 5%
Design effect	3
Total sample size	969
No. of children to be examined	~ 1,050
Number of clusters	30
Sample size (number of children) per cluster	35

Selection of households and children

After the selection of clusters, the households and the target population (children in the age group of 6-12 years) were selected randomly using the standard techniques used in EPI '30 Cluster' surveys. Only one child was selected per household. If there was more than one eligible child in the household, then one child was randomly selected.

Household Sampling

Urine samples from all the subjects examined were collected. Salt samples from the respective households of the children examined were collected for iodine analysis.

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. One sample from each of the available salt varieties was collected from the shops and sent to the State Nutrition Laboratory, Thiruvananthapuram for analysis by iodometric titration.

7

Laboratory Analysis

Iodine in Salt

Iodine content of salt samples from households and retail outlets were analyzed by the method of *iodometric titration*[27] . The iodine content of salt can be determined by liberating iodine from salt and titrating iodine with sodium thiosulphate using starch as an external indicator.

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 as devised by Ohashi T, Yamaki M, Pandav CS, Karmarkar MG and Irie M[26].

Internal Quality Assurance

The Internal Quality Assurance 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 clusters were analyzed. The mean and two standard deviation values were calculated. This was kept as the known sample, to be analyzed with the other salt samples as Internal Quality Control.

ICCIDD provided the technical assistance and training for the laboratory technicians conducting the salt analysis in Kerala.

The urinary iodine excretion estimation was done at the ICCIDD Reference Laboratory in New Delhi. Internal Quality Assurance was also followed in the Reference Laboratory in ICCIDD. As part of the Internal Quality Assurance protocol, a total of 210 urine samples were analyzed on different days to establish the reliability and validity of the process in the laboratory.

8

Data Entry and Data Analysis

The data entry and analysis was done at the Medical College, Thiruvananthapuram.

Quality control in data analysis

The data was entered into a DBASE file and the data entry was double checked for errors. The data analysis was done using the EPIINFO 6.04 statistical software programme.

9

Special Features of the Kerala Study

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

1. This was the first statewide study where the field investigators were physicians. The training of physicians ensured the quality and reliability 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 as the outcome variables.

3. The study protocol was discussed together with the state investigators and a concurrence reached. The study was carried out using the uniform protocol, by the various participants.

4. There was a regular communication and feedback from the state coordinators, which helped to complete the study within the stipulated timeline.

5. The involvement of key institutions, at the State level [Directorate of Health Services (DHS) and Directorate of Medical Education (DME)] NGOs, National Institutions (AIIMS and INMAS, New Delhi), International agencies (UNICEF, India), ICCIDD has helped in highlighting the intersectoral collaboration that is integral to the success of any health care programme.

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

7. As part of capacity building, the study helped to create a pool of trained resource persons at the state level for future activities.

8. The concept of annual cyclical monitoring and sentinel surveillance has evolved from this study. The programme manager can review the change in the iodine status of the population by dividing the State in five zones and covering them turn by turn every year for the next five years.

10

Iodine Deficiency Disorders in the "Hard To Reach" Clusters

In addition to providing state level representative data for Kerala, it was decided to survey three "Hard-to Reach" clusters. The clusters were selected by purposive sampling by the field investigators in Kerala. These areas were identified based on:

1. *a priori* knowledge of, "hard to reach" areas

2. The distance from the nearest urban area

3. Health infrastructure

4. Other health indicators like Infant Mortality Rate, Neonatal Mortality Rate, Maternal Mortality Rate, etc.

The three areas selected were Ponmudi, Iritty and Agaly. The results of the survey in the three clusters are presented in **Annexure – 4**.

11.

Results

A total of 1067 children aged between 6 to 12 years (Mean ± S.D : 8.8 ± 1.9 years) were studied.

The total goitre rate was 16.6% (95% CI: 14.4% - 18.8%), prevalence of Grade I goitre being 14.0% and Grade II goitre being 2.6% (**Fig. - 4**).

There were 529 boys (49.6%) and 538 girls (50.4%) with a mean ± S.D age of 8.7 ± 1.9 years and 8.8 ± 1.9 years, respectively. The total goitre rate in boys and girls were found to be 14.3% (**Fig. -5**) and 18.8% (**Fig - 6**), respectively and this difference in was found to be statistically significant (p= 0.002).

Fig. 4: Total Goitre Rate

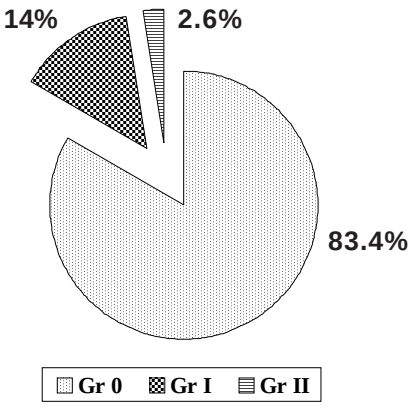


Fig. 5: Total Goitre Prevalence Rate - Boys

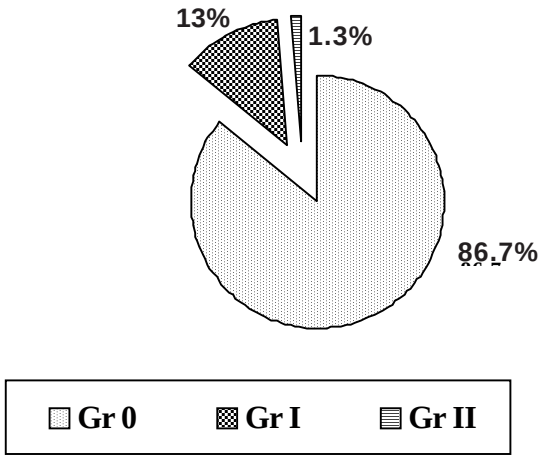
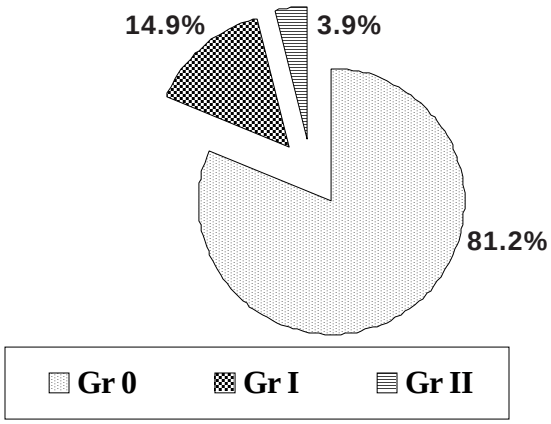


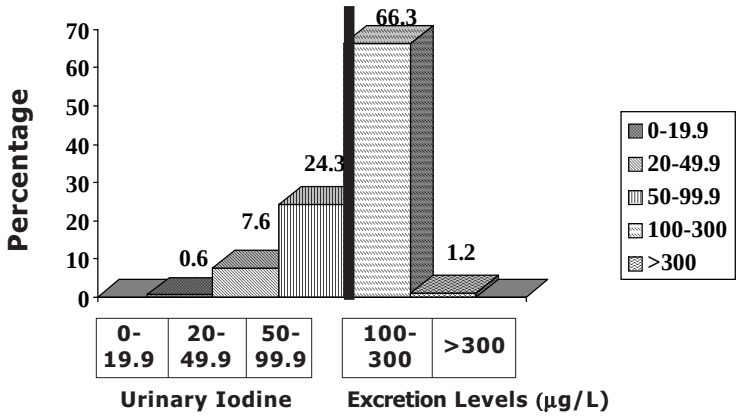
Fig. 6: Total Goitre Prevalence Rate - Girls



Urinary Iodine Excretion

A total of 990 urine samples were analyzed for iodine content. The median urinary iodine excretion was found to be 123.3 μg/L. The range of urinary iodine excretion values was from 10.2 to 378 μg/L. 32.5% of the values were ≤ 100 μg/L and 67.5% of the values ≥ 100 μg/L. The distribution is shown in **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.

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



Iodine Content Of Salt at the Household Level

A total of 1066 salt samples were analyzed. The proportion of households consuming adequately iodised salt was 48.9%. The range of iodine levels in salt in the samples from the households was 0 to 132.3 parts

per million (PPM). The total number of salt samples with some iodine was 1051 (98.6%). The distribution is outlined in **Table 8** and **Fig 8**.

Table 8 : Iodine Content of Salt at the Household Level

Iodine content (PPM)	Number of samples	Percentage
0	15	1.4%
>0-6.9	485	45.5%
7-14.9	45	4.2%
15-30	144	13.5%
30-49	316	29.6%
50-99	59	5.6%
100-133	2	0.2%
TOTAL	1066	100.0%

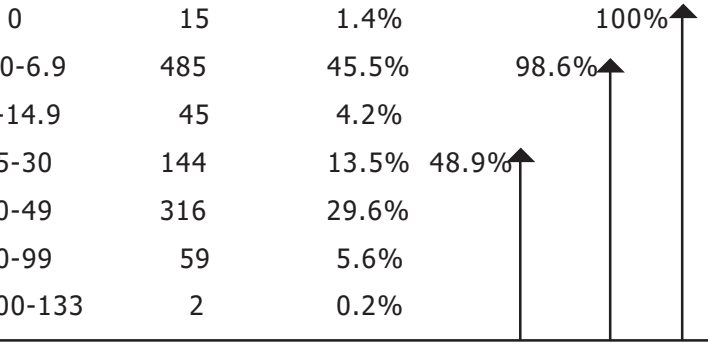
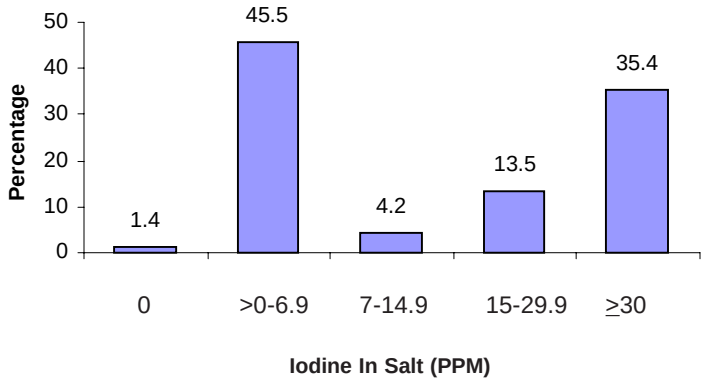


Fig. 8: Distribution of Salt at the Household Level



Iodine Content of Salt at the Retail Level

A total of 59 salt samples collected at retail shops were analyzed. The proportion of retail shops selling adequately iodised salt was 61% (95% C.I. : 48.6% to 73.4%). The range of iodine levels in salt in the samples from the retail shops was 1 to 180 parts per million (PPM). Thus, all the samples analysed had some iodine.The distribution is outlined in **Table 9** and **Fig 9**.

Table 9 : Iodine Content of Salt at the Household Level

Iodine content (PPM)	Number of samples	Percentage
0	0	0%
>0-6.9	18	30.5%
7-14.9	5	8.5%
15-30	8	13.5%
>30	28	47.5%
TOTAL	59	100.0%

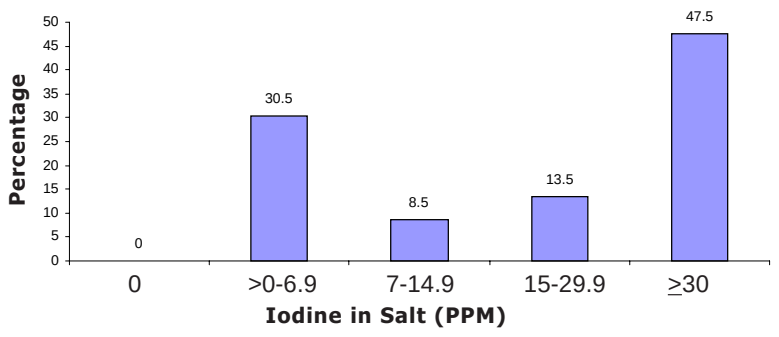


Fig. 9: Distribution of Salt at the Retail Level

Overall Results

The overall results are briefly outlined in **Table 10** below.

Table 10 : Overview of the Results

Variable	Value
Number of children studied	1067
Mean age (Years)	8.8 ± 1.9
Goitre Grade I	14.0%
Goitre Grade II	2.6%
Total Goitre Rate	16.6% (95% CI : 14.4% to 18.8%)
Number of urine samples analysed	990
UIE (μg/L) (Median)	123.3
Proportion < 100 μg/L	32.5%
Proportion < 50 μg/L	8.2%
Number of salt samples analysed	1066
Proportion of households consuming adequately iodised salt (≥15 ppm)	48.9% (95% CI : 45.9% to 51.9%)

12

Qualitative Component of the Kerala Study

The qualitative component of the study was carried out to assess the community perceptions about IDD and iodised salt and also to serve as a source of data triangulation for the quantitative survey. The following were the objectives of the qualitative study:

Objectives

General Objectives

To explore the community perceptions regarding IDD and iodised salt and the implications on the policy of universal salt iodisation and its promotion.

Specific objectives

1. To assess the level of 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

Focus Group Discussions (FGD) among different categories of stakeholders was used for the collection of data.

Study Setting and Participants

The study was carried out in two districts in Kerala, namely Thiruvananthapuram and Calicut. Two categories of stakeholders were identified: buyers and shop owners (also called vendors). Five FGDs were conducted among the buyers and one among the vendors. FGD among the vendors was restricted to one, owing to the difficulty in getting the participants. The four FGDs among the buyers were carried out: one in a panchayat in a coastal area (Puthenthoppe) one in a panchayat in a rural area (Poovachal), one in Cheruppa in Calicut district and one in an urban ward (Poojappura) of Thiruvananthapuram City Corporation. Out of the two rural FGDs, one was held among the low - income group and other among the middle - income category. The subjects were adult females from households in the selected areas.

Sampling

Purposive sampling was done in the selection of urban, rural and coastal sites. To ensure comparability of data across the state, one rural FGD was carried out in one rural panchayat, Cheruppa in northern Kerala.

Tool for Data Collection

A Focus Group Discussion guide in the local language was prepared in advance. The topics for discussion were consistent in terms of the objectives of the study. The broad topics thus identified for discussion included community awareness about different types and brands of salt, household level and retail shop level buying and storage practices, advantages and disadvantages of iodised salt, iodine and health and policy implications of universal salt iodisation.

Data Collection

FGDs were conducted by the investigators themselves or facilitators, with the help of local co-ordinators. Two observers recorded the whole discussion verbatim in addition to tape recording the whole, with the permission of the participants. The transcribed local language version was translated into English before proceeding to data processing and analysis. Sociograms were prepared to assess the dynamics of interaction among the participants.

The study was carried out during the months of January and February 2001.

Data Processing and Analysis

The English version of all the FGDs were analysed manually by the investigators. The following steps were taken to process and analyze the data:

- **Freelisting**

The responses of all the Focus Group Discussion were initially free listed.

• Domain Identification

The next step is identifying the emerging themes, which are called 'domains'. This was done by going through all the free listed responses and understanding the meaning of the responses.

• Coding the responses

The individual responses were categorized and coded as to which domains each of them would belong to.

• Summarizing

Next step was to summarize the responses. This was done by using qualifiers and expressing the observations in semi-qualitative manner with the help of appropriate adjectives. If the proportion of respondents were less than 25% in one category, 'few' or 'some' was used as adjective. If it fell between 25 – 49%, the adjective used was 'nearly half'. If proportion of respondents were between 50-74%, it was expressed as 'majority', between 75 –89% as 'most' and 90% and above were given the adjective 'almost all'.

S.No.	Adjective	Proportion of Respondents
1.	Few / Some	< 25%
2.	Nearly Half	25-49%
3.	Majority	50-74%
4.	Most	75-89%
5.	Almost All	> 90%

Results of the Study

Description of the Study Population

Forty eight (48) women participated in four FGDs on buyers. Out of this 38 (79%) belonged to the age group of 25-40 years. All of them were married and had children. Eleven (28.2%) had an educational level of graduation and above. A majority of urban respondents belonged to this category. Sixteen of them (33.3%) were educated up to 10th standard or 10 +2 level and another nine were educated up to secondary level. There were only seven participants with primary education and none was illiterate. Among the forty eight participants, there were only 2 employed women. The rest were housewives.

Seven vendors participants in the FGDs for the vendors, all of them males in the age group of 40-50 years, hailing from urban areas.

Group Dynamics

In all FGDs, the participants interacted very well and the average time taken for each FGD was 60 to 90 minutes.

Awareness about type of quality salt

Almost all participants knew about powdered and crystal salt and **a majority** could mention at least one brand of iodised salt. Urban participants were more familiar with the brand names like **Annapurna, Sprinkle, Tata** and **Captain Cook**. **A Few** of the rural respondents and almost all respondents from urban

areas could distinguish between powdered iodised and non-iodised salt. Vendors mentioned a couple of brand names of non-iodised salt (MST, AST), which were not listed by the buyers. As far as the buyers are concerned, sources of availability of salt were the local retail shops. For vendors, the source of iodised and non-iodised salt was places like Thoothukkudi (Tuticorin), Thamarakkulam, Chennai and Gujarat.

Regarding the quality of salt, **most** of the rural and costal participants and **almost all** urban participants perceive powdered salt as of better quality. The qualities of powdered salt include its free flowing nature, lack of impurities, convenience in storage and handling and increased salt concentration when compared to crystal salt. Urban participants attributed these qualities specifically to brand products of iodised salt. Presence of impurities was mentioned as the important disadvantage of crystal salt. The vendors also endorsed the views of buyers with regard to the quality of different salts. But **a few** rural respondents mentioned that crystal salts were tastier. They are used in making pickles and in preparation of some curries.

All of them opined that crystal as well as powdered salts is now available in packets. **Almost all** are aware of the difference in price between crystal and powdered salts. The urban participants were aware of the price range among different brand names of iodised salt.

Buying practices

Household level buying practices were assessed. **Almost all** among the affluent group buy powdered salt. **Most** of them prefer to buy iodised salt with brand names and **a few** ask for specific brands. In

rural and coastal areas also, **majority** buy powdered salt and buy whatever brand is available at the shops. **Some** of them buy both crystal and powdered and **a few** resort only to crystal salt.

The respondents were asked about the factors that influence their decision to buy the types and brands of salt. Quality of salt was mentioned as the first and foremost criterion influencing the buying practice. Convenience in using and absence of impurities were projected as the good qualities of powdered salt by most of the participants. Low price was the prime consideration for buying crystal salt. Taste was also mentioned by a few of them who use crystal salt.

Health reasons and need for iodine in food were pointed out by only a couple of participants as the reason for buying iodised salt.

When asked about the source of information which help in the decision making process in the purchase of powdered or iodised salt, **majority** mentioned 'advertisement in media', publicity or free gifts along with powdered salt and, "advice by health professionals" was pointed to out by **a few** as information sources.

The nature of purchase i.e., whether they buy in bulk or small quantity was also elicited from the participants. **Most** of them responded that they buy one or two packets at a time. Regarding the storage of salt for domestic purpose, **most** of them said that they store the salt in glass, plastic or stainless steel containers with a lid. Crystal salt is used as salt solution, which they prepare for short durations. Maximum duration mentioned was one month. **Some** of the

respondents who buy powdered salt also use it as salt solution.

As far as vendors are concerned, storage is easy as salt comes in plastic bags nowadays. Loose salt is not being sold for domestic purpose. The number of bags purchased at a time depends on the incentives for a particular brand. The vendors were unanimous in saying that 'after the introduction of branded powdered salt, there is competition in this field also. The promotion of a particular brand by the shop owners depends on higher profit margin.

Iodised salt

Participants were asked about the advantages and disadvantages of iodised salt. **Nearly half of them** were ignorant about it.

Advantages of iodised salt to prevent goitre and other IDDs were mentioned by **some** of the participants. **A Few** mentioned about the conflicting views that they have heard about iodised salt. It was interesting to note that the proportion of buyers who insist on iodised salt for health reason was very minimal. The vendors shared the same views as that of buyers.

Iodine and Health

A Few could mention the natural sources of iodine in food and **nearly half** of them could mention goitre as an iodine deficiency disorder. **A Few** mentioned other iodine deficiency disorders. The educational campaign about IDD through mass media does not seem to

influence the average Keralite in this matter.

When asked about their perception on the rationale for the use of salt as a vehicle for iodine consumption, **a majority** mentioned the fact that it was cheap, its easy availability and the daily use of salt in almost all items of food.

Knowledge of Legislation

Community perception about a complete ban on sale of non –iodised salt was elicited from the participants. It is to be noted that people were divided on this matter. **A Majority** of them did not favour a complete ban. **Almost all** of them in this category wanted the present system of making both iodised and non-iodised salt available in the market to continue. **One third of the respondents** opined that if a ban is imposed, they would go by the rule and purchase the available variety. The main reason suggested by the group against the ban of non-iodised salt was the "cost difference" which make salt less affordable to the poor. The other reasons suggested were that people are not convinced about its health benefits. The price increase for a commodity like salt in general would not be palatable. They also felt it would be detrimental to the interests of producers of non iodised salt. Salt is also used for non-domestic purposes, felt the respondents.

Attitude of the community towards universal salt iodisation, after having known the health consequences was also assessed by the study. **Most** perceive a favourable attitude among the people for a complete ban if they are made aware of the health consequences. A few of them still anticipated resistance from some quarters.

Giving a disease scenario of hypofunctioning of thyroid and asked about the willingness of people to spend money for preventing the problem, most of them stood in favour of disease prevention vis-a-vis lower price. This confirmed their earlier stand that **majority of people value their health more and would prefer iodised salt to common salt even if there is a difference in price.**

Suggestions for promoting iodised salt

Educational campaign through mass media especially electronic media by different types of programmes was suggested by **most** of the participants. Other suggestions include advertisement of branded products focusing on health issues, targeting school children in the educational campaign and reducing the price of iodised salt.

Narratives and Quotes from the Focus Group Discussions

Salt types

"Crystal salt has impurities. When it is put in water, the impurities begin to float. But powdered salt is *free of impurities*"

- A middle income buyer from Poovachal.

" Crystal salt is used to preserve mangoes, lemons etc. It is cheaper also"

- A middle-income buyer from Poovachal.

"Powdered salt is also used as solution. It will easily mix with the curry and easy to measure also"

- A rural respondent from Poovachal.

Knowledge of Iodised salt

"We have no idea about the advantages and disadvantages of iodised salt. We use according to convenience and price."

- A participant from Puthenthoppe.

This is evident in a statement of one of our respondents " Nobody cares about the benefit. We don't demand for iodised salt from the shop",

- A rural buyer from Poovachal.

"Mental retardation is caused by so many factors. What happens if we give iodine only".

`"If doctor advices that it (iodised salt) is good for health, people will believe and buy it"

- Rural buyers from Poovachal.

"Iodine deficiency is not a problem in Kerala. No need to sell iodised salt"

- Vendor from urban area.

The vendors were also divided in their opinion as to how the community will perceive a ban. Their apprehensions were expressed when they say:

"People will look upon it as an act to get more profit by the merchants"

"Ban will not affect. The use of iodised salt has become common".

" Currently the advertisement of iodised salts focuses on free flow, not health issues"

- An urban buyer from Poojappura.

They share the view **"Price is a factor, but health is more important"**.

" Several bad habits exists even if people know the health consequences. Similarly is the case for non-iodised salt also"

- An urban buyer from Poojappura.

Conclusions

The following are the important conclusions drawn from the qualitative study

- **Most** of the women who participated in FGDs knew about the different types of salt and at least one or two brands of iodised salt.
- **Most** of them are knowledgeable about the difference in price and quality of different types of salt.
- **Almost all** in urban areas buy powdered salt and most of them prefer brand names of iodised salt.
- In rural areas too **majority** buy powdered salt, but not concerned about iodised or non-iodised or specific brand products.
- Quality of product and considerations of price are the prime factors influencing the buying practice.
- Advertisements and incentives are the motivation factors influencing the decision – making of whom
- Health benefits are not a criterion for buying a specific variety even by majority of those who buy iodised salt.
- A sizable proportion of people who buy powdered salt use it in the form of salt solution.
- **Nearly half of the respondents** were ignorant about the advantages and disadvantages of iodised salt.
- **Few** are aware about IDDs other than goiter.
- **Majority** of the participants were not favouring a complete ban of non-iodised salt.

- People are confused and not convinced about the health benefits of iodisation as it is not projected adequately.
- **Majority** perceive a favorable attitude from the people if they are made aware of the health benefits of salt iodisation
- **Majority** would opt for health, if a choice was to be made between health benefits and price of salt.
- Educational campaign through mass media especially electronic media, advertisement of iodised salt focusing on health issues, reducing the price of iodised salt and targeting student population in educational campaign were suggested by people as measures for promoting iodised salt.

13

Discussion

IDD Elimination Programmes

Enlargement of the thyroid gland – goitre- has been reported in endemic proportions in several mountainous regions of the word in the last century. The etiology and pathogenesis of endemic goitre has been thoroughly investigated and environmental iodine deficiency has been identified as the main causative factor.

In the last three decades, it has been established that goitre is only the "tip of the iceberg". It has now been demonstrated that iodine deficiency leads to hypo-thyroxinemia and causes impaired development of the brain and central nervous system in early fetal life in humans. These changes are irreversible and hamper learning abilities, leading to loss of 13 IQ points in the population living in iodine deficient areas. Iodine deficiency not only exists in mountainous areas, as thought earlier, but also extends in varying severity from mild to severe in other areas such as slopes of mountains, flooded areas and even coastal areas. Further, iodine deficiency, when present in mild to moderate proportions, may not show any visible changes in the size of the thyroid gland but still have effects on the brain and central nervous system development in early life. Hence, it is referred to as "**Hidden Hunger**". In order to focus attention on spectrum of disorders caused by iodine deficiency, the term 'Iodine Deficiency Disorders' has also been coined, and widely accepted, to replace endemic goitre.

Different modes of iodine prophylaxis have been employed for the elimination of iodine deficiency. The most economical, effective and widely used method is the use of iodised salt. The other interventions are iodised oil, iodisation of water, distribution of potassium iodide (KI) tablets.

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), Programme 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. A brief mention of these indicators and the indicators used to assess an IDD elimination program are mentioned in **Annexure - 6**. The process indicators include iodine content of salt at the production and consumer level while the outcome indicators are goitre grading (clinical), urinary iodine excretion Neonatal TSH and thyroglobulin in circulation and (biochemical). These indicators are studied 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 11**, were done in the regions of Delhi, Kerala (India), Bhutan, Sri Lanka, Nepal, Bangladesh and Thailand.

Table 11: Total Goitre Rates and Median Urinary Iodine Values in Various Regions of the World

Area	Year	Goitre Prevalence Rates (%)	Median Urinary Iodine Excretion (µg / L)
Delhi[28]	1994	20.5	198.0
Bhutan[29]	1996	14.0	230.0
Nepal[30]	1998	Women-50.0 SAC -40.0	Women-114.1 SAC -143.8
Thailand[31]	1998	Range:0.02 - 6.63	149.8
Bangladesh[32]	1999	17.8	Hilly - 63.8 Flood Prone - 139.3 Plains - 147.7
Kerala	2001	16.6	123.3

*SAC: School Age Children

Most of the studies have reported that goitre rates are above 10% and as per the criterion of median urinary iodine excretion, levels of urinary iodine are satisfactory. This has led to many discussions about the use of Universal Salt Iodisation as a prophylactic strategy and the time taken to demonstrate its impact on IDD indicators. To understand the results of these studies, the following points need to be considered.

Three Phases of IDD Elimination Programmes

In general, the Iodine Deficiency Disorders Elimination Programmes in any region can be seen going through three phases. The three phases depict a gradual evolution from the "virgin" state of iodine deficiency to the iodine replete state. The status of the indicators of assessment of Iodine Deficiency is variable from phase to phase.

The three phases are:

1. **Phase I- Community Diagnosis (Iodine deficiency)**

2. **Phase II- Community Intervention (Iodine deficiency to sufficiency)**

3. **Phase III- Sustainability - (Ensuring optimum iodine intake)**

1. Phase I - Community Diagnosis

This is the phase where the problem has been newly detected. Iodine deficiency exists as a public health problem and efforts to recognize it and measures to control it are yet to be initiated. In this case there is a good association between the goitre prevalence rate Total Goitre Rate (TGR) and Urinary Iodine Excretion (UIE). This is because the thyroid gland, which has been starved of iodine, will take up as much of the iodine as it possibly can and the rest is excreted in the urine.

2. Phase II – Community Intervention

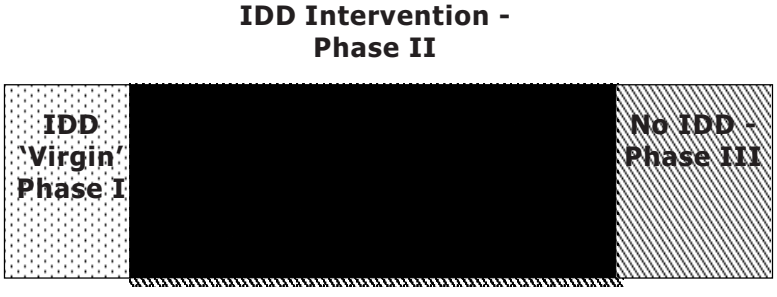
In this phase, the intervention has already begun a mixed picture is seen. The impact indicators are determined by environmental and community factors. Goitre is a historic marker of iodine deficiency. The inverse association between TGR and UIE is not seen. Even though the median urinary iodine values are on the increase, there is a time lag before the goitre prevalence also starts decreasing.

3. Phase III – Sustainability

Control of iodine deficiency is the initial success that an effective programme will achieve. Soon after, there comes into play the need for sustainability of the control programme already in place. This is with the aim to ensure optimum iodine intake on a regular and continuous basis for all time to come. In this phase, once again, there is a good association between Total Goitre Rate (TGR) and Urinary Iodine Excretion (UIE).

The three phases can be represented diagrammatically as:

Fig. 10: Three Phases of IDD Elimination Programmes

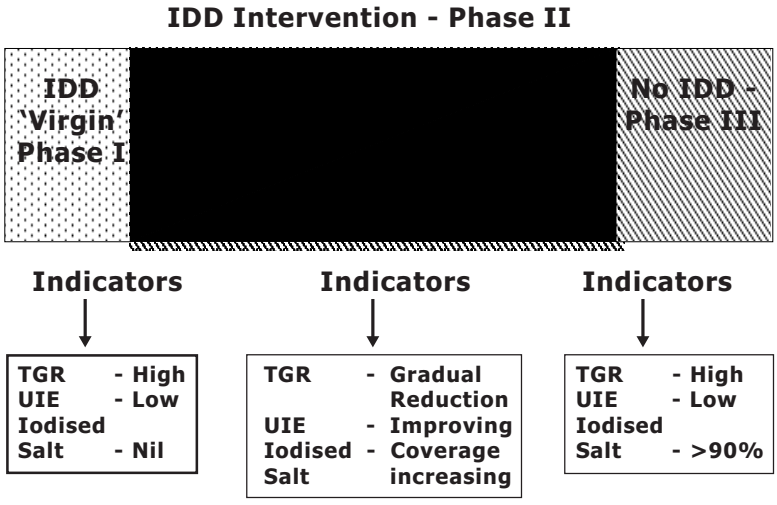


As can be seen in **Fig 10**, the wholly dotted region (**Phase I**) represents the area where IDD has been detected as a public health problem. Iodine deficiency reveals itself in the high goitre rates and low urinary iodine excretion values.

Once an intervention has been applied, be it iodised oil, iodised salt, iodised water or iodine-fortified foodstuff, there emerges a non-linear relation between the total goitre rate and the urinary iodine values. This is the IDD Intervention Phase – the area with the mixed dotted and shaded areas (**Phase II**).

With the success of the intervention and the programme, the area enters the phase of sustanied Elimination of IDD (**Phase III**) – the shaded area. Here again we see a linear relation between the low

Fig. 11: Status of Indicators in the Three Phases of IDD Elimination Programmes



goitre rates and the high urinary iodine values. The issue raised when a programme enters this phase is one of consolidation and sustainability. It is well known that iodine deficiency is a disease of the soil. The impact indicators are determined by environmental and community factors. and cannot really be eradicated, only eliminated and controlled.

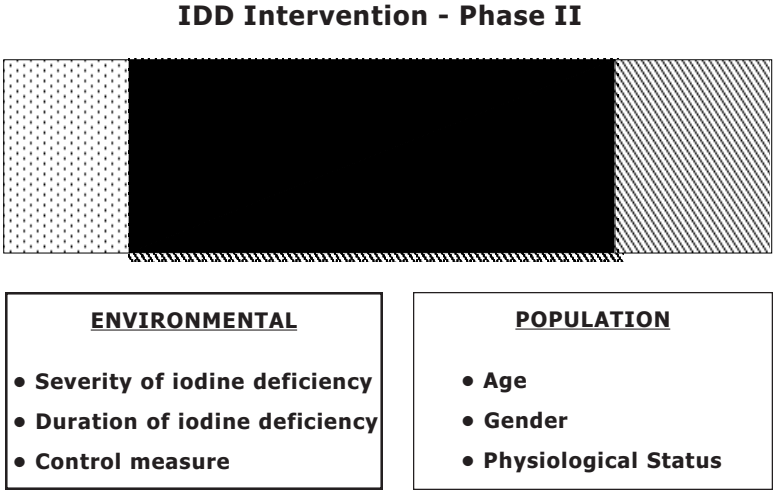
The three indicators mentioned in **Fig 11** above assess different aspects of the IDD status in a community and thus help to track progress towards elimination of IDD. For example, iodine content of salt samples collected in a cross-sectional survey indicates the present level of iodine in salt, but gives no information about the variation occurring in the past. Total goitre rates show long term effects of bioavailability of iodine and the urinary iodine excretion pattern reflects the existing levels of iodine intake and body iodine stores. ***To understand the status of IDD elimination programmes, the result of these indicators should be viewed in totality.***

As shown in the **Fig 12** below, in Phase I & Phase III, there exists an inverse association between the total goitre rate and the urinary iodine excretion.

In Phase II, however, the association between the two is for more complex and not so linear. We may get increased rates of goitre along with adequacy of urinary iodine excretion values, in contrast with the scenario in Phase I and Phase III.

In addition there are various environmental and community factors that play a role in Phase II of the IDD Elimination Programme.

Fig. 12: Factors influencing the three stages of IDD Elimination Programmes



The Environmental factors that play a role in the Phase II of the IDD Elimination Programme are:

1) Severity of Iodine Deficiency

The severity of iodine deficiency plays an important part in the efforts to eliminate IDD. It is known that more severe the iodine deficiency, more intense efforts that are needed to bring the iodine deficiency under control.

2) Duration of Iodine Deficiency

To a part, it is also important how long the region / area has been under the effects of iodine deficiency.

3) Control Measure

It is important that the monitoring of the control measure is in place. The persistance of goitre during phase II can also be due to the consumption of non iodised or inadequately iodised salt by part of the population. In case of iodised salt, one has to make sure that adequately iodised salt is consumed by the population on a regular basis. If it is not so, which is the case in most situations, a scenario emerges where there is no association between total goitre rate and urinary iodine excretion.

The population factors that play a part in phase - II are: Age, Gender and Physiological status such as pregnancy and lactation. It is seen that the effects of iodine deficiency tends to show up more vividly in the younger age groups, in the females whose physiological status such as pregnancy and lactation makes them vulnerable.

In the context of the above determinants, the Kerala survey results needs to be looked into totality.

The WHO/UNICEF/ICCIDD Joint Consultation has established criteria for assessing the severity of iodine deficiency and tracking progress towards elimination of iodine deficiency disorders.

WHO/UNICEF/ICCIDD Indicators To Classify IDD As Public Health Problem

WHO / UNICEF / ICCIDD has recommended indicators to determine whether IDD exists as a public health problem in the surveyed region or area. The indicators and criteria for classifying IDD as a public health problem are outlined in **Table 12**.

Table 12 : 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	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, Kerala as a State is endemic for Iodine Deficiency Disorders in view of its 16.6% total goitre rate. It belongs to the "mild" category. However, adequacy of iodine nutrition is shown by the median urine iodine excretion over 100 μg/L, the median in the study being 123.3 μg/L. Urinary iodine excretion above 100 μg/L reflects adequate iodine nutrition status.

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 Kerala, as shown in **Table 13**, in terms of these goals it is seen that only in urinary iodine excretion has Kerala attained the goal. In the attainment of lower goitre rates and adequacy of salt iodisation at the household level, it still has to achieve the same success. The results of the urinary iodine excretion indicate that Kerala is likely to accelerate reduction of TGR below 5 percent as soon as the proportion of consumption of iodised salt at the household level reaches $\geq$ 90%, and is maintained at that level, thereafter.

Table 13 : Criteria for tracking progress towards eliminating IDD as a public health problem

Indicator	Goal	Kerala
Thyroid size (age gp 6 - 12) proportion with enlarged thyroid	< 5%	16.6%
Urinary Iodine		
Median Urinary Iodine	> 100 μg/L	123.3 μg/L
Proportion below 100 μg/L	< 50 %	32.5%
Proportion below 50 μg/L	< 20 %	8.2 %
Salt Iodisation		
Proportion of Households consuming adequately iodised salt (≥ 15 ppm)	> 90 %	48.9 %

What does the Kerala result mean?

In order to understand the Kerala result in totality, the presence of high goitre rate and the adequacy of urinary iodine excretion, the following possibilities should be considered:

1) Iodine intake from sea fish

2) Increased intake of goitrogens from tapioca

3) Other sources of Iodine

4) Iodised salt intake

5) IDD Control Programme is in Transition (Phase II)

The various possibilities are examined in detail:

1) Iodine Intake from Sea Fish

Kerala is a coastal state and the consumption of sea-fish is higher than the national average. The main type of fish consumed is that of the sea fish variety. The sea fish feed on the sea weeds, which have a inherent ability to concentrate iodine. However, fish consumption in Kerala on an average supplies 40 μg of iodine per day as against a daily requirement of 150 μg of iodine (**Table 14**).

2) Increased Intake of Goitrogens

If there was a significant intake of goitrogens then it could explain the higher goitre prevalence and adequate urinary iodine excretion pattern as seen in the study. As reported by Soman et al area under-cultivation of tapioca with consequent decreased production of tapioca have documented a decrease in the consumption of tapioca in Kerala. This is shown by the **Fig 13**:

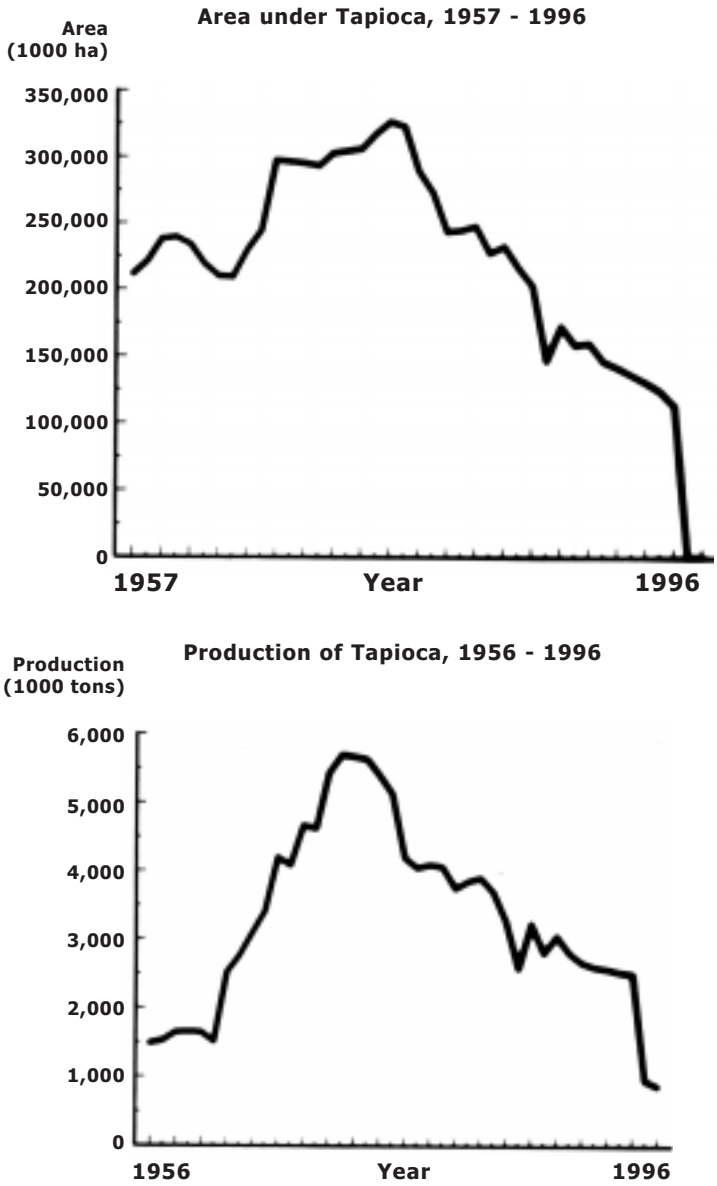
In Kerala, as referred to above, over a period of last 40 years, the area under tapioca production has been constantly decreasing.

If goitrogens were to be the cause of the increased goitre rate and the adequate urinary iodine excretion, then the actions recommended to nullify their effects are: (i) To increase the iodine content of salt and / or (ii) Educate the people about the goitrogenic effects of tapioca consumption and thus try to bring about a decrease in the tapioca consumption (iii) Introduce the community to methods of "detoxifying" of tapioca.

Table 14 : Iodine Obtained from Consumption of Sea Fish

S.No.	Component	Values
1.	Average Iodine Content of dry sea fish per 100 g	87 μg
2.	Per capita monthly fish consumption in rural area - 1.06 Kg	922 μg iodine
3.	Per capita monthly fish consumption in urban areas - 1.59 Kg	1383 μg iodine
4.	Per capita daily iodine intake from fish in rural areas	31 μg of iodine
5.	Per capita daily iodine intake from fish in urban areas	46 μg of iodine
4.+5. / 2	An average iodine intake from fish consumption per person per day	40 μg of iodine

Fig. 13: Areas under Cultivation and Production of Tapioca (1957-1996)



3) Other sources of iodine

There was a time when the iodine content of water, used as a "proxy" for iodine content of soil, correlated relatively well with that of the locally produced food and there was an inverse correlation between it and the prevalence of goitre. This is probably still valid for most countries of the world but in more industrialized countries several factors have changed this association.

In Australia, the udders of milch animals used to be washed in iodophore compounds. With the replacement of iodophore compounds by hot water for the purposes of sterilization, it was found that the urinary iodine excretion in the population was decreasing. It was inferred that the iodophore compounds used in the sterilization of udders also contributed to the iodine nutrition of the population. In the United States, it has been reported that even with a median urinary iodine excretion of 145 μg/L, 15% of women of child bearing age had concentrations less than 50 μg/L, the levels at which thyroid secretion becomes overtly inadequate[33].

Many additives also markedly increase the iodine content of food. The iodine content of poultry and eggs is significantly increased by the use of sea fish flour as chicken food and iodoform in water as disinfectant. Similarly, feeding seaweed, the richest source of iodine in nature, to cattle in Norway greatly increased the iodine content of milk. In many countries, bread and baked goods, as well as milk and diary products, are important sources of iodine. In the United States, the iodine content of bread was increased by the use of iodates. Iodates as oxidants act as dough conditioners. They are especially used in the continuous mix vacuum process and the average iodine content of bread produced by this process is 5 μg/Kg.

Another important artificial source of iodine is the addition of iodine-containing colouring additive (2,4,5,7-tetraiodofluoroscien or erythrosine) in drugs, beverages, foods and cosmetics.

It is obvious that the iodine content of bread, meat, milk, and eggs and their products from different regions and countries will depend on the natural iodine content as well as iodine supplements in the form of iodised salt, iodine enriched animal feeds, iodine containing veterinary medicines, sanitizing agents and colouring substances. However, it appears that none of these sources of iodine are currently contributing to iodine population in Kerala.

4) Iodised Salt

In the year 2000, the requirement of iodized salt in Kerala based on estimated population of 34 million and annual per capita requirement of 6 kg per person was calculated to be 207,500 tons. With the exception of Cannanore, which gets its iodised salt from both the rail and road routes, all the districts of Kerala get their salt by road, mainly from Tuticorin and Chennai. It was seen that 48.9% of the households consumed adequately iodised salt as 43.5 % of the demand of iodised salt is met through the supply from the various salt producers. Kerala imports almost all of its salt as there is no indigenous production of iodised salt. Since there is no indigenous production of iodised salt, the iodine intake through salt is a function of the iodised salt supply to the state. **Fig 14** and **Fig 15** show iodised salt supply to Kerala.

In summary, the intake and output of iodine is shown schematically in **Fig 16**. In Kerala, 67.5% of people have an adequate urinary iodine excretion

Fig. 14: Supply of Iodised Salt to Kerala

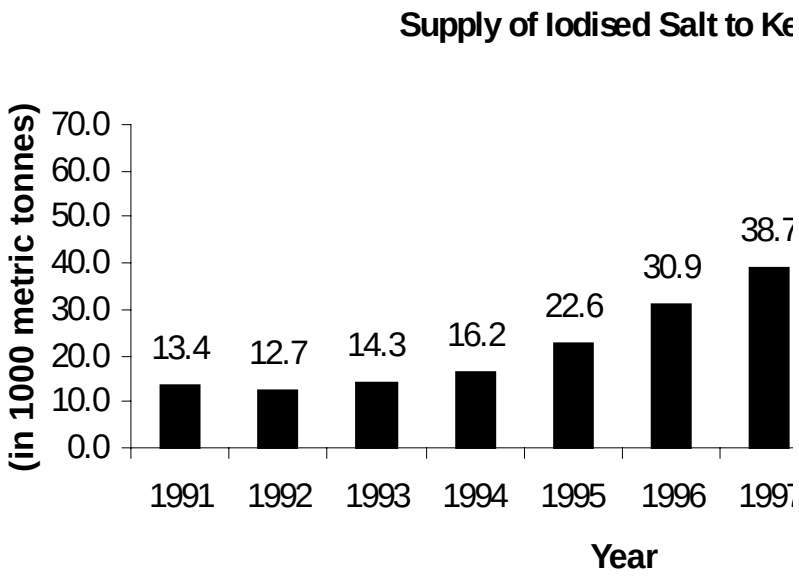
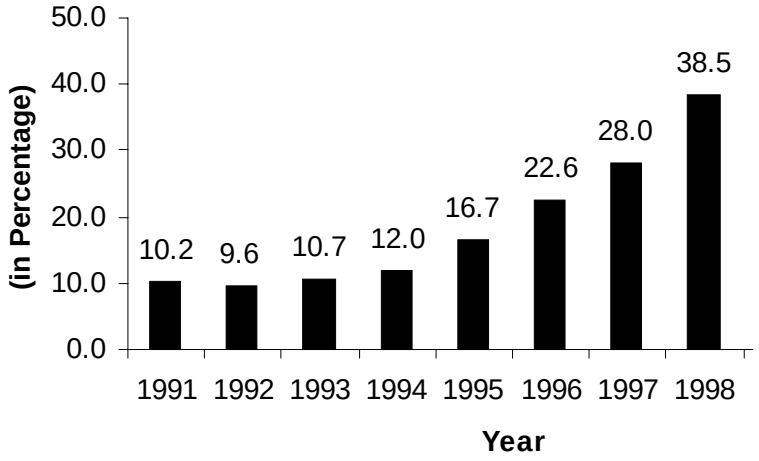
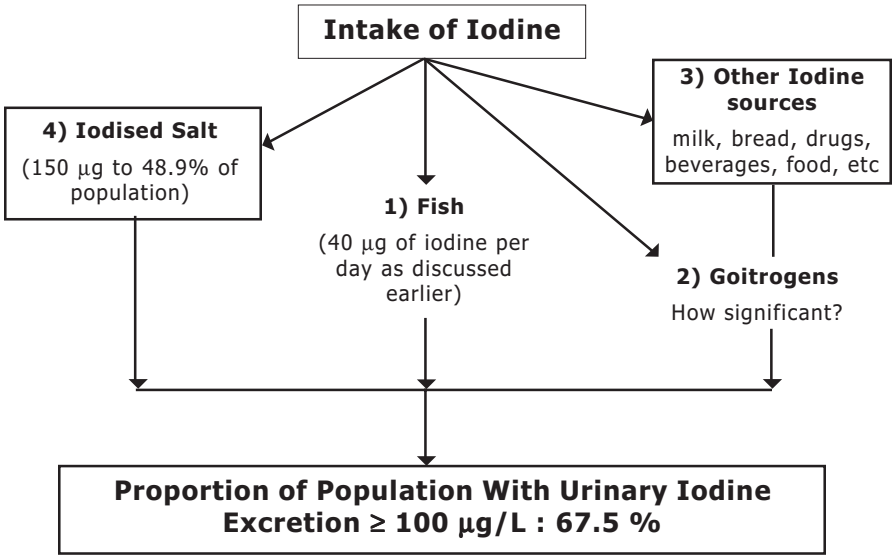


Fig. 15: Supply and Demand of Iodised Salt in Kerala



(urinary iodine $\geq$ 100 μg/L). Also, adequately Iodised ($\geq$ 15 parts per million) salt at the household level is 48.9%. Under normal conditions, 99% of the iodine that is ingested gets excreted in the urine provided the body iodine stores are adequate. If one were to get all the iodine from sources other than iodised salt then the urine iodine would have been significantly lower. Also, if other food factors were to have contributed to the iodine intake, the median UIE would have been much higher. However, the results show that nearly 50% of the population is consuming adequately iodised salt and also that 67.5% of the population have a UIE value above 100 μg/L. This indicates that iodine in the iodised salt contributes considerably to the iodine nutrition in Kerala.

Fig. 16: Intake and Output of Iodine in the Body



As we are all aware, in addition to iodised salt and sea-fish, there exist other food items which may contribute to iodine intake. In order to determine the iodine intake through other food items, it would require an analysis of the food items that constitute typical diet of a majority of the population. Representative information on this would contribute significantly to the understanding of the sources of iodine. Other than iodised salt and sea-fish however, such information would not contribute to the current strategy of supplying iodine through iodised salt.

Urinary iodine concentration is currently the most practical biochemical marker for iodine nutrition, when carried out with appropriate technology and sampling. It assesses iodine nutrition only at the time of measurement, whereas thyroid size reflects iodine nutrition over months or years. Therefore, populations may have attained iodine sufficiency as expressed by median urinary iodine concentration. Yet goitre may persist even in children as there is a lead time required for the goitre prevalence rate in populations to decline as a result of regularly consuming adequately iodised salt.

The National Family Health Survey - 2 (NFHS - 2), a nationwide survey conducted in the year 1998- 1999, assessed, among other indicators, the proportion of households consuming adequately iodised salt, i.e. salt with an iodine content of at least 15 parts per million (15 mg of iodine per 1 kg of salt). This was done using salt testing kits. As per the survey data, 39.3% of the households in Kerala consume adequately iodised salt. If we take into consideration the proportion of households consuming non-iodised salt (47.6%) as determined by the survey, Kerala ranks 24th among

the 25 states surveyed. On the flip side, this means that 52.4% of the households are consuming salt with some iodine in it.

From the above data, it may be reasonable to infer that iodised salt contributes considerably to the iodine intake of the population. Even though fish also contributes to iodine intake, it is important to note that a considerable role is played by consumption of iodised salt.

Table 15. Overview of Results of the Kerala Study

Variable	Value
Number Studied	1067
Mean Age (Years)	8.8 ± 1.9
Goitre Grade I	14.0%
Goitre Grade II	2.6%
Total Goitre Rate	16.6% (95%CI: 14.4%-18.8%)
Median UIE (μg/L) (990 samples)	123.3
Proportion ≤ 100 μg/L	32.5%
Proportion ≤ 50 μg/L	8.2%
Proportion of households consuming adequately iodised salt (1066 samples)	48.9% (95% CI: 45.9%-51.9%)

Table 16. Criteria for Tracking Progress Towards Eliminating IDD as a Public Health Problem

Indicator	**Goal**	**Kerala**
Thyroid size (age gp 6 - 12 years) proportion with enlarged thyroid	<5%	16.6%
Urinary Iodine		
Median urinary iodine μg/L	> 100	123.3
Proportion below 100 μg/L	< 50 %	32.5%
Proportion below 50 μg/L	< 20%	8.2%
Salt iodisation		
Proportion of households consuming adequately iodised salt	> 90%	48.9%

Conclusions & Recommendations*

*** Based on Open Consultation held on 29th April 2001 at Thiruvananthapuram. Invitees included all the field investigators, key public health figures and policy makers at the state and national level.**

14

Conclusions and Recommendations

Conclusions

1) As recommended by WHO/UNICEF/ICCIDD, the total goitre prevalence rate of 16.6% suggests the presence of endemic goitre as a public health problem in Kerala.
2) The prevalence of endemic goitre in a population is a historic marker of iodine deficiency
3) As demonstrated by median urinary iodine (123 μg/L) and proportion of urinary iodine samples below 100 μg/L (32.5%) and proportion of urinary iodine samples below 50 μg/L (8.2%), currently, the iodine nutritive status is possibly adequate in Kerala.
4) A total of 49% of salt samples at household level as analysed by titrimetric procedure of iodine estimation have adequate iodine levels in them. The iodine content in these samples is more than 15 parts per million (ppm) of iodine or 15 mg of iodine / kg of salt.
5) Taking into consideration the contribution of sea fish to the iodine intake of population, 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.
6) This underlines the need to make iodine available on a regular and continuous basis.

Recommendations

1) In view of IDD being a public health problem in Kerala, 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 the whole population for all time to come.

2) All efforts should be made to consolidate the coverage achieved of having 49% adequately iodised salt usage.

3) Accelerated efforts should be made to increase the coverage of adequately iodised salt from 49% to 100% and sustain it thereafter.

4) 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!

5) To achieve Universal Salt Iodisation i.e. more than 90% coverage of adequately iodised salt affordable to all population for all times to come requires a combination of legislation and education.

6) Role of legislation : Legislation and / or appropriate regulatory mechanism facilitates and accelerates accessibility and availability of iodised salt, possibly through Public Distribution System (PDS) specially to lower socio-economic groups and disadvantaged communities, at a price they can afford. In view of the high literacy status in Kerala, they should focus attention on educational efforts so that people consume adequately iodised salt

for all times to come. 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".

7) In view of the results obtained, serious efforts must be made to focus on Information, Education, Communication to eliminate IDD. This aspect has not received due attention since the beginning of the programme. **Table 17** (following item 12) lists the complementary roles played of legislation (prescriptive approach) and IEC and Social mobilization (participatory approach) in our efforts to educate the people about IDD.

8) Almost 100% of the samples examined at household level had some iodine. However, of these, only 49% was found to be adequately iodised. It is likely that inadequately iodised salt is being labeled and marketed as iodised salt. In the absence of legislation banning the sale of non-iodised salt, it becomes vital to have a stringent regulatory mechanism in place to ensure that the labelling is appropriate and the iodised salt logo is appropriately used. 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.

9) Quality assurance procedures should be in place to ensure "Good Manufacturing Practices", as well as transport and storage facilities for iodised salt, so that adequately iodised salt is available to the population on a regular basis. An important intervention is to make iodised salt available

through the Public Distribution System (PDS). This has been introduced successfully in 20 States and Union Territories. **Table 17** below gives the cost of iodised salt in some of the States and Union Territories.

10) 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 Directorate of Health Services, Directorate of Medical Education, branches of Indian Medical Associations and professionals involved in the solution to the IDD problem and associations of salt traders and distributors in Kerala.

11) 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.

12) A State level IDD Committee chaired by Secretary Health should be constituted with representatives of all the stake holders. The state IDD programme Manager should be the Member-Secretary. The progress of IDD elimination activities should be tracked, at least once every six months as a mandate of an established public health committee.

Table 17: Complementary Roles of Legislation* and IEC / Social Mobilization

S.No.	Variables & Phases	Legislation	IEC / Social Mobilization
1.	Stakeholders involved in formulation	- Few - Legislative and Executive	- Many - Interaction of IDD researchers with community and 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 and 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 long 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 that of purchasing adequately iodised salt and using it (iodine salt) regularly every day.

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

As seen in **Table 5**, 84% of the countries in the WHO regions have legislation as a means to ensure adequate coverage of iodised salt

Table 18: Availability of Iodised Salt under the Public Distribution System (PDS)

S.No.	Name of the state	PDS selling price per kg.
1.	Maharashtra	Rs. 2.90 (DPAP areas) Rs. 1.65 (ITDP areas)
2.	Tripura	Rs. 1.90
3.	Lakshadweep	Rs. 2.50
4.	Assam	Rs. 2.00 (Powdered) Rs. 3.00 (Packed salt)
5.	Kerala*	Rs. 2.45 (Crystal salt) Rs. 4.65 (Free Flow)
6.	Orissa	Rs. 2.00
7.	Rajasthan	Rs. 3.25
8.	Tamil Nadu	Rs. 2.50
9.	Delhi	Rs. 2.50 Rs. 3.50 (Refined free flow)
10.	Arunachal Pradesh	Rs. 2.60
11.	Gujarat#	Rs. 0.50

* Through supermarkets, maveli (neigbourhood) stores and super maveli stores

Supplies in ITDP areas with a subsidy component of Rs. 1.85 per kg.

Opportunities for Kerala for the future - Consolidating the achievement

It is clear that despite the great success in many countries, the 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.
- Small-scale producers need to be included in this process to ensure their products are also brought up to standard and deliver the right amount of iodine to the population. This is often best achieved by the formation of cooperatives or working with a common distributor, thus reducing the need for many small iodisation units.
- 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.

Kerala - The Development Role Model

Kerala Vs All-India
Development Indicators

Indicator	Year	Kerala	All-India
Crude birth death rate / 1000	1998	6.4	9.0
Crude birth rate (rural) / 1000	1998	18.3	28.0
Infant mortality rate (/1000 live births)	1998	16	72
Life expectancy at birth (years)	1993	66.5	61.5
Females : Mean age at marriage (Years):	1991	22.3	19.3
Per capita income (Rs)	1995-96	8324	11649
Literacy rate	2001	90%	65%
Female literacy rate	2001	88%	54%

Criteria for tracking progress towards eliminating
Iodine Deficiency Disorders as a public health problem

Indicator	Goal	Kerala
Thyroid size (age gp 6-12 yrs) Proportion with enlarged thyroid	< 5%	16.6%
Median Urinary Iodine μg/L	> 100	123
Salt iodisation Proportion of households consuming adequately iodised salt (Salt > 15 parts per million of iodine)	> 90%	49%

Kerala offers an opportunity to eliminate IDD at an accelerated pace and demonstrate leadership in this field as well

15

Annexures

Annexure – 1

Selection of Sample Communities by Probability Proportionate to Size (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 Kerala

Part I

Cluster no	District	Tehsil	Town/village/ward	Population	Cumulative population
1.	Kasargod	Kasaragod	Bandadka	6530	461637
2.	Kannur	Taliparamba	Payyavoor	22102	1443312
3.	Kannur	Kannur	Edakkad Pt Ward IV	4403	2399712
4.	Wayanad	Mananthavady	Mananthavady	27173	3384600
5.	Kozhikode	Vadakara	Kunnummal	16538	4352338
6.	Kozhikode	Kozhikode	Narikkuni	19912	5328468
7.	Kozhikode	Kozhikode	Koduvally Pt (P) Ward III	2276	6279496
8.	Malappuram	Ernad	Kuzhimanna	24017	7260124
9.	Malappuram	Perinthalmanna	Kuruvambalam	8077	8222994
10.	Malappuram	Tirur	Thirunavaya	21878	9197884
11.	Palakkad	Ottappalam	Kappur	25369	10169377
12.	Palakkad	Palakkad	Ward VI	2822	11129451
13.	Thrissur	Talappilly	Kadavallur	10436	12104305
14.	Thrissur	Thrissur	Anjur	8126	13072166
15.	Thrissur	Kodungallur	Eriyad Pt (P) Ward VIII	3257	14041744

Annexure - 2

List of Clusters for IDD Survey in Kerala

Part II

Cluster no	District	Tehsil	Town/village/ward	Population	Cumulative population
16.	Ernakulam	Kunnathunad	Vazhakulam	12338	15015080
17.	Ernakulam	Kochi	Kuzhuppilly	22316	16000465
18.	Ernakulam	Kanayannur	Mulavukad Pt Ward I	2289	16949993
19.	Idukki	Udumbanchola	Konnathady	29964	17934595
20.	Kottayam	Meenachil	Vallichira	12888	18892226
21.	Kottayam	Kottayam XVII	Thirunakkara	1915	19858880
22.	Alappuzha	Cherthala	Kanjikkuzhi	19188	20834230
23.	Alappuzha	Karthigappally	Pallippad	23606	21799475
24.	Pathanamthitta	Thiruvalla	Ward XXV	1435	22769712
25.	Pathanamthitta	Adoor	Ward XI (Part)	1351	23739753
26.	Kollam	Pathanapuram XIX	Aikarakonam	1742	24708639
27.	Kollam	Kollam	Meenadu	26295	25699129
28.	Thiruvananthapuram	Chirayinkeezhu	Ward IX	1667	26649508
29.	Thiruvananthapuram	Thiruvananthapuram	VII Pangode	10777	27625355
30.	Thiruvananthapuram	Neyyattinkara	Pallichal	33758	28615780

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. Selection of the first household to visit.

2. 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

A 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

A 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.

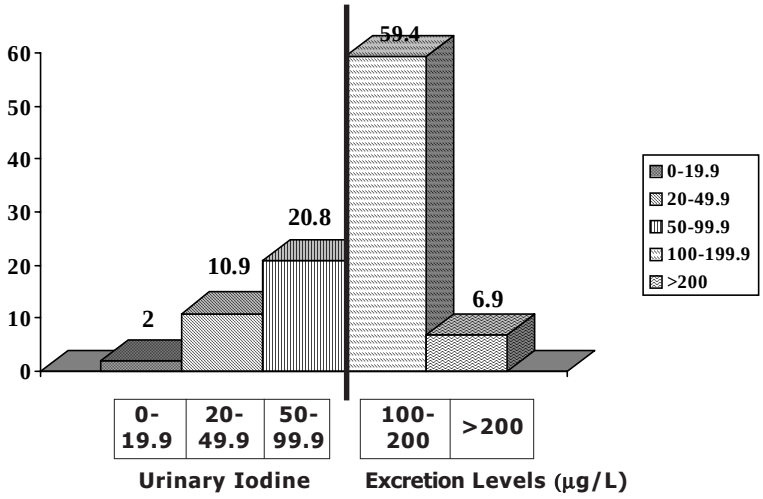
For the present study, only households with school-age children in the age group of 6 – 12 years were considered eligible for enumeration and were included in the sample. A total of 35 eligible children were studied in each cluster. It was recommended that only one child be enrolled from one household. If there were more than one eligible child in any household, the lottery method was used to select the study subject.

The lottery method: The names of all the children are written on separate slips of paper and the slips are placed on the floor. At random, one of the slips is selected and the child whose name is written on that slip of paper is then enrolled into the study.

Annexure - 4

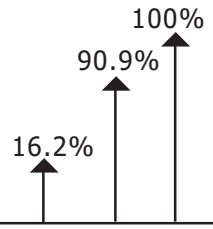
Results for 3 Hard-To-Reach Clusters*

Variable	Value
Number of Children Studied (3 clusters)	102
Mean Age (Years)	8.7 ± 2.3
Goitre Grade I	22.5%
Goitre Grade II	4.9%
Total Goitre Rate	27.4%
Median UIE (μg/L) (90 samples)	120.8
Proportion of Households Consuming adequately Iodised Salt (99 samples)	16.2%



Iodine Content of Salt at Household Level

Iodine content (PPM)	**Number of samples**	**Percentage**
0	9	9.1%
>0-6.9	60	60.6%
7-14.9	14	14.1%
15-29.9	6	6.1%
≥ 30	10	10.1%
TOTAL	99	100.0%



*It is seen that the results from the hard to reach clusters show the same pattern that is seen in the State of Kerala.

The results from the hard to reach clusters, which were not chosen randomly, are also similar to those obtained from the clusters chosen to represent the state of Kerala. With a total goitre rate of 27.4%, a urinary iodine excretion of 120.8 μg/L and the proportion of households consuming adequately iodised salt standing at 16.2%. Even though the proportion of households using adequately iodised salt is 16.2%, it is seen that 90.9% of the households are using salt with some amount of iodine. The distribution of the urinary iodine values also shows striking similarities, with 66.3% of the subjects having an a urinary iodine excretion value of over 100 μg/L. This may be explained on the basis of the higher education status of people living in hard to reach areas and also the excellent health care facilities available to the people.

Annexure - 5

Results of the National Family Health Survey (NFHS - 2) 1998 - 1999 : Ranking by State

Ranking	State	Percentage of households consuming iodised salt
1.	Mizoram	99.3
2.	Arunachal Pradesh	99.2
3.	Assam	98.2
4.	Manipur	97.7
5.	Sikkim	96.9
6.	Himachal Pradesh	96.8
7.	Delhi	93.9
8.	Meghalaya	93.3
9.	Nagaland	89.1
10.	West Bengal	88.7
11.	Punjab	83.3
12.	Haryana	80.5
13.	Uttar Pradesh	77.3
14.	Bihar	77.1
15.	Karnataka	75.9
16.	Jammu & Kashmir	75.2
17.	Madhya Pradesh	75.0
18.	Gujarat	70.5
19.	Orissa	70.4
20.	Maharashtra	68.0
21.	Andhra Pradesh	63.2
22.	Rajasthan	62.9
23.	Goa	62.7
24.	Kerala	52.4
25.	Tamil Nadu	37.3

Annexure - 6

Assessment of Iodine Deficiency Disorders and Monitoring their Elimination

Two editions of the book for programme managers have been produced following consultations held in Geneva in November 1992 and May 1999. The Consultation brought together experts on the field of Iodine Deficiency Disorders from all over the world. The books contain information on the identification, prevention and control of IDD[18]. For continuing the battle against IDD into the new millennium, the books outline international guidelines for assessing and eliminating the IDD. The effort to make this book involved experts on IDD from all three partner organisations, WHO, UNICEF and ICCIDD representing all the Regions of the world. The second edition is freely available, on request, from the World Health Organization. In a sense, it exemplified a partnership at the global level for furthering the cause of IDD Elimination.

In the context, there are some important aspects of this Joint Consultation that should to be incorporated into the NIDDCP.

1) Survey Methods

a. Salt Monitoring

An IDD control programme based on salt iodisation clearly cannot succeed unless all salt for human consumption is being adequately iodised. Therefore the most important thing to monitor is the salt itself, and the most important place to monitor it is at the site of production. The various sites for salt monitoring are:

- Monitoring iodine content at site of production
- Monitoring iodine content at port of entry
- Monitoring salt at the point of final packing
- Monitoring salt at wholesale and retail level

- Monitoring salt at community level

b. Iodine Status Assessment

Iodine status assessment requires carrying out a cross-sectional survey of a representative sample of the entire target population. The recommended survey method is multistage "probability proportionate to size" (PPS) cluster sampling (Sullivan KM, May S. Urinary iodine assessment: a manual on survey and laboratory methods. UNICEF, PAMM. 1999. To be published). This method has been in use for many years for the evaluation of immunization (EPI) coverage, and can be applied to many other health indicators. The target population for the survey should be either school age children or women of childbearing age. Surveys should be either school-based or household based.

c. Sentinel Surveillance

Large scale, representative cross-sectional surveys are generally too costly to be used as a regular instrument for the regular monitoring of IDD control. To assess the change in iodine status of a defined population over time, the method of monitoring which has proved most practical is that done through the selection of sentinel districts. Such districts are chosen on the basis of their being remote and being affected by moderate or severe IDD prior to the implementation of the IDD control programme. In each sentinel district, at least three rural schools should be chosen at random for surveying. An urban area should also be included to act as a control, and again at least three schools should be selected. Sentinel surveillance surveys should be performed at least every two years in the early stages of an IDD control programme, and then reduced in frequency to once every two or three years once the situation appears stable. It is important to be flexible when establishing a system for monitoring IDD control.

2) Survey Indicators

a. Thyroid Size

Assessment of thyroid size by palpation is the time-honoured method of assessing IDD prevalence, but the long response time after iodine supplementation is introduced means that it is of limited usefulness in assessing the impact of programmes once salt iodisation has commenced. The term "goitre" refers to a thyroid gland that is enlarged. The statement that "a thyroid gland each of whose lobes have a volume greater than the terminal phalanges of the thumb of the person examined will be considered goitrous" is empirical but has been used in most epidemiological studies of endemic goitre. Palpation of the thyroid is particularly useful in assessing goitre prevalence. Goitre is graded according to the classification presented in **Table 1** and this is the classification followed in the epidemiological surveys conducted

Table 1 - Simplified classification of goitre* by palpation

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, even when 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 clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

* A thyroid gland will be considered goitrous when each lateral lobe has a volume greater than the terminal phalanx of the thumbs of the subject being examined.

under the NIDDCP.

b. Urinary Iodine

Most iodine absorbed in the body eventually appears in the urine, so urinary iodine excretion is a good marker of very recent dietary iodine intake. In individuals, urinary iodine excretion can vary somewhat from day to day and even within a given day, but this variation tends to dampen out in populations. The cut-off points proposed for classifying iodine nutrition into different degrees of public health significance are shown in **Table 2**. Frequency distribution curves are necessary for full interpretation. Urinary iodine values from populations are usually not normally distributed, and

Table 2 - Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentrations in school-aged children

Median urinary iodine (mg/l)	Iodine intake	Iodine nutrition
< 20	Insufficient	Severe iodine deficiency
20-49	Insufficient	Moderate iodine deficiency
50-99	Insufficient	Mild iodine deficiency
100-199	Adequate	Optimal
200-299	More than adequate iodine intake	Risk of iodine-induced hyperthyroidism within 5 or 10 years following introduction of iodised salt in susceptible groups
>300	Excessive iodine intake	Risk of adverse health consequences (Iodine-induced hyperthyroidism, auto-immune thyroid diseases)

therefore, the median should be used as the measure of central tendency rather than the mean. (Likewise the percentiles should be used as measures of spread rather than standard deviation). Median urinary iodine concentrations of 100 micrograms per litre (μg/l) and above define a population, which has no iodine deficiency, i.e. at least 50% of the sample should be above 100 μg/l. In addition, not more than 20% of samples should be below 50 μg/l. Alternatively, the first quintile (20th percentile) should be at least 50 μg/l. In adults, a urinary iodine concentration of 100 μg/l corresponds roughly to a daily iodine intake of about 150 μg under steady state conditions.

Urinary iodine concentration is currently the most practical biochemical marker for iodine nutrition, when carried out with appropriate technology and sampling. It assesses iodine nutrition only at the time of measurement, whereas thyroid size reflects iodine nutrition over months or years. Therefore, populations may have attained iodine sufficiency by median urinary iodine concentration, yet goitre may persist, even in children.

c. Blood Constituents

Two other indicators are included: thyroid stimulating hormone (TSH) and thyroglobulin (Tg). While TSH levels in neonates are particularly sensitive to iodine deficiency, difficulties in interpretation remain and the cost of implementing a screening programme is too high for most developing countries. The value of thyroglobulin as an indicator of IDD status has yet to be fully explored and it has yet to gain wide acceptance.

3) Indicators for Sustainable Elimination of IDD

In considering whether the sustainable elimination of

iodine deficiency as a public health problem has been achieved, the following criteria should be met (**Table 3**):

- **With regard to the population's iodine status:**

· The median urinary concentration should be at least 100 μg/l, with less than 20% of values below 50 μg/l.

· The most recent monitoring data (national or regional) should have been collected in the last 2 years.

- **If iodised salt is the vehicle for the elimination of iodine deficiency, as in almost all countries, there must be guaranteed availability and consumption of adequately iodised salt, demonstrated by more than 90% of households using adequately iodised salt (>15 PPM iodine). Preconditions for this are:**

· Local production and/or importation of iodised salt in a quantity that is sufficient to satisfy the potential human demand (about 4-5kg per person per year).

· 95% of salt for human consumption must be iodised according to government standards for iodine content, at production or imported level.

· The percent of food-grade salt with iodine content of at least 15ppm, in a representative sample of households, must be equal to or greater than 90%.

· Iodine estimation at the point of production or importation, and at wholesale and retail levels must be made by titration, while at household level, it may be made by either titration or certified kits.

- **At least, eight out of the following ten programmatic conditions are fulfilled:**

- An effective, functional national body (council or committee) responsible to the government for the national programme for the elimination of IDD. This council should be multidisciplinary involving the relevant fields of nutrition, medicine, salt industry, education, the media and consumers, with a chairman appointed by the Minister of Health.
- Evidence of political commitment to universal salt iodisation and the elimination of IDD.
- Appointment of a responsible executive officer for the IDD elimination programme.
- Legislation or regulations on universal salt iodisation. (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.)
- Commitment to assessment and re-assessment of progress in the elimination of IDD, with access to laboratories able to provide accurate data on salt and urine iodine.
- A programme of public education and social mobilisation on the importance of IDD and the consumption of iodised salt.
- Regular data on salt iodine at factory, retail and household level.
- Regular laboratory data on urine iodine in school aged children with appropriate sampling for higher risk areas.
- Co-operation from the Salt Industry in maintenance of quality control.
- Database with recording of results or regular monitoring procedures, particularly for salt iodine, urine iodine and, if available, neonatal TSH, with mandatory public reporting.

Table 3 - Summary of criteria for monitoring progress towards sustainable elimination of IDD as a public health problem

A.	Indicators	Goals*
1.	Thyroid size (age group 6-12) Proportion with enlarged thyroid	< 5 %
1.	Urinary iodine Proportion below 100 µg/l Proportion below 50 µg/l	<50% <20%
2.	Salt iodisation Proportion of households using adequately iodised salt	>90%
3.	Programmatic indicators Attainment of the indicators listed above	At least 8 out of 10

** The goals are expressed as percentage of population*

Partnership Evaluation

In addition there is need for periodic review of the whole program with the help of WHO, UNICEF, ICCIDD, and other appropriate organizations. Such external evaluation provides an independent assessment, which is very helpful for a country programme. It can provide reassurance as to the programme performance and effectiveness.

References

1 Bleichrodt N. and Born MA. Meta-analysis of research on iodine and its relationship to cognitive development. In: The Damaged Brain of Iodine Deficiency, JB. Stanbury (Ed.). Cognizant Communication Corporation, New York, pp 195-200, 1994.

2 43rd World Health Assembly. WHA43.2. World Health Organization, May 1990.

3 World Summit for Children, United Nations, New York, 1992

4 International Conference on Nutrition, Rome, 1992.

5 Hetzel BS. S.O.S for a billion. The nature and magnitude of iodine deficiency disorders. In: SOS For A Billion. Hetzel BS, Pandav CS (Eds.) Oxford University Press, Delhi: pp 5-7, 1995.

6 WHO, UNICEF, ICCIDD. Recommended iodine levels in salt and guidelines for monitoring their adequacy and effectiveness. *WHO/NUT/96.13*. Geneva. 1996

7 Hetzel B.S. Iodine deficiency disorders (IDD) and their eradication. *The Lancet*. **2**: 1126-1129.5, 1983.

8 Delong G.R. Observations on the neurology of endemic cretinism. In: Iodine and the brain. GR Delong, J Robbins and PG Condliffe (Eds.) Plenum Press Publishers. New York, Pp.: 231ff, 1989.

9 Delange F. Endemic cretinism. In: The thyroid. A fundamental and clinical text. 8th (LE Braverman, RD Utiger (Eds.)). Lippincott Publishers. Philadelphia, pp 743-754, 2000.

10 Hetzel B.S., Pandav CS. SOS for a billion. The conquest of iodine deficiency disorders. Oxford University Press Publ. Delhi. 2nd edition. 1996

11 ICCIDD. The Western Hemisphere nears Iodine sufficiency. *IDD Newsletter*, **17**: 1-9, 2001.

12 Pandav CS, Rao AR Iodine deficiency disorders in livestock. Ecology and economics. Oxford University Press Publ. Delhi. 1997

13 MI, WHO, ICCIDD, USAID, PAMM, UNICEF. Assessing country progress in universal salt iodisation programs. Iodised salt program assessment tools (ISPAT). Houston R, Lofti M, Nathan R, Pandav CS (Eds.). Micronutrient Initiative Publ. Ottawa. 1999.

[14] WHO, UNICEF, ICCIDD. Elimination of iodine deficiency disorders in Central and Eastern Europe, the Commonwealth of Independent States, and the Baltic States. Proceeding of a Conference held in Munich, Germany, 3-6 September 1997. F. Delange, A. Robertson, E.McLoughney, G. Gerasimov (Eds.). WHO/EURO/NUT/96.1. WHO. Geneva, 1998.

[15] Hetzel BS. An overview of the prevention and control of Iodinee Deficiecncy Disorders. In: Prevention and Control of Iodine Deficiency Disorders (Hetzel BS, Dunn JT, Stanbury JB, Eds.), Elseiver Science Publishers B.V. (Biomedical Division), pp. 7-31, 1987.

[16] WHO, UNICEF, ICCIDD. Global prevalence of iodine deficiency disorders. MDIS Working Paper # 1, Geneva, 1993.

[17] WHO/UNICEF/ICCIDD. Progress towards elimination of iodine deficiency disorders. WHO/NHD/99.4, WHO. Geneva, 1999.

[18] World Health Organization (WHO). Progress towards the elimination of Iodine Deficiency Disorders (IDD). *WHO/NHD/99.4*., 1999.

[19] ICMR Task Force Study. Epidemiological survey of endemic goitre and endemic cretinism. Indian Council of Medical Research, New Delhi, 1989.

[20] IDD & Nutrition Cell. Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India, New Delhi 2000.

[21] Kochupillai N, et al. Nodular lesions of the thyroid in an area of high background radiation in coastal Kerala, India. Indian J Med Res, 64., 1976.

[22] Ramachandran M. Iodine deficiency disorders. The situation in Kerala. Proceedings of the Nutrition Society of India, Vol **36**, 1990.

[23] K P Paulose. Epidemiological study of goitres in Kerala. Proceedings of CME on thyroid diseases in Kerala, Medical College, Thiruvnanthapuram, 1992.

[24] UNICEF field office for Tamil Nadu and Kerala, *I Plus,* No. **1**, 1995.

[25] Kapil U, Tandon M, Pathak P. Assessment of iodine deficiency in Ernakulam district, Kerala state. *Indian Pediatr,* **36**:178-80, 1999.

[26] Ohashi T, Yamaki M, Pandav CS, Karmarkar MG, Irie M. Simple microplate method for determination of urinary iodine. *Clin Chem*, **46**: 529-536, 2000.

[27] Iodine estimation in iodated salt. **In**: Principle & Procedure for Iodine Estimation, A Laboratory Manual. MG Karmarkar, Pandav CS, Krishnamachari KAVR (Eds.), Indian Council of Medical Research, New Delhi 1986

[28] Pandav CS, Mallik A, Anand K, Pandav S, Karmarkar MG. Prevalence of iodine deficiency disorders among school children of Delhi. *Natl Med J India*,**10**:112-4, 1997.

[29] Karmarkar MG, Pandav CS. Interpretation of indicators of iodine deficiency disorders: recent experiences. *Natl Med J India,* May-Jun;**12**:113-7, 1999.

[30] Nepal Micronutrient Status Survey. Kathmandu, Nepal: Ministry of Health, Child Health Division, HMG / N, New ERA, Micronutrient Initiative, UNICEF Nepal and WHO, 1998.

[31] Personal Communication from Dr. Sangsom Sinawat, Director, Ministry of Public Health, Govt. of Thailand.

[32] Personal Communication from Prof. Q. Salamatullah, ICCIDD Senior Advisor, Bangladesh.

[33] Utiger RD. Maternal hypothyroidism and fetal development. *NEJM*, **341**: 601-602, 1999.

Tracking Progress Towards Sustaining Elimination of Iodine Deficiency Disorders in Kerala, India

International Council for Control of Iodine Deficiency Disorders

Government Medical Colleges of Kerala

Centre for Community Medicine, AIIMS

United Nations Children's Fund

2001

ISBN 81-86813-11-X

Tracking Progress Towards Sustaining Elimination of Iodine Deficiency Disorders in Kerala, India

A Project by

- Government Medical Colleges
  - Thiruvananthapuram (State Coordinating Unit)
  - Thrissur
  - Kozhikode
  - Kottayam
  - Kannuar
  - Alappuzha
- Directorate of Medical Education
- Directorate of Health Services

Government of Kerala

in collaboration with

Centre for Community Medicine & Clinical Epidemiology Unit,
All India Institute of Medical Sciences, New Delhi

Institute of Nuclear Medicine and Allied Sciences, New Delhi

Indian Coalition for Control of Iodine Deficiency Disorders, New Delhi

United Nations Children's Fund, India

International Council for Control of Iodine Deficiency Disorders

November 2001

This Report is Dedicated to
a Legend of
Science And Society

Professor V. Ramalingaswami

(8th August 1921 - 28th May 2001)

Vulimiri Ramalingaswami

August 8, 1921 - May 28, 2001

Vulimiri Ramalingaswami, known as 'Rama' to his colleagues and friends, was born in 1921 in Andhra Pradesh, India. He completed his preliminary education and obtained his M.B.B.S.(1944) and M.D. (1946) degrees from Andhra Pradesh. He was a recipient of D.Phil (1951) and D.Sc. (1967) from Oxford University.

His innate leadership qualities led him to assume many posts of responsibility. He joined the All India Institute of Medical Sciences (AIIMS) as Professor and Head of the Department of Pathology in 1957. He went on to become the Director of the All India Institute of Medical Sciences (AIIMS) in 1969. He remained Director till 1979 and then took charge of the Indian Council of Medical Research (ICMR) as its Director-General, a post he held till 1986. For the following year, he was Scholar-in Residence, Fogarty International Centre, National Institute of Health, Bethesda, Maryland. This was followed by a year as a Visiting Professor in International Health Policy at the Harvard School of Public Health. Between 1988 and 1989 he was the Special Adviser to the Executive Director, UNICEF, New York on Child Survival and Development. He served for a long time as a Special Advisor to the International Development Research Centre of Canada. He has also been a member of the Awards Committee of the Prince Mahidol Prize of Thailand. He was past President of the Indian National Science Academy and also President of the National Institute of Immunology. During the last decade he was appointed as Professor Emeritus at AIIMS and had the distinction of being the First National Research Professor in the field of Medicine.

He was honoured by the Governmnent of India decorating him with 'Padma' Award - the country's civil honours. He receiven the 'Padmashree' in 1967 and within two years, was honoured with the 'Padma Bhushan'.

Rama received many national and international honors during his remarkably distinguished career. He was a Fellow of the Royal Society, London and a Foreign Associate of the National Academy of Sciences of the United States of America, a Foreign Member of the Academy of Medical Sciences, U.S.S.R. and was awarded a Honorary Doctorate of Medicine by the Karolinska Institute, Stockholm. He was a Fellow of the American College of Physicians and Chairman of the Global Advisory Committee of Medical Research, World Health Organization, Geneva.

'Rama' had a wide range of research interests. in addition, whenever there was a national health emergency, he responded promptly by providing leadership to address the problem. This was demonstrated by the role he played in the Bihar famine, Bangladesh refugees, Bhopal gas tragedy and more recently, the plague outbreak in Surat. He was involved in research on human malnutrition, including protein-energy malnutrition, nutritional anemia, liver disease, nutritional blindness, and especially on those disorders arising from a nutritional deficiency of iodine. He was a pioneer in initiating studies on iodine deficiency disorders in India. His study in Kangra Valley is a landmark that paved way to start an iodine prophylactic programme in India. Many of us who had the opportunity to work with him in the laboratory as well as in the field cherish some of the wonderful experiences we obtained during our association. His numerous students occupy important positions in several universities and research institutions all over the world. His 225 scientific publications have been influential, but only a minor indicator of his broad influence in the field of health sciences, public health and nutrition. Through his many personal contacts, and contributions at the times of national, regional and international meetings he wielded a far broader influence on trends both in research and in international health policies.

Rama was a fine scientist, a visionary, an inspiring speaker with a marvellous command of the English language; "a gentleman" in the very best sense of that word. Rama had remarkable personal qualities. Colleagues looked to him for guidance, but also found in him a warmth and friendship that was sustaining. He was a great conciliator, and played a vital role when sharp differences arose among participants in conferences. He could be counted on to settle the conflicting opinions and identify the productive path. His advice was invariably sought and his comments resolved differences and restored communication. His role in this regard will not be easily surpassed.

All of us who had the privilege of his association over the years, and who profited from his wisdom and continued concern of science for society, are diminished by his passing away on May 28, 2001. We are greatly indebted to 'Rama'.

The first meeting of the present study **" Tracking Progress Towards Sustaining Elimination of Iodine Deficiency Disorders in Kerala"** was chaired by him in May 2000. This study is a small step towards partial fulfillment of repayment of our indebtedness towards his leadership and his concern for science and society.

Contents

Tracking Progress Towards Sustaining Elimination of Iodine Deficiency Disorders in Kerala

Planning & Coordination Team, Kerala

Prof K Leelamoni
Dr Vijaya Kumar
Dr Rajamohanan

Planning & Coordination Team, New Delhi

Dr Col R Sankar
Dr Denish Moorthy
Prof M G Karmarkar
Dr Chandrakant S. Pandav

Field Survey Team
Government Medical Colleges

- **Thiruvananthapuram (State Coordinating Unit)**
- **Thrissur**
- **Kozhikode**
- **Kottayam**
- **Kannur**
- **Alappuzha**

Laboratory Team

Dr. K A George
Dr. Vijaya Kumar
Ms. Smita Pandav
Dr. Denish Moorthy
Prof. M G Karmarkar

Unicef Team

Dr. Abdullah Dustagheer
Dr. Patrice Engle
Dr. V.L. Srilata

Data Management & Report Preparation

Dr. K. Vijaya Kumar
Dr Rajamohanan
Dr. Remadevi S.
Prof. K. Leelamoni
Dr. Col R. Sankar
Dr. Denish Moorthy
Dr. K. Anand
Prof. M. G. Karmarkar
Dr. Chandrakant S. Pandav

Office & Administrative Support, New Delhi

Ms. Saroja N
Mr. Peter Parekattil
Ms. Veena N
Mr. Pritam Singh Tanwar
Mr. Ashok Negi
Mr. Ravi Kumar
Mr. Govind Lal
Mr. Harinder Kumar
Mr. R. P. Sharma

Field Survey Team Members

Government Medical College, Kozhikode

Dr. M Ramla Beegum
Dr. P I Narayanan

Government Medical College, Kottayam

Dr. E R Indira Devi

Government Medical College, Kannur

Dr. Jayakrishna T

Government Medical College, Alappuzha

Dr. G Syamala Kumari
Dr Lucy Solomon

Government Medical College, Thrissur

Dr. K Usha Devi
Dr. P K. Accamma

Government Medical College, Thiruvananthapuram

Prof K Leelamoni
Dr. Vijaya Kumar
Dr. Anuja U
Dr. Karthika M
Dr. Srilatha S
Dr. Leela Itty Amma
Dr. Sreekumar
Dr. Remadevi S
Dr. L D Kumar
Dr. Sheela Joseph
Dr. Aysha Beegum
Dr. Sreelatha B
Prof Girija
Dr. Rajamohanan
Dr. Mini S S
Dr. Rajeev J
Dr. Krishna R
Dr. Mallika Rao G
Dr. Sheela M Kumari
Dr. Radhika K
Dr. Anju Mani
Dr. B Jayakumar
Dr. M Haneephabi

x

India & the State of Kerala

The Distribution of "30 Clusters" in Kerala

Acknowledgements

The conception of this study came about after a meeting that was chaired by Professor V. Ramalingaswami and held at the All India Institute of Medical Sciences in May 2000. This meeting was held to discuss the future course of action of iodine deficiency disorders elimination efforts in India. Participants included representation from government departments, non-governmental agencies and international agencies UNICEF, WHO , MI and ICCIDD. The decision to conduct the study in Kerala was taken at the meeting.

The study would not have been possible without the support of the Secretary, (Health) Mr. Rajeev Sadanandan, who was not only instrumental in the initiation of this study but also took keen interest **in the methodology** and planning and implementation of the study during its various stages, including the workshop organised for dissemination of the results of the study. We also wish to thank the Director of Medical Education, Dr. (Mrs.) M.S. Shubadra, whose encouraging support to the medical colleges ensured the smooth functioning of this study. The Dean and the whole Community Medicine Department of Medical College, Thiruvananthapuram were actively involved in this study, making it a success.

The support of the Salt Commissioner's Office in Jaipur, Chennai and Tuticorin is also acknowledged. KIWANIS International through UNICEF India and ICCIDD contributed by giving funding support. UNICEF India and ICCIDD also contributed to technical support for the study.

The results of the study were shared by the study investigators in a dissemination workshop where the active participation of invitees from the Government of India, Government of Kerala, prominent health care and social NGOs and nutritionists and representatives from UNICEF, MI and ICCIDD led to the finalisation of the recommendations of the study.

Last but not the least, the study is dedicated to the children, families and the community at large and the shopkeepers, vendors, traders and distributors dealing with salt and iodised salt, the best vehicle to eliminate Iodine Deficiency Disorders.

Kerala - The Development Role Model

Kerala vs All-India
Development Indicators

Indicator	Year	Kerala	All-India
Crude death rate / 1000 Population	1998	6.4	9.0
Crude birth rate (rural) / 1000 population	1998	18.3	28.0
Infant mortality rate (/1000 live births)	1998	16	72
Life expectancy at birth (years)	1993	66.5	61.5
Females : Mean age at marriage (Years) :	1991	22.3	19.3
Per capita income (Rs)	1995-96	8324	11649
Literacy Rate	2001	90%	65%
Female Literacy Rate	2001	88%	54%

Criteria for tracking progress towards eliminating
Iodine Deficiency Disorders as a public health problem

Indicator	Goal	Kerala
Thyroid size (age gp 6-12 yrs) Proportion with enlarged thyroid	< 5%	16.6%
Median Urinary Iodine (μg/L)	> 100	123
Salt iodisation Proportion of Households consuming adequately iodised salt (Salt ≥ 15 parts per million of iodine)	> 90%	49%

Kerala offers an opportunity to eliminate IDD at an accelerated pace and demonstrate leadership in this field as well