Chapter 10

ASSESSMENT OF IODINE DEFICIENCY DISORDERS IN URBAN SCHOOLCHILDREN OF LOWER SOCIOECONOMIC STATUS FROM TAMIL NADU STATE

10.1. SUMMARY

Urban iodine replete and well-nourished affluent schoolchildren from Shimla public schools had smaller thyroid volumes (chapter 9) in comparison to WHO 2001 thyroid ultrasonography reference. These children had restricted flavonoids intake being on mountains. As there is regional dietary variation in all the States of India, a state other than Himachal Pradesh in North India was selected from South India. The Capital City of Tamil Nadu, Chennai is on plain land.

Present study was conducted to assess iodine deficiency disorders in schoolchildren of lower socioeconomic status by measuring spot urinary iodine levels. The median urinary iodine pointed to sufficient iodine intake. Iron deficiency anaemia was more common. The thyroid size of these iodine replete children was measured by ultrasonography.

The vegetables and cooking-oils consumed in this area are different to those used in Himachal Pradesh. The study was performed on schoolchildren from lower socioeconomic status in separate boys and girls school and also from middle socioeconomic status in one co-education school. The age range was from 5 to 50 years. The subjects were on a mixed diet. Urine samples were collected for iodine (UI) measurement (Method L). All were palpated first for goitre and the thyroid volume (TV) was measured ultrasonographically using a 10MHz probe. Anthropometric measurements were performed. BSA, BMI and Z score for weight-for-age, height-for-age, and weight-for-height and BMI were derived. Medians and 97th percentiles thyroid volumes of 6 - 15 year children were compared to WHO 2001reference.

Thus the severity of malnutrition (WHO classification) based on stunting and undernutrition indices classified 6 - 15 year schoolchildren as low and high respectively. 65% of schoolchildren were pale. None of the children had vitamin A deficiency. The median UI for 6 - 15 year girls and boys was 318 µg/l and 362 µg/l respectively. 16 – 18 year girls and boys had median UI of 301 µg/l and 313 µg/l respectively. Goitre prevalence by palpation was 9% in 6 - 15 year schoolchildren and 14% in 16 – 18 year schoolchildren. Goitre prevalence by ultrasound was %. The median and 97th percentiles for TV estimated for age and BSA by gender were much smaller (almost one third to one half) than European schoolchildren of WHO 2001 reference. By comparison thyroid size for BSA and age was greater in iodine sufficient children from Gujarat (Table 1).

10.2. INTRODUCTION

Urban iodine replete and well-nourished affluent schoolchildren from Shimla public schools had smaller thyroid volumes (chapter 9) in comparison to WHO 2001 thyroid ultrasonography reference. These children were on par nutritionally with WHO standards. They had limited and restricted flavonoids intake being on mountains and represented normative thyroid volume reference. The Capital city of Tamil Nadu, Chennai is cosmopolitan cultural city with a 100% literate population on a plain land. There was universal salt iodization implementation in India up to September 2000. The long-term goal of salt iodization is elimination of iodine deficiency and reduction of the goitre rate to < 5% in school-aged children. Normalization of the goitre rate probably indicates disappearance of iodine deficiency disorders as a public health problem. However, thyroid size may not return to normal for months or years after correction of iodine deficiency.

Present study was conducted to assess iodine deficiency disorders in schoolchildren of lower socioeconomic status by measuring spot urinary iodine levels. Iron deficiency anaemia is common in India.

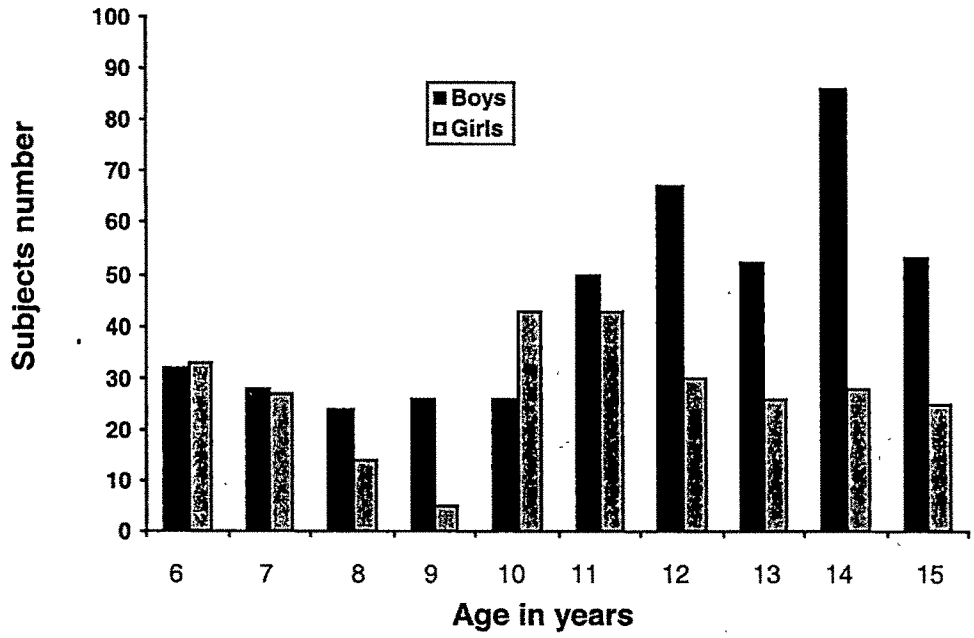
The thyroid size of iodine replete children was measured by ultrasonography to establish normative thyroid volume reference data.

Iron deficiency impairs the efficacy of iodine supplementation (Azizi F, 2002), we studied the relation between serum ferritin and thyroid size, and urinary iodine

10.3. SUBJECTS

The subjects were schoolchildren and some of the staff members from lower to middle socioeconomic status in separate boys and girls schools and a co-education school. The age range was from 5 to 62 years. The 5-year-old children were 52 in number with 37 boys and 15 girls. The total number of children in the 6 – 15-year range was 718 with 444 boys and 274 girls. The age distribution is shown in figure 10.1. There were 60 subjects (42 women and 18 men) in the age range of 16 – 18 years. The adults were 11 females in the age range 30 - 50 years. Thus total number of studied subjects was 841.

FIGURE 10.1. AGE DISTRIBUTION OF 6 – 15 YEAR SCHOOLCHILDREN



10.4. DIET

Most of the subjects (more than 60%) were on a mixed diet and consumed at least eggs if not meat whereas the remaining subjects were purely vegetarian. The consumption of rice was more than that of wheat but pearl millet was not the usual cereal (less than 1% consumed pearl millet). The vegetables consumed were common like potatoes, tomatoes, carrots and beans. The cooking oils used were sunflower and coconut. The subjects consumed iodised salt.

10.5. METHODS

10.5.1. Nutrition

The nutritional status was established from direct and derived indices anthropometric measurements of parameters using standard techniques (chapter 3.4.3.2.). Z-scores for height-for-age (HAZ), weight-for-age (WAZ) and BMI (BMIZ) and the centiles for height, weight and BMI were calculated with the help of software programme based on WHO growth reference. Weight-for-height (WHZ) was calculated from the formula (chapter 3.4.3.1.).

10.5.1.1. WORLD HEALTH ORGANIZATION (WHO) CLASSIFICATION FOR PEM

Z-score deficits (-2 SD) as calculated for HAZ, WAZ and WHZ for all children and adults in the age group of 16-19 years (chapter 3.4.3.1.). These deficits gave rise to three indicators of PEM, stunting, underweight and wasting respectively. These deficits classify the severity of PEM by the percentage prevalence ranges as shown in table 3.5. These reference ranges, however, are only for children less than 5 years of age (WHO, 1995).

10.5.2. Iodine Intake

As it is difficult to measure iodine intake directly from the ingested food, indirect estimation was obtained from the iodine excreted in urine.

10.5.2.1. URINARY IODINE

Spot urine samples were collected from every fourth child and stored at – 20 C until analysis. Method L (Hitachi) (chapter 3.4.1.2.1.) was used to measure urinary iodine. A single iodine laboratory was responsible for all urinary iodine determinations.

10.5.3. Thyroid size

10.5.3.1. PALPATION

All subjects were palpated for goitre and classified in to three simplified goitre grades (chapter 3.4.1.1.1.).

10.5.3.2. THYROID VOLUME

Thyroid ultrasonography was performed using a portable thyroid ultrasound machine with a 7.5MHz linear transducer. Volume of each lobe was calculated (chapter 3.4.1.1.2.). The volumes of both lobes were summed.

10.6. RESULTS

10.6.1. Nutritional status

10.6.1.1. WHO CLASSIFICATION

Preschool children: 5-year old

Stunting was seen in 31% of children (16/ 52) but 50% of girls and 21% of boys were affected. None of the children was undernourished.

6 to 15 year schoolchildren

Stunting was evident in 10% of subjects (73/ 718) with 13% being boys (58/ 444) and 5% (15/ 274) of the girls. Thus the severity of malnutrition based on this index would be classified as low (Table 3.5.).

Undernutrition was seen in 24% of subjects (169/ 718). 17% of girls (46/ 274) and 28% of boys (123/ 444) were undernourished. Thus the severity of malnutrition based on this index would be classified as low in girls and high in boys (Table 3.5.).

16 to 18 year schoolchildren

2 girls (5%) and 9 boys (50%) were stunted. Thus the severity of malnutrition based on this index would be classified as low in girls and very high in boys (Table 3.5.).

Under-nutrition was seen in 50% of girls (20/ 40) and 55% of boys (10/ 18). Thus the severity of malnutrition based on this index would be classified as very high in both girls and boys (Table 3.5.).

10.6.2. IRON DEFICIENCY ANAEMIA

The pallor was not seen in 278/ 785 subjects (35%). One, two and three degree pallor was seen in 50%(394/ 785), 13% (104/ 785) and 2% of subjects.

One degree pallor: Only one child of < 6 years was affected whereas 129 girls (47%) and 53 boys (12%) were in the age range 6 – 15 years. 50% of girls in the age range 16 – 18 years were also affected.

Two-degree pallor: 14% of girls and 12% of boys affected were in the age range 6 – 15 years, 23% of girls and 22% of boys affected were in the age range 16- 18 years.

Three-degree pallor: All affected in this category were females in the age range 11 to 16 years.

HAEMOGLOBIN

6 – 15 YEAR SCHOOLCHILDREN

The haemoglobin was measured in 118 girls and 165 boys. The median Hb concentration was 11.6 gm/dl (IQR = 10.2 – 12.6 gm/dl) in girls and 12.6 gm/dl (IQR = 10.7 – 13.6 gm/dl) in boys.

16 – 18 YEAR SCHOOLCHILDREN

The haemoglobin was measured in 21 girls and 12 boys. The median Hb concentration was 10.2 gm/dl (IQR = 9.2 – 11.1 gm/dl) in girls and 13.9 gm/dl (IQR = 13.1 – 14.6 gm/dl) in boys.

ADULTS

The haemoglobin was measured in 18 women and 9 men. The median Hb concentration was10.7 gm/dl (IQR = 9.7 – 12.6 gm/dl) in women and 13.6 gm/dl (IQR = 12.9 – 14.4 gm/dl) in boys.

10.6.3. VITAMIN A DEFICIENCY

None of the child suffered from vitamin A deficiency as evidenced from the clinical examination for night blindness and Bitot' spot.

10.6.4. URINARY IODINE

Below 6 years

In girls, the median and interquartile range (IQR) of UI was 405 (319 - 512) µg/l.

In boys, the median UI and IQR were 362 (210 - 432) µg/l.

6 - 15 year schoolchildren

The median UI was 318 µg/l (IQR = 184 – 487 µg/l) in girls and 362 µg/l (IQR = 210 – 432 µg/l) in boys. Only 11% girls and 14% boys had UI below 100 µg/l. None of the children had UI below 50 µg/l.

16 –18 year schoolchildren

The median UI was 301 µg/l (IQR = 207 – 375 µg/l) in girls and 313 µg/l (IQR = 254 – 374 µg/l) in boys.

Thus this schoolchildren population of Chennai (Tamil Nadu) was iodine replete.

10.6.5. THYROID SIZE

10.6.5.1. PALPATION

Thyroid was palpable for goitre grade 1 in 66/ 830 (8%). The type of goitre was simple. Goitre grade 2 (diffuse goitre) was seen in three subjects (0.2%).

Below 6 years

None of the children had palpable goitre.

6 – 15 year schoolchildren

24/ 274 girls (9%) and 38/ 444 boys (9%) had grade 1 goitre.

16-18 year schoolchildren

None of the boys had palpable goitre but 6/ 42 girls (14%) were palpable for the same.

Adults

One woman (9%) had palpable goitre.

10.6.5.2. ULTRASONOGRAPHY

6 - 15 YEAR SCHOOLCHILDREN

The median and 97th percentile thyroid volume values for age by gender are shown in Table 10.1. The 97th percentile values for boys and girls were high (Figure 10.2.) thereby showing that goitre is a health problem in more than at least 5% of the schoolchildren population. These values were compared to corrected WHO reference 2001.

The median thyroid volumes for age values were more or less similar to WHO 2001 reference. 97th percentile thyroid volumes for age values were much greater than WHO 2001 reference as shown in Table 9.2 and Figure 10.1.

The thyroid volume was measured in 198 girls and 431 boys. The goitre was seen in 10% of girls overall but in more than 22% of the girls in the age range 14 to15 years. 8% of boys had thyroid enlargement and most affected age was 7 years. The goitre-affected children by percent are shown in Table 10.3.

16-19 YEAR SCHOOLCHILDREN

The thyroid volume was measured for 37 girls and 20 boys in this age group. The upper limit for normality considered was 18 ml. The girls did not show any enlargement but 5% of boys were affected.

The median thyroid volume for age was 7.8 ml (IQR = 5.9 - 9.1 ml) in boys and 6.0 ml (IQR = 5.0 - 7.8 ml) in girls whereas 97th percentile thyroid volume for age was 18.6 ml in boys and 12.9 ml in girls.

ADULTS

20-50 year

The median thyroid volume in men was 7.8 ml (IQR = 5.9 – 9.1 ml) and in women it was 7.6 ml (IQR = 6.5 - 9.8 ml). 97th percentile thyroid volume values were 17.6 ml in men and 20.3 ml in women.

Over 50 years

The median thyroid volume in men was 8.2 ml (IQR = 6.4 – 8.6 ml) and in women it was 7.9 ml (IQR = 5.2 - 16.7 ml). 97th percentile thyroid volume values were 10.6 ml in men and 17.9 ml in women.

TABLE 9.1. THYROID VOLUME RESULTS OF 6 – 15 YEAR SCHOOLCHILDREN

	BOYS			GIRLS		
AGE	3%	MEDIAN (IQR)	97 %	3%	MEDIAN (IQR)	97 %
6	1.7	2.7 (2.3 – 3.0)	3.5	1.3	2.6 (2.1 – 2.8)	2.8
7	2.3	3.1 (2.7 – 4.0)	5.2	1.8	2.7 (2.6 – 3.5)	5.3
8	1.4	3.4 (2.8 – 3.9)	4.6	1.8	3.4 (2.6 – 3.7)	5.8
9	2.1	3.6 (3.1 – 4.5)	6.3	2.6	3.5 (2.8 – 4.4)	5.6
10	2.1	3.7 (3.1 – 4.2)	5.2	2.6	4.3 (2.9 – 5.3)	7.5
11	2.0	3.7 (2.9 – 4.4)	13.0	2.7	4.2 (3.2 – 4.7)	7.2
12	2.5	4.0 (3.1 – 5.7)	11.4	2.9	4.3 (3.6 – 5.4)	7.8
13	2.5	4.0 (3.3 – 5.1)	11.6	2.9	4.6 (4.1 – 6.8)	12.1
14	2.9	4.2 (3.2 – 5.4)	9.5	4.0	6.4 (4.8 – 10)	21.7
15	2.7	4.8 (3.9 – 6.6)	15.7	3.0	5.7 (4.8 – 8.3)	20.7

TABLE 10.2. COMPARISON OF THYROID VOLUME FOR AGE BETWEEN PRESENT (IODINE REPLETE), PREVIOUS (IODINE DEPLETE) STUDY AND WHO (2001 REFERENCE)

AGE	MEDIAN			97TH PERCENTILE		
	PRESENT CHENNAI	WHO 2001	PREVIOUS (GUJARAT)	PRESENT CHENNAI	WHO 2001	PREVIOUS (GUJARAT)
MALES						
6	2.7	2.3	*8.7*	3.5	3.8	*14.0*
7	3.1	2.4	*9.9*	5.2	4.0	*29.0*
8	3.4	2.6	*6.6*	4.6	4.3	*19.0*
9	3.6	2.9	*9.5*	6.3	4.8	*39.0*
10	3.7	3.2	*11.0*	5.2	5.5	*14.0*
11	3.7	3.6	*14.0*	13.0	6.4	*32.0*
12	4.0	4.0	*13.0*	11.4	7.4	*38.0*
13	4.0	4.6	*14.0*	11.6	8.5	*42.0*
14	4.2	5.2	*16.0*	9.5	9.9	*29.0*
15	4.8	5.8	*17.0*	15.7	11.4	*32.0*
FEMALES						
6	2.6	2.1	*8.8*	2.8	3.6	*15*
7	2.7	2.4	*9.2*	5.3	4.2	*36*
8	3.4	2.8	*9.7*	5.8	4.9	*32*
9	3.5	3.1	*8.8*	5.6	5.7	*17*
10	4.3	3.6	*11.9*	7.5	6.5	*17*
11	4.2	4.0	*13.4*	7.2	7.4	*45*
12	4.3	4.5	*14.9*	7.8	8.3	*48*
13	4.6	5.0	*15.1*	12.1	9.3	*30*
14	6.4	5.5	*16.5*	21.7	10.4	*32*
15	5.7	6.0	*15.9*	20.7	11.4	*34*

TABLE 10.3. AGE DISTRIBUTION AND PERCENTAGE AFFECTED BY GOITRE WITH ULTRASONOGRAPHY

	FEMALES (N = 198)		MALES (N = 431)	
AGE	NUMBER	GOITRE %	NUMBER	GOITRE %
6	6	0	21	0
7	17	18	13	23
8	18	11	13	7
9	13	0	19	16
10	5	20	29	3
11	32	3	67	12
12	31	0	77	9
13	27	7	95	7
14	22	23	60	3
15	27	22	37	5

FIGURE 10.2. COMPARISON OF MEDIAN THYROID VOLUME IN 6 – 15 YEAR SCHOOLCHILDREN BETWEEN CHENNAI AND WHO 2001 REFERENCE

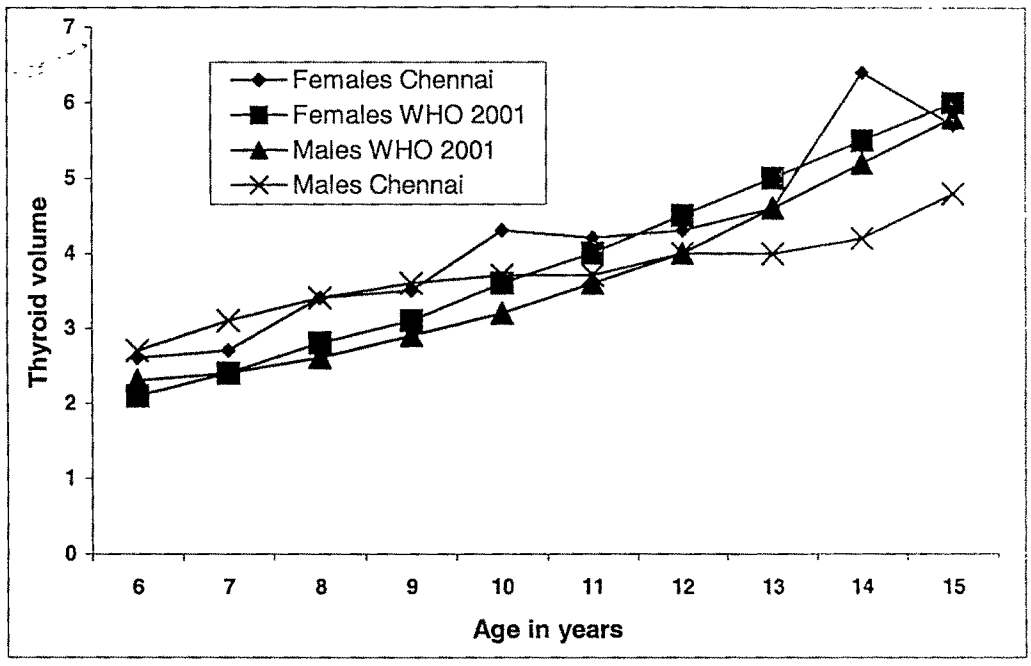
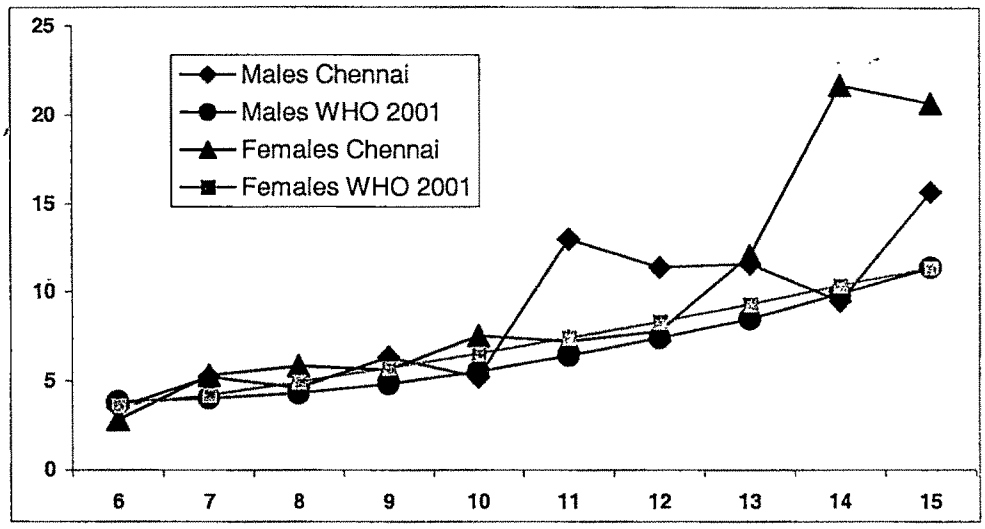


FIGURE 10.3. COMPARISON OF THYROID VOLUME (97TH PERCENTILE) IN 6 – 15 YEAR SCHOOLCHILDREN BETWEEN CHENNAI AND WHO 2001 REFERENCE



10.7. DISCUSSION

The schoolchildren from lower socio-economic status were iodine replete as evidenced from median urinary iodine levels. Vitamin A deficiency was not a common occurrence. These schoolchildren were anaemic as evidenced from median haemoglobin concentration in blood. When ultrasonographically measured thyroid volume was compared to the WHO 2001 international reference, thyroid enlargement was seen in 10% of schoolchildren thus goitre was a health problem in this population.

The causes for this thyroid enlargement could be protein energy malnutrition and anaemia. The pulses consumed lack in tyrosine amino acid which is the building block for thyroid hormone in thyroglobulin molecule. Iron is part of heme molecule that is an important constituent for peroxidase enzyme. The Iodide taken up by the acinar cell is converted to elemental iodine by enzyme peroxidase in the presence of H_2O_2. This elemental iodine combines immediately with tyrosine residue in thyroglobulin at 3 position forming mono-iodo-tyrosine.

Further studies are required to establish the role of iron in thyroid hormone formation.

10.8. CONCLUSIONS

The goitre is still a public health problem in Chennai (Tamil Nadu) and the severity of this problem based on clinical indicator of measurement of thyroid volume by ultrasound as well as by palpation of thyroid gland is **mild** (when 5 – 19.9% of schoolchildren have goitre by palpation and ultrasonography). The causes of this problem may be consumption of goitrogens, protein energy malnutrition and iron deficiency anaemia.