Iodine Deficiency Disorders in Schoolchildren in Kannur District

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1 Introduction

Iodine, which is the Greek word for violet colour, was first isolated as a violet vapour while preparing gunpowder, at the end of 18th century. It was present even at the time of the primordial development of the earth. Large amounts were leached from the surface soil by glaciations, snow or rain and carried by wind, rivers, and floods into the sea. In general the older and the more exposed the soil surface, the more likely it is to be leached of Iodine. Iodine deficiency is likely to occur in all elevated regions subjected to glaciations and heavy rainfall with run-off into rivers. It also occurs in flooded river valleys.

Iodine occurs in soil and sea water in the form of Iodides; it is oxidised by sunlight to iodine which is a volatile substance. Concentration of iodine in sea water is only 0.05mg/litre. However, the return of iodine is slower and in smaller quantities than its loss. Since there exists no natural process of correction, iodine deficiency might persist in soil indefinitely. All crops grown in such deficient soil would also be iodine deficient. As a result, human and animal populations, which are totally dependent on food grown in such soil, become iodine deficient and prone to iodine deficiency diseases.

Iodine, the essential nutrient

The importance of iodine as an essential micro-nutrient arises from the fact that it is a constituent of the thyroid hormone, Thyroxin T_4 and Tri-iodo Thyronine T_3 essential for normal physical and mental development in humans and animals and also for development of the brain and maintenance of body temperature. A deficiency of thyroid hormone from any cause will lead to severe retardation of growth and maturation of almost of all organ systems. Healthy adult human body contains 15 to 30 mg of iodine of which 70 to 80 percent is found in the Thyroid gland.

Iodine is rapidly absorbed through the gut. The normal intake and requirement per person is 100 -150 micro grams / day. Excess iodine is excreted through the kidney, which correlates well with the level of intake (Hetzel, 1989).

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* T. Jayakrishnan is ; M. C. Jeeja is .....

Table 1.1 Recommended daily iodine intake per person

Age/Period	Micro gram / day
0-6 months	40
6-12 months	50
1- 10 year	70-120
Adulthood	120- 150
Pregnancy	175
Lactation	200

(Source: WHO, 1994 trace elements in human nutrition)

Sources

About 90 percent of iodine comes from foods we eat and the remaining from drinking water. Iodine content of the soil determines its presence in both water and locally grown foods. The deficiency is geochemical in nature (Park & Park, 1995). The prevailing popular belief is that sea water and sea foods are not good sources of iodine. Sea water contains 0.05 mg / litre (0.05 ppm) of iodine. But a specific type of sea weed located near coral reefs has an inherent capacity to absorb iodine from sea water. Thus people consuming that sea weed and reef fish which thrives on the weeds, get adequate quantities of iodine. In fish, the thyroid gland, which is rich in Iodine, is located in the head. Eating fish after cutting its head away does not therefore supply adequate iodine. Another source is sea salt, which contains 0.28 ppm of iodine (Salt Department, Government of India).

Iodine Deficiency Disorders (IDD)

Hetzel in 1982 proposed the term IDD to denote all the effects of iodine deficiency on a population’s growth and development, which could be totally prevented by correction of deficiency. These effects are evident at all stages of human life including particularly at the stage of the foetus, neonate, and infancy, which are periods of rapid growth (Hetzel, 1983). The spectrum of IDD at the different stages of human life is shown below.

Spectrum of IDD

Foetus: Abortion, Still birth, Brain damage (Cretinism)

Neonate: Goitre, Brain damage

Child: Goitre, Thyroid deficiency (Loss of energy), Impaired school performance, Retarded physical development

Adult: Goitre with its complications, Thyroid deficiency, Impaired mental functions (Oxford textbook of public health, 1998).

Iodine deficiency in children is characteristically associated with goitre. The goitre rate increases with age and reaches its maximum level by adolescence. Girls have higher prevalence than boys. Observation of goitre rate in schoolchildren of 8-14 years of age provides a convenient indication of IDD in the community. The fact that iodine deficiency is a major preventable cause of nutritional deficiency in growing children was first shown by David Murine in 1920 (Hetzel, 1989). Iodine deficiency is a major barrier to human and social development of community. Up to 70 percent of the population in a severely iodine deficient area could suffer from lethargy caused by IDD, causing irreparable loss due to fall in output in households and in the work place and rise in costs of medical and institutional care. Mental disability leads to poor school performance by children thus producing long-term adverse effects in their lives (Levin, et al, 1991).

Correction of iodine deficiency increases physical and mental energy of a people leading to improvements in learning, work efficiency, and quality of life.

Causes of IDD

Causes of IDD are mainly geo-climatic. The principal underlying cause of environmental iodine deficiency is low iodine content of the soil. In mountainous and hilly areas, iodine content is lost due to years of washing of the soil by glaciers and heavy rains and in plains and riverine areas by recurrent flooding. In all such conditions iodine is leached out and washed away leaving the soil poor in iodine. As a result, the water and all the animal and vegetable foods dependent on the soil directly or indirectly, become iodine-deficient. Deforestation and soil erosion hasten the process of iodine loss from the subsoil (S.O.S. for a Billion, 1997).

In Kerala the acute slope of the land (with 40 rivers flowing westward for an average length of 7 km per *panchayat*) along with rapid deforestation and urbanisation at work, hastens this process. Certain foods like cassava, sweet potato, radish, peas, beans, raggi, cauli flower, and cabbage contain goitrogens (DHS, Thiruvananthapuram, 1996). ‘Goitrogens’ are chemical substances leading to development of goitre. They interfere with iodine utilisation by the thyroid gland. Important among them are cyano-glycosides and thiocyanates which may occur in the above-mentioned food substances or in water (Park & Park, 1997).

The survey conducted by Prema (Kerala Agricultural University) revealed that frequent consumption of tapioca may be one of the reasons for the prevalence of goitre in Kerala. Tapioca contains hydro-cyanic acid which blocks the uptake of iodine by thyroid causing goitre (Tapioca Consumption and Goitre Incidence of Kerala, 1998).

Polluted water with presence of e.Coli tends to produce goitro-genic substances (A. P. Kulkarni and J. P. Bhatath, 1998). Organo-chlorine insecticides widely used in agriculture can also cause goitre (Dr Malathi, 1986). Endemic goitre is found where sand stone type of soil which is rich in lime and calcium, is present (L. C. Gupta, et al, 1995).

Faulty cooking and dietary practices which reduce the bio-availability of iodine make Keralites prone to IDD (Dr Ramachandran, Department of Bio-chemistry in an interview with author, 1996).

Prevalence of more than four percent goitre in a given place indicates iodine deficiency in the soil and in the foodgrains grown in that place.

Solutions for IDD

Marine David of the University of Michigan stated in 1929 that "Iodine deficiency can be prevented any time we want to do it". The reasons why eradication of IDD is considered important are the following:

(i) The problem is of sufficient quantitative significance to justify a major allocation of resources;

(ii) Effective preventive measures suitable for mass application are available;

(iii). System for the delivery of technology is available; and

(iv.) There exist practical methods for monitoring and surveillance (B. S. Hetzel, 1997).

Except for certain types of seaweeds located near coral reefs there are no foods that are inherently rich in iodine. All food derives iodine from the soil on which it grows. If the soil is poor in iodine all food grown on it will be low in iodine. The problem is aggravated by deforestation and soil erosion. In the circumstances, iodine has to be supplied from external sources.

(i) Sea water contains 0.05 ppm /litre of iodine

(ii) Sea salt contains 0.28 ppm of iodine

(iii) Sea weeds on which sea fish feed contain plenty of iodine; but they are not accessible.

Methods for supplementation of Iodine to deficient population

Iodised oil injection

It is used in contrast dyes in diagnostic X ray procedures. A single injection provides iodine for four years. This method targets only select populations. Services of medical/paramedical persons are needed for implementing this remedy. Proper documentation is also needed. Earlier some authors preferred this method in areas inaccessible to iodised salt. But Gopalan argues strongly against this technique practised by using thousands of disposable syringes and army of injectors (Gopalan, C, 1998).

Oral iodised oil administered with a first dose of Oral Polio Vaccine in EPI schedule would improve infant survival and does not reduce neutralising anti-body response to Oral Polio Vaccine (Taffs, R. E, et al , 1999).

Iodine tablets

Tablets containing 100-500mg of Potassium iodate are available in the market for daily consumption. Supervision of daily intake is difficult and there are no ways of ensuring that the affected persons consume the tablets regularly. Oral administration needs direct target contact. But bolus administration is unphysiological and bolus cannot be stored in the body (Dunn, 1987).

Iodised water

This method was introduced by Dr Rosaisuwanik of Bangok. Water is a dietary necessity and must be consumed daily. Potassium iodate is added to the water vessel in which water is stored for drinking. At the community level iodine is administered by introducing porous polymer vessel containing iodine in water supply either in hand pump or in open well water. This arrangement would run risk-free for about a year. Only 10 percent of the total quantity of water; further, the quantity of water consumed by a person varies from day to day and season to season. The adverse effect is that this water may not be acceptable for drinking due to its bad smell and taste (Fish, et al, 1993).

Fortification of foods

This technique has been extremely useful in eliminating a number of micronutrient deficiencies in the developing world. Iodine is added to bread, sugar and candy. Although it is effective, mal-distribution in the diet of a community may cause wide variations in the iodine intake by different sections of that community. However, this technique is used on the basis of commercial rather than health trends (M. G. Venketaesha Mannar).

Iodised salt

The series of studies carried out from 1891 to 1915 proved that after taking sodium iodide tablets for one year, goitre among schoolchildren regressed to about 75 percent. In 1922 iodised salt was introduced in Switzerland. Mass prophylaxis of goitre with iodised salt was first introduced in the USA in 1924. By 1951 goitre almost entirely disappeared from the USA (B. S. Hetzel).

The efforts made during the past 60 years to introduce iodine regularly into the daily diet have shown that several food items can act as possible vehicles. Among them, salt has been the most commonly accepted. The reasons are that salt is universally consumed by all sections of the community irrespective of economic level and that they consumed same level throughout the year. Production of salt is limited to a few production centres. By adding a fixed dose of iodine to salt at centralised locations, the majority of the population would get adequate amounts of iodine. The mixing of salt is a simple operation with no adverse chemical reactions. It will not impart any colour, taste or odour to the salt. Cost of iodisation is low too (Venketesha Mannar, M. G, 1996).

Benefits of IDD control

IDD is one of the three micro nutrition deficiencies declared to be eliminated by WHO, the other two being Vitamin A deficiency and iron deficiency. Apart from minimising human misery, IDD control makes it possible to have better education to children, higher labour productivity, and better quality of life. In IDD control the priority group is women of the age group of 15-44years and children of the age group 0-14 years.

Effects of iodine intervention and the benefits accruing therefrom are indicated below:

Human population

Effects	**Benefits**
Reductions in:	
1. Mental deficiency	1. Higher work output in the household and in the work place
2. Deaf-mutism	2. Reduced cost of medical and custodial care.
3. Spastic diplegia	3. Reduced educational cost from reduced absenteeism and grade repetition and higher academic achievement by students
4. Squint	
5. Dwarfism	
6. Motor deficiency	

Live stock populations

Effects	**Benefits**
Increase in:	
1. Live births	1. Higher output of meat and other animal products
2. Weight	2. Higher animal work input.
3. Strength	
4. Health (less of deformity)	
5. Wool coats in sheep	

Source: Levin, et al, 1991.

Magnitude of the problem

IDD has been described as the world's single-most significant cause of preventable brain damage and mental retardation. It affects about 14 percent of the world population and 834 million persons are affected by goitre (WHO, 1998). There exist 43 million cases of preventable brain damage caused by iodine deficiency. The major regional concentration of population at risk is in Asia (WHO-NUT, 1994). The average goitre prevalence is 7.3 percent (WHO/SEARO, 1985).

India

In India a conservative estimate made in 1989 using the epidemiological model suggested that 150 million persons were at risk from IDD, 54 million persons had goitre and 2.2 million persons suffered from cretinism (C. S. Pandav, et al, 1989). Of the total 480 districts in the country, 275 were surveyed till 1998 of which 235 have been found endemic for IDD (Government of India, 1998; Table 1.1). Nearly 90,000 still births or neonatal deaths occur in India due to IDD. "Himalayan Goitre belt", which is the world's greatest IDD-affected area, extends to 2400 km from Jammu in the north-west and Kashmir to Manipur in the north-east. No State in India is free from IDD (Park & Park, 1997). Bio-chemical Hypothyroidism has been reported up to 10 percent among neonates in northern India (Kochu Pillai & Pandav, et al, 1989).

Table 1.1 Prevalence of Iodine Deficiency Disorders in Different States / UTs of India

State	Total Number of Districts	No. of Districts Surveyed	No.of districts Endemic
Andra Pradesh	23	7	6
Arunachal Pradesh	10	10	10
Assam	18	18	18
Bihar	38	22	21
Goa	02	02	02
Gujarat	19	16	08
Haryana	16	09	08
Himachal Pradesh	12	10	10
Jammu &Kashmir	15	14	11
Karnataka	20	17	06
Kerala	14	14	11
Madhya Pradesh	45	16	16
Maharashtra	31	29	21
Mizoram	04	04	04
Manipur	08	08	08
Meghalaya	05	02	-
Nagaland	07	07	07
Orissa	30	02	02
Punjab	12	03	03
Rajastan	27	03	03
Sikkim	04	04	04
Tamil Nadu	21	12	12
Tripura	03	03	03
Uttar Pradesh	67	34	29

W. Bengal	18	05	05
Andaman & Nicobar Islands	02	Not done	
Chandigarh	01	01	01
Dadar & Nagar Haveli	01	01	01
Delhi	01	01	01
Daman&Diu	01	01	01
Lakshadweep	01	Not done	
Pondicherry	04	Note done	
Total No of Districts	**480**	**275**	**235**

Source: Directorate of Health Service, Government of India, 1998

Kerala

Despite Kerala being a coastal State with a length of 700 km and sea food as staple food for a large section of its population, a survey conducted during 1989-1994 by the Goitre Control Cell of Directorate of Health Services, Thiruvananthapuram has shown that all the 14 districts of the State were endemic to goitre, the prevalence ranging from 4.7 percent in Alappuzha to 27.3 percent in Thiruvananthapuram. In Kannur district, the prevalence rate was recorded to be 11 percent (Table 1.2). A study conducted by Dr Kochu Pillai revealed that in Idukki district goitre prevalence rate was 40-60 percent. A study conducted by Dr K. P. Paulose of Kottayam Medical College found that in Kottayam district goitre prevalence ranged from 9 percent to 19 percent from coastal to hilly areas. Water analysis reveals that the iodine content in highland water was only one-third of iodine in lowland water, 3.6 microgram/litre and 8.6 microgram/litre respectively. A preliminary study by Dr Nandini has shown increase in incidence of goitre in Kerala (KRPLLD Annual Report 1998-'99, 1999). Hospital statistics from ACME Pariyaram shows that the proportional morbidity rate of Thyroid disorder (ICD E00-E07) is 1.4 percent (ACME Pariyaram, 1998).

Iodine intake in Kerala

Iodine intake in a population is invariant to socio-economic factors because iodine concentration in the food is a tiny fraction of its concentration in the soil. However, being a 100 percent consumer state, Keralites depends on other states for the supply of different food articles including cereals, fruits, and vegetables, the parent soils of which are unknown to consumers in Kerala. Much information on the iodine content of the soils and of the cereals, fruits and vegetables consumed by Keralites, is not available either.

Iodine content of our diet ranged from 200-300 micro gram/day of which 39-70 percent was lost during cooking. Thus iodine intake from cooked diet is low. Cereals and pulses together constitute less than half of the daily dietary iodine and the rest has to be met from milk and meat intake. These latter items are consumed less by lower socio-economic

Table 1.2 Goitre Survey by Districts in Kerala

No.	District	Sample	Period of Survey	Prevalence %
1	Trivandrum	School children	1989-92	17.3- 27.3
2	Kollam	,,	1992	5.8-12.9
3	Ernakulam	School children+ Public	1992	9.1
4	Alappuzha		1992	4.7
5	Pathanamthitta	,,	1992	12.6
6	Idukki	,,	1992	17.8
7	Kottayam	,,	1992	21
8	Thrissur	,,	1992	14
9	Palakkad	,,	1992	6
10	Malappuram	,,	1992	11
11	Kozhikode	,,	1992	13
12	Wayanad	,,	1992	21
13	Kannur	,,	1992	11
14	Kasargod	,,	1992	10

Source: Iodine Plus, UNICEF, July 1996

groups, than by others and therefore they remain vulnerable to IDD (S. Ranganathan). Cooking loss of iodine was considerably higher than was assumed earlier. Mahesh et al, from National Institute of Nutrition report that among low socio-economic groups, the regional diet contains only 173-265 micro gram/day of iodine with up to 70 percent cooking loss (ICMR, 1996). The iodine contents of food items commonly consumed by people in Kerala are shown in Table 1.3.

IDD control programme in India

The aim of the IDD control programme in South-East Asia is to keep the goitre rate in the region at not more than 5 percent by 2000 AD.

In India from 1954 to 1962 a pioneering prospective study on iodine deficiency was conducted among 1 lakh persons in Kangra valley in Himachal Pradesh. Goitre prevalence was observed to have come down from 38 percent to 15 percent within five years, as a result of consumption of iodised salt. In 1962 National Goitre Control Programme (NGCP) was launched by Government of India. The objective of the programme was to survey the problem of goitre in the country and make available iodised salt to all endemic areas. In 1982 the technical goitre control review committee of the Ministry of Health and Family Welfare considered the situation in the country in respect of IDD and found that the desired objectives set forth in 1962 were not achieved. The Committee recommended that the entire country should be declared 'Goitre-prone'.

Table 1.3 Iodine content of some Kerala foods micro gram/100 gram

Food	Goitrous	Non-goitrous
Rice	10	40
Wheat	15	32
Bengal gram	13	33
Black gram	17	48
Red gram	19	28
Ground nut	14	47
Cucumber	5	11
Tomato	-	2
Curry leaves	-	16
Lady's finger	-	5
Carrot	-	6
Brinjal	-	2
Apple	-	5
Orange	-	11
Banana	-	16
Papaya	-	11

Source: National Institute of Nutrition, Hyderabad, 1993.

In 1983, the government took a decision to adopt 'Universal iodisation of salt' in the country. It was decided to spread NGCP to all parts of the country. In April 1986, the government initiated steps for achieving the goal of universal iodisation of edible salt by 1992. For this purpose, the Prevention of Food Adulteration Act 1954 (PFA) was amended in 1988 and it was made mandatory that only iodised salt should be sold as an article of food. The level of iodisation was revised upward and fixed at not less than 30 PPM at the production level and not less than 15 PPM at the consumer level. The monitoring of iodisation was the statutory responsibility of the Food and Drug department (ICMR Bulletin, 1996).

In June 1992 NGCP was re-designated as National Iodine Deficiency Disorder Control Programme (NIDDCP). The action plan was to achieve universal iodisation of common salt by 1995. In 1996 the World Health Assembly of WHO declared 90 percent iodisation of edible salt in the member countries. The objective of this project is to reduce the goitre prevalence in the age group of 10 to 14 years to less than 5 percent and to bring down to zero the number of Cretins born by the year 2000. The objective was to be achieved by strengthening the monitoring system from production to consumption of iodine to ensure that 100 percent of population get only iodised salt (C. S. Pandav, 1997).

Despite all these efforts, it is reported that the goitre prevalence rate caused by IDD has registered a 20 percent increase.

2 Objectives, Materials, and Methods

Kerala is known to be a better performing state in our country in respect of education and health indicators. It is the first State in India to have achieved 100 percent literacy. Kerala is the only State in the country which has no ban notification issued against the sale of non-iodised salt. In fact, a raging protest campaign has been going on in the State against the ban on non-iodised salt, since 1989 (Appendix I). In the mean time, the government had initiated some steps to ensure universal access to iodised salt through non-coercive means (Appendix II). In this special situation it is important to study the current status of IDD and the knowledge, attitude, practices and behaviour of the people by using both quantitative and qualitative methods. This will help us to understand the current status of IDD and people's perception about IDD and iodised salt.

The present study is undertaken with the following objectives:

(i) To determine the prevalence of goitre among schoolchildren;
(ii) To determine the probable causative factors related to goitre;
(iii) To determine other nutritional deficiencies among schoolchildren;
(iv) To conduct KAP study of mothers about iodised salt; and
(v) To monitor the iodine levels of the salt available in the retail stores in the study area.

The study is conducted in the Kannur district. Some of the salient features of the district are presented below:

Study area

Kannur district, Kerala State, India.
Land area- 2966 sq. km (7.64 percent of land area of Kerala)
Boundaries - West - Arabian sea
North - Kasargod
East - Karnataka and Wayanad
South- Mahe River

Table 2.1 Population Projected for the Year 2000

Age(years)	Male	Female	Total
0-4	132133	138631	270764
5-14	259679	272451	532130
15-59	753628	790692	1544320
> 60	94080	98706	192786
Total	1239520	1300480	2540000

Source: Government of Kerala, Department of Economics & Statistics, Thiruvananthapuram.

Sex ratio (females per 1000 males) = 1049
Population density = 759/sqkm
Literacy rate = 91.48 percent (Total)
Female - 87.65 percent (Kerala-87 percent)
Male - 95.54 percent (Kerala-94 percent)
Number of *panchayats* - 81
Temperature — 25 * c minimum to35 * c maximum
Average rainfall — 3467mm/year
Latitude ——— 11.40^{o} to 12.48o North
Longitude —— 74.52^{o} to 76.97^{o} East

Kannur district is topographically divided into three areas: coastal area which lies at a height of less than 7.5 metres, midland which lies between 7.5 metres and 75 metres, and highland which has a height of more than 75 metres, above mean sea level.

According to topography and distance from the sea, three different *panchayats* are selected one from each area namely Chapparapadavu, Pariyaram, and Madayi. From these *panchayats* one high school each was identified and students studying in the eighth standard were selected as the subjects.

Table 2.2 Locational details of the sample areas

No.	*Panch-ayat*	Name of school	Distance From the sea	Topography	Soil	Rain Fall mm
I	Chappar-apadavu	BVJMHS (213)	55km	75m	Lateritic	>3400
II	Pariyaram	KKNMHS (230)	30-40km	>7.5m	Lateritic	<3400
III	Madayi	GHS(320)	0-10km	<7.5m	Reverin Alluvium	3000

The first two schools are of the mixed type and the third is a school in which boys' and girls' divisions function separately, but in the same compound.

Sample selection

School goitre survey is accepted to be a rapid and effective approach directly to project to general population. Schoolchildren with high feasibility combined with high vulnerability of the disease represent their age group in the community at large. According to ICCIDD technical team for goitre survey in each sentinel district three rural schools must be selected at random and the team must examine at least 200 children in sample (IDD Bulletin, May 1999).

In endemic areas IDD may affect schoolchildren of age 8 to 14 and goitre grows with age reaching its maximum stage by about 14 years of age. The plan of action against

IDD is to reduce the IDD prevalence rate at 14 years of age to below 5 percent. Accordingly, we have selected students of 8th standard mainly consisting of this age group. In Kerala more than 99 percent of children are enrolled in schools; and above 90 percent of them attend schools regularly. According to ICCIDD, above 50 percent attendance is necessary for screening.

The minimum criterion for anthropometric reference data in a nutrition evaluation sample should contain at least 200 children (Design concept of nutritional epidemiology- Barrie M Margetti and Michel Nelson). In all the three selected schools there were more than 200 students each enrolled in standard VIII, representing both the sexes.

Method of study

The selected schools were visited by the project team and the project was discussed with their headmasters and the other staff, in detail; accordingly they fixed dates for conducting screening camps according to their convenience. The camps were conducted in two days in each school, from morning to evening. All the students of standard VIII who attended school on those days were screened division-wise. They were called to the screening room in the order of entry of their names in the class attendance registers.

The detailed proformas for data collection were filled during the interview. Information was collected on age, religion, number of children in the family, order of birth, and food intake. Weight and height were also recorded for checking with recommended nutritional anthropometric measurement norms for persons in the age groups of 5 to 20 years. Instrumental error was avoided by using the same instrument in all the screening camps.

Each student was clinically examined in detail for iodine deficiency disorders and other nutritional deficiencies like anaemia, Vitamin-A deficiency and PEM, by a team of doctors. In order to avoid inter-observer error and assure sensitivity, the thyroid examination was done by the project team leader who is a qualified medical doctor with experience of more than 13 years. In case of doubt, a second opinion was sought from the co-researcher who is also a qualified physician practising medicine. Thyroid was examined by the palpatory method and goitre was graded according to the new WHO grading system. To avoid bias, the visible goitre (Grade II) was only taken into consideration for estimating the prevalence of IDD, since the contour of the neck, and the fat pad of the neck especially in girls, might give a false impression of Grade I thyroid swelling.

Measurement of IDD

Measurement of IDD provides key information for deciding whether a programme is required for IDD elimination and also to demonstrate its effectiveness.

Methods for epidemiological measurement of thyroid

The following are the methods in use for measurement of thyroid:

(i) Thyroid size by palpation of the thyroid
(ii) Thyroid size by ultra sonography
(iii) Urinary excretion of iodine
(iv) Thyroglobulin concentration in the blood
(v) Thyrotropin (TSH) concentration in the blood
(vi) Thyroid hormones (thyroxine and triiodothyronine) concentration in blood
(vii) Radio iodine uptake
(viii) Prevalence of cretinism

(J. B. Stanbury, A. Pinchera, 1999)

Of the several indicators for IDD, goitre grading and urinary iodine are the most feasible to use as outcome indicators particularly in developing countries while iodine measurement content of salt is the best process indicator (Karmakar, 1999).

Thyroid size by palpation

Thomas Wharton in 1656 suggested that the larger thyroid size in a woman served to beautify her neck! Goitre is a historical relic of IDD. Palpation of the thyroid size has been the standard technique used for measuring endemic goitre. Schoolchildren are, in general, selected for study because of their better accessibility and availability in large numbers; their thyroid size is measured by experienced surveyors during surveys. Enlargement is regarded as significant in a person when the size of the lateral lobes is found to be greater than the terminal phalanx of his/her thumb. There are several advantages to the palpation technique of measurement. It is a technique that requires no instrumentation, can reach large numbers in a short period of time and is not invasive. Overall sensitivity and specificity for palpation compared to sonographicaly demonstrated thyroid enlargement was 51.7 percent and 91.5 percent respectively. So there are chances of under-estimation. There is high level of inter-observer variation especially in low grade goitre i.e., of grades 0 and 1.

Technique

The examiner faces the subject and looks for visible thyroid enlargement. The subject then looks up, extending the neck and making any thyroid enlargement more visible. The examiner palpates the thyroid by sliding his thumb along each side of trachea between the thyroid cartilage and the top of sternum and the size and consistency of the thyroid is carefully noted. The thyroid moves upwards when the subject swallows (ICCIDD Technical Group, May 1999).

Grading of Goitre

WHO recommended in 1999 some changes of goitre grading, from the earlier system of grading into three categories (as shown below), to two categories:

GRADE 0: No palpable or visible goitre

GRADE 1: A mass in the neck, consistent with an enlarged thyroid and, palpable but not visible when the neck is in the normal position. It moves upward in the neck as the subject swallows.

GRADE 2: A swelling in the neck, visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated.

(Report from WHO/UNICEF/ICCIDD, November, 1992)

Quantitative measurement of thyroid size by ultra-sonography

Quantitative measurement of thyroid size by ultra-sonography is free of observer bias but highly expensive hence not feasible in the present situation.

Urinary excretion of Iodine

Approximately 90 percent of the ingested iodine is excreted in urine. Casual samples are collected from groups of approximately 40-50 subjects and estimate is made. The advantages of assessment by this method are that it is entirely objective, is non-invasive, and provides information in the one factor that can be addressed directly, i.e., iodine supply to the individual. It has a few disadvantages too. The excretion of iodine indicates only the recent, but not precisely the immediate, intake of iodine. It is possible that sample is not processed immediately: they might be held until they are returned to the laboratory and remain unprocessed till they reach a distant processing point.

Since laboratory facility for urinary iodine estimation was not available in Kerala, it was not possible for us to make use of this technique.

Table 2.3 Epidemiological criteria for assessing the severity of IDD based on median urinary iodine levels (as suggested by WHO)

Median value Micro gram/litre	**Severity of IDD**
< 20	Severe IDD
20 - 49	Moderate IDD
50- 99	Mild IDD
> 99	No deficiency

Source: WHO/ NUT / 1994

In the developed countries of the world where IDD in human beings does not exist, all babies born are screened to ensure that they have adequate thyroid hormones. Blood levels of T_4 or TSH are measured by radio immuno assay. Neonatal hypothyroidism is defined as T_4 level < 3micro gram / DL and TSH above 50 micro unit/ ml (Stanbery, J. B and A. Pincher, 1999).

Prevalence of cretinism in more than one percent of population is a sensitive indicator of environmental iodine deficiency. Prevalence indicators and criteria for a public health problem are shown in Table 2.4.

Table 2.4 Summary of IDD prevalence indicators & criteria for a public health problem

		Severity of public health problem (prevalence)		
Indicator	**Target Population**	**Mild**	**Moderate**	**Severe**
Goitre Grade >0	*SAC	5 - 19.9%	20-29.9%	>30%
Thyroid volume >97th percentile by ultra sound	SAC	5 - 19.9%	20-29.9%	>30%
Median urinary iodine level(micro gram/litre)	SAC	50-90	20-49	<20

*SAC - School-aged children (WHO/NUT, 1994)

Salt quality monitoring

In an IDD control programme the process indicator is salt iodine estimation (National Medical Journal of India, 1999). Monitoring iodine content of salt has been integrated in the primary health care system in India.

The PFA Act of India specifies that the iodine content of salt has to be 30 ppm at manufacture level and 15 ppm at consumer level in order to ensure adequate levels of consumption of iodine. IDD cells are also being established at the State level to act as nodal points. India has a cadre of food inspectors for collecting salt samples and sending them to laboratories for analysis. It is proposed to hand over this activity to multi-purpose workers under CSSM programme: For monitoring the availability of iodine content at consumer level spot-test kits are supplied to district medical officers (C. S. Pandav, et al, 1997).

Spot-test Kit (Stk)

The iodine content of the salt collected from retailers is estimated by the help of the spot-test kit. The StK developed by MBI Chemicals, Chennai has a sensitivity of 85 percent and specificity of 71 percent. Packed salt bought in autoseal polythene packets and common salt bought in loose packets are tested at once and on the spot.

Procedure

(i) the salt sample is taken in a full spoon;

(ii) after shaking the reagents well, a drop of the test solution is discharged on to the salt;

(iii) the salt will turn into light blue to dark violet depending on the iodine content of the salt; and

(iv) comparison of the colour of the salt with colour given on the colour chart (0—7—15—30 ppm).

Spot-test was made of the samples collected in our study area.

3. Findings and Discussion

Goitre in schoolchildren

Sex-wise prevalence of goitre

In all, 718 students were screened out of which 60 were found to have goitre of grade II i.e., visible goitre. The sex-wise prevalence is as shown below.

Table 3.1 Sex-wise Prevalence of Goitre among Schoolchildren of Standard VIII

Sex	Samples	Goitre	%
Boys	385	17	4.41
Girls	333	43	12.91
Total	718	60	8.35

In girls the prevalence was 12.91 percent which is three times of that among boys - 4.41 percent. The higher rate among girls may be due to physiological characteristics during puberty and quantitative dietary deficiency. The difference is statistically significant at P value=<0.001.

Age-wise distribution of goitre

Table 3.2 shows the age-wise pattern of the children screened and the distribution of goitre among them.

Table 3.2 Age-wise Distribution of Goitre among Schoolchildren of Standard VIII

Age	Number	Percentage	Goitre
12	51	7.10%	3 [5.88%]
13	359	50.43%	35 [9.75%]
14	215	29.94%	16 [7.44%]
15	73	10.17%	5[6.85%]
= ,above 16	20	2.79%	1[5%]

The majority of the children (80 percent) belong to the age group 13-14 and 85 percent of the goitre cases are seen among them. This finding is in conformity with the statement that goitre increases with age and reaches the maximum with adolescence and that maximum goitre is seen in the age group 14 (B. Hetzel,1997).

The school-wise distribution of goitre by sex in the sample area according to the three topographic categories is shown in Table 3.3 (A to C). Prevalence of goitre is significantly higher in the highland area rendering support to the prevailing view among scientists that the cause of IDD is geographical i.e., altitude and distance from the sea.

Table 3.3A Goitre Prevalence among Schoolchildren in the Hilly Area: BVJMHS, Perumbadava

Sex	Samples	goitre	%
Boys	100	7	7
Girls	90	18	20
Total	190	25	13.16

Table 3.3B Goitre Prevalence among Schoolchildren in Midland Area: KKNMHS, Pariyaram

Sex	Samples	goitre	%
Boys	124	5	4.03
Girls	87	13	14.94
Total	211	18	8.53

Table 3.3C Goitre Prevalence among Schoolchildren in Coastal Area: Govt. HS, Madayi

Sex	Samples	Goitre	%
Boys	161	5	3.10
Girls	156	12	7.69
Total	317	17	5.36

The results of a few studies conducted in other parts of the country are presented below for comparison.

Results of earlier Goitre studies

A survey conducted among Delhi schoolchildren during 1975-'78 showed the goitre rate among them to be 29 percent; it was before introduction of iodised salt in Delhi area (Pandav, et al, 1997). A study conducted in schools of rural south Delhi after the introduction of iodised salt in 1990 found that goitre rate was 16 percent with 4.65 percent cases of visible enlargement (Chadurvedi Sanjay, et al, 1996).

Another study made at Gurudaspur district in Punjab did goitre screening among schoolchildren of age 5 to 18 years. Total prevalence was found to be 12.6 percent. The highest prevalence rate was observed in the age above 13, i.e., 15.2 percent. Among girls the prevalence rate was 13.5 percent and among boys, 11.5 percent (L. S. Narad and R. S. Bakshi, 1995).

A study conducted in the coastal areas of Maldives in 30 schools among 2834 students of age group 8 to 12, found the goitre rate to be 23.6 percent. Out of 316 urine samples 65.5 percent had iodine levels below the recommended norm; further water iodine was only 1.65 micro gram/litre (Pandav, et al, 1989).

Among schoolchildren in Hamirpur district of Himachal Pradesh goitre prevalence had been found to be 8.8 percent (Table 3.4).

Table 3.4 Assessment of IDD in Hamirpur District of Himachal Pradesh

	Total	Male	Female
No. of students	6897	3411	3486
Goitre+	610	323	284
Percentage	8.8	9.5	8.2

No significant difference between male and female children.
(Umesh Kapil, et al, *Indian Paediatrics,* Vol. 35 October 1998)

Assessment of impact of IDD control in schoolchildren

On a comparison among States, it was seen that goitre prevalence varied between 20.5 percent in Rajasthan and 0.8 percent in Uttar Pradesh. The rate of consumption of iodised salt varied between 68 percent and 100 percent among the States (Table 3.5).

Table 3.5 Goitre Prevalence in Selected Districts and States

Sate	District	Numbers	Prevalence	Age	Year
Andaman & Nicobar	Andaman	622	9.5	6-12	1997
Bihar	Champaran	328	11.6	6-12	1997
Delhi	Entire state	7475	8.6	8-10	1996
Himachal Pradesh	Kangara	358	5.7	8-10	1996
”	Solan	6724	11.4	8-10	1997
Rajasthan	Bikanir	623	20.5	6-12	1996
Uttar Pradesh	Uttar Kashi	216	2.8	6-12	1998
Orissa	Puri	604	0.8	6-12	1998
Kerala	Ernakulam*	1254	1.0	6-12	1998

(Umesh Kapil, AIMS Delhi, *Indian Paediatrics*, Vol. 35, September 1998)
*According to the report of the survey conducted by State Goitre Cell under Directorate of Health Service in 1992 in Ernakulam district the prevalence of Goitre was 9.2 percent.

Learning disability

The report of IPA/WHO/UNICEF (1997) states that IDD leads to IQ decrease by 5 to 10 points. Children with IDD are ‘less able to learn in childhood and less able to earn in adulthood’ (State of World Children, UNICEF Report, 1994).

Published meta-analysis including 18 studies made on a comparable basis between iodine deficient children and carefully selected control groups has shown that IDD children have mean IQ which was 13.5 points lower than that for the later (Bleichrodt and Born, 1994).

Poor intellectual performance in schoolchildren in a community should stimulate a consideration that it is a part of IDD endemia (*SOS for a Billion*, p.93). Detailed studies made in China, Indonesia, and other South-Eastern Asian countries show that IDD is a problem in schools (Stanburry, 1994).

Bio-chemical hypothyroidism, secondary to iodine deficiency is associated with poor school achievement and cognitive learning in rural children in Bangladesh (Journal of Nutrition, May 1999, 129:5).

The consequences of lowered IQ are impaired learning and poor school performance, growth failure and speech and hearing defects (UNICEF, 1995).

In Bolivia, the correction of IDD improved the mental performance of schoolchildren (Bautista, et al, 1982).

Our study did not have the scientific tool to measure children's IQ and school performance. One school was following a grading system and another school a ranking system of which most of the students were not aware. The third school had no system to assess performance.

In our study, deafness due to iodine deficiency and squint due to IDD were not found.

Features of Hypothyroidism

Varying combinations of clinical signs depend on age of onset, duration, and severity. The clinical signs are the following:

Sub-normal intelligence, delayed milestones, mental deficiency, hearing defect, speech defect, puffiness of face and squint.

In the study group no features of hypothyroidism was found. A case each of squint, deafness, and deaf mutism were found, however, they were due to causes other than iodine deficiency.

Cretin

If the iodine deficiency of a woman is severe the child born to her would also suffer from iodine deficiency with brain and body development permanently stunted and become a cretin. Presence of more than one percent of cretins in an area indicates that the area is iodine deficient, which is a sensitive indicator of environmental iodine deficiency (Park & Park, 15th edition).

In the study group no cretins were found. This does not rule out the possibility of presence of cretins in the community; even if the community has cretins, it is quite unlikely that they would reach standard VIII in school, because they are severely mentally retarded.

Probable causative factors of IDD

Family history of Goitre in the study area

The cause of IDD is found to be mainly environmental and ecological. Endemic goitre is a multifactor disease in which the major factor would be environmental in nature with lesser role of genetic factors (De Breake Leer, et al, 1998). Since no natural correction process is at work of iodine deficiency in the soil of endemic areas, people inhabiting such areas continue to suffer from IDD from generation to generation; crops grown on them and humans and animals which depend upon those crops would therefore remain iodine deficient (Pandav C. S, 1997). In the study, more than two-thirds of the goitre cases identified had a family history of IDD (Table 3.6).

Table 3.6 Goitre Vs Family History of Goitre

Place	Goitre		Family history	
	No	%	No	%
Area I	25	13.16	21	10.79
Area II	18	8.05	10	5.46
Area III	17	5.04	10	4.48
Kannur (Total)	60	8.35	41	6.66

Goitre becomes a clinical problem to a person and the members of his/her family only when the size increases so as to cause a cosmetic problem or creates some symptoms necessitating medical advice. So the number of known goitre cases among the family members is likely to be an under-estimate. The correlation of family history of goitre with prevalence of goitre among schoolchildren in the area is found to be statistically significant (P value 0.033).

Use of tapioca Vs prevalence of Goitre.

The distribution of households in the three sample areas according to tapioca consumption intensity is shown in Table 3.7.

Table 3.7 Intensity of Tapioca Consumption according to Topographical Category

(Total No. of Households = 595)

Tapioca Consumption	area -1		area -2		area -3		Total
	Number	%	Number	%	Number	%	
Never used	2	1.06%	0	0	0	0	2 [o.33%]
Daily or Very often	39	20.85%	20	10.92%	27	12%	86 [14.5%]
Occasional	146	78.07%	163	89.07%	198	88%	507 [85.2%]
Total	187	100%	183	100%	225	100%	595

The relation between tapioca consumption (daily or very often) and the prevalence of goitre is given in Table 3.8.

Table 3.8 Tapioca Consumption and Goitre according to Topographical Category

(in percentage)

Area	Daily or very often- Tapioca	Goitre %
1	20.85%	13.16%
2	10.92%	8.53%
3	12%	5.36%

For a population which has tapioca as staple diet there is over-load of thiocyanate which has goitrogenic action, as the goitrogens inhibit iodine uptake thus leading to goitre. Increasing the availability of iodine could overcome this inhibition. A study conducted by Prema (Kerala Agricultural University) shows that the majority of goitre patients were in the habit of consuming tapioca every day (P. V. Nandini, 1998).

Since tapioca is available only seasonally and the survey was conducted during different months of the year, the reply of the respondents might not have reflected the accurate situation. In the area in which the survey was conducted during the harvest season of tapioca, tapioca consumption would be reported to be high. This was the case with regard to Area 3. Though people who had migrated from central Travancore districts habitually consume tapioca as their main food, the survey conducted in area I which constituted mainly of such people under-reported tapioca consumption due to the consideration that tapioca was an inferior food. Earlier studies conducted in Kerala about consumption of tapioca had also documented instances of under-reporting (UN-CDS, 1975). By taking into account theses possibilities, we conclude that the prevalence of goitre was proportional to tapioca consumption in these areas.

Religion Vs Goitre

This conclusion is reinforced by an analysis of goitre cases among children in the sample according to religion. Of the 718 children screened, 352 (48.9 percent) were Hindus, 232 (32.3 percent) were Muslims, and 134 (18.7 percent) Christians. The distribution of children according to religion and distribution of goitre cases are shown in Table 3.9.

Table 3.9 Goitre Prevalence Rates among Religious Groups in the Sample Schools

School	Hindu		Muslim		Christian	
	Number	Goitre	Number	Goitre	Number	Goitre
1	71	7 [9.86%]	46	4 [8.7%]	73	14 [19.18]
2	92	9 [9.78%]	84	6 [7.14%]	35	3 [8.57%]
3	189	11 [5.85%}	102	3 [2.94%]	26	3 [15.53%]
Total	352	27[7.67%]	232	13 [5.6%]	134	20 [14.92%]

The average goitre prevalence came to 8.4 percent. It is observed that Christians in the sample are more prone to developing goitre [P value=0.007] than the other two groups. Christian parents or ancestors of these students were those who had migrated to their present settlement areas from Central Travancore districts after the fifties; their levels of consumption of tapioca are observed to have been higher than among the others. Also these settlement areas are in highlands, away from the sea. Goitre is not a hereditary disease either. These aspects have to be taken into consideration in further studies.

Diet

Iodine supplementation is higher with non-vegetarian than with vegetarian diet, a fact which was analytically proved through urinary iodine estimation (British Journal of Nutrition, January 1999). Vegetarians are at high risk of developing IDD.

In the study area, there were only nine vegetarians as against 709 non-vegetarians among the sample schoolchildren. We could not show any higher prevalence of goitre among vegetarians. However, this finding is not conclusive since the sample size is small.

In the entire area under study, the staple diet of the population consisted of rice. In the topographical categories I and II, the rice consumed was that imported from other States in India. The mother soils in which this rice was raised, were not known. But in the topographical area III (that is, the coastal area), rice cultivation was practised and the rice consumed was mostly that produced locally.

All non-vegetarians included sea fish in their diet except those in the area I (Hilly) where they use dry, preserved fish which may contain only a lower amount of iodine. This difference was another contributing factor for higher prevalence of goitre in area I.

The iodine content of rice is 10 to 40 microgram/100 gram and the average daily consumption of rice is 300 gram which gives 30 to 120 microgram of iodine. The monthly consumption of rice of a Keralite is 8.7 kg of which 5 kg is ration rice (K. P. Kannan, 2002).

The average daily diet of children in the age group 13-15 years in Kerala provides 1669 K.calories (and 43.6 gram of proteins) which is 273 K.calories lower than in other States for the same age group (Panikar, P. G. K, 1999).

Drinking water

Ten percent of the daily requirement of iodine (15 micro grm) of a person is obtained from the water he/she drinks. Iodine content of the water in India ranges from 6 micro grm / litre to 36 micro grm / litre. Iodine deficiency results, therefore, from geological rather than sociological and economic causes. Most of the households in the study area were found using well water which is a sub-soil source of water in which the iodine content is proportional to that in the soil. The proportion of households using well water for drinking purposes is higher (87 percent) in the study area than in Kerala as a whole (70 percent).

Women's education

An important factor governing the health status of a population is its education level. The level of female education is particularly important since it is women members of the household who are, in general, more directly concerned with the health of its members, especially children. Kerala could attain high standards of health due primarily to high levels of female education. The per capita expenditure on education in Kerala was Rs. 240 in 1999, a figure higher than in the other states of India (P. G. K. Panicker, 1999). In the study area, female literacy level was 92 percent, as against 88 percent for the Kannur district and 87 percent for the state as a whole.

Other nutritional deficiencies

Since other micro-nutrient deficiencies coexist like iron deficiency and Vitamin A deficiency they are also looked into. The National Nutrition Bureau survey report 1990 reveals that consumption of energy and protein among Kerala households is significantly lower than the recommended daily allowances (RDA) as shown below.

Intake in Kerala		**Recommended Daily Allowance**
Calories	2140 K. cal	2350 K. cal
Protein	53 grm	60 grm

The sex-wise distribution of food intake of children in the age group of 13-15 years in Kerala in 1990 was as shown below.

Male - 1669 cal, Protein - 43.6 grm
Female - 1954 cal, Protein - 51 grm

The proportions of persons taking adequate amounts of energy and protein are lower in Kerala than in all the States taken together as shown in Table 3.10.

Table 3.10 Comparison of Adequacy of Energy and Protein Intake in Kerala with all Indian States

Place	Energy adequate	Protein adequate
Kerala	39.7%	71.5%
States pooled	63.3%	83.5%

Anaemia

Anaemia is due to micro-nutrient deficiency of iron. Clinically assessed by looking for the conjunctiva for pallor, we find that 5.15 percent of the children in the sample suffer from varying degrees of anaemia.

However, the prevalence is found to be much lower than was observed during an earlier study conducted in Kannur district by the department of community medicine of the Medical College, Pariyaram under Problem Solving for Better Health (PSBH) in collaboration with Health Action for People, Thiruvananthapuram, in 1998. In that study, the prevalence of anaemia among schoolchildren was found to be 10 percent. The lower rate might have been due to good nutritional status, satisfactory sanitary conditions (which prevent worm infestations), and adequate utilisation of nutrients available in the food consumed.

Vitamin A deficiency (VAD)

Signs of Vitamin A deficiency are the following:

(i) Night blindness
(ii) Conjuctival Xerosis
(iii) Bitot’s Spots
(iv) Corneal Xerosis
(v) Keratomalacia
(WHO Technical Paper Series No. 672)

No eye signs of Vitamin A deficiency were found among the study group (all-India prevalence of VAD is 0.7 percent), may be due to good living conditions and nutritional awareness among women in the study area; and inclusion of green leafy vegetables and meat in the diet of their children providing them with sufficient Vitamin A. The significantly low prevalence of vitamin-related deficiency signs in the area certainly indicates adequate diet and / or efficient utilisation by the body of the nutrient consumed (UN\CDS, 1975).

Anthropometry

Anthropometric measures like growth in terms of height and weight by age comprise a good index of nutritional status. Age-wise distribution of children in the study area by median height and weight is shown in Table 3.11.

Table 3.11 Age-wise Distribution of Children by Median Height and Weight

Age	Weight(Kg)	Height (cm)
12	33	146
13	34	150
14	37	155
15	44	164

The median height and weight of Indian children as per studies conducted in some parts of north India are shown in Table 3.12.

These anthropometric findings are contradicted to the following statements. In terms of the parameters of height by age and weight by age Kerala children are ahead of their counterparts in the other States even with low intake of nutrients. The average intake of nutrients by girls of all age groups in Kerala is lower than in other States (P. G. K. Panikar, 1999).

Table 3.12 Median Height and Weight of Children in North India by Age

Age	Boys		Girls	
	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)
12	144.7	35.4	146.7	38.7
13	150.3	39.4	151.4	42.6
14	158.0	44.7	153.6	45.7
15	164.3	51.0	155.0	48.0

(Agarwal D. K, Upadhya S. K, et al, 1992)

KAP study among mothers about IDD

The KAP study among mothers was conducted by administering a pre-tested questionnaire to the households in the study area through the schoolchildren and requesting them to return the questionnaire the next day to the class teacher after getting them filled by their mothers. Since the questionnaire method was used for the study, there may be some extent of response bias. Eighty-three percent of the mothers returned the proforma and some of which had only incomplete answers.

In IDD, the priority group was women of the reproductive age group (15 to 44 years) and children of 0 to 14 years of age.

Salt used for cooking

The majority of the respondents used non-iodised crystal salt for cooking; 429 households, or 72 percent of the responded families belonged to this category.

Most of the housewives did not know whether the salt used by them was iodised or non-iodised. Some of them used it thinking that it contained enough iodine. It is revealed that crystal salt was being marketed after mislabelling it as iodised salt.The distribution of respondents by the prevalence of goitre and the type of salt consumed is shown in Table 3.12.

Table 3.12 Distribution of Mothers by Goitre Prevalence and Type of Salt Used

Place	Goitre (%)	Common Salt Number (%)	Iodised salt Number (%)	TotalNumber (%)
Area 1	13.16%	144 (77%)	43 (23%)	187 (31%)
Area 2	8.53%	132 (72%)	51 (28%)	183 (31%)
Area 3	5.35%	153 (68%)	73 (32%)	226 (38%)
Total	8.35%	429 (72%)	167 (28%)	596 (100%)

In the study area, 72 percent of households used common salt for cooking. The prevalence rates of goitre in the three areas were inversely proportional to the use of iodised salt in those areas.

Causes of using iodised salt

Most of them use iodised salt not because of its impact on health but because of other reasons like purity and non-caking and free-flowing effects. This shows the influence of advertisement on them in their decision-making (Table 3.13).

Table 3.13 Distribution of Households Using Iodised Salt by Reasons for Using it

	Cause	**No**	**%**
1	Purity	49	29
2	Non-caking	5	3
3	Good for health	81	49
4	Available only in the shop	7	4
5	For responding (NRP)	25	16
	Total	167	100%

Excess intake of salt

Advertising iodised salt as healthy food through media including Door Darshan might increase its consumption leading to hazardous health problems (Malathy, 1996). A study conducted in Thiruvananthapuram has shown that more than 50 percent of the adults are hypertensive and limiting salt intake is essential for control of hypertension (Kalavathy, et al, 2000). It is recommended that all hypertensives must restrict their salt intake to not more than 6 gm per day (Anand, Paul M., 1999).

The effect of taking excess salt on health and intelligence, according to opinions of the respondents is as follows.

Good	12	(2%)
Bad	504	(86%)
Don’t know	76	(12%)
Total	592	(100%)

Under the influence of advertisements appearing in the different types of public media some people tend to take excess salt causing serious health hazards.

Disease due to IDD

Most of the respondents were aware that IDD would cause enlargement in the neck known as goitre (445 persons or 74 percent). But they are unaware of the other consequences of IDD like mental deficiency, deafness and squint. This fact points out the importance of health education about IDD among women. Failure of IDD control programme is due to lack of health education in iodine-deficient areas, marketing non-iodised salt in ID areas and lower production and higher price of iodised salt, than of common salt (KSSP, 1989). Awareness on the part of the respondents about the types of ill-health caused by IDD is reflected from the following figures:

Mental retardation	23 (15%)
Deafness	04 (1%)
Goitre	445 (88%)
Loose motion	35 (7%)
Squint	0
Total	507 (100%)

Date of manufacture

According to Nutrition Advisor, Ministry of Family Welfare of the Government of India, the date of manufacture, the name of manufacturer and the level of iodisation must be stamped on salt packets which must be damp, and moisture-proof. This must be done because iodised salt should be consumed within one year of iodisation. In the opinion of experts in the National Institute of Nutrition, Hyderabad, under standard conditions including transportation by rail or road, 25 to 30 percent iodine is lost within three months and 40 to 60 percent within one year of iodisation.

In our sample, the percentage of housewives who look on date of manufacture while buying packets of iodised salt was only less than 29 percent.

Storage of salt

Depending upon package, transportation and storage, 20 to 40 percent iodine may be lost from the salt. Salt should not be stored in open space or in damp places and never beyond six months. It must be shielded from moisture, sunlight and high temperature. It should be stored in airtight containers made of plastic, wood, glass or clay with well-fitting lid. The moisture content in the salt, humidity in the air, acidity of the salt and chemical form of iodine are important factors limiting the stability of iodine (ICMR Bulletin, June 1996).

In the study area, only about three percent of households store salt in open space. About 51 percent keep salt, however, near the fire place causing loss of iodine due to exposure to high temperature.

Adding salt while cooking

The salt should be added to the food substances after cooking to reduce the loss of iodine. Addition of salt before cooking results in loss of iodine and hastens the loss of other nutrients. Losses in cooking and extent of absorption are other factors which determine the ultimate availability of iodine to the body. Washing salt before use in order to remove impurities would remove all iodine. It is seen that the majority of households (64 percent) in the study area follow the practice of adding salt before cooking.

Banning of non-iodised salt

The majority of the people in the study area were not aware of the order banning the use of non-iodised salt.

Sixty-five percent belonged to this category. However, most of them (63 percent) were in favour of banning; only less than 17 percent considering it unnecessary. About one-fifth of them did not have any definite views on the subject.

By the time the report was prepared, the Central Government lifted the ban order on non-iodised salt, ostensibly for "ensuring job of workers who are involved in traditional salt industry" (Prime Minister's press conference, *Samakalika Malayalam*, May 26 2000).

The UNICEF had requested the Government of India to re-impose the ban on health grounds stating that the lifting of ban would undo all the gains of modern India made in the field of health.

In Kerala, Kerala Sasthra Sahithya Parishat (KSSP) and Health Action for People, Thiruvananthapuram had campaigned for removal of ban on non-iodised salt. They had requested the public to write letters to the Ministry of Health And Family Welfare congratulating the government for its decision removing the ban order:

"This is in support of your move to withdraw the restriction on sale of common salt for direct human consumption. We feel that statistics on iodine deficiency was grossly inflated. Universal iodisation had helped only big companies to earn huge profits. Hence we request the Government of India to withdraw the restriction on the sale of common salt for direct human consumption" (KSSP, 2000).

Salt analysis in the study area

In all the areas crystal salt was available in unpacked form or in packets. Powdered iodised salt was sold only in packets.

Loose salt come in jute or porous plastic bags kept in retail stores in open places exposed to sunlight and moisture, thus creating conditions for loss of its iodine content.

The price of iodised salt is 100 percent higher than that of non-iodised crystal salt; Rs 5 per kg of iodised salt as against Rs 2.50 per kg of non-iodised crystal salt. The price difference is the main factor preventing common people from purchase and consumption of iodised salt.

Iodine quality monitoring of the salt samples

According to the recommendation of ICCIDD, (1999) for salt analysis for iodine quality monitoring, a minimum of 30 samples are required. The salt samples are collected from retailers and the iodine content is checked on the spot without transportation and loss of time using the StK method (Table 3.14).

None of the samples of crystal salt contains any quantity of detectable iodine. Though it

Table 3.14 Result of Salt Analysis for Iodine Quality Monitoring

Type	Number of Samples	O -ppm	15 –ppm	30 -ppm
Crystal	12	12	0	0
Powar	18	0	1	17
Total	30	12	1	17

may contain up to 0.28 ppm of iodine, the quantity is negligible and cannot be detected by this method of analysis. The practice of selling non-iodised crystal salts with false labelling as iodised salt is not uncommon. Except one sample, all powdered salt samples contained 30 ppm of iodine (Table 3.15).

As per the Salt Commissioner's report in 1995, about 75 percent of iodised salt samples taken from different parts of the country had adequate levels of iodine, as reported from the States after conducting tests.

According to the Citizens' report on iodine content of salt at consumer level in Uttar Pradesh where iodine was tested from market samples at retail / consumer levels, 61 percent of the salt samples contained only less than 15 Ppm of iodine (AIIMS, 1994)

A study conducted by ICMR in the rural areas of Palakkad district in Kerala showed that 65 percent of the salt samples collected from households did not contain adequate quantities of iodine (ICMR, 1996.)

Table 3.15 Brand-wise Details of Salt Analysis at Kannur District

S.No	Brand Name	Type	Samples	Iodine- P P M
1	Benwhite	Powder	2	15
2	Sehat	Powder	4	30
3	Kothari	Powder	1	30
4	Annapoorna	Powder	3	30
5	Sprinkle	Powder	2	30
6	Captian cook	Powder	3	30
7	Tata	Powder	3	0
8	Surya	Crystal	2	0
9	STC	Crystal	2	0
10	SSF	Crystal	2	0
11	Vijaya	Crystal	2	0
12	Rassi	Crystal	2	0
13	SMSC	Crystal	2	0

Community-based monitoring uses the salt test kit to assess the presence of iodine in households. Monitoring can be organised in schools. Provision of the kits to the District Medical officers, Community Midwives, Nutrition workers, School teachers and government workers responsible for community health allows ongoing checking and offers effective tools (ICCIDD Technical Group, 1999).

4. Conclusions

In India, the power to declare an area as endemic for IDD is vested with the revenue authorities (Kulkarni, 1988). If more than five percent of the school-age children in an area are suffering from goitre, that area should be classified as endemic to iodine deficiency. Up to 5 percent of goitre may be due to causes other than iodine deficiency (WHO, 1993).

Kannur district is mildly affected with IDD with a goitre prevalence of eight percent. The hilly areas are more affected than the midland and the coastal areas. The causes are found to be multifactorial - geographical, environmental, and nutritional.

The area-wise prevalence rates of goitre are found to be proportional to the presence of goitre among the family members, a fact which indicates that in these areas the problem is a reflection of antedated, long-term and multi-factorial causes. The prevalence is found to be more in girls (12.9 percent) than in boys (4.4 percent); the difference may be due to physiological and nutritional factors.

Goitre is found to be more prevalent among Christians than among Hindus and Muslims and the difference is statistically significant. Further migration studies are required to unravel the causative factors.

Even though 77 percent of mothers have adequate awareness about iodine deficiency disorders 72 percent of them do not use iodised salt for cooking purpose. Fifty-one percent of those using iodised salt are using it not for preventing iodine deficiency but for other reasons such as purity and non-caking quality projected by salt manufacturers in media for promoting their commercial interest.

Only about 35 percent of mothers are found to be aware of the existence of the order banning the sale of non-iodised salt; out of them 65 percent favour the ban.

In all areas both iodised and non-iodised salt are available at retail stores. The crystal salt contains no detectable amount of iodine; powdered iodised salt contains the quantity of iodine prescribed in the PFA Act. The absence of detectable iodine in crystal salt may be either due to natural depletion from sea water from which it is produced through evaporation or to faulty method of packing, transportation and storage by which the available iodine content is lost. In order to ensure iodised salt consumption by the whole population, it must be made available at prices comparable to those of crystal salt.

Appendix I   Resistance against Banning of Common Salt in Kerala

By 1996 almost all State governments except Kerala had issued ban notification on sale of non-iodised salt. Owing to resistance from consumers and health action groups the Kerala government could not issue such a notification.

As Kerala is a non-salt-producing State, its total consumption and industrial requirements are met by imports from Tuticurin in Tamil Nadu. Of the total salt requirement - about 1.90 lakh tonnes per year - the State procures about 20,000 tonnes in the form of iodised salt and the rest as common salt (Government of India, 1996).

Even if the public were made aware of the benefit of consuming iodised salt, the price difference between the common and iodised salt will make the poorer sections of population to continue to buy common salt. In such a case even the people who actually need iodised salt may continue to use common salt and it is administratively impossible to keep a check on such consumption (I Plus, UNICEF, 1996).

Controversies on Iodised salt

Criticising the policy of banning common salt, Kerala Sasthra Sahithya Parishat stated the following in June 1989.

“Causes of goitre in India are socio-economic due to deforestation, flooding, soil erosion, and modern agricultural methods all of which lead to environmental degradation of iodine. So the solution is not iodised salt but sustainable environmental conservation. Banning of non-iodised salt is unscientific, only to help multinationals. We want a scientific study about the state of IDD and goitrogens and then rectify national goitre control programme accordingly.”

Saying no to iodised salt: Leela Menon wrote the following in The Indian Express *on 9 August 1996*

“The second ‘Salt *Sathyagraha*’ is on the horizon in the wake of snow-balling controversy in Kerala over the introduction of iodised salt in Kerala and ban on rock salt from 1 October 1996. The protest by Swami Thapasyananda, Sivanandasramam Thodupuzha is an example: Philip M. Prasad, former Naxalite leader, is planning to conduct a hunger strike in front of the Secretariat, Thiruvananthapuram on August 15th.

“Vypeen was once the salt pan of Kerala spreading over 100 acres. People in Vypeen had earlier demanded the right to reactivate their submerged salt fields only by which could make Kerala self-sufficient on salt.”

M.P. Narayana Pillai wrote in Kalakaumudi *Weekly (Issue No.1088)*

“Banning non-iodised salt is a WHO-sponsored multinational scientific conspiracy to poison us. There are other health problems like anaemia and malaria which affect our country more than goitre.”

Crucifying common salt, Dr Malathi and Dr Swathi Kumar, had this to say in Grihalakshmi, *1996.*

“Goitre is not due to iodine deficiency alone but also to other causes. Instead of iodised salt, it is nutrition education which is essential. Kerala which has already achieved the target of Health for All by 2000, the health priorities should not be on iodised salt.”

Is it necessary to ban common salt? Dr T. Jayakrishnan wrote in Malayala Mannu *on 7 August, 1996.*

“From the October 2 next – the Birthday of Mahatma Gandhi – our government has decided to ban common salt. We have fond memories of eating tender mangoes with common salt. Are such experiences going to be denied to children for ever? Before imposing the ban, the government should conduct studies on goitre prevalence and the iodine content of water, soil and food in Kerala. The iodine content of common salt and reasonable prices for iodised salt must be ensured. Till then, the dual market should be allowed to continue and people should be given the freedom to decide what salt they would choose to consume.”

Dr C.R. Soman expressed the following views in the article written in the KSSP Journal, Janakeeyarogyam, *in April 2000.*

“Indian government have decided to iodise all edible salt. We have to know that in the Kerala situation IDD is not a big problem and that the fish-loving people here get adequate quantities of iodine from their food.”

N.Radhakrishnan, Director, Gandhi Smrithi Darsan, wrote in Samakalika Keralam *on 26 May 2000, thus:*

“Iodisation means globalisation, that is colonization. Gandhiji used salt as weapon against colonisation. Goitre prevalence in an area does not mean that people there do not take iodised salt; it may have been due to nutritional deficiency. We have to find out the real cause and find relevant solutions”.

Appendix II A Proposal for Kerala Plan of Action 1996-2000

Tentative plan of action for consideration by state government.

* Main objective	To control IDD by the year 2000
* Specific objective	To reduce goitre prevalence rate among children under 14 years to less than 5% by 2000 AD.
* Sub objectives	To ensure universal access to iodised salt with acceptable level of Iodine from August 1996.
	To strengthen the monitoring system at the district level to ensure that 100% of the population consumes only iodised salt.
	To create awareness about IDD and iodised salt among the general public

For achieving the above objectives the following actions are suggested.

Orientation training at the State level on IDD

Give orientation training through an inter-sectorial programme requiring the participation of various departments like public health, civil supplies, food and drug administration, education, field publicity, and social welfare, ICDS, traders, voluntary organisations and consumer action groups. Each one of these participants will have a role to play.

(a) Public Health Department	:	Dissemination of knowledge and ICDS about IDD
		Educating the community through the PHCs and other field workers;
		Display of IEC material in all districts; Ensuring use of only iodised salt in hospital kitchens, anganwadis, hotels etc. Informal monitoring of the iodine content in salt with field test kits;
		In-service training of the personnel about IDD.
(b) Civil supplies	:	Sensitising wholesale and retail trader to the IDD control programme;
		Ensuring that traders sell only iodised salt for edible purposes by informal monitoring with field test kits; Interaction with the Public health department;

		Distribution of iodised salt through the Public Distribution System.
(c) Education	:	Introducing IDD in school curriculum. Demonstration of the use of test kits in primary middle and secondary schools. Display of IEC material on IDD and iodised salt in schools;
(d) Food and drug administration	:	Drawal of statutory samples under the PFA act.
(e) Social welfare Dept.	:	Creating awareness of IDD and iodised salt through the institutions under the Department's control;
(f) Field publicity	:	Giving wide publicity to IDD and iodised salt through display of video ,films, postershoardings, cinema slides, etc.
(g) Voluntary Organisations and consumer action groups	:	Dissemination of knowledge about IDD. and iodised salt; Informal monitoring of the iodine content in salt with field test kits.

As a part of maternal and child health programme, the Government of Kerala stresses the importance of consumption of iodised salt by pregnant women. All *Mahila Swasth Sanghs*, Junior Public Health nurses and health inspectors are being trained / sensitised to popularise the consumption of iodised salt.

District level activities.

(a) Creating demand for iodised salt.

* Public health department to organise seminars.
* K A P study on IDD could be undertaken in each district i nvolving the general public.
* Training under ICDS & CSSM programme should be followed by a brief session in IDD.
* Civil supplies department must be sensitised.

(b) Monitoring availability of iodised salt at household level using spot testing kits.

* The report must be reviewed at block, district and state level meetings.
* For monitoring the availability of 15 PPM iodine in the salt consumed in households spot test kits were supplied to District Medical Officers of each district.

(Source: Director of Health Services, Govt. of Kerala, Thiruvananthapuram).

Appendix III Other Salt Quality Monitoring Studies

Household level of monitoring of iodine (17654 samples)

Proportion of samples containing less amount of iodine (below 15 ppm) than required

Rajasthan	31.9%
Goa	48.9%
Bihar	below 20%
Punjab	below 20%
HP	below 20%
Andaman Nicobar	below 20%

(Umesh Kapil, 1998)

For efficiency of IDD control program in an area 90% of edible salt must contain adequate amount of iodine (WHO).

Status of iodine content salt at traders' level

Seventy percent of the salt have iodine content of 15 ppm or more except in Pondichery.

State	Sample size	Iodine content of the salt in ppm					
		Nil (0)		Below 15		15 &above	
		No	%	No	%	No	%
Bihar	71	0	0	14	19.7	57	80.3
MP	108	0	0	19	17.6	89	82.4
Haryana	117	1	0.8	23	19.7	93	79.6
Punjab	177	1	0.6	50	28.2	126	71.2
HP	10	0	0	0	0	10	100
Andaman	13	0	0	1	7.7	12	92.3
Pondicheri	29	0	0	21	72.4	8	27.5

(Umesh Kapil, 1998)

As part of the IDD control programme, a KAP study was conducted among traders of Kerala, for sensitising them on the use of iodised salt.

Seventy-five percent of the samples contain the required amount of iodine >15 ppm prescribed by PFA act. 24.38 percent of the samples contain below 15 ppm of iodine and 0.3 percent of the samples contain no iodine.

The salt trading community's opinion was that though customers were not complaining about the price of iodised salt, reduction or equalisation of price of iodised to that of non-iodised salt was the only means for promoting the consumption of iodised salt by the common people.

A KAP study by Govt. of India of Salt Trading Community in Kerala: April 1996

No.	Question	Response	Number	%
1	Are aware of IDD?	Yes	38	74.50
		No	12	23.52
		NRP	1	1.96
2	Source of awareness	News paper	13	1.96
		Doctor	5	9.80
		NRP	16	31.37
3	Do you know that goitre isIs due to IDD?	Yes	27	52.94
		No	18	35.29
		NRP	6	11.76
4	Do you know that goitre can be Prevented by regular use of Iodised salt?	Yes	27	52.94
		No	18	35.29
		NRP	4	7.84
5	Do you know what Iodised salt is?	Yes	25	49.1
		No	21	41.17
		NRP	5	9.80
6	Do the customers asked for Iodised salt?*	Yes	31	60.78
		No	16	31.37
		NRP	4	7.84
7	Do the customers complaint about The higher cost of iodised salt?	Yes	3	5.88
		No	40	78.43
		NRP	8	15.68
8	If the price of common salt and Iodised were same will the Customer prefer iodised salt?	Yes	45	88.23
		No	3	5.88
		NRP	3	5.88
9	When the Iodised and non iodised Salt are available in the market whyPeople not opting iodised salt?	Absence ofNeed	10	19.6
		Higher cost	12	23.52
		Personal choice	7	13.72
		Ignorance	1	1.96
		NRP	21	41.17

Source: R Mohan, (Deputy salt commissioner)
* In fact, asked for refined salt for its quality in terms of purity and whiteness.
(NRP = no response)

Appendix IV   Iodised Salt and Process of Iodisation

"Inexpensive technology, a time honoured, a time-tested one for control of IDD, is iodised salt" (Gopalan, C, 1998). Iodised salt is the same as common salt which we have been eating but blended with potassium iodate to a level of 50 parts per million equivalent to 30 ppm of iodine. A civilised man has been using salt for centuries. Food tastes better with salt, so a human being takes salt more than his body needs it (I. C. Gupta, 1995). Salt is fortified with potassium iodate at 30 ppm at manufacture level so that at consumer level it will be 15 ppm. The daily average consumption of salt is about 10 gm; therefore by salt fortification the body would get on an average, 150 micro gm of iodine which is the daily requirement. In countries in which salt is of the crude solar variety and is not subject to special drying processing under adverse conditions of moisture, heat, and sunlight, the iodine content of the salt iodinated with potassium iodate remains relatively constant (Kelly F.C, 1953).

Process of iodisation

Production of common salt is one of the most ancient and widely distributed industries of the world. In India salt is produced mainly by evaporation of sea water or lakes and mining solid rock deposits. Eighty-five percent of the salt consumed in India is produced in Tamil Nadu, Rajastan, Gujarat, and Andhra Pradesh. Tuticorin in Tamil Nadu which is the main supply source of salt in Kerala, the method of evaporation of sea water is practised.

Common salt could be blended with potassium iodate by three methods

(i) Spray mixing process

Common salt subjected to a fine spray of potassium iodate solution is thoroughly mixed and packed in high-density polythene (HDPE) packets. The cost of spray-mixing plant is about Rs 1 lakh and it is fabricated in Tamil Nadu and Gujarat.

(ii) Batch process

Follows the same principle as under (i) and is useful while handling smaller quantities of salt.

(iii) The drip feed system

It is ideally suited to produce iodised salt for distribution in packets. The cost of the equipment comes to about Rs 35000.The salt used for fortification need not be refined as long as it does not contain excessive magnesium, the presence of which makes the salt hygroscopic. High humidity causes loss of iodine up to 80 percent within six months. For iodisation the salt used could be in the crystal, crushed or powdered form.

The additional cost of iodisation is Rs 50 per tonne including cost of the iodine compound and labour costs that is 5 paise per kg. At salt production centre iodised salt is available in loose crystal form at about 45 paise per kg and powdered salt at Rs 1 per kg. Cost of bags, transportation charges and wholesale and retailer margins form a big share of the final retail price. The retail price range of iodised salt per kg in remote areas of the country is as follows.

Crystal iodised salt (loose)	Rs. 1.50 - Rs 2.00
Powdered iodised salt (loose)	Rs. 2.00 - Rs 2.50
Powdered iodised salt (packed)	Rs. 2.50 – Rs 4.00
Refined iodised salt (branded)	Rs. 5.50 and above

Only a small quantity of iodised salt (about 10 gm) is required daily per person or, say, 300 gm per month or 3.6 kg per year. The extra cost of iodisation will additionally cost only the price of a cup of tea. For reducing the price of iodised salt it must be marketed without brand names. If the common salt is iodised in crystal form without crushing or powdering the price would increase only by about 10 paise per kg. .

Safety of iodised salt

Issues relating to safety of universal salt iodisation have been carefully examined by an expert group WHO under the joint auspices of FAO\ICCIDD and UNICEF. All concerned agree that universal salt iodisation is the principal public health measure for elimination of IDD. Daily iodine intake up to 1 m gm (1000 micro gram) appears to be entirely safe. Iodisation of salt at a level which ensures an intake of 150 to 300 micro grams per day would well be within a safe range for all populations, irrespective of their iodine status (WHO, 1994).

Analysis of cost-effectiveness

In India the total salt requirement including requirement for consumption by animals is 6 kg per person per year (Human 3.6 kg per year and animal 2.4 kg per year). In India salt requirement per year thus comes to 60 lakh tonnes and in Kerala to 1.8 lakh tonnes.

The cost of the iodisation programme is Rs 1296 million. Benefits of the salt iodisation programme in terms of the value of improved productivity and more efficient management of IDD comes to Rs 4208 million. The cost benefit ratio is 1:3. Cost per beneficiary is Rs 5.20 per year (C. S. Pandav, 1997)

If no control programme were implemented 42,000 new cases of cretins and 126000 cases of still birth or abortion are likely to occur every year in India (WHO/SEARO, 1986).

Salt industry India

Total investment	Rs 2000 crore
Number of employees	Rs 2.5 lakh

Producers	1600 small producers in the organised sector and 6500 small producers in the unorganised sector whose individual holdings are on an average, less than 10 acres.

Iodisation does not interfere with their traditional method of salt manufacture or their trading practices.

Salt iodisation plants in India (as on 31st March 1999)

Small common salt manufactures with less than 10 acre	:	256
Medium common salt manufactures with 10 to 100 acre	:	87
Common salt manufactures with more than 100 acre	:	122
Traders	:	320
Refineries	:	24
Total	:	809
Annual production capacity	:	115 lakh tonnes
Annual requirement	:	60 lakh tonnes

Iodisation has created employment in iodisation, crushing, powdering, and packing of salt. There is not even a single multinational company engaged in salt production. One multinational company in the area is engaged in marketing assistance to some refineries. India is self-sufficient in production of salt and Iodisation plants are fabricated indigenously.
(Source: Salt Department, Government of India, Jaipur, 31 March 2000)

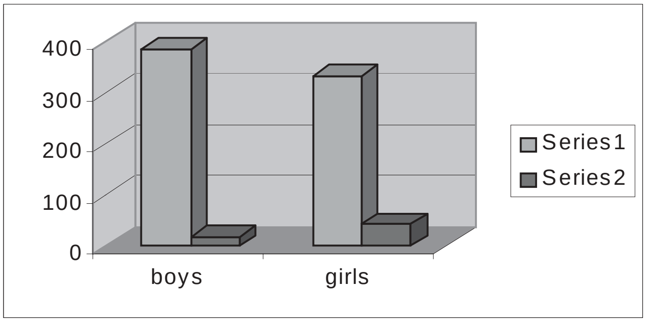
In 1992, Government of India gave permission to install a salt manufacturing unit of thousand acres at Kandla in Gujarat state to an American company namely Cargil cooperation. But due to resistance from all over the country they had to withdraw from India.

With a view to encouraging production of iodised salt, the salt manufacturers were paid subsidy equal to the cost of potassium iodate for production of iodised salt. The subsidy was paid from 1 August 1986 to 29 February 1992. The subsidy was withdrawn from 1 March 1992. Since it is unlikely that the subsidy would be reintroduced the price of iodised salt would tend to rise over time.

Appendix V

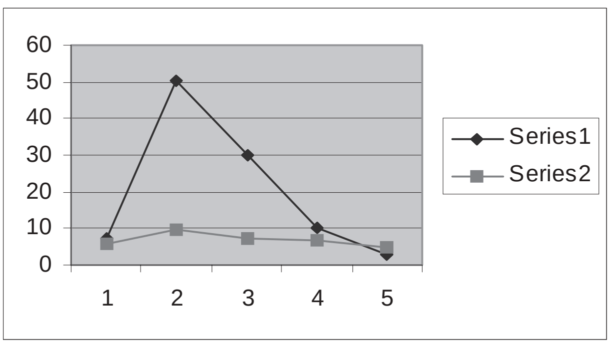
Figures

1. Sex-wise Distribution of Goitre in the Study Area



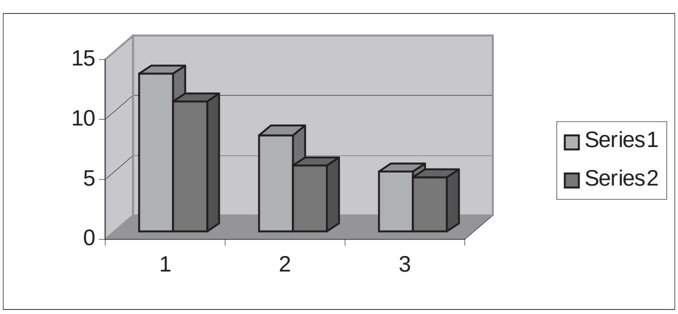
1 = Number of subjects 2 = Number of Goitre.

2. Age-Wise Distribution of Goitre in the Study Area



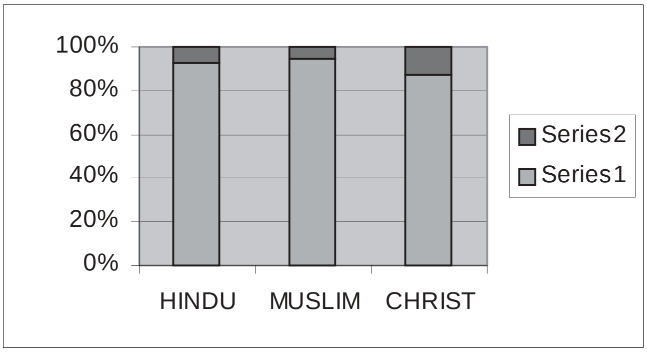
AGE:
1 = 12, 2 = 13, 3 = 14, 4 = 15, 5 = 16 & above.

3. **Relation of Goitre with Family History in the Study Area**



1-%of goitre in the area, 2-% of family history of goitre.

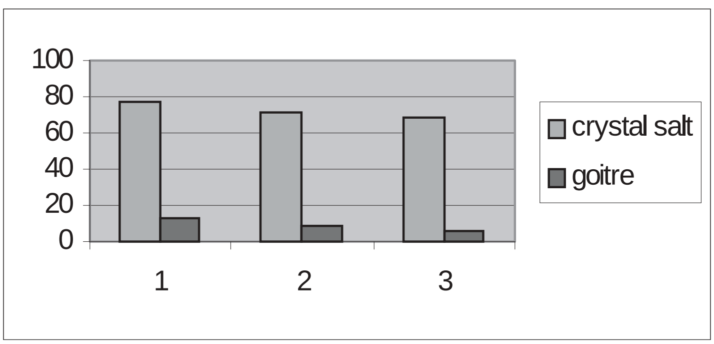
4. Distribution of Goitre among Religions in the Study Area



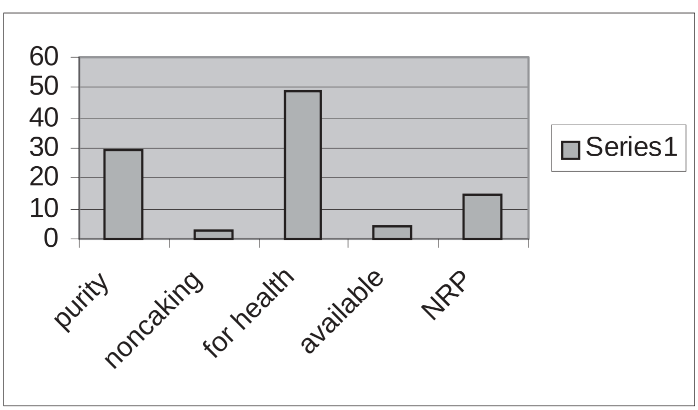
1 – Name of religion, 2 - % of goitre.

5. KAP Study among the Mothers

(i) **Relation of Goitre with Crystal Salt Use Area-Wise**

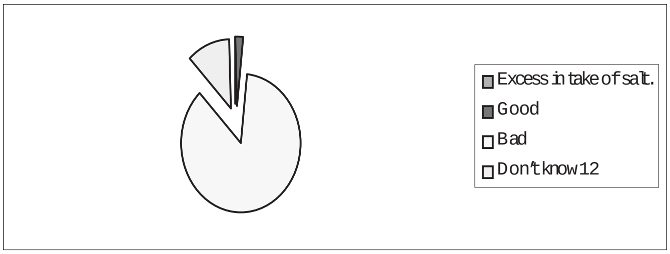


(ii) **Causes of Using Iodised Salt**



29%, 3%, 49%, 4%, 16%.

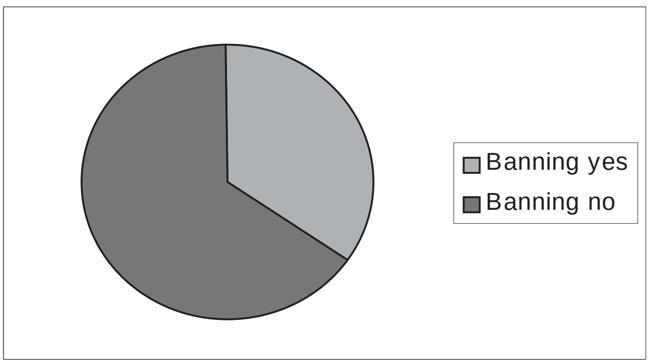
(iii) Opinion about Excess Salt Use



Good= 2%, Bad= 86%, Don't know= 12%.

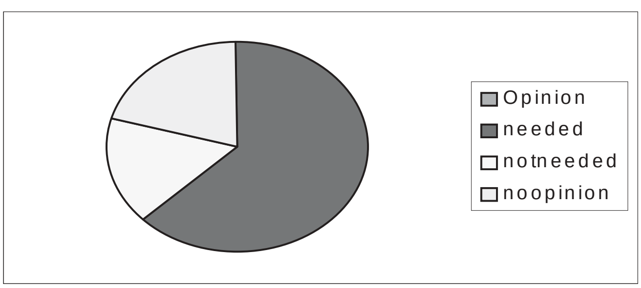
6. Banning of Non-iodised Salt

(i) Awareness about Banning



34.6 % : 65.4 %.

(ii) **Opinion of Awared People about Banning**



% 62.62 : 16.5 : 20.87.

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