Research Article

Prevalence of thyroid dysfunction: Experience of a tertiary care centre in Kerala

Lakshminarayana Gopaliah R[1], Sheetal Lakshminarayana G[2], Nidhish P Sadanandan[3], Pramod M[4]

[1]Dr Lakshminarayana Gopaliah R, MBBS, DNB (General Medicine), DNB (Nephrology), MNAMS, PGDHR, Consultant Nephrologist, Department of Nephrology, EMS Memorial Cooperative Hospital and Research Centre, Perinthalmanna, Malappuram, Kerala,
[2]Dr Sheetal Lakshminarayana G, MBBS, MD (Physiology), DNB (Physiology), MHA, Associate Professor, Department of Physiology, MES Medical College, Perinthalmanna, Malappuram, Kerala,
[3] Nidhish P Sadanandan, MSc (Physiology), Tutor, Department of Physiology, Amrita Institute of Medical Sciences and Research Centre, AIMS Ponekkara PO, Kochi, Kerala.
[4] Pramod M, In charge, Electronic Medical Records, EMS Memorial Cooperative Hospital and Research Centre, Perinthalmanna, Malappuram, Kerala, India

Source(s) of support: Nil, Conflicts of Interest: Nil

Address for Correspondence: Dr. Lakshminarayana GR, Consultant Nephrologist, Department of Nephrology, EMS Memorial Cooperative Hospital and Research Centre, Perinthalmanna, Malappuram, Kerala, India, Pin-679322. E-mail: drlng23@gmail.com

.....

Abstract

Background: There is limited data regarding the prevalence of thyroid disorders in India, and this is the first study to assess their prevalence in northern Kerala. **Methods:** All subjects who underwent blood sampling for estimation of thyroid function tests (TFTs) on their initial visit to the EMS Memorial Cooperative Hospital and Research Centre, Perinthalmanna (2009-2013) were included in the study. **Results:** The study population included 8179 subjects (Males: 3205, females: 4974), of ages from 1-94 (Mean-41.95) years of age. The overall prevalence rate of thyroid function abnormalities was 15.73%; more in females (16.91 %) than males (13.90%). The subclinical hypothyroidism (SCH) was the commonest thyroid abnormality (7.15 %) followed by overt hypothyroidism (4.2%), hyperthyroidism (2.77 %) and subclinical hyperthyroidism (SH) (1.6 %). The prevalence rate of hypothyroidism in different age groups was 2.81 % in 1-19, 3.53 % in 20-45 and 5.36 % in those ≥ 46 years respectively. The prevalence rate of SCH was highest (8.05 %) in the age group of 20-45 years followed by 6.74 % in ≥ 46 and 4.19 % in 1-19 years. **Conclusions:** The thyroid function abnormalities are common and the prevalence is higher in females than males. The prevalence rates of thyroid function disorders were 9.76%, 17.50 % and 15.05 % in age groups of 1-19, 20-45 and ≥ 46 years respectively. The SCH was the commonest abnormality, followed by overt hypothyroidism, hyperthyroidism and SH; first 3 conditions were more common in females than males, whereas last was common in males.

Key-words: Hypothyroidism, Hyperthyroidism, Subclinical Hypothyroidism, Subclinical Hyperthyroidism,

.....

Introduction

The disorders of thyroid function are very common in the world and their prevalence varies widely based on the geographical areas. Thyroid disorders are the most common among all the endocrine diseases in India. The prevalence of overt hypothyroidism and subclinical hypothyroidism is about 4-5% [1, 2] and 4-15% in the developed world is [1, 3]. There are very few studies assessing their prevalence from India. The reported prevalence of thyroid disorders also varies widely (15-25 %) in India [4, 5, 6, 7, 8]. We need large population based multicentre studies for thyroid disorders involving all states to assess their true prevalence. The

Manuscript received: 30th Nov 2015
Reviewed: 10th Dec 2015
Author Corrected: 14th Dec 2015
Accepted for Publication: 1st Jan 2016

aim of the present study was to estimate the prevalence of thyroid disorders in northern Kerala.

Material and Methods

Study design and subjects: This study was retrospective study conducted at EMS Memorial Cooperative Hospital and Research Centre, Perinthalmanna, Malappuram, Kerala, a tertiary care, referral centre in northern Kerala. All subjects who underwent estimation of thyroid function tests (TFTs) on their first outpatient visit from September 2009 to December 2013. Aims of the study were to measure the prevalence of thyroid disorders across wide range of age groups (1-94 years) as assessed by measurement of thyroid hormones. Total of 8179 subjects who underwent estimation of TFTs at their first visit to the hospital were included for the study. Subjects were categorised into different groups for analysis to find-out the difference in prevalence of thyroid disorders based on gender and age (1-19 years, 20-45 years and ≥ 46 years).

Study procedure and statistics: All subjects who underwent blood sampling for estimation of TFTs on their initial visit to the hospital from 2009 to 2013 were included in the study. The triiodothyronine (T3), tetraiodothyronine (T4) and thyroid stimulating hormone (TSH) were analysed by electrochemiluminescence assay (Cobas-Roche Elecys Core immunoassay system - Roche Diagnostics, Mannheim, GmbH). Normal range for T4, T3 and TSH were 5.1-14.1 µg/dL, 60-180 ng/dL and 0.35 to 5.5 µIU/mL respectively, with intra assay and inter assay coefficient of variation (CV) being less than 7 % for all three parameters. Analytical sensitivity of the kit used to measure T4, T3 and TSH was 0.3 µg/dL, 0.1 ng/mL and 0.005 µIU/mL respectively. The presence of either subclinical or overt, hypo- or hyperthyroidism was used to define thyroid dysfunction.

Subjects were classified using following definitions:

Primary hypothyroidism: TSH > 5.5 µIU/mL and T4 <5.1 µg/dL or T3 < 60 ng/dL.

Subclinical hypothyroidism: TSH > 5.50 µIU/mL and normal T4, normal T3.

Secondary hypothyroidism: T4 <5.1 µg/dL or T3 <60 ng/dL and a TSH level that is not appropriately elevated.

Hyperthyroidism: TSH <0.35 µIU/mL and T3 >180 ng/dL or T4 >14.1 µg/dL.

Subclinical hyperthyroidism: TSH < 0.35 µIU/mL and normal T3, normal T4.

Secondary hyperthyroidism: T3 >180 ng/dL or T4 >14.1 ng/dL and a TSH level that is not appropriately supressed.

Statistical analysis was performed using SPSS (Version 17) for Windows. The quantitative variables (age, TSH, T3, T4) have been described as mean ± SD and range. The prevalence of hypothyroidism and other thyroid disorders was summarized as counts and percentages. A Chi-square test was used to assess the trends in the prevalence of hypothyroidism, among different age groups and gender categories. Similar analyses were performed for SCH, hyperthyroidism and subclinical hyperthyroidism. A p value of <0.05 was taken as significant.

Observations

A total of 8179 subjects who underwent estimation of TFTs from 2009 to 2013 were included in the study. Out of the 8179 subjects, 3205 (39.18 %) were males and 4974 (60.82 %) were females [Table 1]. The majority (85 %, *n*=6952) of the study population was reportedly consuming iodized salt.

Table 1: Description of clinical parameters in the study population

Parameter	All subjects (n = 8179) Mean ±SD (Range)	Males (n = 3205) Mean ±SD (Range)	Females (n = 4974) Mean ±SD (Range)	Deviation from linearity (p value)
Age (years)	41.95 ± 18.04 1-94	43.09 ± 18.74 1-92	41.22 ± 17.53 1-92	< 0.0001
T3 ng/dL	113.79 ± 40.61 3.40-651	114.68 ± 44.51 7.49-651.00	113.21 ± 37.88 3.4-651.00	0.24
T4 µg/dL	8.62 ± 2.62 0.42-24.86	8.41 ± 2.48 0.42-24.86	8.85 ± 2.62 0.43 – 24.86	0.19
TSH µIU/mL	4.24 ± 11.56 0.005-100	4.21 ± 11.64 0.005-100	4.26 ± 11.46 0.005 - 100	0.39

The mean age of the study subjects was 41.95 years with a range of 1 to 94 years [Table 1]. The mean age in different groups was 11.12 years in 1 to 19 years (9.58 % of subjects), 33.50 years in 20 to 45 years (49.79 % of subjects) and 59.59 years in those belonging ≥ 46 years (40.62 % of subjects) respectively [Table 2]. There was no statistically significant variation in TSH, T3 and T4 levels based on gender and age groups [Table 1, 2]. Mean age was more in males subjects than females and was statistically significant [Table 1].

Table 2: Description of clinical parameters in the study population based on age groups

Parameter	Age group (years)			Deviation from linearity (p value)
	1-19(n = 784) Mean ±SD (Range)	20-45(n = 4073) Mean ±SD (Range)	≥ 46 (n = 3322) Mean ±SD (Range)	
Age	11.12 ± 6.23	33.50 ± 7.31	59.59 ± 10.18	
T3 ng/dL	128.71 ± 31.07 19.53 – 348.20	117.50 ± 41.87 16.51 - 651.00	105.72 ± 39.36 3.40 - 651.00	0.99
T4 µg/dL	9.25 ± 2.37 0.51 – 21.19	8.75 ± 2.67 0.42 - 24.86	8.45 ± 2.58 0.43-24.86	0.89
TSH µIU/mL	4.56 ± 13.48 0.005 - 100	4.53 ± 12.36 0.005 - 100	3.82 ± 9.83 0.005-100	0.84

Table 3: Prevalence rate of thyroid disorders and its variation with gender

Thyroid function status	All Subjects (8179) n (%)	Gender		
		Males (3205) n (%)	Females (4974) n (%)	Chi square test (males vs females) p-value
Hypothyroidism (primary)	325 (3.97)	121 (3.77)	204 (4.10)	0.40
Hypothyroidism (secondary)	19 (0.23)	9 (0.28)	10 (0.20)	
Subclinical Hypothyroidism	585 (7.15)	183 (5.71)	402 (8.08)	0.00003
Hyperthyroidism (primary)	222 (2.71)	70 (2.18)	152 (3.05)	0.011
Hyperthyroidism (secondary)	5 (0.06)	2 (0.06)	3 (0.06)	
Subclinical Hyperthyroidism	131 (1.60)	61 (1.90)	70 (1.40)	0.13
Total subjects with thyroid dysfunction	1287 (15.73)	446 (13.90)	841 (16.9)	0.0003

Thyroid function abnormalities were present in 15.73 % of subjects [table 3]. The prevalence rate of thyroid function abnormalities was higher in females (16.91 %) than males (13.90 %) [Table 3] and it was statistically significant (p =0.0003). Thyroid function abnormalities were more common in female subjects than males in all age groups; it was statistically significant in 1-19 and ≥ 46 year age groups and insignificant in those with age ranging 20-45 years [Table 5, 6, 7]. Thyroid function abnormalities were highest in age group of 20-45 years (17.50 %), followed by ≥ 46 years (15.05 %) and 1-19 years (9.76 %) [Table 4]. The association age with prevalence of thyroid disorders was statistically significant.

Hypothyroidism: The prevalence of hypothyroidism in the study population was 4.2 % (n = 344). Among those with hypothyroidism the majority (94.48 %, 325 out of 344) were of primary hypothyroidism and 5.52 % (19 out of 344) had secondary hypothyroidism [Table 3]. The prevalence rate of hypothyroidism was more in females (4.3 %) than males (4.05 %) [Table 3] but difference was not statistically significant (p=0.40). The prevalence rate of hypothyroidism in different age groups was 2.81 % in 1-19, 3.53 % in 20-45 and 5.36 % in those ≥ 46 years respectively [Table 4], and this increasing prevalence with age was statistically significant (p = 0.006). The prevalence rate of hypothyroidism was more in female subjects than males in age groups of 1-19 (p=0.22) and ≥ 46 years (p=0.04) [Table 5, 7]. In subjects belonging to age group of 20-45 years the prevalence was more in males than females; however it was not statistically significant (p=0.17) [Table 6].

Table 4: Prevalence rate of thyroid dysfunction and its variation according to age groups

Thyroid function status	All Subjects (8179) n (%)	Age group			Prevalence trend with age Chi square test p-value
		1-19 years (784) n (%)	20-45 years (4073) n (%)	≥ 46 years (3322) n (%)	
Hypothyroidism (primary)	325 (3.97)	21 (2.68)	139 (3.41)	165 (4.97)	0.006
Hypothyroidism (secondary)	19 (0.23)	1 (0.13)	5 (0.12)	13 (0.39)	
Subclinical Hypothyroidism	585 (7.15)	33 (4.19)	328 (8.05)	224 (6.74)	0.00009
Hyperthyroidism (primary)	222 (2.71)	16 (2.04)	135 (3.31)	71 (2.13)	0.001
Hyperthyroidism (secondary)	5 (0.06)	1 (0.13)	4 (0.10)	0	
Subclinical Hyperthyroidism	131 (1.60)	2 (0.25)	102 (2.50)	27 (0.81)	< 0.00001
Total subjects with thyroid dysfunction	1287 (15.73)	74 (9.76)	713 (17.50)	500 (15.05)	<0.00001

Table- 5: Prevalence rate of thyroid dysfunction according to gender in age group of 1-19 years

Parameter	All Subjects (8179) n (%)	Age 1-19 Years		Chi square test (males vs females) p value
		M (336) n (%)	F (448) n (%)	
Hypothyroidism (primary)	325 (3.97)	6 (1.78)	15 (3.35)	0.22
Hypothyroidism (secondary)	19 (0.23)	1 (0.30)	0	
Subclinical Hypothyroidism	585 (7.15)	9 (2.68)	27 (6.02)	0.018
Hyperthyroidism (primary)	222 (2.71)	2 (0.59)	14 (3.12)	0.006
Hyperthyroidism (secondary)	5 (0.06)	0	1 (0.22)	
Subclinical Hyperthyroidism	131 (1.60)	0	2 (0.45)	0.2
Total subjects with thyroid dysfunction	1287 (15.73)	18 (5.05)	59 (13.16)	0.0002

Table-6: Prevalence rate of thyroid dysfunction according to gender in age group of 20-45 years

Parameter	All Subjects (8179) n (%)	Age 20-45 Years		Chi square test (males vs females) p value
		M (1434) n (%)	F (2639) n (%)	
Hypothyroidism (primary)	325 (3.97)	56 (3.90)	83 (3.14)	0.17
Hypothyroidism (secondary)	19 (0.23)	3 (0.21)	2 (0.07)	
Subclinical Hypothyroidism	585 (7.15)	88 (6.14)	240 (9.10)	0.0017
Hyperthyroidism (primary)	222 (2.71)	39 (2.72)	96 (3.64)	0.15
Hyperthyroidism (secondary)	5 (0.06)	2 (0.13)	2 (0.07)	
Subclinical Hyperthyroidism	131 (1.60)	55 (3.83)	47 (1.78)	0.0001
Total subjects with thyroid dysfunction	1287 (15.73)	243 (16.94)	470 (17.80)	0.48

Table -7: Prevalence rate of thyroid dysfunction according to gender in age group of ≥ 46 years

Parameter	All Subjects (8179) n (%)	Age ≥ 46 Years		Chi square test (males vs females) p value
		M (1435) n (%)	F (1887) n (%)	
Hypothyroidism (primary)	325 (3.97)	59 (4.11)	106 (5.61)	
Hypothyroidism (secondary)	19 (0.23)	5 (0.34)	8 (0.42)	0.04
Subclinical Hypothyroidism	585 (7.15)	86 (5.99)	138 (7.31)	0.086
Hyperthyroidism (primary)	222 (2.71)	29 (2.02)	42 (2.22)	
Hyperthyroidism (secondary)	5 (0.06)	0	0	0.56
Subclinical Hyperthyroidism	131 (1.60)	6 (0.42)	21 (1.11)	0.021
Total subjects with thyroid dysfunction	1287 (15.73)	185 (12.89)	315 (16.69)	0.002

Subclinical hypothyroidism: Subclinical hypothyroidism (SCH) was observed in 7.15 % (*n*-585) participants [Table 3]. The prevalence rate of SCH was higher (8.08%) in the females than males subjects (5.71 %) and it was statistically significant (p =0.00003) [Table 3]. The prevalence rate of SCH was highest (8.05 %) in the age group of 20-45 years followed by 6.74 % in ≥ 46 years and it was lowest in the age group of 1-19 years (4.19 %), statistically significant association (p= 0.00009) was found with age [Table 4]. Rate of SCH was more in females than male subjects in all ages [Table 5, 6, 7] and this increased prevalence was statistically significant in 1-19 (p=0.018) and 20-45 (p=0.017), but not in 20-45 year age group (p=0.086).

Hyperthyroidism: The prevalence rate of hyperthyroidism was 2.77 % (*n*-227) [Table 3]. The majority were primary hyperthyroidism (97.80 % - 222 out of 227) and 2.20 % (5 out of 227) had secondary hyperthyroidism. The prevalence rate was higher in females (3.11 %) than males (2.24 %) and it was statistically significant (p=0.011) [Table 3]. The prevalence rate of hyperthyroidism was highest (3.41 %) in 20-45 years age group followed by 2.17 % in 1-19 and 2.13 % in ≥ 46 years and the association was found to be statistically insignificant (p = 0.001) [Table 4]. Rate of hyperthyroidism was more in female subjects than males of all ages [Table 5, 6, 7] and it was found to be significant statistically 1-19 years age group (p =0.006) but not in those belonging to 1-19 (p=0.15) and ≥ 46 years (p=0.56).

Subclinical Hyperthyroidism: The prevalence of rate of subclinical hyperthyroidism was 1.60 % (n – 131) [Table 3]. The prevalence rate was higher in males (1.9 %) in comparison to females (1.4 %) but it was not statistically significant (p =0.13) [Table 3]. Those in age group of 20-45 years had highest prevalence (2.50 %) followed by 0.81 % in ≥ 46 years and prevalence rate was least (0.25 %) in those belonging to age group of 1-19 years and the association with age was statistically significant (p < 0.00001) [Table 4]. The prevalence rate of subclinical hyperthyroidism was more in females than males in age groups of 1-19 and ≥ 46 years and the association was found to be statistically significant ≥ 46 years age group (p=0.021) but not in those ranging from 1-19 years (p= 0.2) [Table 5, 7]. In the age group of 20-45 years the prevalence rate was higher in males than females and it was significant statistically (0.0001) [Table 5].

Discussion

The present study was conducted to find out the prevalence of thyroid function abnormalities in subjects of wide range of age groups who underwent estimation of TFTs, first study of its kind from northern Kerala. Majority (85 %) of the subjects were consuming iodized salt. Thyroid function abnormalities were very common in this post iodization era, similar to other studies from India [4, 5, 6, 7].

In our study thyroid function abnormalities were noted in 15.73 % of all subjects. Our observation of high prevalence rates of thyroid dysfunction is similar with earlier reports of Menon UV et al (19.6 %) from Cochin [5]. Thyroid dysfunction was more common in females (16.89 %) than males (13.91 %) in the present study. Higher prevalence of thyroid dysfunction in females in our study is consistent with other studies from India [5, 6, 7, 8].

In our study the subclinical hypothyroidism (SCH) was the commonest thyroid function abnormality affecting 7.15 % of subjects, more common in females (8.08 %) than males (5.71%). SCH as the commonest thyroid

abnormality has been reported in cross sectional studies from Cochin (9.4%) [5] and Delhi (19.3 %) [8]. A multicentre (8 cities) study from India also reported a reported a prevalence rate of SCH to be 8.02 % (females 8.73 %, males 7.17%). In the above studies the SCH was more common in females than males similar to our study. The prevalence rate of SCH was highest in age group of 20-45 years, followed by ≥ 46 years and it was least in 1-19 years category. The prevalence of SCH is shown to increase with age in previous studies [5, 6]. In our study higher prevalence of SCH in age group of 20-45 years may be due to lesser number of subjects in this category as compared to ≥ 46 years.

Hypothyroidism was the second commonest thyroid abnormality seen 4.2 % of subjects in the study and the prevalence rate increased with age, and similar prevalence rate has been reported from a population-based studies done from Cochin (3.9%) [5] and Delhi (4.2 %) [8]. However, the reported prevalence rate of hypothyroidism varies from 8.88 to 21.67 % based on the place of study [6]. The high prevalence figures in Cochin, Kolkata have ascertained that thyroid disorders in India are not confined to the conventional iodine-deficient sub-Himalayan zone but extending to the plain fertile lands as well as areas reporting majority of population consuming iodized salt. In our study majority (85 %) were reportedly consuming iodized salt. A possible etiological role of cyanogenic foods acting as goitrogens [9], industrial and agricultural contaminants acting as thyroid disruptors [10] and deficiencies of micronutrients (iron, selenium and zinc) [11] which can interfere with thyroid function may be considered; in subjects consuming iodized salt. The prevalence rate of hypothyroidism was more in females than males, irrespective of age group of subjects. The prevalence of hypothyroidism was also shown to increase with age in our study.

Hyperthyroidism was the third commonest thyroid abnormality affecting 2.77 % of subjects in our study. The prevalence rate of hyperthyroidism was more in females than males in all age groups. The hyperthyroidism was more common in age of 20-45 years than those of ≥ 46 and 1-19 years. Earlier studies by Abraham R [7] form Pondicherry and Menon UV et al [5] form Cochin et al have reported prevalence of overt hyperthyroidism of 1.2 % and 1.3% respectively.

The subclinical hyperthyroidism was found in 1.60 % subjects in the present study. The subclinical hyperthyroidism was common in age group of 20-45 years similar to overt hyperthyroidism. The prevalence rate was higher females than male subjects in 1-19 and ≥ 46 years category. In those belonging to 20-45 years the prevalence was more in males in comparison to females. Earlier studies have reported a prevalence rate of subclinical hyperthyroidism from 0.6-1.6 % similar to our study [5, 7].

Our study has few limitations: Firstly, from the consumption of iodized salt, the study presumed that the target population was iodine sufficient, without testing for reliable markers such as iodine content in salt samples or urinary iodine excretion. Secondly, markers of autoimmunity (anti TPO) were not tested.

To summarize the present study is to first of its kind to assess the prevalence of thyroid disorders in northern part Kerala, with subjects belonging to wide range of age groups, and majority consuming iodized salt.

Conclusions

Thyroid disorders are common in northern Kerala similar to rest of the Country. Thyroid dysfunction was more common in females than males in all age groups. Thyroid disorders were common in age of 20-45 years than 1-19 and ≥ 46 year categories. Subclinical hypothyroidism is the commonest thyroid disorder followed by overt hypothyroidism, hyperthyroidism and subclinical hyperthyroidism. A possible etiological role of cyanogenic foods acting as goitrogens, industrial and agricultural contaminants acting as thyroid disruptors and deficiencies of micronutrients (iron, selenium and zinc) which can interfere with thyroid function needs to be evaluated in future studies involving hypothyroidism; as majority of subjects were consuming iodized salt.

Funding: Nil
Conflict of interest: None.
Permission of IRB: Yes

References

1. Hollowell JG, Staehling NW, Flanders WD, Hannon WH, Gunter EW, Spencer CA, Braverman LE. Serum TSH, T(4), and thyroid antibodies in the United States population (1988 to 1994): National Health and Nutrition Examination Survey (NHANES III). J Clin Endocrinol Metab. 2002 Feb;87(2):489-99.

2. Hoogendoorn EH, Hermus AR, de Vegt F, Ross HA, Verbeek AL, Kiemeney LA, Swinkels DW, Sweep FC, den Heijer M. Thyroid function and prevalence of anti-thyroperoxidase antibodies in a population with borderline sufficient iodine intake: influences of age and sex. Clin Chem. 2006 Jan;52(1):104-11. Epub 2005 Oct 27.

3. Bemben DA, Hamm RM, Morgan L, Winn P, Davis A, Barton E. Thyroid disease in the elderly. Part 2. Predictability of subclinical hypothyroidism. J Fam Pract. 1994; 38 (6): :583–588.

4. Unnikrishnan AG, Menon UV. Thyroid disorders in India: An epidemiological perspective. Indian J Endocrinol Metab. 2011 Jul;15(Suppl 2):S78-81. doi: 10.4103/2230-8210.83329.

5. Usha Menon V, Sundaram KR, Unnikrishnan AG, Jayakumar RV, Nair V, Kumar H. High prevalence of undetected thyroid disorders in an iodine sufficient adult south Indian population. J Indian Med Assoc. 2009 Feb;107(2):72-7.

6. Unnikrishnan AG, Kalra S, Sahay RK, Bantwal G, John M, Tewari N. Prevalence of hypothyroidism in adults: An epidemiological study in eight cities of India. Indian J Endocrinol Metab. 2013 Jul;17(4):647-52. doi: 10.4103/2230-8210.113755.

7. Abraham R, Srinivasa Murugan V, Pukazhvanthen P, Sen SK. Thyroid disorders in women of Puducherry. Indian J Clin Biochem. 2009 Jan;24(1):52-9. doi: 10.1007/s12291-009-0009-y. Epub 2009 May 8.

8. Marwaha RK, Tandon N, Ganie MA, Kanwar R, Sastry A, Garg MK, Bhadra K, Singh S. Status of thyroid function in Indian adults: two decades after universal salt iodization. J Assoc Physicians India. 2012 Apr;60:32-6.

9. Chandra AK, Mukhopadhyay S, Lahari D, Tripathy S. Goitrogenic content of Indian cyanogenic plant foods & their in vitro anti-thyroidal activity. Indian J Med Res. 2004 May;119(5):180-5.

10. Kalra S, Unnikrishnan AG, Sahay R. Thyroidology and public health: The challenges ahead. Indian J Endocrinol Metab. 2011 Jul;15(Suppl 2):S73-5. doi: 10.4103/2230-8210.83326.

11. Zimmermann MB, Köhrle J. The impact of iron and selenium deficiencies on iodine and thyroid metabolism: biochemistry and relevance to public health. Thyroid. 2002 Oct;12(10):867-78.

.....

How to cite this article?

Lakshminarayana Gopaliah R, Sheetal Lakshminarayana G, Nidhish P Sadanandan, Pramod M. Prevalence of thyroid dysfunction: Experience of a tertiary care centre in Kerala. *Int J Med Res Rev* 2016;4(1):12-18. doi: 10.17511/ijmrr.2016.i01.002.

……