IODINE NUTRITION STATUS IN SRI LANKA

2005

Medical Research Institute

Department of Healthcare and Nutrition

2006

unicef

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EXECUTIVE SUMMARY

Iodine deficiency (IDD) is the single most common cause of preventable mental retardation and brain damage in the world. It decreases child survival and impairs growth and development. Iodine deficiency was recognised as a public health problem in Sri Lanka following the 1986 national survey that documented total goitre prevalence of 18.2%. In 1995, the government of Sri Lanka launched "Universal Salt Iodisation" (USI) as the mainstay of iodine deficiency control. With strong private-public partnership and financial and technical support from external development partners, the Ministry of Health intensified the USI. In continuation of the efforts to eliminate the iodine deficiency in Sri Lanka, national IDD survey was conducted to assess the status of iodine nutrition.

A cross sectional study of children from 60 primary schools in Sri Lanka was carried out. Thirty schools were randomly selected from provinces that demonstrated urine iodine levels between 100-200µg/L in 2000 survey and other 30 schools were selected from provinces with urine iodine levels below 100 and above 200µg/L. Thirty children were randomly selected from each school for the study. Thyroid glands of children aged 6-10 years were measured by palpation and graded according to the WHO, UNICEF, and the international Council for the Control of iodine Deficiency's (ICCIDD) joint criteria. Iodine content of household salt samples was analysed. Casual urine samples were analysed for urinary iodine.

A total of 1900 children were studied. Median urinary iodine concentrations of 152.5 µg/L indicated optimal iodine nutrition in Sri Lanka. Adjusted prevalence of goitre (3.8%), was higher in girls than boys, and ranged from 0.5% to 10.3% in the different provinces. Median urinary iodine concentration in 1,879 samples was 154.4µg/L ranging from 6.1 to 1,754.8µg/L. The results of the study in 1,594 samples also

showed that 91.2% of households consumed iodised salt. The frequency distribution of urinary iodine levels shows that 34.7% of the children had urine iodine levels in the 'adequate' range with 30.9% with lower values (<100µg/L) and 35.5% with higher values (≥200µg/L). Only 0.1% of children had very low urinary iodine values of <20µg/L. Comparison of the results of this study with the results of the study carried out in year 2000 showed a reduction in the goitre rate from 20.1% to 3.8%; increased urinary iodine levels from 145.3µg/L to 152.5µg/L and the increased household consumption of iodised salt from 49.5% to 91.2%.

With private-public partnership and financial and technical support from external development partners, Sri Lanka has achieved the goals of eliminating iodine deficiency as a public health problem. The challenge ahead is sustaining the gains and achievements made through the programme.

ACKNOWLEDGEMENTS

This study regarding a growing and ironically preventable disease iodine deficiency could not have been accomplished without the support of many committed persons. No survey can come to life without ample funding, so I wish to thank UNICEF for funding this study. A special thank you goes out to Dr. Aberra Bekele, Head of Early Childhood Care and Development programme, and D.P. Adikari, Project officer, Nutrition for the continuous support from day one, and for all those important critical comments. I am grateful to Dr. Lulu Raschid, Acting Director, Medical Research Institute who was a force of strength. She gave her fullest most support for the successful completion of this study. Director General of Health Services, Dr. Athula Kahadaliyanage gave the leadership and encouragement wholeheartedly as he does always. Last, but foremost in mind are the pivotal operators: the Provincial Directors, Principals of the schools, teachers, parents, and children. To one and all I wish to say that I am deeply indebted to you for having been partners in the study without whom this study would not have been completed in the fruitful manner that it has.

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CHAPTER 1
BACKGROUND

Iodine deficiency is the world's single most significant cause of preventable brain damage and mental retardation. Nearly two billion people in the World may be at risk for iodine deficiency, and recent estimates suggest that 15.8% of people experience some degree of goitre. Over one third (37%) of school age children Worldwide (a total of 285 million) are iodine deficient. Approximately 40% of the burden occurred in the South East Asia Region (SEAR)[1].

Sri Lanka context: Sri Lanka is an island situated in the Indian Ocean with a most beautiful coast line with relief features like bays, lagoons and capes. The hilly region in the centre of the island with its mountain ranges, waterfalls, plateaus, valleys and rivers are the components of the scenic beauty of the country. Sri Lanka consisting of nearly 19 million population is situated in the northern hemisphere close to the equator between latitude of 5 and 10 degrees. It is administratively divided into 9 Provinces and 25 Districts.

IDD status among schoolchildren: Studies that have been made since 1947 indicated that there was an endemic goitre belt in the south-west region extending over the whole of the Western, Sabaragamuwa, Central, Southern Provinces and part of the Uva Province, which constitute the wet zone of Ceylon (before called Sri Lanka)[2].

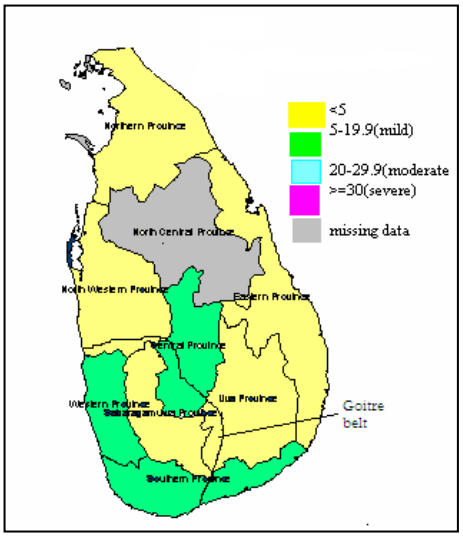


Figure 1: Goitre prevalence among schoolchildren by Provinces in 1947

Apart from this several studies which were carried out prior to the implementation of iodised salt indicated that there was a mild to moderate prevalence of goitre. Cretinism was not an extensive problem

from the beginning and absence of deaf-mutes may have been due to the relatively mild nature of iodine deficiency[3]. Figure 1 shows the goitre belt and extent of goitre in 1947[2].

The first systematic assessment of iodine deficiency disorders in Sri Lanka was conducted in 1986[4].

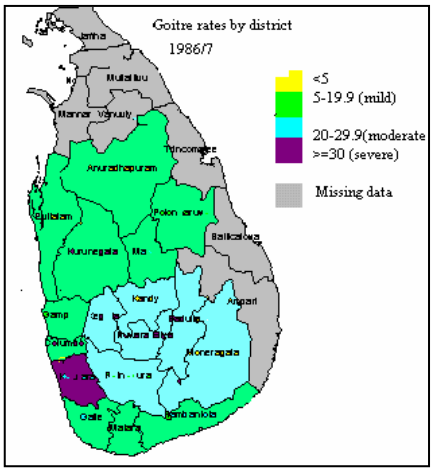
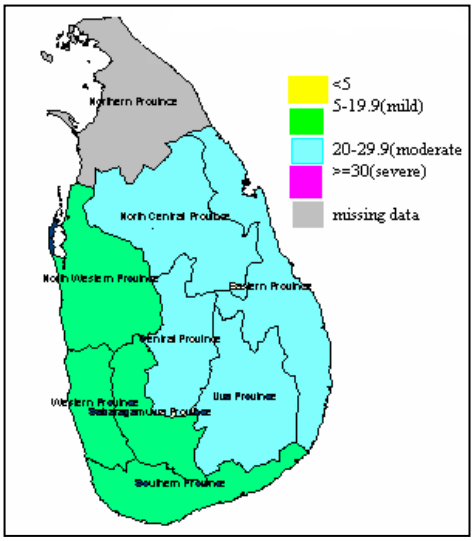


Figure 2: Goitre prevalence among schoolchildren by district in 1986

Although the overall goitre prevalence was 18.2 per cent, the prevalence rates in Kalutara district was as high as 30.2 per cent while Matale district had the lowest of 6.3 percent (Figure 2). In response to the above situation and in line with the goals set by the World Health Assembly and the World Summit for Children in 1990, the government of Sri Lanka decided to embark on iodine deficiency control placing "Universal Salt Iodisation" as the main thrust of the control programme.



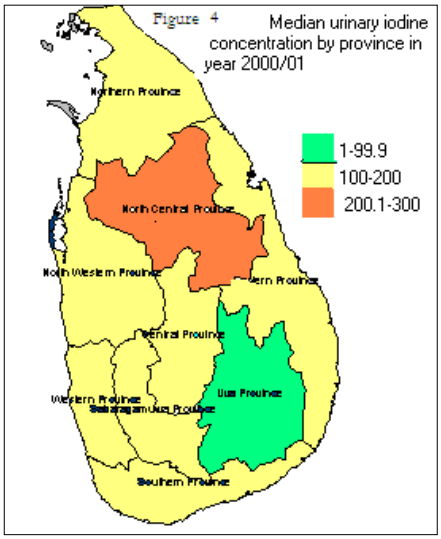
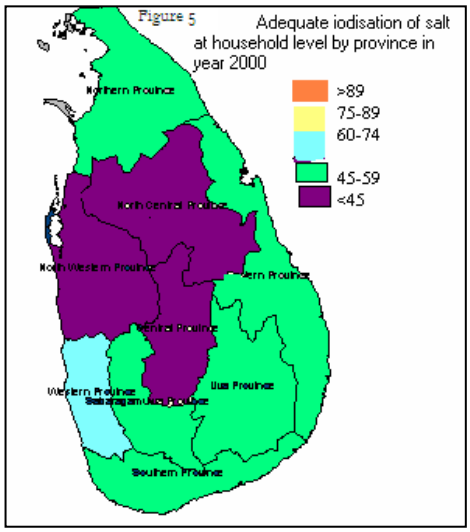


Figure 3 and 4: Prevalence of goitres and urinary iodine levels by Provinces in 2000/1

The Medical Research Institute (MRI), Department of Nutrition, carried out a national IDD survey in 2000/1 of 2,630 children, 8-9 years old, in all the country's health administrative areas, from 9 Provinces with the

support of UNICEF[5]. It relied on the urinary iodine concentration to assess iodine nutrition. The national median urinary iodine concentration was 145.3µg/L; 69.3 percent were below 100µg/L, 22.1 percent were between 50-99µg/L, 7.1 percent were 20-40µg/L and 1.4 percent was below 20µg/L. At the Provincial level, 8 out of 9 Provinces had median urinary iodine levels > 100µg/L and less than 11% of the children had urinary iodine levels below 50µg/L (Figure 3). The total goitre rate was 20.1% by palpation method indicating with provincial variation (Figure 4) and the 49.5% of salt samples were adequately iodised at household level. Figure 5 shows the distribution of iodine levels in salt at household level in different provinces.



The finding of the national study was presented in March 2001. A consultative meeting was conducted to develop the work plan on iodine control in July 2001. Briefing session was conducted with salt producers at the end of the year 2001. At the meeting it was ensured that the regular quality control of iodine concentration in salt at the point of production for each batch by using titration method is essential. UNICEF agreed to support the laboratory chemicals and reagents required to undertake titration method. The Ministry of Health agreed to prepare the guidelines and forms for monitoring and assessment of iodised salt.

IDD status among adolescents: In 2004 January, MRI conducted a study among 870 children aged 10-18 years in NuwaraEliya district with the assistance of South East Asian Regional Office (SEARO) of World Health Organisation (WHO) in New Delhi. It revealed that the goitre rate was 3.7% among adolescents and the median urinary iodine concentration was 109.6µg/L ranging from 13.4- 704.8µg/L[6].

IDD status among pregnant women: A study carried out in 1967 with 2870 pregnant women from 17 antenatal clinics revealed the goitre prevalence ranged from 0.4 – 34.8 percent[7]. Another study conducted by MRI in 1987/88 involving 1235 pregnant women in Kalutara district indicated 65.5 percent of goitre rate[8]. Urine samples of 499 pregnant women were examined in 30 antenatal clinics of Kalutara district in 2003 revealed that the median urine iodine levels at 120.1μg/L with a range of 7 – 778.1μg/L which indicated an adequate iodine nutrition status among pregnant women in Kalutara district[9].

IDD status among neonates: Premawardana (2000) has examined 612 neonates on the 4-5th day after birth and found that Thyroid Stimulating Hormone (TSH) levels have been under 10mU/L in all subjects indicating neonatal hypothyroidism is not a significant problem[10].

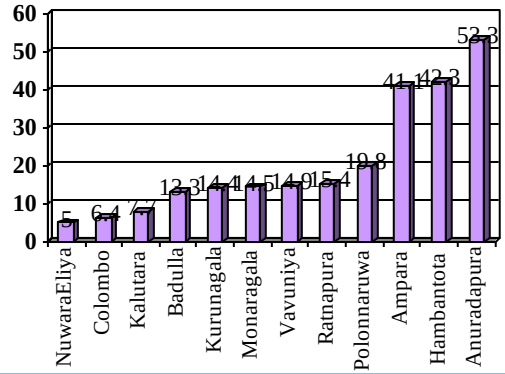
Iodine induced thyrotoxicosis, thyroiditis and thyroid cancer: A study conducted in 2000 reported that there was no evidence of thyroid induced thyrotoxicosis after examining 363 schoolgirls of 11-16 years from Colombo, Kandy, Matale, Kalutara and Galle districts. In the same study it was stated that high age related prevalence of thyroid antibodies (TgAb) ranging 11-69% among schoolgirls[11]. Another study revealed 300 thyroid cancer patients from 1974-2001 and indicated highly significant reduction of anaplastic thyroid cancer and the extent of extra-thyroidal spread at presentation of differentiated thyroid cancer after iodisation in 1995. In contrast a highly significant increase in papillary carcinoma was noted in the post-1996 period[12].

Iodine content of food: Mahadeva et al (1967) shows that the iodine content of the food of people living even in goitre endemic areas was about 300-350μg per person per day, even after allowing for extreme losses amounting to 38% which may occur during cooking, whereas the daily iodine content of the food in Jaffna, which is one of the goitre non-endemic areas, was about 850μg per day[7]. Mean iodine content in 100

gram of food items in the present day market are as follows; full cream milk powder (40µg), cereals (35µg), infant milk formula (77µg) etc.

Iodine content in drinking water: Sri Lanka gets water mainly from rainfall. Some areas of the island get rain throughout the year. Where rainfall is seasonal, water is stored in irrigation tanks, ponds and reservoirs. Where there is no surface water, the water requirements are fulfilled by tapping underground water by means of tube wells. Four hundred and eighteen drinking water samples were tested between 2001-2004 at MRI laboratory and the iodine content in drinking water varied from 0-535.5µg/L[13]. Figure 6 shows the median iodine content of drinking water in different districts.

Figure 6: Median iodine level in drinking water



Salt production: Salt is produced locally by 2 major salt producers and around 270 small scale producers. Salt is manufactured by solar evaporation using sea water. Potassium iodate is used for iodisation. Two thirds of iodised salt production is handled by small scale producers. There are a few producers who import iodised salt and packet it for distribution. Figure 7 indicates the different methods adopted by the small scale producers for iodisation process.

Figure 7

Salt iodisation methods among small scale salt producers

Capacity building for production of iodised salt in the country: In order to build the country's capacity for production of iodised salt, UNICEF heavily invested on capacity building of salt producing companies – earlier focusing on the Lanka Salt Ltd and Puttalam Salt Limited and after cease fire support extended to the Mantai Salt Limited in Mannar, Elephant Pass Saltern and Kilinochchi. Each salt producing factory was provided with iodisation machine and salt washing machines to iodised salt and also provided with laboratory equipment and reagents for monitoring of iodised salt at the company level.

Support to capacity building of the government to monitor and evaluate the programme: Since 1992, UNICEF has been supporting the Ministry of Health to control iodine deficiency disorders in Sri Lanka. UNICEF supported the Ministry of Health to build capacity of health workers at peripheral and national levels to monitor the iodine content of salt and evaluate the impact of the programme. This includes the establishment of National Reference Iodine Laboratory at Medical Research Institute (MRI) and network of laboratories that include 14 hospital laboratories in provinces.

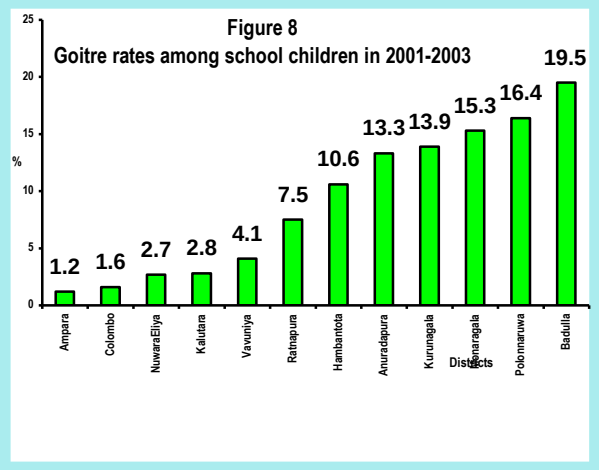
Public health staffs are expected to monitor the iodised salt at production, retail and household level by rapid test kit. Every year UNICEF provides over 25,000 iodine test kits for use by health workers

particularly the Public Health inspectors' top monitor the iodine content of salt at retail level.

The Ministry of Health together with UNICEF took measures to raise the public awareness and demand for iodised salt through awareness creation, social mobilisation and advocacy throughout the island.

Legislation: In order to support the implementation of salt iodisation programme, the government has passed a law that regulates the production and distribution of iodised salt in the country. This was incorporated into the Food Act and enforced in July 1995[14]. Regulation under this act bans the production, distribution and sale of non-iodised salt for human consumption. The iodine content of salt at household level was considered at 25ppm in the legislation. After considering the proportion of children with more than adequate levels of urine iodine in the country, which was indicated in the MRI study[5], the legislation was revised in the year 2005, requiring 15ppm iodine in salt at household level[15]. Quality assurance system was established by the food administration unit of Ministry of Health for iodide salt through the public health system.

Surveillance: MRI study indicated the need to make iodine available on a regular and continuous basis in 2001. Therefore, a system of "SURVEILLANCE" for tracking the biological progress with respect to the elimination of IDD as a public health problem was initiated by the National Iodine Committee at the Ministry of Health. The Nutrition Department at the Medical Research Institute was given the responsibility of tracking the biological indicators, such as goitre rate



among primary schoolchildren, urinary iodine levels and salt iodine levels at household, retail and production levels.

Surveillance programme was initiated in the year 2001 and 4 districts were evaluated every year. Figure 8 shows the goitre prevalence from 2001-2003 which varied from 1.2% in Ampara district to 19.5% in Badulla district[13].

Figure 9: Median urinary iodine concentration in different dictricts, 2001-2003

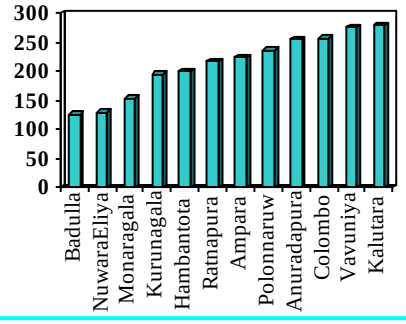


Figure 9 indicates the median urinary iodine concentration during the process of surveillance in different districts which varied from 125.5µg/L in Badulla district to 280.7µg/L in Kalutara district.

Figure 10: Household salt iodine content in 2001-2004 (n=1743)

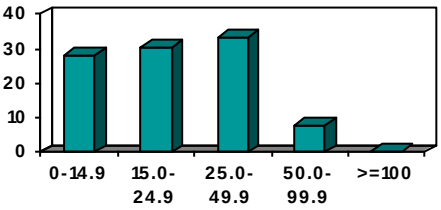
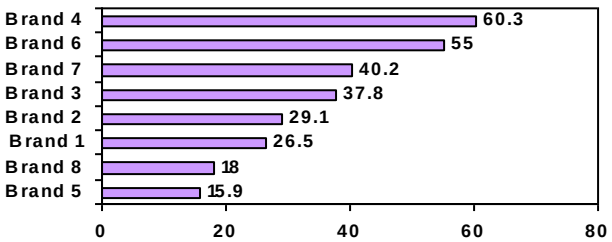


Figure 10 shows the iodine content in salt at household level during the surveillance in different districts. It varied from 1.5-423.5ppm.

During the process of surveillance salt samples were brought from retail shops in different districts and tested for iodine levels by titration method in MRI laboratory. Iodine levels ranged from 5.3ppm to 418.9ppm. There were 8 different brands and the median iodine value of salt is shown in Figure 11. It varied from 15.9ppm to 60.3ppm.

Figure 11: Median iodine content of salt at retail outlets (n=15)



The findings of surveillance programme were used to increase awareness among members of National Iodine Committee, relevant officials in the ministry of health, clinicians, salt producers and public health officers and this help to enhance the monitoring mechanism.

Rehabilitation of salt plants to accelerate salt iodisation: In December 2004, Sri Lanka was faced with the tsunami disaster thus the Hambantota salterns were affected. The damage was assessed by UNICEF with the assistance of salt producers and the iodisation process was revitalised[16].

As part of the post tsunami initiatives ICCIDD with the assistance of the Micronutrient Initiatives (MI) Asia launched a project to modernise the Hambantota and Puttalam salterns[17]. Under this project these two major salt manufacturers are expected to produce at least 75,000 metric tons of iodised salt which is 80% of the national requirement of the country. Thus it will reduce the iodisation process by the small scale producers and they can do the packeting of iodised salt for sale which will reduce the wide variation of iodine levels in salt.

After considering the above facts, it was decided to conduct a national survey to assess the progress of the iodine nutrition status in the country. Hence this study was conducted under the following objectives.

OBJECTIVES

- to determine the goitre prevalence,
- to determine the iodine nutritional status by measuring urinary iodine levels,
- to measure the iodine levels in the salt at household level.
- to identify the factors related to the salt producers.

CHAPTER 2
METHODOLOGY

It was a cross sectional nation wide study.

2.1. Study population

The study population was identified as school children aged 6-9 years.

2.2. Study sample

It was intended to conduct this study based on the findings of the previous national survey on urinary iodine levels of the different districts in the country. Accordingly, the entire country was divided into 2 areas; low (where the urinary iodine level was <100μg/L) or high (where the urinary iodine level was >199μg/L) and normal (where the urinary iodine level was between 100-199μg/L. The details are given in Table 1.

Table 1

Distribution of districts according to urinary iodine levels in year 2000

Areas	Urinary iodine levels as indicated by previous survey	Districts
Low	<100μg/L	Badulla, Monaragala.
High	≥200μg/L	Anuradapura, Polonnaruwa. Killinochchi, Jaffna, Vavuniya, Mullative, Mannar. Kurunagala, Puttulum.
Normal	100 – 199μg/L	Colombo, Gampaha, Kalutara. Kandy, Matale, NuwaraEliya. Batticaloe, Ampara, Trincomale. Galle, Matara, Hambantota. Ratnapura, Kegalle.

Calculation of sample size

In calculating the sample size, the prevalence of goitre (p) was taken as 20%[5]. The 95% confidence interval was applied and the error was taken

as 5%. The non response rate was considered as 10%. Because of the clustering effect of schools design effect was taken as 7.

According to formula described for iodine estimation[18], the required number of sample, *n* was calculated as follows.

$$n = \frac{1.96^2 \times p \times (100-p)}{(5\%)^2} \times \text{df (design effect)}$$

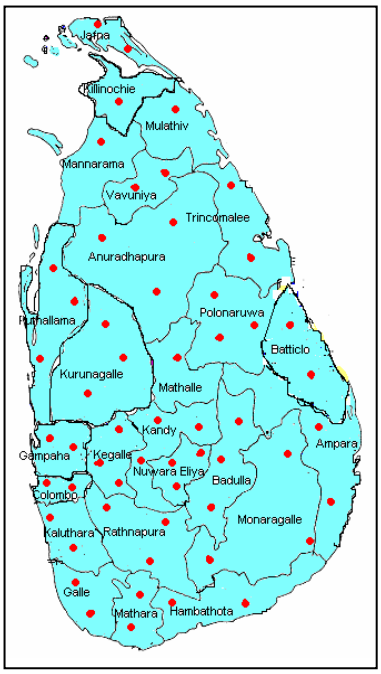
$$n = \frac{1.96 \times 1.96 \times 0.2 \times 0.8}{(.05)^2} \times 7$$

$$n = 1800$$

Based on these parameters the number of children to be studied during the study was 1800.

Identification of sample

Recommended sampling methodology by the WHO/UNICEF/ICCIDD (1992), was followed for the present study[19].



A multi-stage stratified sampling technique was used to identify the sample. According to the "EPI 30 cluster" methodology, 30 schools were selected from the 11 districts of the low or high urinary iodine values and 30 schools were selected from the 14 districts of the normal urinary iodine values as indicated in Table 1.

Figure 12: Distribution of the schools studied in districts. Each red dot represents a school

During the first stage of sampling proportionate stratification was done to identify the number of schools in the low / high and normal areas according to probability proportional to population size (PPS) in each district. During the second stage of sampling all schools in each district were listed with the population of children between 6-10 years of age. The selection was done according to probability proportional to population size (PPS). Figure 12 shows the distribution of schools within the country.

The study population (respondents) consisted of male and female children in the age group of 6 to 9 years. According to the total sample size of 1800, a sample size of 30 per school is required to achieve the 60 schools. During the third stage of sampling, all classes with children in grade 2, 3 and 4 classes were listed out because the children of the chosen age groups are in these classes. One class from each grade was randomly selected by using lots.

Ten children were selected from each selected class from the attendance register by using computer generated random numbers. A total of thirty children from each school were included for the assessment. In some classes when the numbers of students were 10-15, all the children were included for the assessment. However, it was found that some schools had less than 30 children. In such cases all the children were included and the balance was taken from the adjacent school from the same district or Province.

2.3. Study instrument

During the study the following components are assessed.

- Clinical examination for goitre,
- Estimation of iodine in a casual sample of urine,
- Assessment of iodine content of a sample of salt brought by the child from the household

A structured format was developed to obtain identification data, birthday and sex of children in the selected classes and the information was obtained from the attendance register and marked on the format by a member of the study team (Annex-1).

2.4. Selection and training of interviewers

A group of 10 public health inspectors were trained as field investigators to assess the goitre status of the study group. They had an experience of examining goitre during the national survey conducted in 2000. A theoretical and practical training for assessment of goitre was conducted prior to the survey.

2.5. Method of data collection

Clinical examination for goitre: Selected children in schools were assessed for the presence/absence of goitre.

Grading of goitre was done according to the WHO/UNICEF/ICCIDD criteria as follows[19]:

Grade 0 - Thyroid not palpable not visible,

Grade 1 - Thyroid palpable but not visible with neck in normal position. Moves up wards in the neck as the subject swallows.

Grade 2 - Goitre visible with neck in normal position. Consistent with enlarged thyroid when the neck is palpated.

Measurement of urine iodine: Casual sample of urine for estimating urinary iodine was obtained from selected 30 children, from each school. A total of 1800 urine samples were collected. Each child was provided with a disposable paper-cup with a wide mouth and was requested to collect the urine sample, by urinating directly into the cup. Members of the study team, wearing disposable gloves, transferred approximately 5 ml of the urine specimen from the cup to a tight fitting screw-capped

plastic container. The remaining urine and the cups were disposed of appropriately.

The urine samples were labelled with identification data for the province,

school and the child (in that order). All 30 samples were stored in a large plastic container and this package was marked with the province and school and then transported for storage. Samples were transported to the area Divisional Drug Stores and stored at -4^{0}C. They were transported to the laboratory of the Nutrition Department of Medical Research Institute (MRI) every week with cold packs and stored at -20^0 till taken for analysis. The method of assessing iodine concentration was the modified micro plate method, which is the simplified method adopted from Pino Method[19].

All samples were analysed by the trained Medical Laboratory Technologists (MLT). Quality control analysis was carried out throughout by using samples with known iodine values. The urine samples were tested on "first arrived - first assessed" basis. The results were entered into the computer data sheet with the labelling details.

Estimation of iodine content of salt at household level: Children have brought a sample of salt from home, in a polythene pack. The level of iodine in the salt samples was determined with rapid field test kits (MBI-India) and the titration method. The salt samples were classified according to their iodine levels in regard to the colour change observed with the rapid test kit.

Five teams were deployed for the study. Each team comprising of 2 field investigators were responsible for data collection. All selected schools were informed about the study. The consent forms were distributed to all children in the selected classes prior to the study to obtain the consent of the parents/guardians. The schools were informed the date of the visit and the selected students from the selected class were requested to bring salt samples on that day. All fieldwork was completed during September - October 2005.

Identification of factors associated in salt producers: The field investigators were instructed to visit at least one salt producer in each province. Interviewer administered questionnaire was introduced to salt producers to obtain information on related factors. Salt samples were collected and dispatched for laboratory analysis.

Data analysis

The data entry and analysis was carried out using the EPI/INFO software package.

Ethical consideration

Informed written consent was obtained from the parents by a letter from the Principal Investigator forwarded through the class teacher. Permission was obtained from the Education authority and Provincial Directors of Health Services for the study. Ethical clearance was obtained from the ethical committee of Medical Research Institute.

CHAPTER 3

RESULTS

A total of 1900 children aged 6-9 years from 9 provinces were studied. Of them, 964 (50.7%) were males and 936 (49.3%) were females. The mean age of children was 8.4 (SD=1.2) years.

Prevalence of goitre by provinces

All the children were palpated for goitre. Among this group, 3.5% had Grade 1 goitre and 0.3% had Grade2 goitre, giving a total goitre rate (TGR) of 3.8% (Table 2).

Table 2

Prevalence (%) of goitre by provinces in 2005

Province*	No. examined	Prevalence of goitre			Total goitre rate* (confidence limits)
		Grade 0	Grade 1	Grade 2	
Western	192	92.7	6.8	0.5	7.3 (3.6-11.0)
Central	205	88.8	9.8	1.5	10.3 (6.9-15.5)
Southern	211	99.5	0.5	0.0	0.5 (-0.5-1.4)
Northern	190	99.5	0.5	0.0	0.5 (-0.5-1.6)
Eastern	173	98.3	1.7	0.0	1.7 (-0.2-3.7)
North Western	207	99.0	1.0	0.0	1.0 (-0.4-2.3)
North Central	264	99.2	0.8	0.0	0.8 (-0.3-1.8)
Uva	268	92.2	7.1	0.7	7.8 (4.6-11.1)
Sabaragamuwa	190	96.8	3.2	0.0	3.2 (0.7-5.6)
Sri Lanka	**1900**	**96.2**	**3.5**	**0.3**	**3.8 (3.0-4.7)**

***Total goitre rate= (grade 1+2)** (X^2=73.8, df=8, P=0.000)

The total goitre prevalence varied between provinces with the highest prevalence noted in the Central Province (10.3%) and the lowest in the Southern and Northern Provinces (0.5%). Grade 2 goitre rates were low, ranging from 0.5-1.5%. The high prevalence in the Central Province is of special significance as this province is situated at the highest elevation from the sea level ranging from 250 – 2500 sq. meter. The highest rate of grade 2 goitre (1.5%) was also detected in Central province.

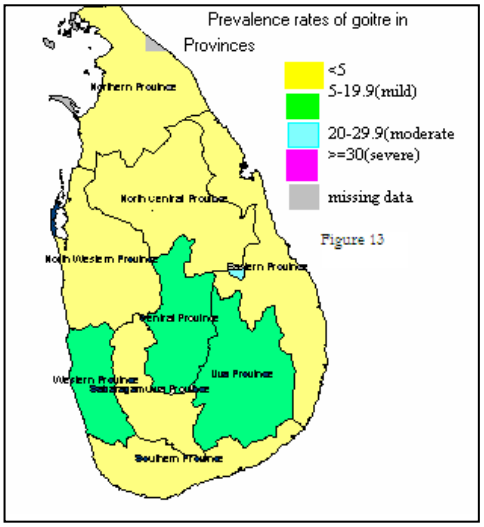


Figure 13: Distribution of goitre prevalence in different Provinces

Figure 13 indicates that the goitre is no more a public health problem in 6 out of 9 Provinces in the country.

Prevalence of goitre by sex

Table 3 indicates that, the prevalence of total goitre rate was higher among females (4.7%) than among males (3.0%). Grade 2 goitre rate was similar among both sexes (0.3%).

Table 3

Goitre prevalence in children by gender

Gender	Total Examined	Prevalence of goitre (%)			Total goitre rate (%) (confidence limit)
		Grade 0	Grade 1	Grade 2	
Male	964	97.0	2.7	0.3	3.0 (1.9-4.1)
Female	936	95.3	4.4	0.3	4.7 (3.3-6.1)
Sri Lanka	**1900**	**96.2**	**35.2**	**0.3**	**3.8 (3.0-4.7)**

(X^2=3.7, df=1, P=0.06)

Urinary iodine levels by province

Table 4 show the urinary iodine concentration in 1879 casual urine samples from school children aged 6-9 years which was 98.9% of the total children examined. The national median urinary iodine concentration was 154.4µg/L indicating iodine sufficiency. However, North Central (230.0µg/L) and Northern Provinces (283.4µg/L) indicated high level of median urinary iodine concentration recommended than normal (>199µg/L)[19].

Figure 14 shows the distribution of urinary iodine concentration in different Provinces indicating optimum urinary iodine levels in 7 out of 9

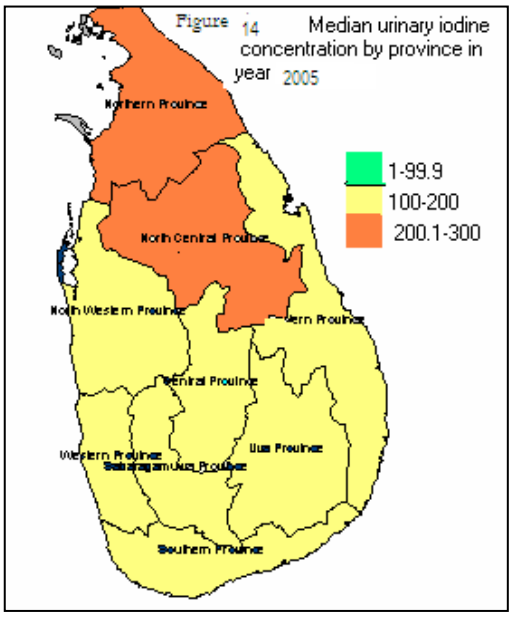
Provinces in the country and more than adequate iodine level in Northern and North Central Provinces.

Table 4

The levels of urine iodine by provinces

Province	Total Examined	Urinary iodine concentration (µg/L)		
		Median	Range	CI*
Western	192	142.2	6.1-1055.6	149.5-184.9
Central	205	111.0	20.8-679.0	131.7-160.5
Southern	206	144.7	10.4-755.2	145.7-174.4
Northern	184	283.4	43.8-1754.8	323.8-411.7
Eastern	170	160.4	23.7-784.8	167.3-208.9
North Western	204	152.8	25.9-1568.8	175.5-223.4
North Central	263	230.0	26.6-1398.8	246.6-292.7
Uva	265	108.5	20.0-607.9	128.3-153.1
Sabaragamuwa	190	109.0	23.0-966.0	138.4-175.3
Sri Lanka	**1879**	**154.4**	**6.1-1754.8**	**190.7-206.7**

*CI = Confidence Limit (F=41.9, P=0.000)



Study of the **frequency distribution of urinary iodine levels by province** shows that 34.7% of the children had urine iodine levels in the 'adequate' range with 29.9% with lower values and 35.5% with higher values (Table 5). Of those who had lower values, only a small percentage (0.1%) had very low values of <20µg/L. Seven provinces has shown zero values below 20µg/L and in Western and Southern Province percentage was 0.5%.

The group that had iodine levels of above 300μg/L indicating a possible excessive iodine intake, the percentages ranged from 6.8% in the Uva and Southern Provinces and 43.5% in the Northern Province. It must be noted that of the 184 urine samples studied from the Northern Province, 69% had values higher than the 'adequate' value, compared to 20% in the Uva province.

Table 5

Frequency distribution of urine iodine levels by provinces

Province*	**Total examined**	**Percentage of urine iodine levels (μg/L)**					
		Deficiency			**No deficiency**		
		< 20	**20-49.9**	**50-99.9**	**100-199.9**	**200-299.9**	**>=300**
		Severe	**Moderate**	**Mild**	**Ideal**	**More than adequate**	**Excessive iodine intake**
Western	192	0.5	4.2	21.9	49.0	15.6	8.9
Central	205	0.0	9.8	33.7	33.2	14.1	9.3
Southern	206	0.5	11.2	21.8	38.8	20.9	6.8
Northern	184	0.0	0.5	4.3	26.1	25.5	43.5
Eastern	170	0.0	10.0	17.1	35.3	25.9	11.8
North Western	204	0.0	4.4	20.6	43.1	14.7	17.2
North Central	263	0.0	2.7	12.2	26.6	25.5	33.1
Uva	265	0.0	12.1	32.8	35.1	13.2	6.8
Sabaragamuwa	190	0.0	11.6	34.7	26.8	13.7	13.2
Sri Lanka	**1879**	**0.1**	**7.4**	**22.4**	**34.7**	**18.7**	**16.8**

(X^2=353.9, P=0.000)

Estimation of iodine levels in salt samples from households

Each school child who participated in the goitre assessment was requested to bring a sample of salt from his/her house and test kits were used to determine the level of iodination. A majority of children i.e. 83.9% brought samples of salt from 'home'. All the salt samples were brought to the MRI laboratory for testing iodine levels by the titration method.

The iodine content in household salt based on titration of 1594 samples is shown in Table 6. The mean iodine content in household salt was 28.0ppm where it is recommended that the iodine content of household salt be in the range of 15-25ppm. However, there are Provincial variations indicating higher level of iodine content of 32.7ppm in Central Province.

Table 6

Iodine content of salt samples at household level measured by titration method by provinces

Province	No.	Iodine content (ppm)		
		Median	Range	CI*
Western	152	28.5	11.6-82.5	29.0-32.7
Central	179	32.7	6.3-76.7	31.7-35.9
Southern	156	27.5	12.1-77.7	27.5-31.1
Northern	173	18.5	7.4-73.0	19.9-22.9
Eastern	130	29.1	6.3-74.0	31.1-36.8
North Western	158	28.0	8.4-73.0	27.8-31.5
North Central	253	28.6	5.3-96.8	30.8-35.2
Uva	223	28.5	8.1-73.0	30.2-33.7
Sabaragamuwa	170	32.0	3.1-70.3	30.5-34.4
Sri Lanka	**1594**	28.0	**3.1-96.8**	**30.1-31.5**

*CI = confidence limit; (F=13.7, P=0.000)

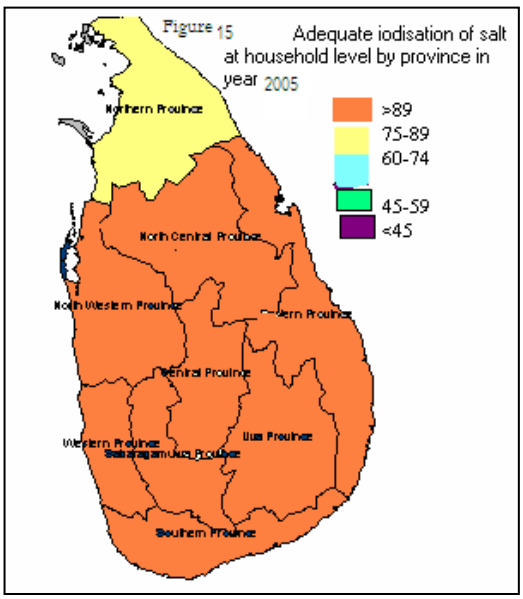


Table 7 shows that over 90% of households had access to adequately iodised salt indicating 91.2% of the samples had iodine levels within the permitted range, i.e. 15ppm. It was observed that 61.0% of salt samples had iodine values higher than the permitted range (above 25ppm) and

only 8.8% had lower values. Of the samples with very low iodine values, i.e. less than 15ppm, the highest percentage was seen in the Northern Province (27.7%). Figure 15 presents the distribution of adequately iodised salt samples in different Provinces. It shows that Northern Province has low values compared to other Provinces.

Table 7

Frequency distribution of iodine level in salt at household level by provinces

Province	**No.**	**Frequency distribution of samples exposure as % according to salt iodisation level (ppm)**			
		<15	**15-25**	**25.1-50**	**50-100**
Western	152	3.9	33.6	55.3	7.2
Central	179	5.6	24.0	57.5	12.8
Southern	156	2.6	39.1	53.8	4.5
Northern	173	27.7	41.6	*28.9*	*1.7*
Eastern	130	9.2	26.9	44.6	19.2
North Western	158	6.3	31.6	56.3	5.7
North Central	253	9.9	27.7	47.4	15.0
Uva	223	5.8	24.7	56.5	13.0
Sabaragamuwa	170	7.6	25.3	58.2	8.8
Sri Lanka	**1594**	**8.8**	**30.1**	**51.0**	**10.0**

(X^2=95.6, P=0.000)

After testing for titration the remaining salt samples (n=1423) were tested with rapid test kit. For a sample of salt to be considered as 'adequately iodinated' the colour has to change to purple indicating an iodine content of 15ppm. According to this specification, only 89.2% of the samples were 'adequately iodinated' (Table 8). The lowest percentage of samples with adequate iodination was seen in the Southern province, i.e. 82% and highest in Western province, i.e. 95.9%.

Table 8

Adequate iodination of salt at household level tested by rapid test kit method by provinces

Province	No.	Rapid test kit (%)	
		No. positive	Confidence limit
Western	146	95.9	92.7-99.1
Central	113	92.0	87.0-97.0
Southern	161	82.0	76.0-87.9
Northern	79	91.1	84.9-97.4
Eastern	152	86.8	81.5-92.2
North Western	150	83.3	77.4-89.3
North Central	233	92.3	88.8-95.7
Uva	217	91.7	88.0-95.4
Sabaragamuwa	172	87.2	82.2-92.2
Sri Lanka	1423	89.2	87.6-90.8

Salt producers

Sri Lanka has 2 major salt producers in Hambantota and Puttulum with over 200 small scale producers. The average annual production of salt in the country estimated about 130,000 tons. The production of edible salt is around 95,000 tons per year. The estimated per capita consumption of salt is around 15g per day (including losses). The production cost of iodised salt is Rs. 7 per kg which gives the cost per person per year Rs. 35/=[20].

During the survey salt producers were visited by the investigators in Provinces where the producers were close to the school which was studied. A total of 12 salt producers were visited and they were interviewed. Salt samples were brought from the producer for analysis at MRI by the titration method.

Table 9

Characteristics of salt producers

Area	No.	%
Type of producer		
• Large (>=5000tons/year)	2	16.7
• Medium (1000-4999 tons/year)	4	33.3
• Small (1000 tons/year)	6	50.0
Method of iodisation		
• Spray dry mix	4	36.4
• Wet mixing directly	7	63.6
• Dry mixing directly	0	0.0
• Importing	1	12.0
Awareness of ill effects of iodine deficiency:		
• Goitre	12	100.0
• Cretinism	1	8.3
• Mental retardation	5	41.7
• Do not know	0	0.0
• Other	1	8.3
Knowledge on benefits of consuming iodised salt		
• Prevent goitre	7	58.3
• Mental retardation	1	8.3
Awareness on regulations of salt		
• Iodine content	7	58.3
Method used to check iodine in salt		
• Rapid test kit	10	83.3
• Titration method	1	8.3
• None	1	8.3
Difficult in obtaining rapid test kits		
• Yes	7	58.3
• No	5	41.7
Expiry date of the test kit used by the producer		
• Within the expiry date	6	54.5
• Past the expiry date	5	45.5

Table 9 presents the characteristics of salt producers. Majority were small scale producers who handled around 1000 tons of iodised salt per year and one producer did only importing iodised salt and packaging it. The method of iodisation was mainly with the diluting potassium iodide

and pours over the salt and mixes it with the shovel. Only 36.4 percent used the method of iodisation as spray dry method (Figure 16). The median iodine content of salt samples brought from the producers was 30.1ppm ranging from 12.1-49.7ppm.

Figure 16

Method of iodisation by salt producers and storage facilities



Table 10

Process of iodisation at production level and related factors

Factors	No.	%
Training of staff for iodisation		
Yes	7	58.3
No	5	41.7
Availability of written instructions on iodisation procedure		
Yes	0	0.0
No	12	100.0
Labelling on salt packets		
1. Name of the producer		
Yes	11	91.7
No	1	8.3
2. Lot and batch number		
Yes	9	75.0
No	3	25.0
3. Potassium iodide content in PPM or mg/kg		
Yes	7	58.3
No	5	41.7
4. Other information required by the low		
Yes	11	91.7
No	1	8.3
Storing of iodised salt before distribution		
Yes	11	91.7
No	1	8.3
Periodical inspection of salt packets prior to the distribution		
Yes	7	58.3
No	5	41.7

Table 10 shows that none of the salt producers had written instructions on the process of iodisation and the quantities to be added. Majority had followed the labelling requirements indicated by the legislation.

As indicated in Table 11 that the quality of salt, obtaining potassium iodide are identified as problems by the salt producers.

Table 11

Resources obtained for iodisation (n=11)

Area	No.	%
Obtain iodisation equipment at an affordable price		
Yes	5	45.5
No	6	5.0
Obtain potassium iodate at an affordable price		
Yes	8	72.7
No	3	27.2
Obtain common salt at better quality status		
Yes	7	63.6
No	4	36.4
Obtain common salt at better quality status		
Yes	7	63.6
No	4	36.4
Adequate stocks of potassium iodide and packaging materials		
Yes	9	81.8
No	2	18.2

CHAPTER 4

PROGRESS OF IDD ELIMINATION OVER THE YEARS

There is a strong political commitment by the Minister of Health directing to make proper iodisation standards. A Director Environmental and Occupational Health was appointed as a responsible focal point for IDD elimination program by the Director General of Health Services. National Iodine committee was established with all the stakeholders under the Ministry of Health but ironically regular meetings were not conducted. Public Health Inspectors are expected to test the iodine level of salt at producer, retail and household levels within their respective areas. But the information is not included at the National system of health information.

Table 12 presents the progress of indicators that were identified by the WHO/ICCCD/UNICEF as goals in eliminating iodine deficiency disorders. It shows that Sri Lanka has shown a remarkable achievement and arrived at its goals 10 years after the iodisation.

Table 12

Progress of indicators towards eliminating IDD in Sri Lanka

Indicators	Goal	Before iodisation	5 yrs after iodisation	10 yrs after iodisation
Goitre %	<5	20.1	20.9	3.2
Median urinary iodine (µg/L)	100-199	-	149	159
% adequately iodised salt at Household level	> 90	-	49.0	91.8

Table 11 shows that goitre rate has decreased from 20.1 to 3.2 in year 2005. Sri Lanka maintains the median urinary iodine values between 100-200ug/L for last 10 years. Household level iodisation has gone up from 49% to 91.8% in the year 2005.

Comparison of goitre rates from 1986 – 2005

Goitre rates were compared from 1986 – 2005 and it shows a marked reduction of goitre rates in each Province.

Figure 17

Comparison of goitre rates in Provinces from 1986 – 2005

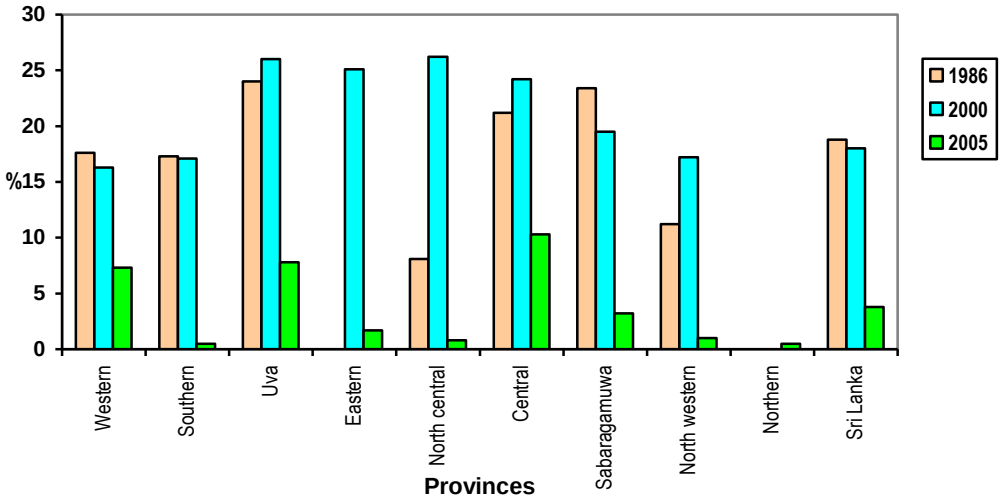


Figure 17 shows that there is a reduction of goitre rates in all Provinces. It is interesting to note that even at present there is a goitre prevalence with a public health significance in the south-west region of the country which was defined as the goitre belt in 1947. It indicates that a close monitoring is needed to prevent the re-emergence of IDD as a public health problem.

Figure 18 presents that almost all the Provinces have been maintaining an adequate level of urine iodine since 2000. On the other hand, it showed high iodine content among children living in the Northern Province which clearly indicates that they ingest more iodine than their counterparts living in other Provinces. The most likely explanation is high iodine levels in the drinking water in Northern Province in addition to the iodine in salt.

Figure 18

Comparison of urinary iodine levels from 2000 – 2005

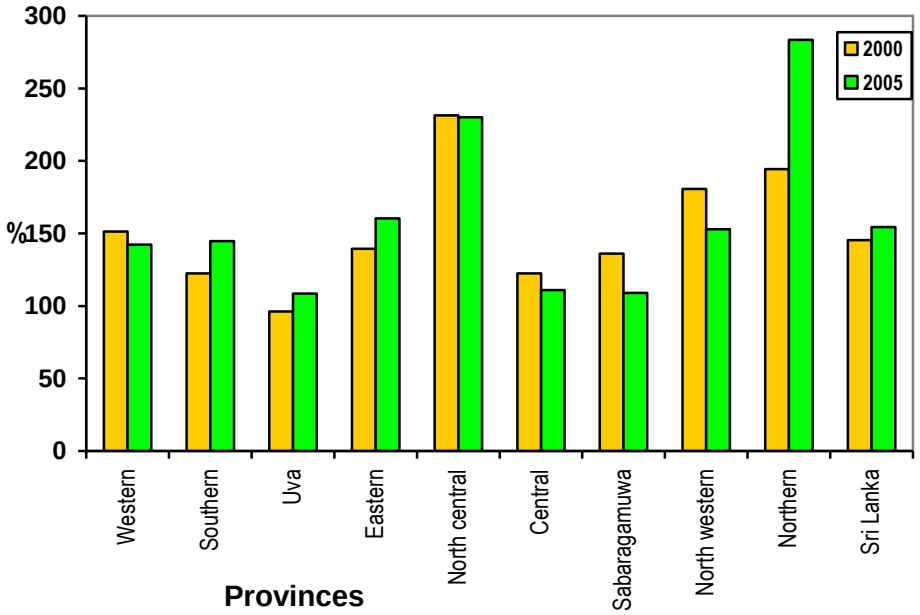


Figure 19

Comparison of iodine levels in salt at household level by rapid test kit from 1995 – 2005

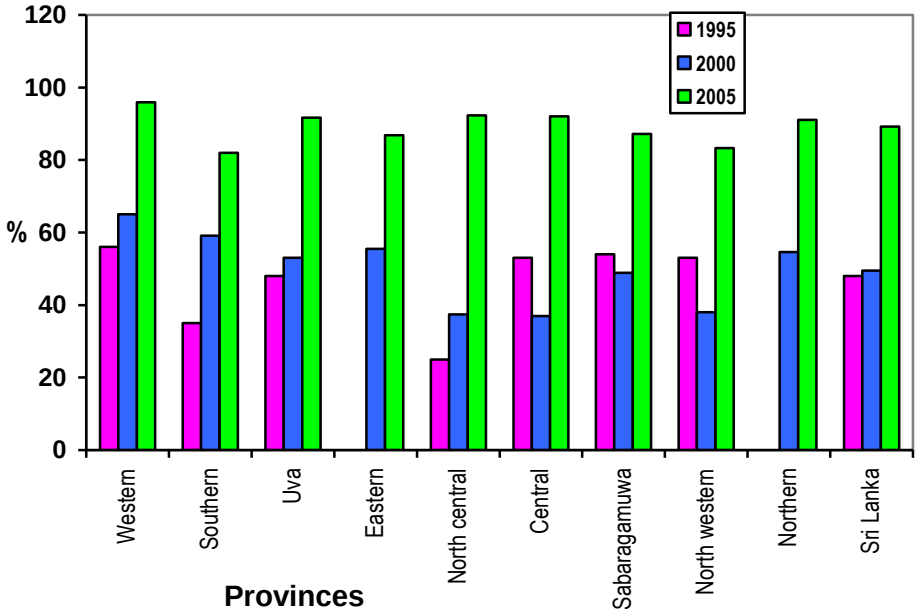


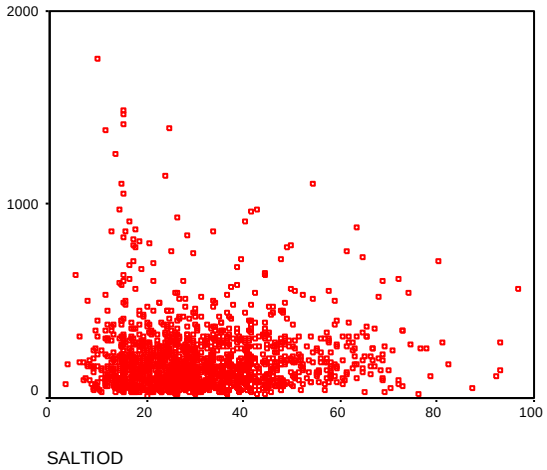
Figure 19 indicates the significant increase of salt iodine levels at households from 1995. Southern and North Western Province showed the lesser percentage of iodine levels in salt compared to the other

Provinces. These are the two Provinces in which the two major salterns are situated thus people have access to get non iodised salt. This highlights the need for increasing awareness on benefits of iodised salt among people in these Provinces.

Figure 20 presents the correlation of urinary iodine levels with salt iodine levels indicating positive correlation with increasing level of iodine in salt.

Figure 20

Comparison between urinary iodine and salt iodine levels



CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Sri Lanka has eliminated IDD as a public health problem on a national scale. However, there remains the problem of prevalence of mild goitre in the Western, Central and Uva provinces and problem of non-iodised salt in Northern, Eastern, North Central and Sabaragamuwa Provinces. Though Sri Lanka has attained adequate iodine nutrition status, it needs to continue to pay special attention to IDD endemic areas to avoid IDD return.

On the other hand, a significant proportion of urine samples in North Central and Northern Provinces showed iodine contents that were high signalling the need for strengthening the quality assurance systems at different levels.

As IDD can forcefully bounce back despite present efforts and successes, the following recommendations are made from the study:

1. To establish an effective inter-sectoral national iodine committee covering all the involved institutions.
2. Maintain the provision of technical and logistical capacities for the assessment of iodine in salt and urine at National Reference Laboratory to facilitate the sustainability.
3. Integrate indicators of IDD elimination into the national system of health information, in particular the household coverage of iodised salt.
4. Ensure annual surveys of iodine status in risk-prone districts.
5. Conduct nationwide IDD survey every five years.
6. Support operational research in the field of eliminating IDD
7. Salt producers should verify the salt quality prior to purchase from salterns.
8. Register all the salt producers under the Ministry of Health for easy follow up.

9. Arrange the facilities to obtain rapid test kits for salt producers and to establish laboratory facilities to determine the iodine levels in salt at production.
10. Finances must be made available to achieve all the above recommendations which will assist to maintain the sustainability of USI.

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DATA COLLECTION FORMAT - School based survey on iodine deficiency

Date | | | | | | | | |

Province | | School No. | |
District | | Sector | |
Type of school | | Code field investigator | |

School Name - ……..
(Sample labeling = province number/school number/serial number)

Serial No	Child's Name	Birthday	Goiter 0 = no 1= palpable 2= palpable & visible	Male /female 1 - male 2 - female	Salt sample 1-yes 2-No	Urine sample 1-Yes	Weight (kg)	Height (cm)

DATA COLLECTION FORMAT - SALT PRODUCERS

Date | | | | | | | | |

Province | | | Code field investigator | | |
District | | | Method of iodisation | | |

(1= Spray dry mix, 2 = wet mixing directly 3= dry mixing directly 4= other)

1. Name of the producer (Serial Number) : ……..

2. Type of producer : 1. Large (≥ 5,000 tons / year)
2. Medium (1,000 - 4,999 tons / year)
3. Small (1,000 tons / year)

3. Do you know the ill effects of iodine deficiency? (mark more than one)
   1. Goitre
   2. Cretinisum
   3. Mental retardation
   4. Don't know
   5. Other (specify) ……

4. What are the benefits of consuming iodised salt? (don't suggest answer, write the response as it is)

……

5. What are the regulations of salt?
   1. …….
   2. ……..
   3. ……

6. What is the method used to check iodine in the salt?
   1. Rapid test kit
   2. Titration method
   3. None

7. Have you ever difficult in obtaining rapid test kits?
   1. Yes
   2. No

8. Check the rapid test kits for expiry dates by the interviewer.
   1. Within the expiry date
   2. Past the expiry date

9. Trained the staff for iodisation
   1. Yes
   2. No

10. Is there written instruction on iodisation procedure?
   1. Yes
   2. No

11. Labels on package contain adequate and accurate information

11.1.Name of the producer
   1. Yes
   2. No

11.2.Lot and batch numbers
   1. Yes
   2. No

11.3.potassium iodate in ppm or mg/kg
   1. Yes
   2. No

11.4.Other information required by the law
   1. Yes
   2. No

12. Iodised salt is stored before the distribution
    1. Yes
    2. No

13. Do they inspect packaged salt periodically prior to the distribution?
    1. Yes
    2. No

15. Are Producers able to obtain iodisation equipment at an affordable cost?
    1. Yes
    2. No

16. Are Producers able to obtain potassium iodide at an affordable cost?
    1. Yes
    2. No

17. Are Producers able to obtain common salt at better status?
    1. Yes
    2. No

18. Are producers maintain adequate stocks of materials including potassium iodide and packaging?
    1. Yes
    2. No

19. What are your suggestions to improve this iodisation process?
    1. ……
    2. ……
    3. ……

20. Have you obtain a salt sample?
    1. Yes
    2. No

(Salt Sample labelling = Province number/district number/serial number)