Iodine deficiency among school children aged 6-18 years in Sri Lanka

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Abstract

Objectives: To estimate the prevalence of goitre, urinary iodine levels among school children aged 6-18 years and to measure the iodine in household salt.

Methods: Cross-sectional study including randomly selected 1798 children from 30 schools in NuwaraEliya district which has the highest elevation in Sri Lanka, were assessed for goitre by the palpation and urinary iodine levels. Iodine content was analysed in the 4177 samples of salt used in the households of schoolchildren.

Findings: Overall prevalence of goitre in the districts was 2.8% (CI=2.0-3.9%). The goitre prevalence significantly increases during 10-14 years aged group in both sexes. Total goitre rate was higher among females (4.6%) than among males (1.0%). The median urinary iodine level was 129.5μg/L (range 2.7-1646.8μg/L) and was higher among males (139.6 μg/L) than females (119.6 μg/L). Only 0.7% of children had values below 20μg/L, indicating a severe iodine deficiency. Household level adequacy of iodisation was 66.4% and median iodine content was 17.9 mg/kg (range 1.5 - 264.0 mg/kg) in the district.

Conclusions: These results indicated that optimal iodine nutrition has achieved in the NuwaraEliya district of Sri Lanka. Effective monitoring programme is needed to control the wide variation of iodine content in salt which is a priority.

Keywords: Iodine deficiency, urinary iodine, iodised salt, Sri Lanka

Introduction

Iodine deficiency is likely to be the single most common preventable cause of mental retardation and brain damage[1]. In 1990, 1572 million people in the world suffered from iodine deficiency. When we go down the memory lane of the history of Sri Lanka, the problem of endemic goitre was recognised by researchers since 1843[4,5,6,7,8,9]. Goitre belt was found to extend throughout the Western, Sabaragamuwa, Central, Southern and part of Uva province. In the wake of this, the universal iodisation of salt was to come into operations from 1st of January 1995 and potassium iodate was designated as the sole source of iodine[10]. Iodised salt was also brought under food regulation. Since then non iodised salt was banned on sale under the food act.

Sri Lanka is an island situated in the Indian Ocean with the total land area of 65,610 sq. km. Its greatest width and length are 225 and 435 kilometres respectively. Sri Lanka is divided into three ecological zones, nine provinces and 25 administrative districts. The total population of the country was 18.7 million in 2001[2].

The national study was conducted by the Medical Research Institute in 2000/1 and found 20.9% of schoolchildren had visible or palpable goitre indicating it as a public health problem in Sri Lanka even at present [11]. The iodine nutritive status was optimum in all the provinces of Sri Lanka other than in Uva province which showed a mild degree of iodine deficiency. It was found that only 49.5% of households had adequate levels of iodine in salt.

Not many studies were available on iodine deficiency of adolescence. Therefore it was decided to carry out a rapid assessment among children including both primary schoolchildren and

adolescence in an endemic area after two years of the national survey. We aimed to estimate the prevalence of goitres in the school children of age 6-19 years, to determine the urinary iodine levels and to measure the iodine levels in household salt.

Methods

School children aged 6-19 years in the NuwaraEliya district, which has the highest elevation (about 2400M from the sea level) in Sri Lanka were included in the sample. The population of the district is 550,000 with the average temperature from 12.3 to 20.1^{0}C and the rainfall is about 2082.5 mm/year.

The sample size of 1800 was calculated by taking the prevalence of goitre rate among children was 30%, confidence interval was 95% and the error was 5%. The sampling frame was the list of all the schools in the district categorised by sector (urban, rural/estate). Stratified sampling was used to select 30 schools according to the population of children in selected age group proportionate to the urban and rural/estate schools in the district. Children from grade 2 – 11 from each school were identified as the study population. Classes from each grade in each school varied. One class from each grade was randomly selected from each school.

All children in the selected classes were given consent forms to obtain the consent from their parents/guardians through the class teacher and were provided with polythene bags to get the sample of household salt on the prefixed date.

Eight to ten children were randomly selected from each selected class out of children who had obtained the consent of their parents and were present on the day of the study from the attendance register. When the required number of 60 children was not in the selected schools the remaining number of children was included from the closest school which was already selected for the study.

Three trained field investigators determined the size of thyroid by palpation and the goitre was graded according to the WHO/ICCIDD/UNICEF/1994[13]. Around 50% of the children were re-examined for goitre by the Nutrition Assistant who was specially trained to palpate goitre.

Sixty casual urine samples were obtained from children in each school in the morning during school hours and stored at -20^{0}C until analysed. Urine iodine was assessed by using simple modified microplate method[14]. Internal and External quality control was assessed with samples which were sent from the laboratory of CDC/Atlanta.

Salt samples, which were brought by the children who were subjected to the study, were sent to the laboratory to test the iodine by titration method. Other salt samples were tested by the rapid test kit.

The study was approved by the ethics committee of the Medical Research Institute. Written permission was obtained from the relevant Health and Education authorities. The data was entered to the EPI/INFO package and the SPSS software package was used to analyse the data. The study period was February to March 2003.

Results

All the children had obtained the consent from parents. A total of 1800 children included in the study. Of them, 907 (50.4%) were males and 893 (49.6%) were females. Children were categorised into three groups by age, i.e. primary schoolchildren (6-9.9 years), early adolescence (10-14.9 years) and late adolescence (15-19 years).

Prevalence of goitre

Among the 10-14 year age group, 3.6% had Grade 1 goitre and 0.2% had Grade2 goitre (Table 1). The total goitre prevalence between age groups varied with the highest prevalence noted in the 10-18 year age group (3.8%) which is significantly higher than the 5-9 and 15-19 year age groups (2.4%). Grade 2 goitre rates were low, ranging from 0.1-0.2%. Overall prevalence of goitre is 2.8%. This indicated the goitre is no longer a public health problem in the district.

Total goitre rate was higher among females (4.6%) than among males (1.0%). The highest total goitre prevalence among female children was in the age group 12-18 age groups (6.0%). The goitre rate is significantly higher among 12-18 year age group than among 6-11 year age group in both sexes. The goitre prevalence significantly increases with the increasing age in both sexes. Though there is no exact pattern of relationship with goitre and age, the goitre prevalence is highest at the age of 14 years in both males and females, i.e. 2.2% and 18.2% respectively. But this observation should be interpreted cautiously due to low sample sizes.

Goitre rates were compared among the children in urban and rural/estate sectors (Table 5). There is no significant difference of prevalence of goitre in both age groups in relation to the sector.

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 both age groups in NuwaraEliya district in a range of 2.7-1646.8μg/L (Table 6). Thirty two children had not given urine samples, i.e. 1.8% of the total sample.

Urinary iodine levels by sex

Table 7 shows that median urinary iodine levels among males was 139.6 μg/L and was higher than females (119.6 μg/L). It is important to note that an adequate urine iodine levels among males and females in both age groups.

Study of the **frequency distribution of urinary iodine levels by age groups** shows that 38.9% of the children had urine iodine levels in the 'adequate' range while 35.4% had lower values and 25.7% had higher values (Table 8). Of those who had lower values, only a small percentage (0.7%) had very low values of <20μg/L, indicating a severe iodine deficiency.

The group that had iodine levels of above 300μg/L indicating a possible excessive iodine intake, the percentages ranged from 9.1% in the 6-11 years age group and 11.8% in the age group of 12-18 years. It indicates the wide variation in the distribution of urinary iodine levels in the district without much variation with the age group.

Estimation of iodine levels in salt samples from households

Each school child in the selected class was requested to bring a sample of salt from his/her home. Salt samples, which were brought by the children who were selected for the goitre and urine study, were sent to the laboratory for testing with titration method. Other salt samples were tested by the rapid test kits to determine the level of iodination.

A majority of children brought samples of salt from 'home'. There were 4117 salt samples. Of which 2734 (66.4%) samples were brought by the children who were not selected for the study. The results of MBI rapid test kit for those 2734 samples were presented in Table 9. About 18.2% of samples had no iodine according to the results of MBI 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 at 15 mg/kg as specified in the present legislation of Sri Lanka. According to this specification, only 49.2% of the samples were 'adequately iodinated' (Table 9). Some amount of iodine i.e. 0-15mg/kg was present in 32.5% of samples.

The salt samples, which were brought by the study population, were tested by the titration method in the laboratory. About 1383 (76.8%) children out of 1800 of the study population brought salt samples from their households. As shown in the Table 10, the median iodine content of salt did not show much variation, with the age. However, it is important to note the extremely wide variation of the iodine content in the salt at household level in NuwaraEliya district (1.5 - 264.0 mg/kg). Similar findings were observed in the study conducted in year 2000/1[11].

According to the Table 11, the frequency distribution of the iodine content of salt at household level did not show much variation, with the age. Table 11 shows that 66.4% of salt samples 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 salt samples had iodine values higher than 25mg/kg.

The iodine deficiency status in NuwaraEliya district, Sri Lanka, according to the WHO classification (criteria) is presented in Table 12, based on the findings of the study. Taking the prevalence of goitre and median urinary iodine levels as the indicators, iodine status among both age groups could be considered as satisfactory.

It is interesting to note that the iodine status of both age groups was satisfactory in spite of the fact that the proportion of households with intake of salt with adequate levels of iodine was inadequate.

. There was no data to compare on urinary iodine excretion before the USI.

Discussion

This study was carried out in the district of the highest elevation in the country and considered as the mountainous area. Palpation has been used in 1986/7 study to estimate the prevalence of goitre which was carried out before the USI indicated that high prevalence of goitre (27.6%) in this district among schoolchildren aged 5-20 years[9]. This study showed that the introduction of iodised salt had a very positive impact on goitre prevalence which decreased in the district studied from 27.6% to 2.7%. Our results show that the prevalence of goitre increased with the age mainly during the growth spurt and then again decreased and comparable with the early age – it was 1.

Conclusion

NuwaraEliya district in Sri Lanka has achieved the goal in eliminating IDD as a public health problem as indicated by urinary iodine levels and the 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 and the need for regular monitoring of the process of iodination and the monitoring at the level of manufacture and at household level.

It is recommended the following action be considered:

- Creating regular awareness sessions among the salt manufacturers as 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 retail shops and households.

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Table 1

Goitre prevalence in children of 6-19 years by sex

Age Years	Sex	Total examined	Prevalence of goitre (%)			Total goitre rate* % (CI)
			Grade 0	Grade 1	Grade 2	
6 - 9.9	Male	460	99.6	0.4	0.0	0.4
	Female	431	97.0	3.0	0.0	3.0
	Total	891	98.3	1.7	0.0	1.6
10 – 14.9	Male	282	98.2	1.8	0.0	1.8
	Female	293	90.8	8.5	0.7	9.2
	Total	575	94.4	5.2	0.3	5.4
15 – 19	Male	165	98.8	1.2	0.0	1.2
	Female	167	98.8	1.2	0.0	1.2
	Total	332	98.8	1.2	0.0	1.2
Overall		**1798**	**97.2**	**2.7**	**0.1**	**2.8 (2.0-3.5)**

CI = Confidence Interval Total goitre rate = Goitre grade 1+2 (*x^2=22.24, P=0.00001)

Table 3

Prevalence of total goitre by age and sex

Age	% of goitre in Male			% of goitre in Female		
Years	**No.examined**	**TGR***	**CI**	**No.examined**	**TGR****	**CI**
6 - 9.9	458	0.4	0.1-1.2	422	2.8	2.0-5.3
10 – 14.9	282	1.8		271	9.2	
15 – 19	165	1.2	0.1-3.1	162	1.2	3.8-8.8
Overall	**905**	**1.0**	**0.3-1.7**	**855**	**4.6**	**3.2-5.9**

TGR=grade 1 and 2 goitre CI = Confidence Interval (*x^2=4.27, P=0.19 and **x^2=20.5, P=0.00003)

Table 4

Prevalence of goitre by age and sex

Age	% of goitre in Male		% of goitre in Female		Total % of goitre		
Years	**No.**	**TGR***	**No.**	**TGR****	**No.**	**TGR*****	**CI**
6	111	0.0	100	3.0	211	1.4	-0.1-2.9
7	114	0.9	117	0.0	231	0.4	-0.4-1.3
8	126	0.0	115	3.5	241	1.7	0.2-3.2
9	112	0.9	107	7.5	219	4.1	1.3-6.2
10	101	2.0	121	5.8	222	4.1	1.5-6.1
11	32	0.0	32	6.3	64	3.1	-1.5-4.8
12	5	0.0	6	0.0	11	0.0	-
13	98	2.0	106	11.3	204	6.9	3.7-10.5
14	46	2.2	22	18.2	68	7.4	2.2-12.5
15	101	2.0	110	0.0	211	0.9	-0.4-2.3
16	41	0.0	32	6.3	73	2.7	-0.8-6.3
17	13	0.0	18	0.0	31	0.0	-
18	7	0.0	5	0.0	12	0.0	-
All	**907**	**1.0**	**891**	**4.7**	**1798**	**2.8**	**2.0-3.5**

TGR=Total Goitre Rate (both grade 1 and 2 goitre) (*x^2=31.4, P=0.001, **x^2=31.4, P=0.002, ***x^2=31.4, P=0.002)

Table 5

Prevalence of goitre by age and sector

Sector	Urban		Rural/Estate		**Overall**		
	No.	**TGR***	**No.**	**TGR****	**No.**	**TGR*****	**CI**
6 - 9.9	247	2.8	139	3.6	386	3.1	1.6-4.2
10 – 14.9							
15 – 19	940	2.2	472	3.8	1412	2.8	1.8-3.6
Overall	**1187**	**2.4**	**611**	**3.8**	**1798**	**2.8**	**2.0-3.5**

CI=Confidence Interval (*x^2=0.01, P=0.7, **x^2=2.36, P=0.1, ***x^2=2.4, P=0.1)

Table 6

The levels of urine iodine by age

Age Years	Total* examined	Median urinary iodine concentration (µg/L)*	Range (µg/L)
6 - 9.9	871	118.8	2.7 - 1079.6
10 – 14.9	571	139.3	15.4 – 1646.8
15 – 19	326	143.3	13.4 – 770.0
Overall	**1768**	**129.5**	**2.7 - 1646.8**

(* F=8.9, P=0.0001)

Table 7

Prevalence of median urinary iodine levels by age and sex

Age	Male Median urinary iodine (μg/L)*			Female Median urinary iodine (μg/L)**		
Years	**No.**	**Median**	**Range (μg/L)**	**No.**	**Median**	**Range (μg/L)**
6 - 9.9	453	127.7	18.1-1079.6			
10 – 14.9	281	144.9	15.6-1646.8			
15 – 19	164	160.9	13.4-770.0			
Overall	**898**	**139.1**	**13.4-1646.8**			

*F=4.8, P=0.008,

Table 8

Frequency Distribution of urinary iodine levels

Age group Year	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
6 - 9.9	1116	0.9	8.2	28.9	38.6	14.2	9.1
10 – 14.9							
15 – 19	602	0.2	4.3	25.7	39.5	18.4	11.8
Overall	**1768**	**0.7**	**6.9**	**27.8**	**38.9**	**15.7**	**10.0**

Table 9

Adequate iodination of salt (mg/kg) at household level

Age group in years	No.	Level at the rapid test kit positive (%)		
		0ppm	0-15ppm	>15ppm
6 - 9.9	2138	18.5	33.2	48.3
10 – 14.9				
15 – 19	596	17.1	30.5	52.3
Overall	2734	18.2	32.5	49.2

Table 10

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)
6 - 9.9	931	17.9	1.5-423.5
10 – 14.9			
15 – 19	449	18.5	2.6-132.2
Overall	**1380**	**17.9**	**1.5-423.5**

Table 11

Frequency distribution of iodine level in salt at household levels

Age group in Years	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
6 - 9.9	933	35.2	39.8	22.7	1.8	0.5
10 – 14.9						
15 – 19	450	30.2	45.6	21.1	2.7	0.4
Overall	**1383**	**33.6**	**41.6**	**22.2**	**2.1**	**0.5**

Table 12

Iodine deficiency status in NuwaraEliya district, Sri Lanka by age groups according to the WHO classification

Age group in Years	Indicators		
	Goitre	Median urinary iodine (μg/L)	% of household using adequately iodise salt (>15ppm)
6 - 9.9	2.4 Normal	122.7 Ideal	64.8 Inadequate
10 – 14.9			
15 – 19	3.8 Normal	143.3 Ideal	69.8 Inadequate
Overall	2.8 Normal	129.5 Ideal	66.4 Inadequate

Table 13

Progress of iodine nutrition status in NuwaraEliya district, Sri Lanka

8 years after the implementation of universal salt iodisation

District	1986/1987		2003	
	No. Examined	Prevalence of Goitre (%)	No. Examined	Prevalence of Goitre (%)
NuwaraEliya	4438	27.6	1798	2.7

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Editor,

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Submission of a manuscript

Herewith I am submitting a paper on progress of eliminating iodine deficiency disorders in Sri Lanka. This material has not been submitted for publication elsewhere. Summary of the study findings was submitted to the SEARO office who have funded for this study and the Ministry of health to implement the recommendations.

I agree to transfer copyright to the WHO if the article is selected for publication.

Thanking You.

Yours truly,

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Dr. Renuka Jaytissa

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Dr. Rukshana Haide