Chapter 4

BIOCHEMICAL ASSESSMENT OF IODINE DEFICIENCY DISORDERS IN BARODA AND DANG DISTRICTS OF GUJARAT AT FIELD CONDITIONS: A STUDY OF 1363 SCHOOLCHILDREN AND 959 ADULTS

4.1. SUMMARY

To date, no major survey that uses biochemical prevalence indicators of Iodine Deficiency Disorders (IDD) has been carried out in Gujarat State. The severity of IDD in Baroda and Dang Districts of Gujarat (Western India) was assessed using biochemical prevalence indicators of IDD. This would establish a biochemical baseline in a sub-sample of the larger population of Gujarat that could be used to monitor the effectiveness of iodine replacement programs. In the present study 1,363 children (0.01 - 15 years) and 959 adults (16 - 85 years) were studied and data were collected on dietary habits and anthropometric and biochemical parameters such as height, weight and urinary iodine (UI) and blood TSH respectively. BSA and BMI were calculated. Drinking water and salt consumed in different places were analyzed for iodine content.

The median UI was 65 µg/l (the interquartile range was 38 – 108 µg/l) in children and 73 µg/l in adults suggesting mild to moderate iodine deficiency. The mean TSH was 2.08 ± 2.06 mU/l in children and 1.59 ± 2.4 mU/l. in adults which is quiet high. Six to seven percent of the studied population had whole blood TSH values > 5 mU/l. Females from both districts were more affected by iodine deficiency as evidenced by lower true urinary iodine and higher mean TSH levels. Most of the subjects were vegetarian and consumed goitrogens. The interfering substances in the urine samples, postulated to be the goitrogens, were significantly higher in Baroda boys and Dang girls as compared to their counterparts ($p < 0.001$). Boys were more malnourished than girls as evidenced from lower BMI were. Dang district was more severely affected by IDD as compared to Baroda. Drinking water in Dang district was lacking in iodine content. Iodine in salt varied around 7 to 2000 parts per million.

The data from the present study, therefore, suggest that IDD is a public health problem in both districts of Gujarat. Baroda district (rural) is a new pocket of IDD. High amounts of dietary goitrogens, and lack of iodine in Dang water, account for IDD.

4.2. INTRODUCTION

Iodine deficiency disorders (IDD) encompass a variety of health problems caused by insufficient iodine in the diet. Iodine is an essential trace element supplied naturally by food and water for the normal synthesis of thyroid hormones. Normal human health, growth and development, particularly of the brain are directly dependent on thyroid hormone homeostasis (WHO, 1990). The thyroid is unique among the endocrine glands for its dependence on iodine for normal hormone production. A range of other goitrogenic

substances found naturally in the environment also influence thyroid hormone production and metabolism.

The fight against IDD remains one of the major public health challenges at the 21st century. Recent, WHO reports (1999) estimate that about 2 billion people (38 %) is at, risks of IDD in 130 countries out of total 191in the world.

One of the fundamental purposes of IDD surveillance is to determine the magnitude and distribution of IDD within a population. Measurement of the extent of IDD in a population indicates the severity of the problem. Assessment of IDD can provide a long-term monitoring, serve as an advocacy tool to highlight the extent of IDD problems, and stimulate action including the appropriate allocation of resources for eliminating IDD.

A combination of mainly clinical and biochemical parameters is used to assess the iodine status of a population. The biochemical indicators comprise urinary excretion of iodine (UI), serum thyroglobulin levels and serum thyrotropin (TSH) levels, whereas the clinical indicators include prevalence measures of thyroid size (goitre) and neurological disability such as cretinism (WHO/NUT/1994). Thyroid hormone measurement and radioiodine uptake are not recommended for surveillance purposes (WHO, 1994). Urinary iodine is the main impact indicator (WHO, 1999). For nearly half a century the benchmark method for determining the state of iodine nutrition has been the measurement of iodine excretion in the urine (Stanbury JB, 1994). Since most iodine that is absorbed is excreted in the urine, the UI level is a good marker of dietary iodine intake. While it is not generally possible to obtain 24 - hour samples of urine under field conditions, measurements of iodine concentration in a casual urine sample from 40 - 50 subjects is an excellent surrogate. The method is entirely objective and non-invasive, and it provides information on the one factor that can be addressed directly, ie iodine supply to the individual. The excretion of iodine indicates the recent, but not precisely the immediate intake of iodine. Urinary iodine measuring method has several

potential sources of error (May W et al, 1991). Blood spot TSH measurement is an excellent indicator for the case detection of hypothyroidism in neonates but may also be used as a surrogate measure of iodine nutrition in the entire community by looking at the skewness of the distribution of the entire set of blood TSH values (Stanbury JB, 1994). In a population survey, the collection of a blood spot on a filter paper can be used to measure TSH (WHO/NUT/1994). However, further study of TSH distributions among older subjects is needed to improve understanding of the specificity of their relationship to iodine deficiency. However, by its very nature it requires that universal neonatal screening be in place, a situation that is not generally found in a developing country like India.

Endemic goitre and cretinism are widely distributed over the subcontinent of India in a broad Himalayan and sub-Himalayan belt. There are more and more isolated pockets of endemic goitre being reported from different parts of India.

To date, no major survey that uses biochemical prevalence indicators of IDD has been carried out in Gujarat State. Our objectives were

1. To assess the severity of IDD in Baroda and Dang districts of Gujarat State using biochemical prevalence indicators of IDD,
2. To establish a biochemical baseline in a sub-sample of the larger population of Gujarat, that could be used to monitor the effectiveness of iodine replacement programs.

4.3. SUBJECTS AND METHODS

4.3.1. POPULATION STUDIED:

The study group comprised 1363 children (aged 3 days -15 years) and 959 adults (16-85 years). Of children, 1121 tribal children were selected randomly by school visits from boarding and day schools in various villages (viz., Vaghai, Dediapada, Rutambhara, Baripada, Dungarda and Rambhas) in Dang district. Two hundred and forty-two rural children were included from the villages of Muval and Tentalav in Baroda district by household surveys. There were 641 boys and 722 girls (M: F = 0.8) (Table 4.1.). Adults were selected randomly by home surveys and school visits. Figure 4.1. shows their age and sex distribution. There were 504 males and 455 females (M: F ratio = 1.1: 1). There were 604 rural subjects (327 males and 277 females) that belonged to two villages of Baroda district and stayed in their homes. Tribals (n = 355) from Dang district included 178 males and 177 females, 148 resided at home and 207 were boarding school residents (Table 4.2.). These boarding were meant for tribal children below the poverty line and were run from the Government funds, which was a lump sum of rupees 250 per month per child. Information on age, sex, height and weight was recorded. Urine samples for urinary iodine (UI) and blood spots for TSH determination were collected.

4.3.2. URINARY IODINE (UI):

Since casual urine samples were collected, it was desirable to measure about 300 from a population group to allow for varying degrees of subject hydration and other biological variation between individual (A sample of 200 specimens would give a relative precision of 20 %, eg. 50 ± 10 % below 100 µg/l). UI analysis used a Technicon Autoanalyzer II (Sandell EB, 1937 and May SL, 1997).

4.3.3. BLOOD SPOT TSH:

Commercially available Bioclone neonatal thyrotropin (TSH) Elisa kits for the quantitative determination measured TSH.

4.3.4. ANTHROPOMETRY:

Weight and standing height for all subjects were collected. BSA and BMI was calculated

4.4. RESULTS

4.4.1. URINARY IODINE LEVELS

CHILDREN:

The median total UI (true UI plus interfering substances) was 148 μg/l and true UI level was 65 μg/l (IQR 38 - 108) (Table 4.3.). Large amounts of interfering substances were detected in urine, presumably due to goitrogens (May S, 1990). The median serum TSH level was 1.58 mU/L (IQR 0.56 - 3.2) (Table 4.3.).

TABLE 4.1. GEOGRAPHICAL, RESIDENTIAL AND SEX-WISE DISTRIBUTIONS OF CHILDREN

District	Subjects	village	Males	Females	Home	boarding	Total
Baroda	242	Muval	113	68	181	-	181
		Tentalav	43	18	61	-	61
Dang	1121	Vaghai	233	238	414	57	471
		Dediapada	14	19	15	18	33
		Rutambhara	-	216	-	216	216
		Baripada	15	11	-	26	26
		Saputara	68	17	85	-	85
		Rambhas	51	39	-	90	90
		Dungarda	104	96	74	126	200

TABLE. 4.2. DISTRIBUTION OF THE ADULTS (N = 959) BASED ON GEOGRAPHY, RESIDENCE AND GENDER

District	Subjects	village	Males	Females	Home	boarding	Total
Baroda	604	Muval	232	208	440	-	440
		Tentalav	95	69	164	-	164
Dang	355	Vaghai	107	75	124	58	182
		Dediapada	2	12	0	14	14
		Rutambhara	-	91	0	91	91
		Baripada	40	0	0	40	40
		Saputara	24	0	24	0	24
		Rambhas	4	0	0	4	4

FIGURE 4.1. AGE AND SEX DISTRIBUTION OF ADULTS

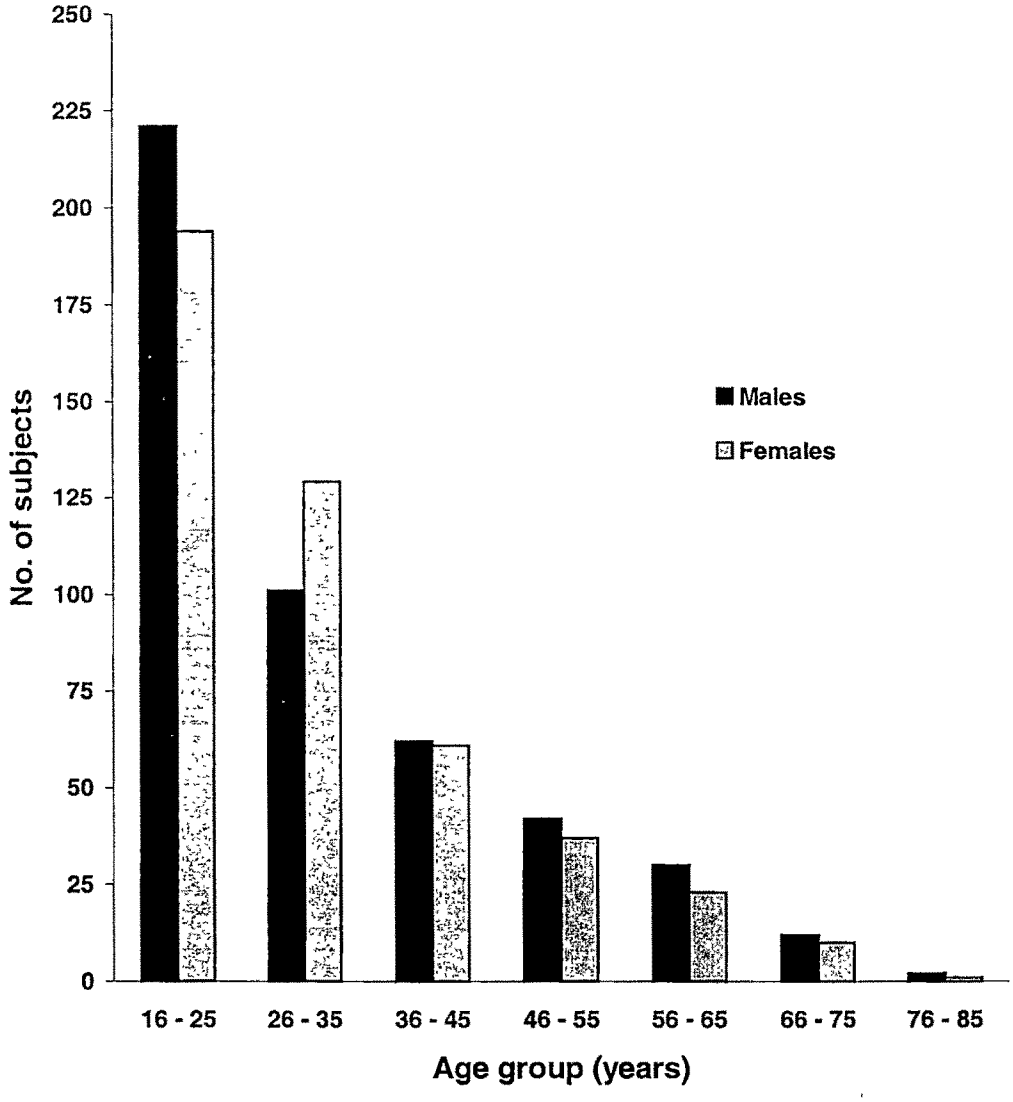


TABLE 4.3. DATA ANALYSIS: GUJARAT CHILDREN

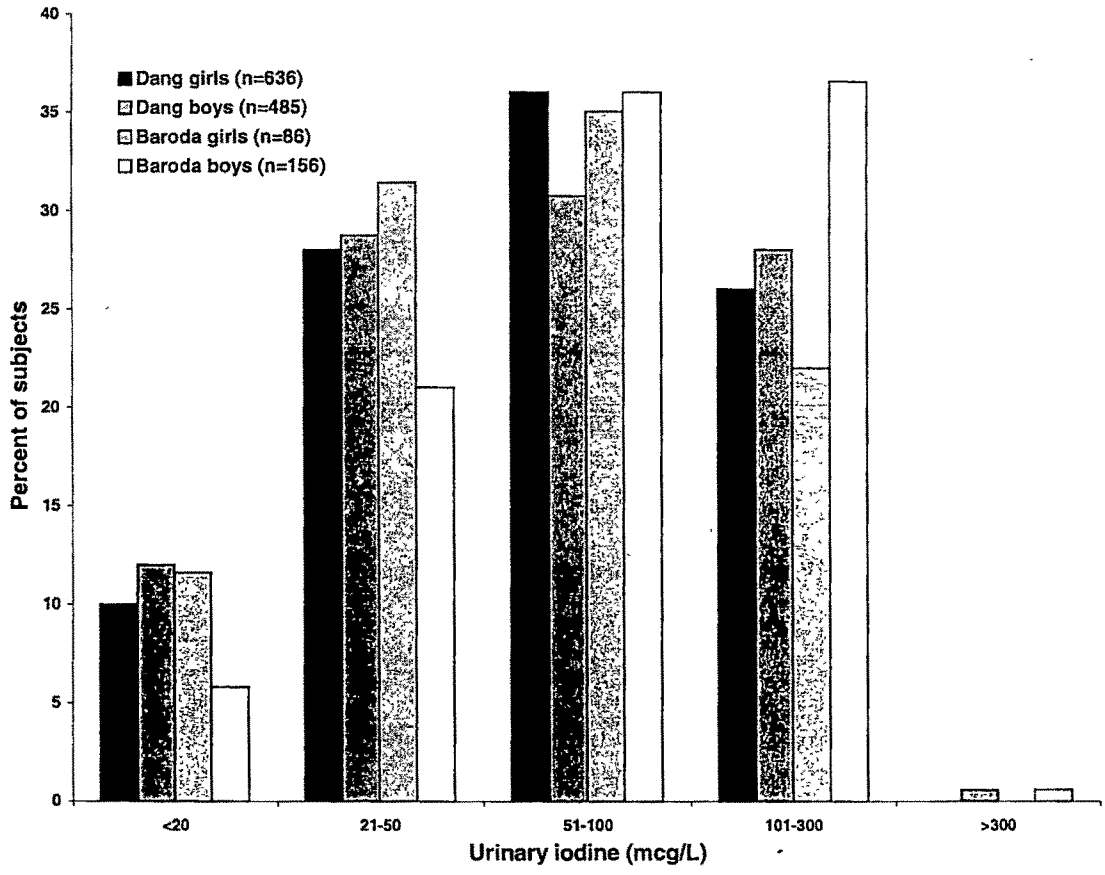
Parameters	Range	Mean ± SD	Median (IQR)	97th percentile
Age (years)	0-15	11.5 ± 2.8	12 (10-!4)	15
Height (cm)	38-170	129 ± 17.8	132 (122-140)	154
Weight (kg)	1-55	26.3 ± 8.5	25 (20-33)	43
BMI (kg/m^2)	6.9–29.5	15.7 ± 4.5	14.5 (13-17.4)	20.3
Total UI (μg/l)	0-1500	207.3 ± 175	148 (80 –288)	612
True UI (μg/l)	0-1110	79 ± 61	65 (38-108)	199.8
IS (μg/l)	0–816	128.3 ± 133	76 (30-185)	461.8
TSH (mU/l)	0–32.5	2.08 ± 2.06	1.58 (0.56-3.2)	6.43
BSA (m^2)	0.10–1.5	0.97 ± 0.22	0.96 (.9-1.25)	1.4

Median (IQR) = Median with an interquartile range in parentheses

Girls had lower UI levels in Baroda, but not in Dang district where both sexes were affected equally. (Table 4.4.). The blood TSH levels were significantly different amongst females and males from Dang ($p_i < 0.001$) but not in Baroda district ($p = 0.08$) (Table 4.4.).

Classification of the study group into subgroups based on urinary iodine values as recommended by WHO (2) is shown in Figure 4.2. In Baroda greater than 78% of girls and 63% of boys are iodine deficient (UI < 100 μg/l), while 43% of girls and 27% of boys had moderate iodine deficiency (UI < 50 μg/l). In Dang district 74% of girls and 71% of boys are iodine deficient (UI < 100 μg/l), while 38% of girls and 40% of boys had UI < 50 μg/l (moderate iodine deficiency).

FIGURE 4.2. FREQUENCY DISTRIBUTION OF URINARY IODINE IN μg/l



< 20	Iodine deficiency (severe)
21-50	Iodine deficiency (moderate)
51-100	Iodine deficiency (mild)
101-300	Adequate iodine intake
> 300	More than adequate iodine intake

TABLE 4.4. ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS IN CHILDREN FROM BARODA AND DANG DISTRICTS BY GENDER

Baroda (n=242) Girls (n= 86)				Boys (n = 156)			
Parameter	**Range**	**Mean±SD**	**Median (IQ)**	**Range**	**Mean±SD**	**Median (IQR)**	**P**
Age	0.05-15	9.9±3.7	11 (8 - 13)	0.3-15	10.3±3.6	11 (8–13)	0.4
Height	38-168	110±28	108 (95-135)	40-164	117±25	122 (102–135)	0.07
Weight	1-46	22.5±8.6	22 (17–29)	3-50	23±8.0	22 (17– 29)	0.6
BSA	0.1–1.4	0.8±0.26	0.8 (0.7–1.0)	0.2–1.4	0.86±0.24	0.86 (0.7–1.0)	0.16
BMI	7-40	19±7.5	16.9 (14–22)	9.7-39	18.2±8.5	14.8 (13–20.5)	0.06
Total UI	0-465	150±105	110 (78–196)	25-770	213±128	180 (116–282)	0.004
True UI	0-260	73±53	63 (36–90)	0-260	95±60	84 (48-125)	0.001
IS	0-340	76.5±67	54 (33–94)	9-560	118±87	97 (62–159)	0.001
TSH	0–25.8	1.95±2.9	1.5 (0.6–2.7)	0-8.4	1.4±1.5	0.95 (0.3–2.1)	0.08
Dang (n=1121)		**Girls (n=636)**			**Boys (n= 485)**		
Age	5–15	12±2.4	12 (10 – 14)	4–15	11.3±2.4	11 (10–13)	0.001
Height	84-160	133±12.9	135(127-142)	61-170	131±14	131 (125–139)	0.001
Weight	10-55	28.5±8.7	27.5 (21–36)	11–50	25±7.6	24 (20–29)	0.001
BSA	.05–1.4	1.0±0.2	1.0 (0.9–1.2)	.04–1.5	0.97±0.2	0.95 (0.8-1.08)	0.001
BMI	8.7–27	16± 3.1	15.4 (13–18)	7-32	14.2±2.3	13.7 (12.7-15)	0.001
Total UI	0–1080	228±192	167 (76–331)	0–1500	182±167	126 (71–247)	0.01
True UI	0–288	76±51.5	63 (36–105)	0–1110	79±72	64 (37–108)	0.8
IS	0–816	153±151	96 (30–240)	0– 624	103±119	58 (26–140)	0.001
TSH	0–11.7	2.5±2.1	2.2 (0.9– 3.7)	0–15.2	1.8±1.8	1.3 (0.4–3.0)	0.001

Median values; Numbers in parentheses indicate interquartile range

Total urinary iodine (UI), True UI, Interfering substances (IS) unit = µg/l

TSH measurement unit is mU/l

BMI unit is kg/m^2

BSA unit is m^2

Age in years

Weight and height is in kg and cms

All the villages of Dang district except Rutambhara had low amount of interfering substances. Resident girls of Rutambhara boarding school had very high total urinary iodine levels (60 – 1080 μg/l), the majority of which was contributed by large amounts of interfering substances (36 - 816 μg/l) with median true UI = 100 μg/l (Table 4.5.).

In Dang district, villages (Vaghai, Saputara, Dediapada, Baripada, Rambhas, Rutambhara, and Dungarda) showed differences in distribution of all the parameters (Table 4.5.).

Using the least significant difference method of multiple comparisons, we found the following pattern for various parameters used in this study:
BMI: (Rambhas, Baripada, Dungarda) < (Vaghai, Saputara) < Rutambhara < Dediapada.
Total UI: (Dediapada, Baripada, Rambhas, Dungarda, Saputara) < Vaghai <Rutambhara.
True UI: (Dediapada, Baripada, Rambhas, Dungarda, Saputara, Vaghai) < Rutambhara.
IS: (Dediapada, Baripada, Rambhas, Dungarda, Saputara) < Vaghai < Rutambhara.
TSH: Rambhas < (Dungarda, Saputara, Vaghai) < (Dediapada, Rutambhara) < Baripada.
BSA: Dungarda < (Saputara, Dediapada, Rambhas, Baripada) < Vaghai < Rutambhara.
(Note: Groups of villages in parenthesis are comparable and "<" indicates statistically less significant parameter value than the village or group of villages next to it).

TABLE 4.5. MEDIAN (IQR) VALUES OF BIOCHEMICAL AND ANTHROPOMETRICAL PARAMETERS IN CHILDREN FROM DANG VILLAGES

Village	Vaghai	Saputara	Dediapada	Baripada	Rambhas	Rutambhara	Dungarda
BMI (kg/m^2)	14.1	14.1	19.5	13.6	12.8	18.0	13.2
	(13-16)	(13–17)	(16.8–22)	(13–14)	(12–14)	(17.0–19.5)	(12.4–14)
BSA (m^2)	0.99	0.83	0.93	0.95	0.9	1.21	0.84
	(0.9-1)	(0.68–1)	(0.7–1.07)	(0.83–1)	(0.84–1)	(1.1–1.28)	(0.7– 0.9)
Total UI	148	118	72	86	86	360	104
(μg/l)	(60-296)	(58–180)	(52– 91)	(42–130)	(52-140)	(246 – 515)	(75–142)
True UI	60	64	49	49	54	100	49
(μg/l)	(32-105)	(20–105)	(36–63)	(21– 96)	(28–96)	(68 – 130)	(35–80)
IS	84	48	20	27	31	262	47
(μg/l)	(20-198)	(34–85)	(17– 30)	(16–56)	(14–62)	(175 – 370)	(31–720)
TSH	1.95	2.07	3.84	4.06	0.9	3.08	1.15
(mU/l)	(0.6-3.3)	(0.9–2.9)	(3.6–3.99)	(3.6–4.5)	(0.84–1)	(1.35–4.52)	(0.83–1.7)

IQR = interquartile range

ADULTS

The median total UI (that includes interfering substances) for all adults was 160 µg/l and more accurate true UI (after removal of interfering substances) was 73µg/l. Thus large amounts of Interfering substances (IS) were detected in urine, presumably due to goitrogens (Table 4.6.).

Total urinary iodine was significantly lower in females ($p < 0.001$) but true UI was not different ($p = 0.29$). In Baroda, women had significantly lower total and true UI ($p < 0.001$) whereas in Dang men had lower values for both UI levels ($p < 0.001$) (Table 4.7.). IS were greater in Baroda men and Dang women ($p < 0.001$).

TABLE 4.6. DATA ANALYSIS FOR ADULT POPULATION

Parameters	Range	Mean ± SD	Median (IQR)	97thpercentile
Age (years)	16 - 85	31.4 ± 15	28 (18–40)	65
Height (cm)	122 – 180	155.2 ± 9.2	154.9 (149–162)	173
Weight (kg)	21 - 92	45.8 ± 9.7	45 (40–50)	68.5
BMI (kg/m^2)	10.9 – 39.6	19.0 ± 3.7	18.3 (16.7–20.6)	27.5
Total UI (µg/l)	0 - 1256	209.7 ± 175	160 (90–270)	670
True UI (µg/l)	0 - 450	88.5 ± 63.5	73 (40–120)	225
IS (µg/l)	0 - 920	121.3 ± 131	74 (37–159)	500
TSH (mU/l)	0 – 32.98	1.59 ± 2.4	0.79(0.11–2.36)	6.9
BSA (m^2)	0.89 – 1.9	1.41 ± 0.16	1.39 (1.30–1.51)	1.6

Classification of the study group into subgroups, based on UI values as recommended by WHO, is shown in Figure 4.3. A (Dang) where 52% of women and 75% of men are iodine deficient (UI <100 µg/l). While 31% of women and 46% of men had moderate (UI < 50 µg/l) iodine deficiency.

TABLE 4.7. ANTHROPOMETRIC MEASUREMENTS AND BIOCHEMICAL PREVALENCE INDICATORS IN ADULTS FROM BARODA AND DANG DISTRICTS BY GENDER

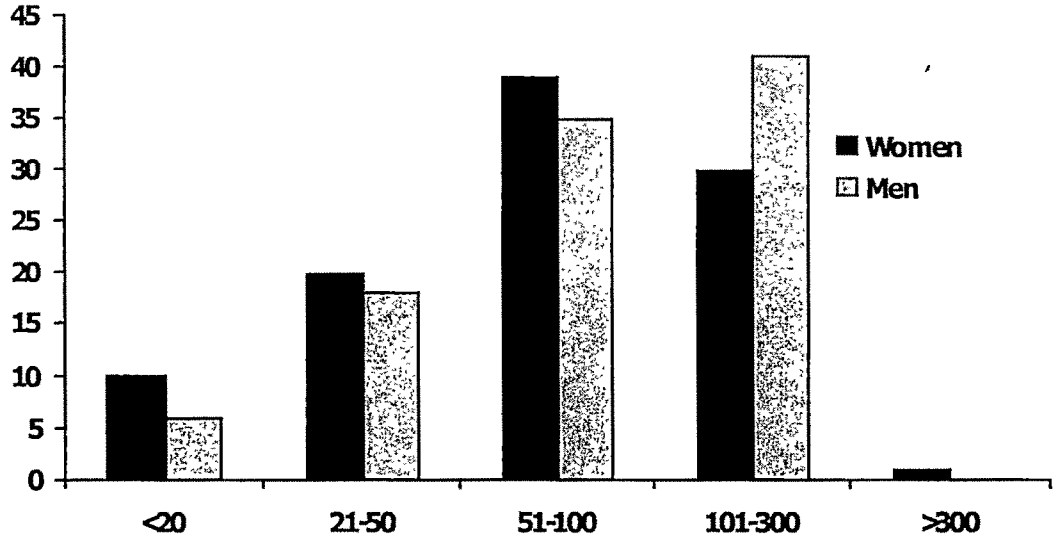
Baroda (n = 604)	*Women (n = 277)*		*Men (n = 327)*		
parameter	**Mean±SD**	**Median (IQR)**	**Mean±SD**	**Median (IQR)**	***P***
Age	37.5 ± 15	35 (26-48)	36.6±15	33 (25-47)	NS
Height	151 ± 5.8	151(147-154)	163±6.6	163 (158-167)	0.001
Weight	46 ± 11	45 (39-51)	49± 9	48 (43-55)	0.001
BMI	20.4 ± 4.9	19 (17-23)	18.6±3.3	18 (16-20)	0.001
Total UI	163 ± 105	128 (91-220)	211±123	192 (116-276)	0.001
True UI	80 ± 57	65 (40-110)	94± 58	84 (51-126)	0.003
IS	83 ± 66	64 (40-110)	118± 88	96 (56-162)	0.001
TSH	1.5 ± 2.1	0.9 (0.13-2.4)	1.24± 1.4	0.8 (0.15-2.0)	0.08
BSA	1.4 ± 0.2	1.3 (1.2-1.5)	1.5± 0.1	1.5 (1.4-1.6)	0.001
Dang (n = 321)	*Women (n = 181)*		*Men (n = 140)*		
Age	21.6 ± 7	18 (17-28)	19.3±6	17 (17-19)	0.003
Height	147 ± 7.5	147(143-152)	157±8.4	158 (152-163)	0.001
Weight	40 ± 5	40 (36-44)	44±6.4	44 (40-48)	0.001
BMI	18.5 ± 2.6	18.4 (17-20)	17.9±2.2	17.6 (16.5-19)	0.03
Total UI	327 ± 279	222 (79-560)	143±129	94 (53-196)	0.001
True UI	107 ± 83	90 (40-163)	68±49	55 (28-100)	0.001
IS	220 ± 213	135 (28-377)	75±98	32 (17-78)	0.001
TSH	2.7 ± 3.8	1.1 (0.2-4.1)	1.1±1.6	0.36 (0-1.6)	0.001
BSA	1.3 ± 0.1	1.3 (1.2-1.4)	1.4±0.13	1.4 (1.3-1.7)	0.001

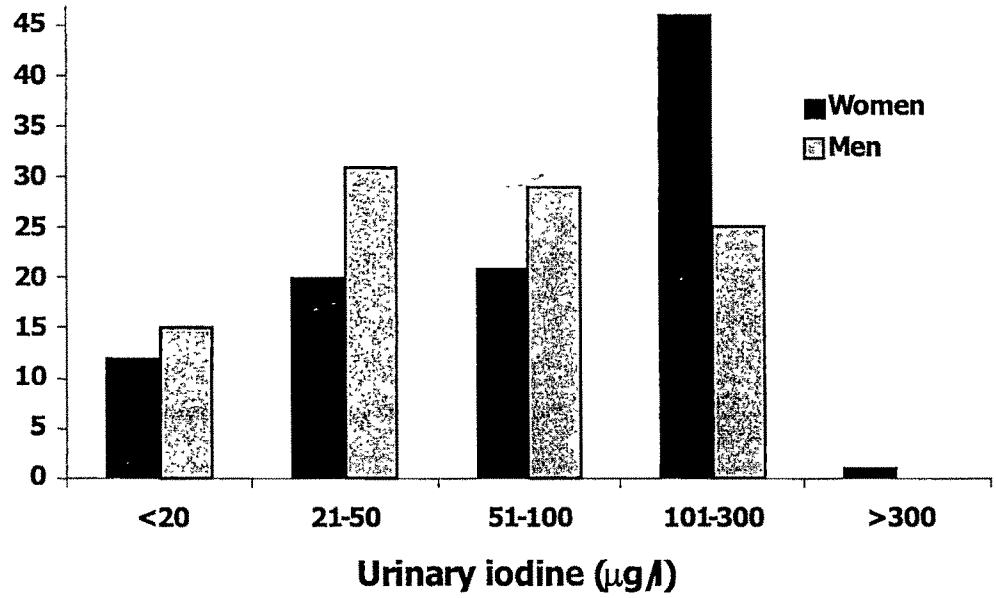
Age is in years, height in cm, weight in kg, BMI is in kg/m^2 and BSA is m^2

Total UI, True UI and interfering substances (IS) are in µg/l and TSH is in mU/l

FIGURE 4.3. FREQUENCY DISTRIBUTION OF URINARY IODINE IN μg/l A (DANG) AND B (BARODA)

< 100	Iodine deficiency
101 – 300	Adequate iodine intake
> 300	More than Adequate iodine intake





In Baroda district 69% of women and 59% of men are iodine deficient (UI<100 µg/l) while30% of women and 24% of men had moderate (UI < 50 µg/l) iodine deficiency (Figure 4.3. B).

Thus IDD is far from being eliminated in both the districts of Gujarat that manufacture 70% of iodinated salt for India. Tribals from Dang (n =355) had statistically significant lower UI concentrations and IS levels in urine ($p<0.001$) as compared to Baroda.

All the villages of Dang district except Rutambhara had low levels of total and true UI. In fact median true UI was < 50 µg/l in four villages of Dang. Resident girls of Rutambhara boarding school had very high total urinary iodine levels (92–1256 µg/l) and true UI (15–450), the majority of which was contributed by large amounts of interfering substances (36-816 µg/l) with median true urinary iodine of only 150 µg/l (Table 4.8.).

There were no significant differences in the total urinary iodine between the two villages Muval and Tentalav of Baroda district whereas true urinary iodine was higher in Tentalav ($p<0.05$) (Table 4.9.).

TABLE 4.8. MEDIAN VALUES OF BIOCHEMICAL AND ANTHROPOMETRICAL PARAMETERS IN ADULTS FROM DANG VILLAGES (WITH INTERQUARTILE RANGE IN PARENTHESES)

Village	Vaghai	Saputara	Dediapada	Baripada	Rambhas	Rutambhara
BMI **(kg/m^2)**	*17.2*	*18.2*	*18.5*	*19.7*	*20.2*	*19.0*
	(16.2 -19)	(16.7 – 20)	(15.1 – 20.8)	(18.5 – 22.7)	(19.1 – 21.5)	(18.1 – 20.3)
BSA **(m^2)**	*1.35*	*1.31*	*1.21*	*1.52*	*1.56*	*1.3*
	(1.28–1.44)	(1.18–1.43)	(1.1 – 1.29)	(1.32 – 1.6)	(1.55 – 1.61)	(1.23 – 1.45)
Total UI **(µg/l)**	*88*	*146*	*74.5*	*34*	*81*	*560*
	(48 - 192)	(76 – 170)	(64 – 100)	(18.5 – 70.5)	(32 - 128)	(370 – 700)
True UI **(µg/l)**	*47*	*104*	*55.5*	*24*	*28*	*150*
	(26 - 80)	(33 – 148)	(30 - 72)	(10.5 – 58)	(24 – 64)	(108 – 200)
IS **(µg/l)**	*29*	*33*	*25.5*	*10*	*33*	*262*
	(16 - 96)	(21 – 42)	(18 – 40)	(7 – 13.5)	(8 – 68)	(175 – 470)
TSH **(mU/l)**	*1.35*	*0.64*	*4.13*	*3.56*	*0.23*	*1.62*
	(1.28-1.44)	(0.26–0.98)	(3.84 – 4.29)	(3.24 - 3.56)	(0 – 0.33)	(0.4 – 4.98)

TABLE 4.9. BIOCHEMICAL AND ANTHROPOMETRIC PARAMETERS FROM BARODA DISTRICT VILLAGES

Parameters	Range	Mean ± SD	Median (IQR)
Muval			
BMI (kg/m^2)	11.1 – 39.6	19.5 ± 4.2	18.6 (16.7 - 21.6)
Total UI(µg/l)	0 - 720	197.9 ± 118	177 (108 – 258)
True UI (µg/l)	0 - 425	90.6 ± 58.6	80 (50 – 120)
IS (µg/l)	0 - 510	107.3 ± 82.4	84 (49 – 140)
TSH (mU/l)	0 – 24.4	1.26 ± 1.79	0.79 (0.10 - 2.0)
BSA $(m)^2$	0.94 – 1.9	1.44 ± 0.16	1.44 (1.33 - 1.54)
Tentalav			
BMI (kg/m^2)	10.9 – 33.8	19.4 ± 4.2	18.6 (16.7 - 21.5)
Total UI (µg/l)	0 - 600	167.8 ± 115	128.5 (87.5 – 234)
True UI (µg/l)	0 - 240	80.2 ± 55.2	72 (36 – 108)
I S (µg/l)	0 - 440	87.6 ± 75.6	63.5 (37.5 – 118)
TSH (mU/l)	0 – 8.82	1.58 ± 1.62	1.0 (0.33 – 2.64)
BSA $(m)^2$	1.04 – 1.84	1.47 ± 0.16	1.47 (1.37 - 1.58)

4.4.2. BLOOD TSH LEVELS

CHILDREN

5.8% of the population had whole blood TSH values > 5mU/l. Linear regression analysis showed no significant correlation between UI and blood TSH. However, when the population was divided into urinary iodine bands then median blood TSH levels were higher in those groups with lower urinary iodine level (Table 4.10.).

The frequency distribution of blood TSH levels for girls and boys of Baroda and Dang districts is shown in figure 4.4. Blood spot TSH values > 5 mU/l were seen in 9 % girls and 3 % boys from Dang and 3 % girls and 4.5 % boys in Baroda. TSH values > 3 mU/l were noted in 36 % of girls and 24 % of boys from Dang and 21 % of girls and 13 % of boys from Baroda district. There have been no population normative values for TSH published for this population or for schoolchildren from an iodine replete environment.

FIGURE 4.4. FREQUENCY DISTRIBUTION OF TSH

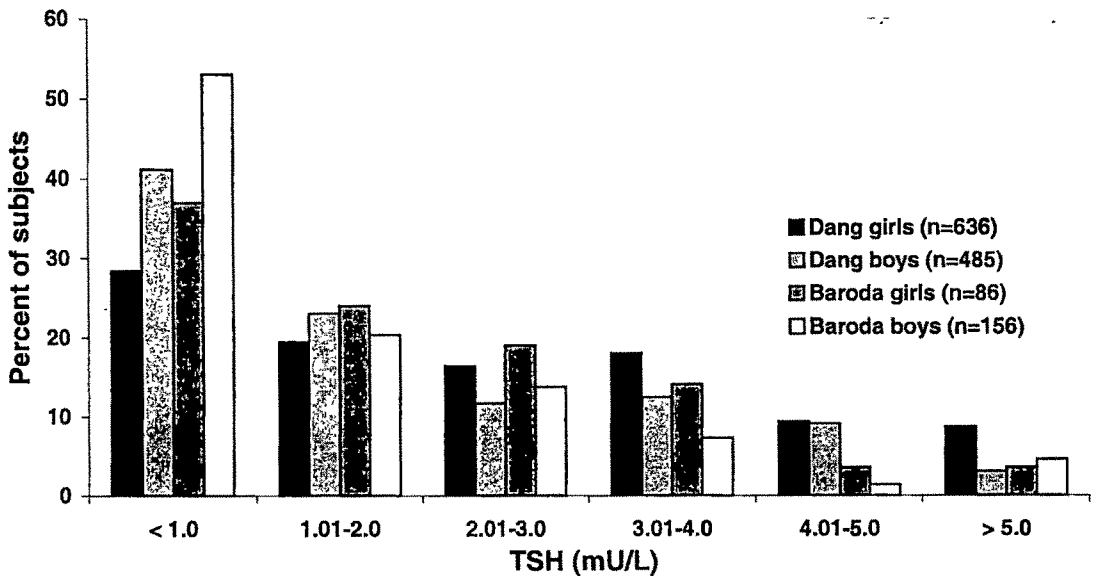
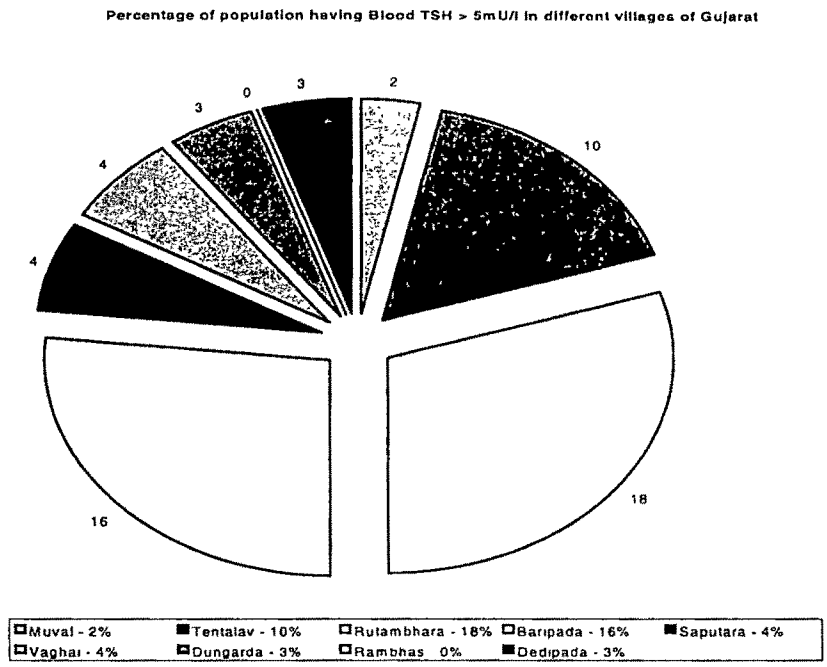


TABLE 4.10. MEAN AND MEDIAN TSH VALUES FOR DESCRIBED URINARY IODINE (UI) RANGE

UI Range (μg/l)	Subjects Number (n)	TSH Mean ± SD	TSH Median (IQR)	TSH > 5 mU/l
0 – 20	139	2.28 ± 2.5	1.59 (0.21-3.58)	9.5 %
21 - 50	370	1.89 ± 2.12	1.49 (0.5-2.99)	3.0 %
51 -100	454	2.11 ± 1.77	1.77 (0.77-3.27)	3.7 %
101 – 200	340	2.25 ± 2.34	1.49 (0.43-3.49)	6.7 %
201 – 300	31	1.8 ± 1.77	0.99 (0.76-2.07)	6.5 %
> 300	4	1.14 ± 1.55	0.54 (0.27-1.7)	0 %

FIGURE 4.5. PERCENTAGE POPULATION WITH BLOOD TSH LEVELS > 5 mU/L IN DIFFERENT VILLAGES OF GUJARAT



Distribution of percent population having TSH > 5 mU/l from different villages of Gujarat is shown in Table 4.11 and figure 4.5. The highest proportion of children in this category was from Rutambhara (18%) and the lowest in Rambhas (0%) in Dang district and Tentalav (10%) and Muval (3%) in Baroda district respectively (Table 4.11.).

TABLE 4.11. PERCENTAGE OF SUBJECTS HAVING TSH > 5MU/L AND MEAN TSH ± SD VALUES FROM THE VILLAGES OF BOTH DISTRICTS

District	Village	% of subjects TSH > 5mU/l	Mean ± SD TSH (mU/l)
Baroda	Muval	3	1.34 ± 1.20
	Tentalav	10	2.25 ±3.67
Dang	Rutambhara	18	3.32 ± 2.39
	Baripada	16	4.04 ± 1.07
	Saputara	4	1.96 ± 1.16
	Vaghai	4	2.20 ±1.18
	Dungarda	3	1.50 ± 1.43
	Dediapada	3	3.06 ± 1.65
	Rambhas	0	0.22 ± 0.30

ADULTS

The mean ± SD value of TSH for all subjects irrespective of gender or district was 1.59 ± 2.4 (Table 4.6.). Seven percent of the subjects had whole blood TSH values >5 mU/l. Linear regression analysis showed a very weak ($r = 0.07$) but statistically significant ($p = 0.02$) correlation between UI and blood spot TSH levels. In Dang the mean TSH levels were significantly higher in females than males ($p < 0.001$) whereas in Baroda there was no significant gender difference ($p = 0.08$). Dang district subjects had significantly higher mean TSH concentration ($p<0.001$) than their counterparts in Baroda district (Table 4.7.).

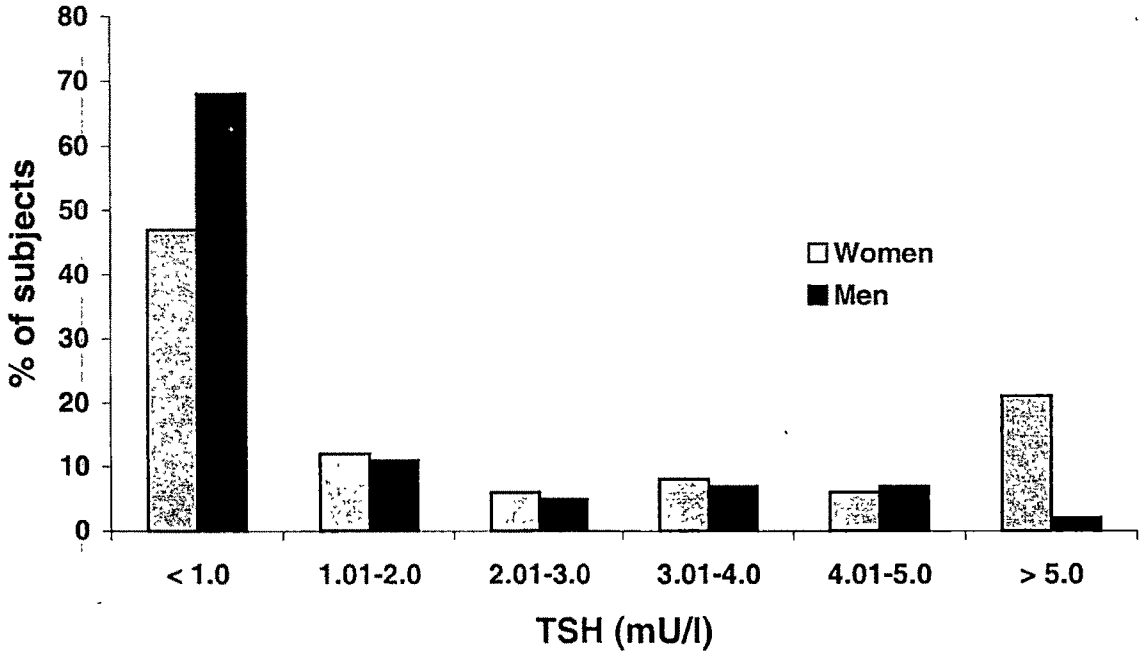
The frequency distribution of blood spot TSH levels for men and women of Baroda and Dang is shown in figures 4.6. A and B respectively. Blood spot

TSH values > 5 mU/l were seen in 20% women and 3% men from Dang and 3% women and 4% men in Baroda.

The normative values for TSH as a prevalence indicator to describe the severity of IDD, as a significant public health problem is not published so far by any recognized international body including WHO/UNICEF/ ICCIDD (1994, 1999). The upper limit of 5 mU/l for blood spot TSH is only for the target population of neonates. If we consider an upper limit of 3 mU/l for adult population then 35% women and 16% men from Dang district and 18% women and 14% men from Baroda district show increased TSH levels.

Distribution of percent population having TSH > 5 mU/l from different villages is shown in Table 4.12. The highest proportion of subjects in this category was from Rutambhara and lowest in Rambhas, Baripada and Saputara in Dang district.

FIGURE 4.6. FREQUENCY DISTRIBUTION OF TSH (mU/l) IN DESCRIBED RANGES A (BARODA) AND B (DANG)



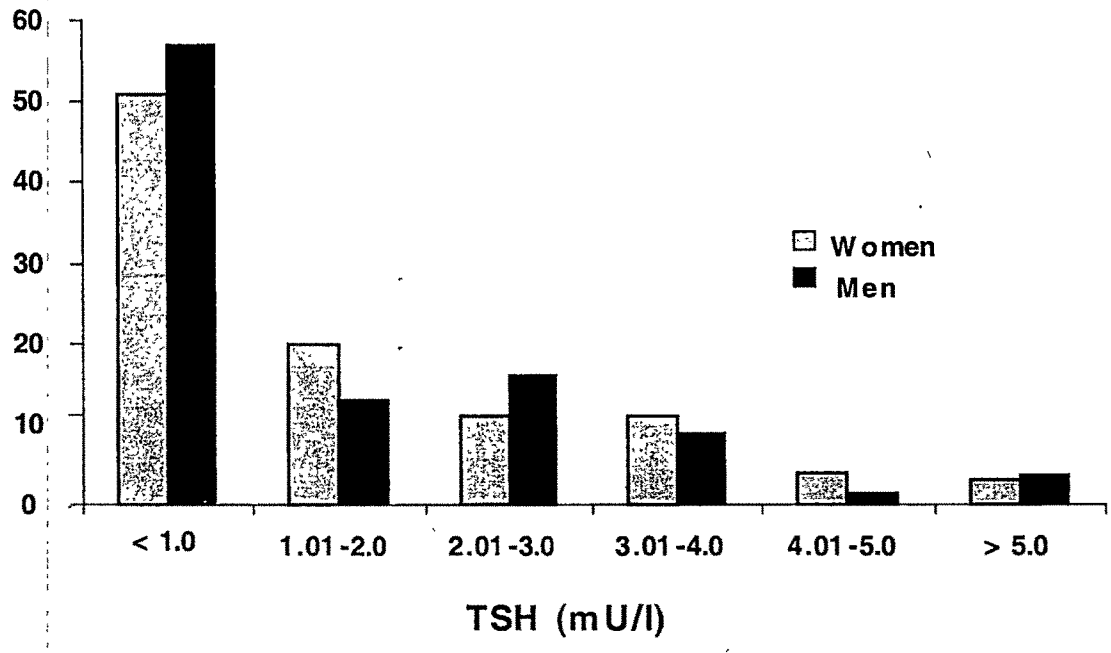


TABLE 4.12. PERCENTAGE OF SUBJECTS HAVING TSH > 5 MU/L AND MEAN TSH WITH SD VALUES FROM THE DISTRICTS VILLAGES

District	Village	% of subjects TSH > 5mU/l	Mean ± SD TSH (mU/l)
Baroda	Muval	3	1.26 ± 1.79
	Tentalav	4.5	1.58 ± 1.62
Dang	Rutambhara	24.5	2.7 ± 2.7
	Baripada	0	3.46 ± 0.33
	Saputara	0	0.79 ± 0.74
	Vaghai	8.5	1.7 ± 3.5
	Dediapada	3	3.84 ± 1.27
	Rambhas	0	0.22 ± 0.30

4.4.3. VARIATION OF BIOCHEMICAL VALUES BY VILLAGE

CHILDREN

4.4.3.1. BARODA:

There were no significant differences in the variables like total urinary iodine, true urinary iodine, interfering substances and TSH between the two villages Muval and Tentalav ($p > 0.05$) of Baroda district. BMI was significantly lower for Tentalav village compared to Muval village of Baroda district ($p < 0.001$) but height and BSA were higher in Tentalav ($p < .001$ and $p < 0.004$ respectively) (Table 4.13.).

TABLE 4.13. RESULTS OF CHILDREN FROM TENTALAV AND MUVAL (BARODA DISTRICT)

Parameters	Range	Mean ± SD	Median (IQR)
TENTALAV			
BMI (kg/m^2)	9.6 – 18.4	13.5 ± 1.6	13.6 (12.4 - 14.1)
Total UI (μg/l)	0 - 416	172 ± 113	128.5 (96 – 238)
True UI (μg/l)	0 - 252	78.9 ± 52.3	67.5 (45 – 108)
IS (μg/l)	0 - 278	93.0 ± 72.5	72.5 (32 – 147)
TSH (mU/l)	0 – 25.82	2.25 ± 3.67	1.44 (0.42 - 2.63)
BSA (m^2)	0.46 – 1.34	0.92 ± 0.19	0.92 (0.80 - 1.07)
MUVAL			
BMI(kg/m^2)	6.9 - 75	20.2 ± 8.7	17.5 (14.3 - 23.6)
Total UI(μg/l)	32 - 770	196 ± 126	156 (103 – 260)
True UI (μg/l)	0 - 400	89.5 ± 60	75 (45 – 120)
I S(μg/l)	2 - 560	107 ± 85	80 (50 – 140)
TSH (mU/l)	0 – 5.29	1.34 ± 1.2	1.1 (0.31 - 2.06)
BSA (m^2)	0.66 – 1.5	1.03 ± 0.16	0.99 (0.91 - 1.14)

4.3.3.2. DANG:

The detailed results of all the parameters studied in villages of Dang district are shown in Tables 4.14. to 4.20

TABLES 4.14. TO 4.20. RESULTS OF SCHOOLCHILDREN FROM DANG DISTRICT, GUJARAT (SAPUTARA, BARIPADA, DEDIAPADA, RUTAMBHARA, VAGHAI, RAMBHAS, DUNGARDA)

TABLE 4.14. RESULTS FROM SAPUTARA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	4 – 15	10 ± 3.3	10 (7-13)
Height(cm)	91.4–154.9	120.9 ± 16.1	121.9 (106.7-132.1)
Weight (kg)	10 - 50	23.1 ± 9.8	19 (16-28)
BMI (kg/m^2)	11.1 – 22.5	15.0 ± 2.7	14.1 (12.9-16.7)
Total UI ($\mu g/l$)	20 - 480	140.1 ± 97.7	118 (58-180)
True UI ($\mu g/l$)	8 - 255	70.5 ± 59.1	64 (20-105)
IS ($\mu g/l$)	11 - 272	69.6 ± 56.1	48 (34-85)
TSH (mU/l)	0 – 5.0	1.96 ± 1.16	2.07 (0.89-2.89)
BSA (m^2)	0.51 – 1.47	0.88 ± 0.24	0.83 (0.68-1.01)

TABLE 4.15. BARIPADA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	6 - 15	10.6 ± 1.7	11 (10-12)
Height (cm)	112 - 164	132.6 ± 12.8	131 (124-138)
Weight (kg)	16 - 43	23.8 ± 6.2	23.5 (20-26)
BMI (kg/m^2)	7.8 – 17.2	13.4 ± 1.8	13.6 (12.8-14.2)
Total UI (μg/l)	26 - 282	100.2 ± 67.8	86 (42-130)
True UI (μg/l)	8 - 126	59.6 ± 39.2	49 (21-96)
IS (μg/l)	2 - 156	40.6 ± 38.6	27 (16-56)
TSH (mU/l)	0.21– 5.81	4.04 ± 1.07	4.06 (3.56-4.54)
BSA (m^2)	0.71 – 1.4	0.95 ± 0.16	0.95 (0.83-1.03)

TABLE 4.16. DEDIAPADA VILLAGE

Parameters	Range	Mean ± SD	Median IQR
Age (years)	4 - 15	11.9 ± 2.9	12 (10-15)
Height (cm)	61 – 152.4	116.2 ± 20.7	121.9 (96.5-129.5)
Weight (kg)	12 - 41	26.3 ± 7.9	26 (20-33)
BMI (kg/m^2)	12.1 – 32.2	19.7 ± 4.0	19.5 (16.8-22.1)
Total UI (μg/l)	38 - 180	77.2 ± 30.9	72 (52-91)
True UI(μg/l)	15 – 110	52.1 ± 20.7	49 (36-63)
IS (μg/l)	10 - 70	25.0 ± 13.6	20 (17-30)
TSH (mU/l)	0 – 4.45	3.06 ± 1.65	3.84 (3.57-3.99)
BSA (m^2)	0.41 – 1.25	0.91 ± 0.22	0.93 (0.69-1.07)

TABLE 4.17. RUTAMBHARA VILLAGE

parameters	Range	Mean ± SD	Median
Age (years)	13 - 15	14.1 ± 0.8	14 (13-15)
Height (cm)	121.9 - 160	141.9 ± 6.2	142.2 (137.2-147.3)
Weight (kg)	25 - 55	36.7 ± 5.1	37 (34-40)
BMI (kg/m^2)	12.9 – 27.2	18.2 ± 2.0	18.0 (17-19.5)
Total UI (μg/l)	60 - 1080	387.4 ± 179.1	360 (246-515)
True UI (μg/l)	16 - 280	104.8 ± 50.1	100 (68-130)
IS (μg/l)	36 - 816	282.6 ± 138.8	262 (175-370)
TSH (mU/l)	0 – 11.57	3.32 ± 2.39	3.08 (1.35-4.52)
BSA (m^2)	0.93 – 1.44	1.20 ± 0.1	1.21 (1.14-1.28)

TABLE 4.18. VAGHAI VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	9 – 15	12.2 ± 1.8	12 (11-14)
Height (cm)	115 - 170	136.0 ± 9.8	135 (129-142)
Weight (kg)	11-47	27.3 ± 7.0	25 (22-32)
BMI (kg/m^2)	6.9 – 23.1	14.5 ± 2.2	14.1 (12.8-15.9)
Total UI (μg/l)	0 - 1500	207.7 ± 190.3	148 (60-296)
TRUE UI (μg/l)	0 - 1110	77.6 ± 74.3	60 (32-105)
IS (μg/l)	0 - 807	130.2 ± 139.8	84 (20-198)
TSH (mU/l)	0-15.17	2.2 ± 1.98	1.95 (0.61-3.28)
BSA (m^2)	0.66 – 1.5	1.03 ± 0.16	0.99 (0.91-1.14)

TABLE 4.19. RAMBHAS VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	9 - 15	10.6 ± 1.2	11 (10-12)
Height (cm)	112 – 160	130.4 ± 8.2	130 (125-135)
Weight (kg)	15 – 47	22.4 ± 4.8	22 (19-25)
BMI (kg/m^2)	10.5 – 18.4	13.0 ± 1.4	12.8 (12.0-13.9)
Total UI (μg/l)	0 - 350	109.8 ± 79.5	86 (52-140)
True UI (μg/l)	0 - 192	60.9 ± 40.2	54 (28-96)
IS (μg/l)	0 - 290	48.9 ± 55.0	31 (14-62)
TSH (mU/l)	0 – 1.17	0.22 ± 0.30	0.13 (0-0.32)
BSA (m^2)	0.70 – 1.46	0.92 ± 0.12	0.9 (0.84-1.0)

TABLE 4.20. DUNGARDA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	6 - 13	9.6 ± 2.1	10 (8-11
Height (cm)	88.5 – 149.9	121.3 ± 12.6	121.9 (114.3-129.5
Weight (kg)	11 - 37	20 ± 4.6	20 (17-23
BMI (kg/m^2)	8.4 – 25.5	13.5 ± 2.1	13.2 (12.4-14.2
Total UI (μg/l)	12 - 600	128.1 ± 88.8	104 (75-142
True UI (μg/l)	3 - 250	62.6 ± 41.5	49 (35-80
IS (μg/l)	0 - 450	65.5 ± 59.3	47 (31-72
TSH (mU/l)	0 – 11.98	1.5 ± 1.44	1.15 (0.83-1.7
BSA (m^2)	0.54 – 1.24	0.83 ± 0.14	0.84 (0.72-0.92

ADULTS

There were no significant differences in the variables like age, weight, total urinary iodine, BMI and BSA between the two villages Muval and Tentalav of Baroda district whereas height, true urinary iodine, interfering substances were higher in Muval and TSH was higher in Tentalav ($p<0.05$) (Table 4.8.).

Dang district villages (Vaghai, Saputara, Dediapada, Rambhas, Rutambhara, Baripada, Dungarda) showed differences in distribution of all the parameters (Table 4.9.).

Using the least significant difference method of multiple comparisons, we found the following pattern for various parameters used in this study:

Height: Dediapada<(Rutambhara, Saputara)<(Vaghai, Baripada) < Muval < (Tentalav, Rambhas)

Weight: (Dediapada, Saputara, Rutambhara, Vaghai)<(Muval, Tentalav, Baripada, Rambhas)

BMI: All comparable in terms of pair wise multiple comparisons.

Total UI: Baripada<(Rambhas, Dediapada, Saputara, Vaghai, Tentalav, Muval)<Rutambhara.

True UI: Baripada <(Rambhas, Dediapada, Vaghai, Tentalav)<(Muval and Saputara)<Rutambhara.

Interfering S: Baripada<(Dediapada, Saputara, Rambhas, Vaghai, Tentalav) <Muval<Rutambhara.

TSH: Rambhas<(Saputara, Muval, Tentalav, Vaghai)<(Rutambhara, Baripada, Dediapada).

BSA: Dediapada<(Rutambhara, Saputara, Vaghai)<(Muval, Baripada and Tentalav) <Rambhas.

(Note: Groups of villages in parenthesis are comparable and "<" indicates statistically significantly less ($p<0.05$) than the village or group of villages next to it).

Iodine content of drinking water in Dang was nil but adequate in Baroda district. This is reflected in lower median urinary iodine levels in Dang district.

Pearl millet is rich in dietary goitrogens mainly flavonoids like apigenin, vitexin and glycosyl vitexin. The quantity of vitexin and apigenin was higher in pearl millet from Tentalav.

The details of the anthropometric and biochemical parameters for each village survey are given separately in Tables 4.21. to 4.26.

TABLES 4.21. TO 4.26. RESULTS OF ADULTS FROM DANG DISTRICT, GUJARAT (SAPUTARA, BARIPADA, DEDIAPADA, RUTAMBHARA, VAGHAI, RAMBHAS)

TABLE 4.21. RAMBHAS VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	28 - 45	36 ± 6.16	37.5 (30-38)
Height (cm)	152–170	162.7 ± 6.31	162.5 (161-168)
Weight (kg)	47 - 62	54.8 ± 5.4	53.5 (53-60)
BSA (m^2)	1.48–1.72	1.58 ± 0.08	1.56 (1.55-1.61)
BMI (kg/m^2)	17.9– 26	20.8 ± 2.8	20.2 (19.1-21.5)
Total UI (µg/l)	32 - 184	89.7 ± 58.9	81 (32-128)
True UI (µg/l)	24 - 64	38 ± 18.9	28 (24-64)
IS (µg/l)	8 - 160	51.7 ± 59.6	33 (8-68)
TSH (mU/l)	0 – 0.6	0.23 ± 0.22	0.23 (0-0.33)

TABLE 4.22. VAGHAI VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	16 - 56	21.8 ± 7.2	18 (17-27)
Height (cm)	137 - 176	154.8 ± 7.8	154.9 (150-160)
Weight (kg)	26 - 59	42 ± 6.0	41 (38-45)
BMI (kg/m^2)	11.3 – 25.2	17.6 ± 2.3	17.2 (16.2-18.7)
Total UI (μg/l)	0 - 800	140.1 ± 141.9	88 (48-192)
True UI (μg/l)	0 - 300	61.2 ± 51.7	47 (26-80)
IS (μg/l)	0 - 500	78.9 ± 102.9	29 (16-96)
TSH (mU/l)	0 – 33	1.7 ± 3.5	0.3 (0-1.7)
BSA (m^2)	1.04 – 1.7	1.36 ± 0.11	1.35 (1.28-1.44)

TABLE 4.23. RUTAMBHARA VILLAGE

Parameters	Range	Mean ± SD	Median
Age (years)	16 - 19	17.4 ± 0.9	17 (17-18)
Height (cm)	132.1–157.5	146.2 ± 5.1	147.3 (142.2-149.9)
Weight (kg)	32 - 50	40.9 ± 4.4	41 (37-44)
BMI (kg/m^2)	15.3 – 24.4	19.1 ± 1.8	19.0 (18.1-20.3)
Total UI (μg/l)	92 - 1256	532.4 ± 230.1	560 (370-700)
True UI (μg/l)	15 - 450	155.0 ± 77.6	150 (108-200)
TSH (mU/l)	0 – 10.93	2.7 ± 2.7	1.62 (0.4-4.98)
BSA (m^2)	1.08 – 1.45	1.29 ± 0.08	1.3 (1.23-1.45)

TABLE 4.24. SAPUTARA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	16 - 18	16.8 ± 0.5	17 (17-17)
Height (cm)	129.5–167.6	148.7 ± 10.8	148.6 (139.7-158.8)
Weight (kg)	28 - 53	40.5 ± 6.8	42.5 (34.5-45)
BMI (kg/m^2)	12.1 – 23.9	18.3 ± 2.2	18.2 (16.7-19.8)
Total UI (µg/l)	50 - 252	135.7 ± 57.9	146 (76-170)
True UI (µg/l)	15 - 220	99 ± 58.2	104 (33-148)
IS (µg/l)	0 - 96	36.7 ± 22.6	33 (21-42)
TSH (mU/l)	0 – 2.72	0.79 ± 0.74	0.64 (0.26-0.98)
BSA (m^2)	1.01 –1.56	1.3 ± 0.15	1.31 (1.18-1.43)

TABLE 4.25. BARIPADA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	17 - 40	30.8 ± 11.3	33 (21.5-40)
Height (cm)	134 - 171	155 ± 15.6	157.5 (144-166)
Weight (kg)	37 - 59	49.5 ± 9.7	51 (42-57)
BMI (kg/m^2)	18.1–24.9	20.6 ± 3.0	19.7 (18.5-22.7)
Total UI (µg/l)	14 - 96	44.5 ± 36.7	34 (18.5-70.5)
True UI (µg/l)	9 - 80	34.3 ± 32.8	24 (10.5-58)
I S (µg/l)	5 - 16	10.3 ± 4.6	10 (7-13.5)
TSH (mU/l)	2.99–3.72	3.46 ± 0.33	3.56 (3.24-3.56)
BSA (m^2)	1.16–1.64	1.46 ± 0.21	1.52 (1.32-1.60)

TABLE 4.26. DEDIAPADA VILLAGE

Parameters	Range	Mean ± SD	Median (IQR)
Age (years)	16 - 40	23.9 ± 9.6	17.5 (16-35)
Height (cm)	122 – 165	141 ± 14.3	138.4 (129.5-152.4)
Weight (kg)	21 – 45	36.6 ± 6.2	36 (34-42)
BMI (kg/m^2)	12.5 – 27	18.8 ± 4.2	18.5 (15.1-20.8)
Total UI (μg/l)	23 - 208	93.6 ± 55.8	74.5 (64-100)
True UI (μg/l)	5 - 130	60.5 ± 38.8	55.5 (30-72)
IS (μg/l)	9 - 78	33.1 ± 22.7	25.5 (18-40)
TSH (mU/l)	0 – 5.54	3.84 ± 1.27	4.13 (3.84-4.29)
BSA (m^2)	0.9 – 1.45	1.2 ± 0.15	1.21 (1.1-1.29)

Iodine content of drinking water in Dang was nil but adequate in Baroda district. This is reflected in lower median urinary iodine levels in Dang district.

Iodine content of salt consumed was 7-10 parts per million (PPM) from most places with one exception having 2,000 PPM.

4.5. DISCUSSION

We used biochemical prevalence indicators and epidemiological criteria to assess the severity of IDD in the Baroda and Dang districts of Gujarat State aiming at a large target population of preschool and school aged children along with adults. Using criteria recommended by WHO (WHO/ICCIDD/NNICEF, 1994) for defining the severity (prevalence) of IDD as a public health problem, Gujarat State population has mild IDD based on median urinary iodine and blood TSH levels. It should be understood that "mild" is a relative term; it does *not* imply that this category of IDD is of little consequence (WHO/ICCIDD/NNICEF, 1994). We found that greater than 70 % of children and adults remain iodine deficient and greater than 3 % of studied population have blood TSH levels above the normal range of > 5 mU/l (ICCIDD, June-July 1999). These findings are even more disturbing given that an iodine deficiency control program has been implemented in this region of India. These findings indicate that further iodine prophylaxis measures and greater monitoring of the effectiveness of such a program need to be undertaken in this region.

Although the study population can be categorised as mild-to-moderate affected by iodine deficiency, there was great variation in the expression of the severity of iodine deficiency amongst individuals and villages. Iodine deficiency was more prevalent and of greater severity in female population from Baroda. In both districts, almost one in four female children had moderately severe iodine deficiency. The increased proportion of girls of child - bearing age having iodine deficiency is particularly important because iodine deficiency in the foetus and infant can lead to irreversible intellectual and neurological damage (Boyages SC, 1993). Goitre prevalence rates (GPR) were not measured for this population.

The differences of IDD severity based on biochemical parameters between different villages of Dang district can be explained by the fact that the children selected from boarding schools consumed iodized salt whereas those from households did not. This history of iodized salt intake had no bearing on IDD prevalence as median urine iodine was below 50 μg/l in most of the villages (Table 4.6.).

Females from Dang and males from Baroda showed high amounts of interfering substances in the urine probably due to the higher intake of spices and organic disulfides in onions and garlic (Gaitan E, 1989). We hypothesize that these interfering substances detected in urine are probable goitrogens or their metabolites and they interfere with synthesis of thyroid hormones and hence the increase in blood TSH in these subjects. We have identified large amounts of apigenin from pearl millet from Baroda and its quantity was almost double in one of the villages (Tentalav). The higher values for TSH in children from Tentalav may be explained by the greater intake of flavonoids like vitexin and apigenin.

There was a strong correlation of serum TSH values against urinary iodine values. The lower the urinary iodine values the greater the rise in blood TSH values (Table 4.10.). As expected from the UI data, girls were more likely to have values of blood TSH above 5mU/l (7.7% of girls, 3% of boys). Coincident ingestion of goitrogens may also have an impact on blood TSH values as seen in the village of Rutambhara. Here, a staggering 18 % of the females had serum TSH levels above 5.0mU/l (Table 4.11.), whilst only 45 % and 10 % had mild and moderate iodine deficiency, respectively.

Biochemical indicators of IDD in this population may underestimate the severity of the problem, in part, explained by the concomitant impact of goitrogens and malnutrition in the pathogenesis of goitre. Besides being the main IDD status indicators, the biochemical parameters are core indicators in monitoring progress towards the goal of eliminating IDD as a significant

health problem. Present study shows that IDD is far from elimination in Gujarat and it is very important to ensure sustained control of IDD for entire population.

4.6. CONCLUSIONS

Based on biochemical prevalence indicators, IDD is a public health problem in Gujarat State. Dang district is more affected due to lack of iodine in drinking water apart from contribution of malnutrition and dietary goitrogens. Iodized salt policy has not had the desired success in this district. Baroda district is a newly identified pocket of IDD, the main causative factors being iodine deficiency as well as other factors such as goitrogens and malnutrition. There is an urgent need to address the problem of iodine deficiency with introduction of alternative measures of iodine prophylaxis, correction of malnutrition and for devising methods to remove or alter dietary goitrogens.