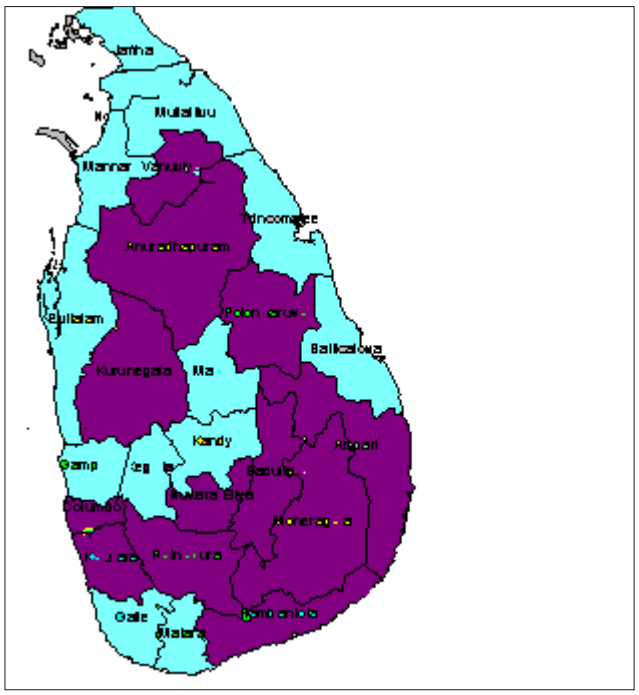
Annual cyclic monitoring of indicators to track Iodine Deficiency Disorders in Sri Lanka 2001-2003



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1. INTRODUCTION

Background

Iodine deficiency is the world's single most significant cause of preventable brain damage and mental retardation. Over 2.2 billion people in the World may be at risk for iodine deficiency, and recent estimates suggest over one billion people experience some degree of goitre. Approximately 17% of the burden occurred in the South East Region (SEAR) [1].

IDD situation after introduction of iodised salt

Several studies were carried out prior to the implementation of iodised salt. Establishment of urine iodine and salt iodine laboratories were done at the Nutrition department in the Medical Research Institute (MRI) in 2000 with the assistance of UNICEF.

The study was conducted by the Medical Research Institute (MRI) to estimate the process and the impact evaluation at Provincial level in 2000/1[2]. The following conclusions and recommendations were drawn from that study. As recommended by WHO/UNICEF/ICCIDD, the total goitre prevalence rate (TGR) of 20.9% in 2000/1 suggests the presence of endemic goitre as a public health problem in Sri Lanka even at present, which is a historic marker of iodine deficiency. As demonstrated by median urinary iodine (UI), currently the iodine nutritive status is possibly adequate in Sri Lanka in all the provinces other than the Uva province. Uva province showed a mild degree of iodine deficiency. It was found that the proportion of households with intake of salt with adequate levels of iodine was inadequate. Another important observation was the wide variation in the iodine content of the different brands of salt available, both between brands and within a given brand. Inadequate coverage in the monitoring of retail outlets by the health personnel was also found.

The findings of the National study were 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 2001. In 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 it after looking for an easy method to carry out titration. Ministry of Health agreed to prepare the guidelines and forms for monitoring and assessment of iodised salt.

After considering the proportion of children with more than adequate levels of urine iodine in the country, which was indicated in the MRI study[2], the legislation was revised since year 2003, requiring 15ppm iodine in salt at household level.

Sri Lanka is undergoing the second phase of the IDD elimination programme where the TGR is high, UI are on the increase. This indicated the need to make iodine available on a regular and continuous basis. Therefore, a system of "cyclic monitoring of indicators" for tracking the biological progress with respect to the elimination of IDD as a public health problem was initiated from the year 2001. In "cyclic monitoring", Sri Lanka was divided into five areas, 5 districts were included in each area. Every year one area was assessed for monitoring in a five year monitoring cycle to cover all the districts (5 districts per year) to facilitate in maintaining and sustaining interest as well as commitment for regular monitoring of IDD.

Therefore it was decided to carry out the cyclic monitoring under following objectives:

- to estimate the prevalence of goitres in the school children of age 8 - 9 years,
- to determine the iodine nutritional status by measuring urinary iodine levels,
- to measure the household iodised salt consumption pattern.
- to estimate the iodine content of drinking water

2. METHODS

The study population was identified as school children aged 8 - 9 years. 12 districts out of 25 districts were completed so far, i.e. Badulla, Monaragala, Anuradapura and Polonnaruwa in year 2001, Colombo, Hambantota, Kurunagala, Vavuniya, Ampara and Ratnapura in year 2002 and NuwaraEliya and Kalutara districts in year 2003.

The required sample size was calculated by taking the followings into the consideration: the prevalence of goitre among children was 30%, the error was $\pm$ 0.05 and the α error was 0.05 ($z_{1-\alpha/2}$ = 1.96). The sample size was 350 children in the 8 - 9 year old age group.

A multi-stage stratified sampling technique was used to identify the sample. During the first stage, the number of schools by sector (urban/rural & estate) were listed out by district. 6 schools from Colombo and Kalutara districts and 12 schools from other districts were selected using "probability proportionate to size" sampling technique from each sector. The children were in grade 4 were supposed to be of 8 - 9 years. Classes of grade 4 in each school varied. During the third stage of sampling, all classes with children in grade 4 were listed out in the selected schools and one class from each grade was randomly selected from each school.

All children in the selected classes were given the consent forms to get the consent from their parents/guardians through a letter from the Principal investigator forwarded through the class teacher. All children who had obtained the consent of their parents and were present on the day of the study were identified from the attendance register. Ten children were randomly selected from each selected class by using attendance register.

Clinical examination for goitre

Three teams carried out the field work, each team comprising of 3 field investigators, one of whom was trained in goitre assessment was responsible for grading of goitre according to the WHO/ICCIDD/UNICEF/1994[3]. Around 50% of goitre were rechecked and confirmed by the Nutrition Assistant who was specially trained to palpate goitre.

Estimation of iodine in urine

About 10 urine samples were collected from each school. All selected children were made to wash their hands with soap and water under the supervision of the study team. Each child was provided with a disposable paper-cup with a wide mouth and were requested to collect the urine sample, by urinating directly into the cup and to fill half the cup provided. 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 appropriately.

The urine samples were labelled with identification data i.e. district number, school number and the serial number of the child (in that order). Urine samples from each class were stored in the large plastic containers separately and this package was marked with the district number, school number, class number and number of samples and then transported for storage. The samples were transported to one place and stored at -20^{0}C. They were then transported to the laboratory of the Nutrition Department of Medical Research Institute (MRI) at the end of week with cold packs and stored at -20^0 till taken for analysis. Medical Laboratory Technologists and research officer performed laboratory analysis.

Urine iodine was assessed by using the simple modified microplate method[4]. External quality control was assessed with samples, which was sent from the laboratory of CDC/Atlanta.

Assessment of iodine content of household salt

All children in the selected classes of Kalutara and NuwaraEliya districts were asked to bring salt samples. Children were provided with the polythene bag to get the sample of household salt on the prefixed date. Salt samples, which were brought by the children who were selected to collect urine samples, were sent to the laboratory to test the iodine by titration method. Other salt samples were tested by the rapid test kit.

Estimation of iodine content in drinking water

The field investigators were instructed to collect drinking water samples in the locality of the school from all the available sources such as taps, wells, deep wells, tube wells, streams etc.

Water samples were transported to the MRI laboratory using the same procedures adopted for samples of urine.

Ethical clearance was obtained from the institution Ethical Committee and permission was obtained from relevant Health and Education authorities. The data was entered to the EPI/INFO package and the analysis was performed. The study period was November 2001 to March 2003.

3. RESULTS

All children in selected classes had obtained consent from their parents/guardian. The participation rate was 100%. During the cyclic monitoring 5877 children were studied. Of them, 49.8% were males and 50.2% were females. The mean age of children were 9.8 years (SD=1.5).

Prevalence of goitre

Table 1 shows the goitre prevalence in children. The grading was done according to the WHO/ICCIDD/UNICEF classification[3].

Table 1

Goitre prevalence in children by sex

District	No.	Grade 1			Grade 2			Total goitre rate		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Colombo	246	2.3	0.9	1.0	0.0	0.0	0.0	2.3	0.9	1.6
Kalutara	935	1.6	3.5	2.5	0.2	0.0	0.3	1.8	3.5	2.8
NuwaraEliya	1760	1.0	4.6	2.7	0.0	0.0	0.0	1.0	4.6	2.7
Hambantota	340	5.0	15.6	10.6	0.0	0.0	0.0	5.0	15.6	10.6
Ampara	168	0.0	3.0	1.2	0.0	0.0	0.0	0.0	3.0	1.2
Vavuniya	197	3.4	4.6	4.1	0.0	0.0	0.0	3.4	4.6	4.1
Kurunagala	431	5.2	13.5	9.7	7.2	1.7	4.2	12.4	15.2	13.9
Anuradapura	409	3.7	9.2	6.4	6.1	3.1	4.6	9.8	12.3	13.3
Polonnaruwa	391	9.3	12.9	11.3	4.9	6.2	5.6	14.2	19.1	16.4
Badulla	481	19.0	20.0	19.5	0.0	0.0	0.0	19.0	20.0	19.5
Monaragala	359	9.8	21.0	15.3	0.0	0.0	0.0	9.8	21.0	15.3
Ratnapura	160	2.9	3.3	3.1	1.5	6.5	4.4	4.4	9.8	7.5

Total goitre rate (TGR) = Goitre grade 1+2

The total goitre prevalence between districts varied with the highest prevalence noted in the Badulla district (19.5%) and the lowest prevalence in the Ampara district (1.2%). Grade 2 goitre rates were low, ranging from 0 – 3.4%. Grade 1 goitre rates varied from 1.0% to 19.5%

between districts. Total goitre rate was higher among females in all the districts than among males except in the Colombo district. The highest total goitre prevalence among female children was noted in Monaragala district (21.0%) and the lowest in Colombo district (0.9%). Prevalence of goitres in Colombo, Kalutara, NuwaraEliya, Ampara and Vavniya districts are less than 5% indicating the goitre is no long a public health problem in these districts.

Urinary iodine levels

The "adequate" urinary iodine levels are considered to be within the range 100-200μg/L according to WHO (1994) [13]. The median urinary iodine levels were above the accepted cut-off point of 100μg/L in all the districts in a range of 110.9 – 261.1μg/L (Table 2).

Table 2

The levels of urine iodine by districts

Districts	Total* examined	Median urinary iodine concentration (μg/L)			Range (μg/L)
		Male	Female	Total	
Colombo	60	275.6	213.8	258.1	61.6 - 758.5
Kalutara	405	273.4	300.0	280.7	21.8 – 1932.4
NuwaraEliya	1768	139.1	119.6	129.5	2.7 - 1646.8
Hambantota	110	247.9	156.2	200.7	22.8 - 1291.4
Ampara	59	247.6	219.3	223.7	86.3 - 921.3
Vavuniya	62	327.2	261.1	276.8	47.7 - 1274.1
Kurunagala	116	206.7	189.2	195.6	20.5 - 849.6
Anuradapura	109	273.3	219.2	255.5	56.1 - 1036.2
Polonnaruwa	120	251.1	199.5	236.3	30.9 - 1033.0
Badulla	110	145.4	110.9	125.5	16.5 - 568.4
Monaragala	99	149.1	162.7	154.0	20.9 - 434.0
Ratnapura	50	206.6	216.8	216.8	42.4 - 900.7

Table 2 shows that median urinary iodine levels among males was higher than females in all the districts except in the Monaragala district. It is important to note that an adequate urine iodine level among males and females is present in all the districts.

Study of the **frequency distribution of urinary iodine levels by districts** shows the wide variation between districts. 98.3% of children in the Colombo and Ampara districts had urine iodine levels in the 'adequate' range (Table 3). 35.5% of children in the Badulla district had lower urinary iodine values indicating the deficiency status. Of those who had lower values, only 1.8% of children from the Badulla district had very low values of <20μg/L, indicating a severe iodine deficiency.

Table 3

Frequency Distribution of urinary iodine levels

Districts	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
Colombo	60	0.0	0.0	1.7	35.0	25.0	38.3
Kalutara	405	0.0	1.2	7.2	20.5	25.9	45.2
NuwaraEliya	1768	0.7	6.9	27.8	38.9	15.7	10.0
Hambantota	110	0.0	3.6	15.5	30.0	20.0	30.9
Ampara	59	0.0	0.0	1.7	33.9	33.9	30.5
Vavuniya	62	0.0	1.6	8.1	16.1	29.0	45.2
Kurunagala	116	0.0	3.4	12.1	35.3	19.8	29.3
Anuradapura	109	0.0	0.0	3.7	25.7	33.9	36.7
Polonnaruwa	120	0.0	0.8	7.5	35.0	23.3	33.3
Badulla	110	1.8	5.5	28.2	41.8	16.4	6.4
Monaragala	99	0.0	4.0	16.2	50.5	21.2	8.1
Ratnapura	50	0.0	2.0	8.0	36.0	20.0	34.0

45.2% of children in the Vavuniya and Kalutara district had iodine levels of above 300μg/L indicating a possible excessive iodine intake. About one third of children studied in all the districts had urinary iodine levels above 300μg/L except in Badulla, Monaragala and NuwaraEliya districts.

Iodine levels in salt samples from households

Each school child in the selected class of the NuwaraEliya and Kalutara districts were requested to bring a sample of salt from his/her house. Salt samples, which were brought by the children who were selected to assess the urine samples were, send to the laboratory for testing with titration method.

Table 4
Iodine content of salt samples at household level measured by titration method

Age group in Years	No.	Median iodine content (mg/kg)	Range (mg/kg)
Kalutara	360	30.1	2.1 – 99.4
NuwaraEliya	1380	17.9	1.5 - 423.5

About 76.8% of children in the NuwaraEliya and Kalutara districts brought salt samples from their households. As shown in Table 4, the median iodine content of salt is higher in the Kalutara district (30.1mg/kg) than in NuwaraEliya district (17.9mg/kg). However, it is important to note the extremely wide variation of iodine content in the salt at household level in both NuwaraEliya and Kalutara district (1.5 – 423.5 mg/kg). Similar findings were observed in the study conducted in year 2000/1[2].

Table 5
Frequency distribution of iodine level in salt at household levels

District	Total examined	Frequency distribution of samples exposure as % according to salt iodisation level (mg/kg)				
		0-14.9	15.0-24.9	25.0-49.9	50.0-99.9	>=100
NuwaraEliya	1383	33.6	41.6	22.2	2.1	0.5
Kalutara	360	22.8	18.9	45.0	13.5	0.0

According to Table 5, the frequency distribution of iodine level in salt at household level did not show much variation, between the two districts. Table 5 shows that 66.4% of salt samples in NuwaraEliya district and 77.2% of salt samples in Kalutara district had iodine levels within the permitted range, i.e. above 15mg/kg, which is the recommended household level by the Government of Sri Lanka. Almost all salt samples had some amount of iodine. It was observed

that 24.8% of the salt samples in NuwaraEliya district and 58.5% of salt samples in Kalutara district had iodine values higher than 25mg/kg.

Iodine levels in drinking water

Drinking water samples were tested for iodine in all the districts and are shown in Table 6. Highest iodine values were shown in the drinking water samples from Anuradapura district with extremely wide variation (1.8 - 535.5μg/L) giving median value of 53.3μg/L. The lower iodine values in drinking water were observed in the Colombo, Kalutara and NuwaraEliya districts (6.4, 5.5 and 5.0μg/L respectively). These findings indicate iodine levels of the drinking water varied within and between districts.

Table 6

The levels of iodine in drinking water by districts

Districts	No. of samples	Median iodine levels (μg/L)	Range (μg/L)
Colombo	6	6.4	4.3 - 10.2
Kalutara	26	7.7	0.0 – 378.4
NuwaraEliya	19	5.0	0.0 - 13.9
Hambantota	46	42.3	4.1 - 268.2
Ampara	26	41.1	3.4 - 151.6
Vavuniya	26	14.9	2.4 - 94.3
Kurunagala	45	14.4	0.0 - 181.8
Anuradapura	55	53.3	1.8 - 535.5
Polonnaruwa	48	19.8	2.0 - 131.0
Badulla	53	13.3	0.0 - 145.4
Monaragala	47	14.5	0.0 - 256.4
Ratnapura	21	15.4	0.0 - 56.7

A summary of findings are presented in Table 7. Taking the prevalence of goitre and median urinary iodine levels as the indicators, iodine status in the population of Colombo, Kalutara, Ampara, NuwaraEliya and Vavuniya districts could be considered as satisfactory. Badulla and Monaragala districts need further attention to combat iodine deficiency. The proportion of households with an intake of salt with adequate levels of iodine was not sufficient.

Table 7

Iodine deficiency status in different districts of Sri Lanka during the annual cyclic monitoring from 2001-2003, according to the WHO classification

District	Indicators			
	Goitre	Median urinary iodine (μg/L)	Median iodine level in drinking water (μg/L)	% adequately iodised salt at Household
Colombo	1.6 Normal	258.1 More than adequate	6.4	-
Kalutara	2.8 Normal	273.4 More than adequate	7.7	77.2 Inadequate
NuwaraEliya	2.7 Normal	129.5 Ideal	5.0	66.4 Inadequate
Hambantota	10.6 Mild	200.7 More than adequate	42.3	-
Ampara	1.2 Normal	223.7 More than adequate	41.1	-
Vavuniya	4.1 Normal	276.8 More than adequate	14.9	-
Kurunagala	13.9 Mild	195.6 Ideal	14.4	-
Anuradapura	13.3 Mild	255.5 More than adequate	53.3	-
Polonnaruwa	16.4 Mild	236.3 More than adequate	19.8	-
Badulla	19.5 Mild	125.5 Ideal	13.3	-
Monaragala	15.3 Mild	154.0 Ideal	14.5	-
Ratnapura	7.5 Mild	216.8 More than adequate	15.4	-

Table 8 shows that the children with grade 2 goitres had high level of mean urine iodine levels compared to the children with grade 1 goitres and children without goitres. Same was observed with drinking water which is highly significant. It should be investigated further.

Table 8

Mean urinary iodine and drinking water iodine levels in relation to goitre levels of children

Goitre status	Mean (SD) iodine levels (μg/L)	
	Urine*	Drinking water**
Grade 0	214.4 (17.9)	37.8 (48.9)
Grade 1	218.4 (176.6)	39.9 (45.3)
Grade 2	288.0 (153.2)	146.4 (170.6)

*(F=2.2, P=0.1) **(F=20.4, P=0.000)

Observation of salt production sites

The following observations were made on the salt production sites during school visits.

- Over 280 iodised salt producers are present in Sri Lanka and few are importing iodised salt and packed here.
- About 16 production sites were visited during visit to schools. It was informed that health officers (PHI. FDI) do not visit the production sites regularly.
- Even the salts were not washed and with full of dirt. In some brands of salt it was found that a very low level of iodine in salt (average 5mg/kg) which is not at all enough to fulfil the requirement of people.
- A wide variation of iodine levels in salt was observed. At times it was more than 100mg/kg (the legislated level is 25mg/kg in Sri Lanka from 1995). The average iodine level of imported salts are 50mg/kg
- During the iodisation, batches of iodised salt were not checked for iodine levels. It was tested only with rapid test kits which were also past the expiry date. When samples were taken from same batch of iodised salt, iodine level ranged from 5-100mg/kg. This was due to improper mixing of the Potassium iodate solution.

4. CONCLUSIONS AND RECOMMENDATION

The districts Colombo, Kalutara, Ampara, NuwaraEliya and Vavuniya have achieved the goal of eliminating IDD as a public health problem according to the urinary iodine levels and prevalence of goitre. The wide variation in the iodine content in the salt samples at household level indicates the need for improving the quality of salt iodisation. Regular monitoring of the process of iodisation, the monitoring at the level of manufacture and at household level are needed.

- Average iodine level of drinking water in the Anuradapura district is 53.3µg/L. Three litres of water drunk by an adult per day fulfil the daily requirement of iodine (150µg/L). With the iodised salt it may be many times more than the recommended intake. In spite of that the grade 2 goitre prevalence is also high among the children in the district.
- Daily intake of 2000µg of iodine should be regarded as excessive or potentially harmful. Therefore developed countries had set up safe intake levels for adults as follows[5]:

Australia	2000µg
UK	1000µg
USA & Canada	1100µg

- The high levels of iodine in salt and drinking water have contributed to a marked increase of iodine intake among children in all the districts.
- There is now compelling evidence that such **excess** can give rise to **thyroid dysfunction and lead to goitre**. Adverse effects includes increased incidence of **auto immune thyroid** and possibly **papillary cancer in thyroid**.

With the universal programme going on in a country monitoring and evaluation of the programme is really necessary because both iodine deficient and iodine sufficient population are involved with the programme. In addition, iodine fortified foods are freely available in Sri Lanka at present and high iodine levels were found in drinking water in some parts of Sri Lanka, e.g Anuradapura. Therefore it is very important to control the quality of iodised salt at the level of production, importation, retail and consumer. It is also important to revise optimal levels of iodine in the salt time to time in relation to the urine iodine levels of the population.

It is recommended the following action be considered:

- Creating regular awareness sessions among the salt manufacturers on the importance of monitoring iodine level. Such awareness sessions should be supplemented by field visits to sites where salt iodisation takes place to provide guidance on the correct procedures.
- Ensure regular quality control of iodine concentration in salt at the point of production for each batch by using titration method with the preparation of guidelines and formats for monitoring and assessment of iodised salt.
- Preparation of guidelines and training of peripheral health staff on periodic monitoring of salt iodine levels in production sites, retail shops and households.

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Herewith I am submitting the report of the above project. Thank you for your assistance.

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