Biochemical pattern and prevalence of thyroid disorders among adults in a tertiary hospital in North-East Nigeria

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Abstract

Thyroid disorders are a relatively common group of endocrine disorders globally. Thyroid function tests are critical for diagnosing, screening, and prognosticating thyroidal and non-thyroidal diseases, and their accurate interpretation is required for effective and accurate patient management. A retrospective analysis of thyroid function tests - Thyroid Stimulating Hormone (TSH), Free Thyroxine (fT4), and Free Triiodothyronine (fT3) - was carried out at a Nigerian tertiary hospital between January 2017 and January 2024. The tests were conducted using an enzyme-linked fluorescent immunoassay system and interpreted following standard protocols. A preponderance of female patients was investigated for thyroid diseases, with a male-female ratio of 2.2:1. The majority (80.8%) of the analyzed requests showed a euthyroid pattern; primary hyperthyroidism was the most common biochemical pattern of thyroid dysfunction observed, accounting for 10.8% of all the analyzed requests. Secondary hyperthyroidism and hypothyroidism were generally rare. Occasional cases (0.3%) of T3 toxicosis were also observed. Goiters remain a common presentation of thyroid diseases in our environment. Primary hyperthyroidism and primary hypothyroidism are the most common forms of thyroid dysfunction observed.

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Introduction

Thyroid disorders are a relatively common endocrine disorder globally.[1,2] It is likely to be encountered clinically because it is the second most common endocrine disorder globally, and in Nigeria, it is second only to diabetes mellitus.[3,4] Thyroid hormones are critical for normal brain development, growth and skeletal development, menstrual cycle regulation, fertility, and the regulation of general metabolism.[5,6] They also modulate humoral and cell-mediated immunity, making thyroid disorders a clinically significant group of diseases.[7] The etiology of thyroid disorders is variable and includes dyshormonogenesis, trophoblastic tumors, iodine deficiency, autoimmune inflammation of the thyroid gland (as in Grave's disease, sub-acute thyroiditis, and transient subacute thyroiditis), and medications (like amiodarone, lithium, interferon alpha, and tyrosine kinase inhibitors).[5,6] The clinical presentation of thyroid diseases is variable and includes thyroid gland enlargement (with or without pressure symptoms), irregular menstruation, subfertility, weight loss or gain, myopathy, heat or cold intolerance, exophthalmos, and other symptoms associated with hyperthyroidism or hypothyroidism.[5,6]

Thyroid Function Test (TFT) is an essential pillar in the screening, diagnosis, prognostication and monitoring response to treatment, and changes in these biochemical parameters often precedes the clinical signs and symptoms of the disease.[5,6] TFT encompasses the assay of three parameters which include: Thyroid Stimulating Hormone (TSH), Free Thyroxine (fT4) and/or Total Thyroxine (TT4), and Free Triiodothyronine (fT3) and/or Total Triiodothyronine (TT3).[5,6,8] TFT assays have signifi-

cantly improved over the last two to three decades, making it easier to interpret the results, with more than 90% of those tested being found to be euthyroid.[8] Because TSH is the best indication of minor changes in thyroid production due to log-linear negative feedback from the thyroid hormones, it is considered the most essential parameter of TFT and is employed alone for initial screening of thyroid problems in many laboratories.[5,6,8] However, despite its clinical utility as the first line test for screening of thyroid disorders, TSH alone might be misleading in conditions such as recent treatment of thyrotoxicosis, pituitary diseases, non-thyroidal illness, adrenal insufficiency, TSH-secreting pituitary tumor and thyroid hormone resistance.[8] Thyroxine is the primary product of the thyroid gland as 100% of the hormone is derived from the gland and secreted at approximately 70-90 microgram per day.[5,6] In contrast, triiodothyronine is produced at a rate of 15-30 micrograms per day, of which only about 20% comes from direct secretion and the remaining 80% is derived from thyroxine, which involves de-iodination of the outer beta ring of thyroxine in peripheral tissues, particularly the kidneys and liver.[5,6] Reverse T3 (rT3), which is produced following de-iodination of the inner alpha ring is physiologically inert, but it is typically increased in patients with Sick Euthyroid Syndrome.[5,6] Ultimately, compared to fT4, fT3 concentration is a poor indicator of thyroid secretion since it is influenced by a variety of non-thyroidal events such as systemic disease, prolonged fasting or starvation, and some medications.[5,6] Thyroid hormones exist in two forms in the plasma: total, which makes up approximately 99% of the hormone and is typically attached to three major plasma proteins (albumin, transthyretin, and thyroxine binding globulin), and free, which makes up less than 1% and is the form that is metabolically active.[5,6] The protein bound and the free hormone fractions exist in a state of equilibrium to provide ready source of the free fraction whenever the need arises.[5,6] Free thyroid hormones are now more often preferably measured in laboratory assays than total thyroid hormones because total T4 and T3 concentrations may be misinterpreted due to pathological or physiological changes in binding protein plasma concentrations, which does not affect the concentration of free thyroid hormones.[5,6] This retrospective study investigated biochemical patterns and prevalence of thyroid disorders in a tertiary health care facility in Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH) Bauchi North East Nigeria from January 2017 to January 2024 using the outcome of TFT results.

Materials and Methods

This is a retrospective study of medical records and laboratory data for TFT analysis seen in the chemical pathology department of ATBUTH Bauchi within a span of six years (January 2017 to January 2024). Samples for TFT analysis are usually received from family medicine, endocrinology, surgery (general surgery, urology, ENT, ophthalmology), obstetrics & gynecology, pediatrics, and cardiology clinics. Some are also received from private clinics and laboratories within Bauchi and public health facilities from neighboring states. This study included samples from adult patients aged 18 years and above, and the information obtained from the laboratory records included clinical diagnosis, age, sex, and resultant TFT results. Requests without age specification or those without the full complement of TSH, fT3, and fT3 were excluded from the study. The routine laboratory analysis for TFT that is utilized in the laboratory is briefly summarized as follows: blood samples for TFT assay are allowed to clot and then centrifuged immediately at 1000 revolutions per minute for ten minutes so as to separate the cellular component from the supernatant (serum), and stored at -20^{0}C until analysis, which is usually carried out twice in a week. Biochemical analysis of the hormones (TSH, fT4, and fT3) was then performed using the mini-Vidas system (Biomerieux®; Marcy-l'Étoile, France), which uses the principle of enzyme-linked fluorescent immunoassay, which has a limit of detection of 0.05 µIU/mL, 1.0 pmol/L and 0.7 pmol/L for TSH, fT4, and fT3 respectively. Individual results were interpreted using a standard method to arrive at the biochemical pattern of thyroid disorder.[5,6,8] Data were entered into a pre-designed proforma, and descriptive statistical analysis was carried out using SPSS version 21.0 (IBM Corporation; Armonk, USA) to determine frequencies and percentages as well as the mean, range, and Standard Deviation (SD) of age. The data were presented in frequency distribution tables and charts. The Health Research Ethics Committee of ATBUTH, Bauchi, waived ethical approval in accordance with its local regulations.

Outcome measures

The following reference limits were used to interpret the TFT results: TSH, 0.5mIU/L to 4.1mIU/L; fT4, 9.0pmol/L to 19.0pmol/L; fT3: 3.2pmol/L to 6.8pmol/L.

Biochemical interpretation of TFT results was carried out as follows:[5,6,8] i) euthyroid, TSH, fT3, and fT4 are within normal reference level; ii) primary hyperthyroidism, suppressed TSH, with elevated fT4 and/or fT3; iii) secondary hyperthyroidism, elevated TSH with elevated fT4 and/or fT3; iv) T3 toxicosis, suppressed TSH with elevated fT3 and normal fT4; v) subclinical hyperthyroidism, suppressed TSH with normal fT4 and/or fT3; vi) primary hypothyroidism, elevated TSH with suppressed fT4 and/or fT4; vii) secondary hypothyroidism, suppressed TSH with low fT4 and/or fT3; viii) subclinical hypothyroidism, elevated TSH, with normal fT3 and/or fT4; ix) sick euthyroid syndrome, low or normal fT4 and/or fT3 in the presence of normal, low or slightly high TSH; x) euthyroid hyperthyroxinaemia, normal TSH, with elevated fT4 and high, normal, or low fT3.

Results

A total of 1134 requests for TFTs were received over the study period. The overwhelming majority of the patients were females, accounting for 69% of the total requests received (Figure 1).

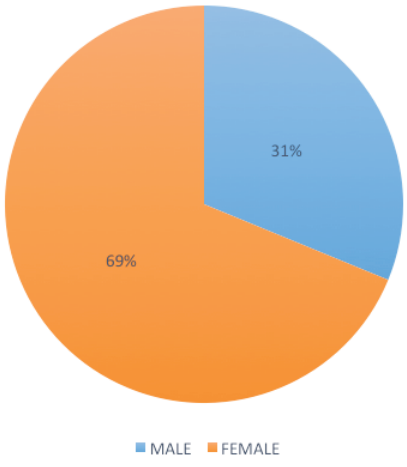

Figure 1. Gender distribution of patients investigated for thyroid dysfunction (Jan, 2017-Jan, 2024).

The patients were aged 18-85, with a median age of 36. The age groups 20-29 and 30-39 were the most common, accounting for 27.3% and 23.8% of the total number of patients (Table 1).

Endemic goiter was the most common clinical indication for TFT requests, accounting for 31.0% of cases. Other common indications were toxic goiter, Graves' disease, and hyperthyroidism/thyrotoxicosis (Table 2). Infertility was the most common non-thyroid indication for TFT requests (Table 2).

Table 3 shows the distribution of the interpretative diagnosis of TFTs. The majority (80.8%) were euthyroid. The overall prevalence of thyroid dysfunction was found to be 19.2%, with primary hyperthyroidism being the most common form of thyroid dysfunction observed after TFT analysis. T3 toxicosis was the least common type of thyroid dysfunction observed, accounting for 0.3% of cases.

Discussion

This study examined the biochemical patterns of TFTs in a Nigerian tertiary hospital. There was an overwhelming majority of female patients as compared to males, probably reflecting the fact that thyroid diseases are generally commoner in women than men. According to GLOBOCAN estimates, age-standardized incidence rates for thyroid diseases in 2020 were 10·1 per 100.000 women and 3·1 per 100.000 men, respectively.[9] Similarly, female preponderance has been documented in previous studies in Nigeria.[10,11] Most of the requests received were from individuals in the age range of 20-39 years, accounting for more than half of TFT requests over the study period. While there is a dearth of data in the literature regarding the overall age distribution of thyroid diseases, common thyroid disorders (hyperthyroidism and hypothyroidism) tend to occur around this age group.[10]

Not surprisingly, an overwhelming majority of the requests were from thyroid-related problems. However, non-thyroid conditions such as infertility were also indications for TFT requests. This observation is corroborated by previous studies.[12,13] The majority of the thyroid-related requests were due to clinical suspicion of goiters (endemic or toxic). This pattern is understandable, considering the fact that goiters are the most common clinically recognizable indication of thyroid diseases. In addition, this preponderance of goiters may be due to iodine deficiency. Similar observations have been made by Mshelia *et al*. and Jimoh *et al*.[10,14]

Biochemical evidence of thyroid dysfunction was observed in 19.2% of the requests with the euthyroid pattern accounting for an overwhelming majority (80.8%) of all requests received. This observation is much higher than those reported by Mshelia *et al.* (67.2%) and Jimoh *et al.* (43%).[10,14] These differences may reflect variations in assay conditions between the different laboratories as well as the much larger sample size of TFT analyzed in this study compared to most other studies in the region. Of note, Mshelia *et al.* analyzed Total T3 and T4, as opposed to fT3 and fT4 that were utilized in this study. Free thyroid hormone measurements are believed to be a more accurate representation of thyroid gland activity than total measurements since the latter can be affected by factors such as changes in the concentration of binding plasma proteins.[6] In addition, the assay method used in both studies was ELISA-based, unlike our study, where an enzyme-linked fluorescent assay was used. The latter is believed to have slightly superior sensitivity than ELISA, generally.[15,16]

Primary hyperthyroidism was the most common thyroid dysfunction observed in this study. It accounted for 10.8% of samples analyzed and occurred at a median age of 35 years, with a predominant occurrence in females (Table 4). The frequency of occurrence and common age group of affectation are similar to findings in other studies. Primary hypothyroidism was the second most common pattern of thyroid dysfunction, in keeping with most previous

Table 1. Age distribution of patients investigated for thyroid dysfunction (Jan, 2017-Jan, 2024).

Age group (years)	Frequency (%)
<20	44 (3.9)
20-29	310 (27.3)
30-39	270 (23.8)
40-49	165 (14.5)
50-59	116 (10.2)
60-69	136 (12.0)
70-79	85 (7.5)
≥80	8 (0.8)
Total	1134 (100.0)

Table 2. Distribution of clinical indication for Thyroid Function Tests.

Clinical indication	Frequency (%)	Gender	
		Female	Male
Endemic goiter	352 (31.0)	244	108
Toxic goiter	170 (15.0)	105	65
Graves' Disease	165 (14.6)	109	56
Thyrotoxicosis/hyperthyroidism	116 (10.2)	95	21
Infertility	100 (8.8)	68	32
Hypothyroidism	136 (12.0)	100	36
Routine monitoring	50 (4.5)	28	22
Cardiac disease	35 (3.0)	23	12
Others	10 (0.9)	8	2
Total	1134 (100.0)	780	354

Table 3. Distribution of interpretative diagnosis from Thyroid Function Tests (TFT).

TFT diagnosis	Frequency (%)
Euthyroid	916 (80.8)
Hyperthyroidism	
Primary	123 (10.8)
Secondary	4 (0.4)
Subclinical	9 (0.8)
Hypothyroidism	
Primary	33 (2.9)
Secondary	6 (0.5)
Subclinical	26 (2.3)
Sick Euthyroid Syndrome	7 (0.6)
T3 toxicosis	3.03
Euthyroid hyperthyroxinemia	7.06
Total	1134 (100.0)

TFT, Thyroid Function Tests.

Table 4. Age and sex distribution of diagnostic categories of Thyroid Function Test.

Diagnosis	Median age (range) in years	Male : female ratio
Euthyroid	35 (18-85)	1:2.3
Primary hyperthyroidism	35 (18-79)	1:4.3
Secondary hyperthyroidism	30 (18-71)	1:3
Subclinical hyperthyroidism	64 (40-80)	1:4.5
Primary hypothyroidism	47.5 (18-77)	1:2
Secondary hypothyroidism	65 (33-71)	1:2
Subclinical hypothyroidism	43.5 (20-79)	1:4.3
Sick Euthyroid Syndrome	34.5 (20-66)	1:6
Euthyroid hyperthyroxinaemia	36.6 (22-42)	1:1.2
T3 Toxicosis	25 (19-50)	NA

NA, Not available.

studies within the country.[10,14,17,18] Subclinical hypothyroidism was the second most common subtype of hypothyroidism in this study. It was at least four times more common in females and occurred at a median age of 43.5 years. It is a biochemically defined condition whose prevalence appears to increase with increasing age.[19] The relative prevalence of mild subclinical hypothyroidism in older individuals and the observation of increased TSH levels in the elderly, coupled with the absence of significant health impact of this observation, has resulted in the suggestion that age-related reference ranges in TSH should be used in this age group to avoid unnecessary thyroid hormone supplementation.[20]

Secondary hyperthyroidism and secondary hypothyroidism were both the least common forms of hyperthyroidism and hypothyroidism, respectively. This finding is consistent with previous studies in the country.[10,14] Secondary hyperthyroidism occurred at a median age of 30 years, consistent with information in the literature.[10,14] Secondary hypothyroidism occurred at a median age of 65 years. This finding is consistent with information in literature, which states that this disorder is reported commonly in older women greater than 60 years of age.[9]

Cases of sick euthyroid syndrome were also observed in the study and accounted for 2.3% of all the requests received. This was noted to occur at a median age of 34.5 years and was more common in females. It has been observed that sick euthyroid syndrome can occur across all age groups and sexes; as such, no particular age bracket or sex is particularly susceptible.[21] Sick euthyroid syndrome frequently accompanies critical illnesses of diverse etiology but is potentially prone to interpretative difficulties, especially in situations where the underlying clinical scenario is not provided.[22] It is an important syndrome to recognize as it has prognostic implications: the probability of mortality correlates with serum FT4 levels.[21,23]

Euthyroid hyperthyroxinaemia was rarely observed in this study and constituted three cases. These were observed as part of routine requests in patients without clinical evidence of thyroid disease. It is defined as a condition in which elevated fT4 and/or fT3 levels are associated with normal TSH levels in the absence of clinical signs and symptoms of thyroid disease.

Conclusions

The results of this study reflect requesting patterns based on the clinical impression of the managing physician and do not necessarily correspond to the actual prevalence and distribution of thyroid dysfunction in the community. However, it is based on fT3 and fT4 measurements using a highly sensitive and specific enzyme-linked fluorescent immunoassay system and, as such, may provide a slightly better picture of thyroid dysfunction compared to previous studies in our region. The high frequency of euthyroid goiters observed may reflect a continued iodine deficiency despite ongoing attempts at iodine supplementation. Primary hyperthyroidism and primary hypothyroidism remain the most common forms of thyroid dysfunction in our setting.

References

1. Ogbera AO, Kuku SF. Epidemiology of thyroid diseases in Africa. Indian J Endocrinol Metab. 2011;15:S82-8.
2. Hussain N, Anwar M, Nadia N, Ali Z. Pattern of surgically treated thyroid disease in Karachi. Biomedica. 2005;21:18-20.
3. Ogbera AO, Fasanmade O, Adediran O. Pattern of thyroid disorders in the Southwestern region of Nigeria. Ethn Dis. 2007;17:327-30.
4. Watkinson JC. Fifteen years' experience in thyroid surgery. Ann R Coll Surg Engl. 2010;92:541-7.
5. Carl AB, Edward RA, David EB. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. Fifth Edition. St. Louis, Missouri, USA: Elsevier Saunders; 2012.
6. Crook MA. Clinical Biochemistry and Metabolic Medicine. Eight Edition. London, UK: Hodder Arnold; 2012.
7. Clare FH, Simpson Ellen AS, John HB, et al. Preliminary Evidence of Immune Function Modulation by Thyroid Hormones in Healthy Men and Women aged 55 – 70 years. Journal of Endocrinology. 2009;202:55-63.
8. Dayan CM. Interpretation of thyroid function tests. Lancet. 2001;357:619-24.
9. Lamartina L, Leboulleux S, Borget I, Schlumberger M. Global thyroid estimates in 2020. Lancet (Diabetes and Endocrinology). 2022;10:235-6.
10. Mshelia DS, Bakari AA, Mubi BM, et al. Biochemical pattern

of thyroid disorders in Maiduguri, Northeastern Nigeria. International Scholars Journal. 2020;8:1-7.
11. Ogbera AO, Fasanmade O, Adediran O. Pattern of thyroid disorders in the Southwestern Region of Nigeria. Ethnicity and Disease. 2007;17:327-30.
12. Birador SM, Poornima RT, Sonagra AD, Jayaprakash MDS. Thyroid dysfunction in infertile women. IJPBS. 2012;2:53-8.
13. Emokpae MA, Osadolor HB, Omole OA. Sub-clinical hypothyroidism in infertile Nigerian women with hyperprolactinaemia. Nig. J Physiol. Sci. 2011;26:35-8.
14. Jimoh AK, Ghazal MS, Adeleke AB, et al. Biochemical pattern of thyroid function test and clinical impression of thyroid disorder in a rural tertiary health institution in Nigeria. Ann Afr Med. 2020;19:89-94.
15. Abdalla BE, Abdealla AM. Hormonal immunoassays; comparison using ECL & ELFA. Professional Med J 2015;22:648-55.
16. Pramila K, Gopinath P, Divya DM. Analytical Sensitivity of TSH assays by ELISA AND ELFA. Nat J Basic Med Sci. 2016;6:1-6.
17. Okpara HC, Ene AB, Enang EO, Aluka TM. Spectrum of thyroid dysfunction among patients evaluated by thyroid function tests at a tertiary clinical laboratory in Calabar, Nigeria. Ann Med Health Sci Res. 2017; 7:411-7.
18. Amballi AA, Adeleye AO, Oritogun AS, Salu LO. Pattern of thyroid dysfunction in a semiurban Nigerian population through thyroid function tests in a private laboratory, Sagamu, Ogun State, Nigeria. Int J Biochem Biotechnol. 2012;1:146-9.
19. Ross DS, Burch HB, Cooper DS, et al. 2016 American Thyroid Association Guidelines for diagnosis and management of hyperthyroidism and other causes of thyrotoxicosis. Thyroid. 2016;26:1343-421.
20. Walsh JP. Thyroid Function across the Lifespan: Do Age-Related Changes Matter? Endocrinol Metab (Seoul). 2022;37: 208-19.
21. El-Ella SSA, El-Mekkawy MS, El-Dihemey MA. Prevalence and prognostic value of non-thyroidal illness syndrome among critically ill children. An Pediatr (Engl Ed). 2019;90:237-43.
22. Okayama D, Minami Y, Kataoka S, et al. Thyroid function on admission and outcome in patients hospitalized for acute decompensated heart failure. J Cardiol. 2015;66:205-11.
23. Wang B, Liu S, Li L, et al. Non-thyroidal illness syndrome in patients with cardiovascular diseases: A systematic review and meta-analysis. Int J Cardiol. 2017;226:1-10.