



PREVALENCE OF THYROID DISORDERS IN A TERTIARY CARE HOSPITAL IN PUNJAB

Biochemistry

Vaneet Kaur*

Associate Professor, Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Patiala *Corresponding Author

Brinder Chopra

Professor, Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Patiala

ABSTRACT

Background: Thyroid disorders are amongst the most prevalent endocrine disorders in our country. In India, 42 million suffer from thyroid disorders.

Aim: To find out the prevalence of thyroid disorders in Punjab.

Material and methods: A total of 1370 patients presenting to the Clinical Biochemistry Lab with suspicion of thyroid disorder in Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Patiala were enrolled for this study. Overnight fasting samples of the patients were taken in plain vacutainers and the serum separated was analysed for thyroid function tests (T3, T4 and TSH) on the same day on an instrument based on chemiluminescence.

Results: The prevalence of thyroid disorders was found to be 24.2% (332) in the study population. 75.8% (1038) were found to be euthyroid. Amongst the patients with thyroid dysfunction, hypothyroidism has been seen in 19.5% (subclinical hypothyroidism 17%, overt hypothyroidism 2.5%) and hyperthyroidism in 4.7% (subclinical hyperthyroidism 2.3%, overt hyperthyroidism 2.4%). Maximum number of hypothyroid patients were seen in the age group of 40-49 years and hyperthyroid patients were seen in the age group of 20-29 years. Both hypothyroidism and hyperthyroidism have been found to be common in females. Also, the mean \pm SD levels of TSH in both subclinical and overt hypothyroidism and subclinical and overt hyperthyroidism have been found to be clinically significant.

Conclusions: We have tried to provide a baseline regarding the prevalence of thyroid disorders in the population of Punjab.

KEYWORDS

Euthyroid, hypothyroidism and hyperthyroidism

Introduction

Thyroid disorders are amongst the most common endocrine diseases in India (1). The total burden of thyroid disorders in India has been estimated to be approximately 42 million (2). Thyroid disorders are more common in women than in men. The higher prevalence of thyroid disorders in females may be associated with estrogen and progesterone (3). Genetic and various environmental factors including geographical location, nutrition and diet especially iodine intake affect the prevalence of thyroid disorders.

Thyroid disorders are broadly classified as hyperthyroidism and hypothyroidism depending upon the functional capacity of the thyroid gland (2). Hypothyroidism is 10 times more common in women than in men (4). The prevalence of hyperthyroidism is also reported as more common in women than in men (5). These two entities are further segregated as subclinical and overt dysfunction (4).

There is not much data available on the prevalence of thyroid disease in Punjab making it important for conducting this study.

Material and Methods

The present study has been conducted on 1370 patients with suspicion of thyroid disorder who reported to the Clinical Biochemistry Lab in Gian Sagar Medical College and Hospital, Ramnagar, Rajpura, Patiala during a 3 year period from June 2013 to May 2016. The study was conducted after taking permission from Institutional ethical committee. After overnight fasting, 3 ml of venous blood was collected in plain vial under aseptic conditions. The blood collected was allowed to clot and then centrifuged. The serum separated was analyzed for thyroid function tests (T3, T4 and TSH) on the same day on an instrument based on chemiluminescence (Liasion, Diasorin). The reference ranges for T3, T4 and TSH are as follows:

T3=0.6 – 1.65 ng/ml
T4=4.4 – 11.0 microg/dl
TSH=0.25 – 5.25 microIU/ml.

Those patients having T3, T4 & TSH levels within the reference range were classified as euthyroid, those with TSH levels \geq 5.25 micro IU/ml as hypothyroid and those with TSH \leq 0.25 micro IU/ml as hyperthyroid. Hypothyroidism was classified as subclinical if TSH \geq 5.25 microIU/ml with T3 & T4 within the reference range, and as overt if TSH \geq 5.25 microIU/ml with T3 & T4 below 0.6 ng/ml & 4.4 microg/dl respectively. Hyperthyroidism was classified as subclinical if TSH \leq 0.25 micro IU/ml with T3 & T4 within the

reference range, and as overt if TSH \leq 0.25 micro IU/ml with T3 & T4 above 1.65 ng/ml & 11.0 micro g/dl respectively.

Statistical analysis

This was carried out with the help of a statistician. The normality of quantitative data was checked by measures of kolmogorov-Smirnov tests of normality as data for thyroid disorders was skewed. Kruskal-Wallis test followed by Mann-Whitney test was applied to compare these values for different age groups. Mann-Whitney U test was carried out for statistical analysis of comparisons of genders. Discrete categorical data were represented in the form of either number or percentage (%). Proportions were compared using Chi square or Fisher's exact test, depending upon their applicability. Spearman correlation coefficients were calculated to see the relationship of various variables. All the statistical tests were 2 sided and were performed at a significance level of $\alpha = 0.05$. Analysis was conducted using IBM SPSS STATISTICS (version 22.0).

Results

The current study was a retrospective hospital based study carried out in the Department of Biochemistry involving 1370 patients (276 males and 1094 females) with suspicion of thyroid disorder who were subjected to thyroid function tests. Maximum number of patients (347) were seen in both the age groups of 30-39 years and 40-49 years and minimum number of patients (42) were seen above 70 years of age. Maximum number of females (290) were seen in the age group of 30-39 years and maximum number of males (63) in age group of 40-49 years whereas minimum number of both females (27) and males (15) were seen in the age group above 70 years of age (Table 1).

Table 1 Distribution of the study population in different age groups

Age group(years)	Gender		Total
	Males	Females	
10-19	20	44	64
% within gender	7.2	4.0	4.7
20-29	58	239	297
% within gender	21.0	21.8	21.7
30-39	57	290	347
% within gender	20.7	26.5	25.3
40-49	63	284	347
% within gender	22.8	26.0	25.3
50-59	41	144	185
% within gender	14.9	13.2	13.5

60-69 % within gender	22 8	66 6	88 6.4
≥ 70 % within gender	15 5.4	27 2.5	42 3.1

Table 2 shows the distribution of the study population according to the status of thyroid. Out of 1370 patients with suspected thyroid disorder, 75.8% (n = 1038; 823 females & 215 males) were categorized as euthyroid. Subclinical hypothyroidism has been seen in 17% patients (n = 233) comprising of 41 males & 192 females. 2.5% (n = 34) of patients had overt hypothyroidism comprising of 08 males and 26 females. Subclinical hyperthyroidism has been seen in 2.3% patients (n = 32, 05 males and 27 females). Overt hyperthyroidism has been seen in 2.4 % patients (n = 33, 07 males and 26 females). The gender wise distribution of the study population into different states of thyroid is not clinically significant (p=0.769).

Table 2 Distribution of the study population according to the status of the thyroid

Status of thyroid		Gender		
		Males	Females	Total
Euthyroid	Number	215	823	1038
	% within gender	77.9	75.2	75.8
Subclinical Hypothyroidism	Number	41	192	233
	% within gender	14.9	17.6	17
Overt Hypothyroidism	Number	8	26	34
	% within gender	2.9	2.4	2.5
Subclinical Hyperthyroidism	Number	5	27	32
	% within gender	1.8	2.5	2.3
Overt Hyperthyroidism	Number	7	26	33
	% within gender	2.5	2.4	2.4

p=0.769 (Nonsignificant)

The age wise distribution of the study population in different groups of thyroid is seen in table 3. Table 4 and 5 shows the age wise distribution of the males and females respectively in various thyroid groups. In the age group of 10-19 years, out of 64 patients, 55 are euthyroid (14 males, 41 females), 5 have subclinical hypothyroidism (3 males ,2 females), none with overt hypothyroidism, only 3 males have subclinical hyperthyroidism,& one female has overt hyperthyroidism. In the age group of 20-29 years, out of 297 patients, 231 are euthyroid (51 males, 180 females), 39 are subclinically hypothyroid(4 males, 35 females), 4 have overt hypothyroidism(1 male, 3 females), 11 have subclinical hyperthyroidism all of which are females, 12 have overt hyperthyroidism(2 males, 10 females). The age group of 30-39 years has a total of 347 patients out of which 267 are euthyroid (44 males, 223 females), 60 have subclinical hypothyroidism (8 males, 52 females), 6 have overt hypothyroidism (2 males, 4 females), 8 have subclinical hyperthyroidism (2 males, 6 females) and 6 have overt hyperthyroidism (1 male, 5 females). In the age group of 40-49 years, out of 347 patients, 253 patients have euthyroidism(48 males, 205 females), 69 patients have subclinical hypothyroidism(9 males, 60 females), 10 patients have overt hypothyroidism(3 females, 7 females), 8 are subclinically hyperthyroid (2 males, 6 females) and 7 have overt hyperthyroidism (1 male, 6 females). In the age group of 50-59 years, out of a total of 185 patients, 138 are euthyroid (32 males,106 females), 35 are subclinically hypothyroid (8 males, 27 females), 6 have overt hypothyroidism which are only females, 4 have subclinical hyperthyroidism (1 male, 3 females) and only 2 females have overt hyperthyroidism. In the age group of 60-69 years, out of a total of 88 patients, 62 are euthyroid (15 males, 47 females), 20 are subclinically hypothyroid (7 males,13 females) and only 5 females have overt hypothyroidism, 1 female patient has subclinical hyperthyroidism and no patient has overt hyperthyroidism. In the age group above 70 years of age, 32 are euthyroid (11 males, 21 females), 5 have subclinical hypothyroidism (2 males, 3 females), 3 have overt hyperthyroidism (2 males, 1 females) and only one female patient each

has subclinical hyperthyroidism and overt hyperthyroidism. Table 3 shows no association between any thyroid group with age (p = 0.057). Table 4 shows no association between age and the different thyroid groups in males.

Table 3 Age wise distribution into different thyroid groups

Groups	Age Groups(years)							Total
	10-19	20-29	30-39	40-49	50-59	60-69	≥ 70	
Euthyroid	55	231	267	253	138	62	32	1038
(% within age group)	85.9	77.8	76.9	72.9	74.6	70.5	76.2	75.8
Subclinical Hypothyroidism	5	39	60	69	35	20	5	233
(% within age group)	7.8	13.1	17.3	19.9	18.9	22.7	11.9	17
Overt Hypothyroidism	Nil	4	6	10	6	5	3	34
(% within age group)	Nil	1.3	1.7	2.9	3.2	5.7	7.1	2.5
Subclinical Hyperthyroidism	3	11	8	8	4	1	1	36
(% within age group)	4.7	3.7	2.3	2.3	2.2	1.1	2.4	2.6
Overt Hyperthyroidism	1	12	6	7	2	Nil	1	29
(% within age group)	1.6	4	1.7	2	1.1	Nil	2.4	2.1

p value = 0.057 (Nonsignificant)

Table 4 Age wise distribution of males in various thyroid groups

Groups	Age Groups(years)							Total
	10-19	20-29	30-39	40-49	50-59	60-69	≥ 70	
Euthyroid	14	51	44	48	32	15	11	215
(% within age group)	70	87.9	77.2	76.2	78	68.2	73.3	77.9
Subclinical Hypothyroidism	3	4	8	9	8	7	2	41
(% within age group)	15	6.9	14	14.3	19.5	31.8	13.3	14.9
Overt Hypothyroidism	Nil	1	2	3	Nil	Nil	2	8
(% within age group)	Nil	1.7	3.5	4.8	Nil	Nil	13.3	2.9

Subclinical Hyperthyroidism (% within age group)	3	Nil	2	2	1	Nil	Nil	8
Overt Hyperthyroidism (% within age group)	15	Nil	3.5	3.2	2.4	Nil	Nil	2.9
Subclinical Hypothyroidism (% within age group)	Nil	2	1	1	Nil	Nil	Nil	4
Overt Hypothyroidism (% within age group)	Nil	3.4	1.8	1.6	Nil	Nil	Nil	1.4

Table 5 Age wise distribution of females in various thyroid groups

Groups	Age groups							Total
	10-19	20-29	30-39	40-49	50-59	60-69	≥ 70	
Euthyroid (% within age group)	41 93.2	180 75.3	223 76.9	205 72.2	106 73.6	47 71.2	21 77.8	823 75.2
Subclinical Hypothyroidism (% within age group)	2 4.5	35 14.6	52 17.9	60 21.1	27 18.8	13 19.7	3 11.1	192 17.6
Overt Hypothyroidism (% within age group)	Nil Nil	3 1.3	4 1.4	7 2.5	6 4.2	5 7.6	1 3.7	26 2.4
Subclinical Hyperthyroidism (% within age group)	Nil Nil	11 4.6	6 2.1	6 2.1	3 2.1	1 1.5	1 3.7	28 2.6
Overt Hyperthyroidism (% within age group)	1 2.3	10 4.2	5 1.7	6 2.1	2 1.4	Nil Nil	1 3.7	25 2.3

P=0.047 (Significant)

Table 5 showing age wise distribution of different thyroid groups in females has a significant p value = 0.047. In the age group of 10-19 years, euthyroid group forms a maximum percentage (93.2% with 41 females) as compared to subclinical hypothyroidism (4.5% with 2 females), overt hyperthyroidism (2.3% with 1 female) whereas in other age groups, euthyroid group is seen in the range of (71.2 – 77.8%), subclinical hypothyroidism (11.1 – 21.1%), overt hypothyroidism (1.3 – 7.6%), subclinical hyperthyroidism (1.5 – 4.6%), overt hyperthyroidism (1.4 – 4.2%).

Table 6 shows the Mean ± SD levels with minimum and maximum levels of T3, T4 and TSH in different age groups. Mean ± SD T3 levels are seen to be decreasing with age (p = 0.006). The mean levels of T3 are significantly more in the age group of 10 – 19 years (1.290 ± 1.219) as compared to the Mean ± SD levels in the age group of 40 – 49 years (1.049 ± 0.601, p = 0.0406), age group of 50 – 59 years (1.025 ± 0.522, p = 0.033), age group of 60 – 69 years (0.908 ± 0.321, p = 0.001) and age group of ≥ 70 years (0.883 ± 0.429, p = 0.008). The mean ± SD levels of T4 are highest in the age group of 10 – 19 years (8.707 ± 5.276) and then seen to be decreasing till age group 30 – 39 years in which the levels are (8.093 ± 3.025), then increasing in age group of 40 – 49 years (8.191 ± 3.268) and in 50 – 59 years (8.447 ± 3.773) and then decreasing levels are observed in the age group of 60 – 69 years (8.239 ± 2.319) and in the age group above 70 years of age (7.869 ± 2.558). But the change in mean ± SD levels of T4 with age is not significant (p = 0.628). The mean ± SD levels of TSH are highest in the age group of 30 – 39 years (7.957 ± 30.116). But the change in TSH levels in different age groups is not significant (p = 0.113).

Table 6 Mean ± SD levels of thyroid hormones in different age

groups

Age groups	No.	Mean± SD	T3		Mean± SD	T4		TSH		
			Min	Max		Min	Max	Min	Max	
10 – 19	64	1.29 ± 1.219	0.6	8.0	8.704 ± 5.276	4.4	38	3.257 ± 3.546	0.0	24.8
20 – 29	297	1.068 ± 0.447	0.1	3.3	8.339 ± 3.054	0.2	28.7	4.197 ± 9.592	0	100
30 – 39	347	1.055 ± 0.560	0.2	8.0	8.093 ± 3.025	0.7	39.5	7.957 ± 30.116	0	413
40 – 49	347	1.049 ± 0.601	0.2	8.0	8.191 ± 3.268	0.1	39	6.936 ± 16.714	0	172.5
50 – 59	185	1.025 ± 0.522	0.2	4.8	8.447 ± 3.773	2.4	33.2	6.307 ± 21.396	0	264
60 – 69	88	0.908 ± 0.321	0.1	1.9	8.239 ± 2.319	1.1	13.7	5.279 ± 11.682	0	100
≥ 70	42	0.883 ± 0.429	0.3	2.5	7.869 ± 2.558	1.8	14.2	3.090 ± 2.853	0.01	14.5

T3 = p = 0.006

T4 = p = 0.628

TSH = p = 0.113

The mean ± SD levels along with minimum and maximum values of T3, T4 and TSH in different groups of thyroid is given in Table 7.

Table 7 Mean ± SD levels of thyroid hormones in various thyroid groups

Thyroid group	No.	Mean± SD	T3		Mean ± SD	T4		TSH		
			Min	Max		Min	Max	Mean ± SD	Min	Max
Euthyroid	1038	1.009 ± 0.341	0.1	3.8	8.23 ± 2.217	1.8	33.6	2.646 ± 3.605	0	100
Subclinical Hypothyroidism	233	0.952 ± 0.228	0.6	1.9	6.947 ± 2.005	0.4	15.9	16.89 ± 27.65	5.3	246.5
Overt Hypothyroidism	34	0.528 ± 0.0299	0.2	1.6	5.182 ± 3.939	0.1	11.8	49.97 ± 85.30	0	413
Subclinical Hyperthyroidism	36	1.416 ± 1.538	0.2	8.0	11.075 ± 7.858	5.6	38	0.078 ± 0.077	0	0.2
Overt Hyperthyroidism	29	3.379 ± 1.531	1.9	8.0	19.537 ± 6.995	12	39.5	0.015 ± 0.021	0	0.1

The mean ± SD levels of TSH in euthyroid individuals is 2.646 ± 3.605. The mean ± SD levels of TSH are significantly higher (p < 0.001) in subclinical hypothyroidism and overt hypothyroidism are 16.890 ± 27.658 and 49.970 ± 85.30 respectively. Also, the mean ± SD levels of TSH in subclinical hyperthyroidism and overt hyperthyroidism are significantly lower (0.078 ± 0.077, 0.015 ± 0.021, p < 0.001).

Mean ± SD levels of T3 in euthyroid individuals is 1.009 ± 0.341, lower (0.952 ± 0.228) in patients with subclinical hypothyroidism and lowest (0.528 ± 0.0299) in patients with overt hypothyroidism (p < 0.001). The mean ± SD levels of T3 are significantly higher (p < 0.001) both in patients with subclinical hyperthyroidism (1.416 ± 1.538) and in overt hyperthyroidism (3.379 ± 1.531).

The Mean ± SD levels of T4 in patients with subclinical

hypothyroidism (6.947 ± 2.005) and in overt hypothyroidism (5.182 ± 3.939) are significantly lower ($p < 0.001$) than the patients with euthyroid status (8.23 ± 2.217). Also, the mean \pm SD levels of T4 in patients with subclinical hyperthyroidism (11.075 ± 7.858) and in overt hyperthyroidism (19.537 ± 6.995) are significantly higher ($p < 0.001$) than the patients with euthyroid status.

DISCUSSION

Thyroid disorders are amongst the most common endocrine diseases in India. But the data on the prevalence of thyroid disorders in Punjab is scanty. This retrospective study was conducted for a 3 year period on 1370 patients with suspicion of thyroid disorder. A female preponderance was observed with the number of females being three times the number of males.

In the present study, out of 1370 patients with suspected thyroid disorder, 75.8% were found to be euthyroid. This has been supported by other studies conducted by Rebecca et al (6) and Arora et al (7) which reported 80% and 74.82% patients respectively as euthyroid. Tayal et al (8) also reported a prevalence of 85% patients as euthyroid in a study conducted in New Delhi.

We found that 24.2% patients in our study were having thyroid dysfunction. Doeker et al (9) also reported a prevalence of 22.16% of thyroid dysfunction in a study conducted in Andheri, Mumbai. Other studies conducted by Arindam Bose et al (10) and Rebecca et al (6) found a prevalence of 15.35% and 15.8% respectively.

Amongst the thyroid dysfunction patients 19.5% were having hypothyroidism and 4.7% were having hyperthyroidism. Hypothyroidism has a greater prevalence than hyperthyroidism. A hospital based study of thyroid disorders in rural population of gurgaon, Haryana conducted by Arora et al (7) reported 16.8% patients with hypothyroidism and 8.2% patients with hyperthyroidism. Another study conducted by Dhok et al (11) on thyroid disorders in Wardha reported 11.5 % patients to be hypothyroid and 2.3% patients to be hyperthyroid.

Also, both hyperthyroidism and hypothyroidism have been observed more in females as compared to males (Table 2) which is similar to other studies as conducted by Tayal at al (8). Subclinical hypothyroidism was observed in 17% patients . Our results are supported by study conducted on 1905 patients in Acharya Vinoba Bhawe rural hospital in Swangi, Wardha who reported a prevalence of 14.8% (11). Hypothyroidism has a greater prevalence than hyperthyroidism . Also, both hypothyroidism and hyperthyroidism have been observed more in females as compared to males (Table2) which is similar to studies like Tayal et al (8) and Braverman (12).

The prevalence of overt hypothyroidism in the present study is 2.5% which is similar to a study conducted in Puducherry by Rebecca et al (1.9%).

Amongst the hyperthyroid patients, 2.3% of patients had subclinical hyperthyroidism in the present study. Doeker et al (9) reported a much higher prevalence of subclinical hyperthyroidism (5.97%) and Rebecca et al (6) and Hoogendoorn study(13) reported a prevalence of subclinical hyperthyroidism to be 0.6 and 0.8% respectively.

The present study showed a prevalence of 2.4% of patients having overt hyperthyroidism which is very similar to the prevalence of overt hyperthyroidism (2.5%) reported by Doeker et al (9). Hoogendoorn study(13) found a prevalence of overt hyperthyroidism to be very less (0.4%).

The study population was divided into different age groups to see the percentage of occurrence of hypothyroidism and hyperthyroidism in different age groups. Maximum number of hypothyroid patients were seen in the age group of 40 -49 years (subclinical hypothyroidism 19.9% and overt hypothyroidism 2.9%) whereas maximum number of hyperthyroid patients were seen in the age group of 20 - 29 years (subclinical hyperthyroidism 3.7% and overt hyperthyroidism 4%). Doeker et al (9) also found the highest number of patients with hypothyroidism (both overt and subclinical) b/w the age group of 30 - 49 years.

The Mean \pm SD levels of TSH are highest in the age group of 30- 39 years. The Mean \pm SD levels of TSH in subclinical and overt

hypothyroidism and subclinical and overt hyperthyroidism are clinically significant ($p < 0.001$).

Conclusion

In this study we have tried to provide a baseline regarding the prevalence of thyroid disorders in the representative population of Punjab as we could not find much work in this region on the prevalence of thyroid disorders. Hence, further population based studies are recommended to confirm the above findings.

REFERENCES

1. Kochupillai N. Clinical endocrinology in India. *Curr Sci* 2000; 79: 1061-67.
2. Delang F. The Disorder induced by iodine deficiency. *Thyroid*. 2002; 12:839-847.
3. Nimmy N J et al. A Survey on the Prevalence of Thyroid Disorder Induced by Demography and Food Habits in South Indian Population. *Indian Journal of Pharmacy Practice*. Apr-Jun 2012; 5(2): 49-52.
4. Vanderpump MP, Tunbridge WM. Epidemiology and prevention of clinical and subclinical hypothyroidism. *Thyroid* 2002; 12: 839-47.
5. Tunbridge WM, Evered DC, Hall R, Appleton D, Brewis M, Clark F, et al. The spectrum of thyroid disease in a community. The Whickham survey. *Clin Endocrinol (Oxf)* 1977; 7:481-93.
6. Abraham R, Murugan VS, Pukazhvanthen P and Sen SK. Thyroid disorders in women of Puducherry. *Indian Journal of Clinical Biochemistry*, 2009;24(1): 52-59.
7. Arora P, Prasad S, Karunanand B. Hospital based study of thyroid disorders in rural population of Gurgaon, Haryana. *International Journal of Current Research and Review*. 2016; 8(21): 6-11.
8. Tayal D, Goswami B, Gupta M et al. Prevalence of thyroid disorders in patients visiting a tertiary care center in New Delhi: A three year study. *Asian Journal of Medical Science*. 2012(3): 15-23.
9. Deokar PG, Nagdeote AN, Lanje MJ, Basutkar DG. Prevalence of thyroid disorders in a tertiary care center. *International Journal of Current Research and Review*. 2016; 8(9): 26-30.
10. Bose A, Sharma N, Hemvani N, Chitnis DS. A Hospital based prevalence study on thyroid disorders in Malwa region of Central India. *Int J Curr. Microbiol. App. Sci* .2015;4(6): 604-611.
11. Dhok AJ, Adole PS, Puppallwar PV, Aggarwal U. Status of thyroid disorders at Acharya Vinobha Bhawe Rural Hospital, Sawangi (Meghe), Wardha, India. *Thyroid Res Pract* 2015;12:62-6.
12. Braverman LE. Evaluation of thyroid status in patients with thyrotoxicosis. *Clin Chem* 1996;42:174-8.
13. Hoogendoorn EH, Hermus AR, de Vegt F, Ross AH, Verbeek ALM, Kiemeny LALM et al. Thyroid dysfunction and prevalence of Antithyroperoxidase antibodies in a population with Borderline Sufficient Iodine Intake: Influences of Age and Sex. *Clin Chem* 2006; 52: 104-11.