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RESEARCH ARTICLE

Prevalence of Thyroid Disorders in the Southeastern Region of Bangladesh

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ABSTRACT

Thyroid disorders are a prominent global health concern, with prevalence rates varying significantly across regions and demographic groups. This study aimed to investigate the prevalence and characteristics of thyroid dysfunction among patients with thyroid swelling in southeastern Bangladesh. Data were collected from the Institute of Nuclear Medicine and Allied Sciences, Chattogram, over a five-month period (April to September 2024) and included all patients presenting with thyroid swelling. Thyroid hormone levels, including Thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4), along with age, sex, and Thyroid Imaging Reporting and Data System (TI-RADS) categories, were recorded using a structured clinical format to identify patterns in thyroid dysfunction. Statistical methods such as descriptive statistics, independent samples t-tests, correlation analysis, and linear regression were applied to analyze the data. The study population was predominantly female (85%), with an average age of 37 years. Most patients exhibited elevated TSH levels, with an average of 7.92 mIU/L. Females had significantly higher mean TSH levels (9.32 mIU/L) than males (0.41 mIU/L), whereas males had higher FT3 (10.10 pmol/L) and FT4 (88.01 pmol/L) levels, suggesting sex-based differences in thyroid hormone regulation ($p < 0.05$). A negative correlation between age and TSH levels ($r = -0.232$, $p = 0.053$) indicated that TSH levels tended to decrease with advancing age. Additionally, an inverse relationship was observed between TSH levels and TI-RADS categories, highlighting a potential link between hormone levels and imaging assessments. These findings provide critical insights into the local epidemiology of thyroid disorders, emphasizing the need for targeted public health interventions in the Chattogram region. By addressing region-specific factors, this study contributes to a broader understanding of thyroid health and aids in developing tailored health strategies.

1. INTRODUCTION

Neck swelling is a common clinical presentation in ENT practice, and if it is not properly managed, it can lead to significant morbidity and even mortality. Among these cases, thyroid swelling is the most prevalent (M. M. Rahman, Begum, & Majumder, 2023; Rout K, Ray CS, Behera SK, 2011). Thyroid disease is a common endocrine disorder caused by dysfunction at the tissue level (Samiran Sana, Sadiur Rahman Sajon, Sohel Rana, Zobaida Mostarin & Mahmud, 2017). The thyroid is a component of the endocrine system, which consists of glands responsible for producing, storing, and releasing hormones into the bloodstream, allowing them to reach and affect the body's cells (A. M. Rahman, Choudhury, & Hira, 2023). Thyroid disorders are among the most prevalent endocrine conditions

worldwide, with Bangladesh having a particularly high incidence (Selim & Kamrul-Hasan, 2023a). The prevalence of thyroid disorders increases with age (K. C. Das et al., 2010), making them a major global health problem (K. C. Das et al., 2016; Sharma, Magar, & BK, 2021). Although the exact burden of thyroid dysfunction in Bangladesh remains unclear, it is estimated that approximately 20% of the population is affected by these conditions. Unlike other endocrine diseases, thyroid disorders are relatively easy to diagnose, and their treatment is both accessible and cost-effective. Common thyroid-related issues in Bangladesh include hypothyroidism, thyroid autoimmunity, hyperthyroidism, goiter, iodine deficiency disorders, and thyroid cancers. Hypothyroidism is the most prevalent thyroid disorder both in Bangladesh and globally (Selim & Kamrul-Hasan, 2023b).

The thyroid gland, shaped like a butterfly, is situated at the base of the neck. It secretes hormones that regulate metabolism according to the body's needs. These hormones influence essential functions, such as breathing, heart rate, both the central and peripheral nervous systems, body weight, muscle strength, menstrual cycles, body temperature, and cholesterol levels. While not essential, the thyroid gland plays a key role in regulating metabolism by stimulating oxygen consumption in tissues (A. M. M. M. Rahman, Choudhury, & Hira, 2022).

The thyroid uses iodine from food to create two primary hormones: triiodothyronine (T3) and thyroxine (T4). While the thyroid is the sole source of T4, most of the T3 in the blood comes from the conversion of T4 by the enzyme 5'-deiodinase. Balancing the T3 and T4 levels is crucial because T3 and T4 determine the basal metabolic rate which affects the energy level of a person. The hypothalamus and the pituitary gland work together to regulate these levels. The hypothalamus releases thyrotropin-releasing hormone (TRH), which signals that the pituitary gland adjusts the production of thyroid-stimulating hormone (TSH). TSH, in turn, prompts the thyroid gland to increase or decrease its production of T3 and T4.

The FT3 and FT4 are free T3 and T4 in blood, their reading is lesser than the total T3 and T4. Such research is crucial for developing tailored healthcare strategies and improving thyroid health management in the region. Considering the context of Bangladesh, we found no studies assessing the prevalence of thyroid dysfunction in patients with gland swelling.

The prevalence of thyroid disorders can vary based on regional and demographic factors. Most previous studies were conducted among a specific group of people in a specific location to understand the prevalence of thyroid hormone disorders (AK, SR, AA, & S, 2006; KC et al., 2010; M et al., 2020; M. Shahid et al., 2021; M. M. Shahid & Ferdousi, 2021). Several studies have highlighted the persistence of thyroid disorders in Bangladesh despite the implementation of iodine supplementation programs. For example, one study (A. M. Rahman et al., 2023) aimed to assess the serum levels of T3, T4, and TSH in a group of school-aged children residing in the urban area of Chattogram, Bangladesh. Another study (A. K. Das et al., 2020), conducted in Chattogram among children with idiopathic nephrotic syndrome, assessed their thyroid hormone status, compared thyroid function before and after steroid treatment, examined the correlation with serum albumin levels, and compared thyroid function with that of a control group. Another study (Ahmad, Amin, Hossain, & Chawdhury, 2018) was conducted at the Upazila Health Complex in Boalkhali, Chattogram, and at the 250-bed General Hospital in Chattogram to evaluate the effectiveness of thyroid surgery under local anesthesia. However, the work here focuses on a broader age group.

In Bangladesh, limited research has been conducted on the specifics of thyroid function in different age groups and sexes. This research gap highlights the need for comprehensive studies focusing on thyroid-stimulating hormone (TSH), free triiodothyronine (FT3), and free thyroxine (FT4) levels in the population of Chattogram. The Chattogram, located in the southeastern part of Bangladesh, is a major port city and metropolitan area surrounded by hilly regions, making it a unique case for studying the prevalence of thyroid disorders. The region's diverse population, ranging from urban dwellers to rural inhabitants, provides an opportunity to examine the prevalence of thyroid dysfunction among patients with gland swelling who visit the Institute of Nuclear Medicine and Allied Sciences, Chattogram.

Therefore, this study aimed to assess thyroid hormone levels in patients visiting the Institute of Nuclear Medicine and Allied Sciences, a medical centre in Chattogram and to explore the prevalence of thyroid dysfunction among those with gland swelling. Addressing this research gap in thyroid

function specific to Chattogram is crucial for developing effective public health strategies and improving thyroid health outcomes. By focusing on local variations in TSH, FT3, and FT4 levels; TI-RADS categories; and age and sex, this research contributes valuable data to the global understanding of thyroid health and helps tailor interventions to the unique needs of the Chattogram population.

2. METHODOLOGY

2.1 Study area and study subjects

This is a cross-sectional study conducted at the Institute of Nuclear Medicine and Allied Sciences, Chattogram. The study spanned 5 months, from April 2024 to September 2024, and included all patients with gland swelling who visited the hospital during this period. A total of 99 patients from this hospital in Chattogram city were investigated for this study. During this time, two doctors voluntarily participated in the study. Thyroid hormone levels, including TSH, FT3, and FT4 levels, as well as sex and age, were documented using a predesigned clinical format to identify thyroid disorders. Blood samples were collected for measuring TSH, FT3, and FT4 levels. The laboratory reference ranges provided by the manufacturer were as follows: TSH 0.35–4.94 mIU/L, FT4 9.01–19.05 pmol/L, and FT3 2.63–5.70 pmol/L (Chen et al., 2020). All 99 patients underwent an ultrasound test and categorize TI-RADS into five groups based on ultrasound report. Statistical analyses, such as descriptive statistics, correlation coefficient analysis, and regression analysis, were performed via SPSS version 25.

2.2 Variable description

Thyroid hormones are crucial for the development and regulation of normal metabolic processes throughout life. Clinically, thyroid function is evaluated by measuring the levels of thyroid-stimulating hormone (TSH) and free thyroid hormones (Taylor et al., 2023). The TSH assay is essential for assessing thyroid function and measuring the serum levels of TSH, free triiodothyronine (FT3), free thyroxine (FT4), total triiodothyronine (T3), and total thyroxine (T4) to provide a comprehensive evaluation (Shivaraj G, Prakash BD, Sonal V, 2009; Yao et al., 2021). TSH, a hormone produced by the pituitary gland, stimulates the thyroid gland to produce thyroid hormones. Measuring TSH levels in the blood helps evaluate thyroid function, with high TSH levels typically indicating an underactive thyroid (hypothyroidism) and low levels suggesting an overactive thyroid (hyperthyroidism). FT3 refers to the free triiodothyronine level in the blood, which is one of the active thyroid hormones. Free T3 (FT3) represents the portion of triiodothyronine that is not bound to proteins and is available to cells and tissues, playing a crucial role in regulating metabolism. Abnormal FT3 levels can indicate thyroid dysfunction, with high levels often observed in hyperthyroidism patients and low levels observed in hypothyroidism patients. FT4 measures the levels of free thyroxine, another key hormone produced by the thyroid gland, in the blood. Free T4 is the unbound form of thyroxine that is biologically active and can be converted into the more potent T3 hormone. Measuring FT4 levels helps assess thyroid function, with high levels typically indicating hyperthyroidism and low levels suggesting hypothyroidism. In the dataset, gender refers to the classification of individuals as male or female, whereas age represents the current age of the patient. The Thyroid Imaging Reporting and Data System (TI-RADS) is a standardized classification system used to evaluate thyroid nodules based on ultrasound features (Karizaki et al., 2020). We categorize TI-RADS into five groups: TI-RADS 1: benign or normal, with no nodules or completely benign findings. TI-RADS 2: not suspicious (benign), typically includes nodules with features such as simple cysts. TI-RADS 3: mildly suspicious, usually applies to large nodules with low-risk features. TI-RADS 4: moderately suspicious, often solid nodules with some concerning characteristics. TI-RADS 5: highly suspicious, nodules with features strongly associated with malignancy.

2.3 Informed consent statement

Written consent was obtained from each participant before their inclusion in the study, ensuring their understanding and voluntary participation.

3. RESULTS

The study spanned 5 months, from April 2024 to September 2024, and investigated 99 patients with gland swelling who visited the hospital during this period. Majority of the patients were female, 85%

female and 12% male. Most patients were 37 years old, and the mean age of the patients was 38 years. The majority of the patients had a TSH level of 9.61658 (Table 1). The majority of patients belong to the TI-RADS 3 category, which means that most of them are mildly suspicious, with large nodules (Figure 1).

Table 1: Baseline clinical characteristics of the patients

Variables	Sample size, n	Description	Mean ± SD	Min, Max
Age	99	14-67 years, continuous data	37.34 ± 13.10	14, 67
Sex	99	Male =0; female = 1	0.85 ± 0.36	0,1
TSH	70	Thyroid-Stimulating Hormone levels, Continuous data	7.92 ± 30.36	0.001, 150
FT3	54	Free Triiodothyronine levels, Continuous data	6.72 ± 5.78	0.94, 30.80
FT4	68	Free Thyroxine levels, Continuous data	48.40 ± 72.78	1.30, 495
TI-RADS	99	TR1= 1; TR2= 2; TR3= 3; TR4= 4; TR5= 5	2.90± 1.01	1, 5

SD = standard deviation; Max = maximum; Min = minimum.

The sample size varies across different variables because some patients underwent only an ultrasound test and did not complete the blood test. In total, we investigated 99 patients. Of these, 70 patients underwent the TSH test, 54 underwent the FT3 test, and 68 underwent the FT4 test. All 99 patients underwent an ultrasound test.

Among the 99 patients examined, 10% were classified in the TR1 category, 23% in the TR2 category, 36% in the TR3 category, 27% in the TR4 category, and 3% in the TR5 category (Figure 1).

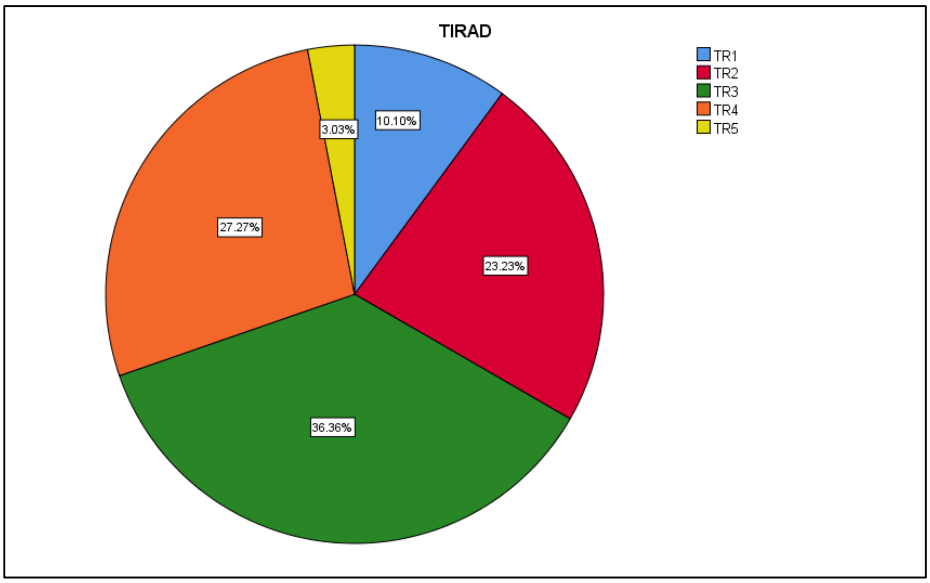

Figure 1: Pie chart of TI-RADS categories

In this study, we categorized age into 10-year intervals, following the methodology used in the referenced thyroid study [13], to understand the age-specific thyroid hormone status (Table 2).

Table 2: Thyroid hormone values among different groups

Age	TSH, n (mean)	FT3, n (mean)	FT4, n (mean)
14-25	19 (25.38)	16 (5.68)	18 (27.77)
25-35	19 (1.51)	10 (5.52)	17 (64.03)
35-45	15 (1.82)	11 (10.17)	15 (72.00)
45-55	11 (1.15)	11 (6.91)	12 (25.16)
55-65	5 (0.50)	5 (4.49)	5 (60.74)
65-75	1 (0.60)	1 (6.54)	1 (17.24)

P value	0.119	0.349	0.381
Sex			
Male	11 (0.41)	9 (10.10)	11 (88.01)
Female	59 (9.32)	45 (6.05)	57 (40.76)
P value	0.123	0.093	0.002

N.B: If the p-value is less than 0.10, there are significant differences among the group means. n means the number of individuals, and (mean) means the mean value.

The ANOVA results indicated no statistically significant differences in thyroid hormone levels among the different groups, where the p-value for all hormones studied across different age groups is ($p > 0.05$). A small sample size ($n = 99$) may have reduced the power to detect true differences. However, there was a statistically significant difference in thyroid hormone levels between males and females. The analysis demonstrated that females, on average, had higher TSH levels (mean = 9.32 mIU/L) than males did (mean = 0.41 mIU/L), as shown by an independent samples t-test. In contrast, males had higher levels of FT3 (mean = 10.10 pmol/L) and FT4 (mean = 88.01 pmol/L) than females did ($p < 0.05$).

Table 3: Correlation of thyroid gland standards with the baseline clinical characteristics of patients

		Age	Sex	TSH	FT3	FT4	TI-RADS Categories
Age	Pearson Correlation	1	-.123	-.232	.105	.068	.023
	Sig. (2-tailed)		.226	.053	.448	.583	.818
	N	99	99	70	54	68	99
Sex	Pearson Correlation	-.123	1	.108	-.265	-.241*	.014
	Sig. (2-tailed)	.226		.376	.053	.048	.894
	N	99	99	70	54	68	99
TSH	Pearson Correlation	-.232	.108	1	-.210	-.139	-.297*
	Sig. (2-tailed)	.053	.376		.131	.262	.013
	N	70	70	70	53	67	70
FT3	Pearson Correlation	.105	-.265	-.210	1	-.001	.044
	Sig. (2-tailed)	.448	.053	.131		.992	.753
	N	54	54	53	54	54	54
FT4	Pearson Correlation	.068	-.241*	-.139	-.001	1	-.177
	Sig. (2-tailed)	.583	.048	.262	.992		.150
	N	68	68	67	54	68	68
Categories	Pearson Correlation	.023	.014	-.297*	.044	-.177	1
	Sig. (2-tailed)	.818	.894	.013	.753	.150	
	N	99	99	70	54	68	99

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation analysis revealed a significant negative correlation between age and TSH levels ($r = -0.232$, $p = 0.053$), indicating that as age increases, TSH levels tend to decrease (Table 3). No significant correlation was found between age and FT3 or FT4 levels, suggesting that FT3 and FT4 levels remain relatively stable with age. Sex was significantly correlated with FT4 levels ($r = -0.241^*$, $p < 0.05$), with males generally having higher FT3 levels than females. The analysis revealed a statistically significant negative correlation between TSH and TI-RADS categories ($r = -0.297$, $p < 0.05$). This finding indicates that as TSH levels increase, the TI-RADS categories tend to decrease. Since higher TI-RADS categories suggest a greater likelihood of thyroid nodule malignancy, this finding suggests that higher TSH levels are associated with lower-risk nodules. In contrast, lower TSH levels may correspond to nodules in higher TI-RADS categories, potentially indicating a greater risk of malignancy.

Linear regression analysis

Linear regression is performed to model and analyze the relationship between two variables. The figure shows how the dependent variable (TSH) changes when the independent variables (age, sex, FT3, and FT4) change. The linear regression model that shows how the dependent variable, TSH (thyroid-stimulating hormone), changes when the independent variables (age, sex, FT3, and FT4) change can be written as follows:

$$TIRADS = \beta_0 + \beta_1 * age + \beta_2 * gender + \beta_3 * FT3 + \beta_4 * FT4 + \beta_5 * TSH + \varepsilon$$

where:

The TI-RADS category is the dependent variable (the outcome we are trying to predict).

While, age, sex, TSH, free triiodothyronine (FT3), and free thyroxine (FT4) were the independent variables (predictors).

β0 is the intercept (the expected value of the TI-RADS categories when all the predictors are zero).

β1, β2, β3, β4, and β_5 are the coefficients that represent the change in TI-RADS categories for a one-unit change in each predictor.

ϵ is the error term, representing the variation in TI-RADS categories that cannot be explained by the model.

This model was used to analyze the impact of age, sex, TSH, FT3, and FT4 on TSH levels and to predict TI-RADS categories based on these variables (Table 4).

Table 4: Relationships of age, sex, TSH, FT3, and FT4 with TI-RADS categories.

	Beta	t	Sig.
Constant		4.658	.000
Age	.072	.509	.613
Sex	-.136	-.905	.370
FT3	-.070	-.496	.622
FT4	-.254	-1.771	.083
TSH	-.330	-2.305	.026

The regression coefficient of -2.305 suggests that for every 1-unit increase in TSH, the TI-RADS category is expected to decrease by 2.305 units, assuming all other model variables remain constant.

4. DISCUSSION

The data of 99 participants with thyroid disease were analyzed in the present study, and the distributions of TSH, FT3, FT4, and TI-RADS categories, age, and sex were presented. The results of this study revealed a statistically significant difference in thyroid hormone levels between males and females, as indicated by the significant p-value obtained from the analysis. Specifically, the data show that females, on average, have higher TSH levels (mean = 9.32) than males do (mean = 0.41), as shown by an independent samples t-test. This finding contradicts the results of previous studies (Hadlow et al., 2013). In contrast, males had higher levels of FT3 (mean = 10.10) and FT4 (mean = 88.01) than females did ($p < 0.05$), suggesting potential sex-specific variations in the regulation of thyroid function. However, it's worth noting that the sample size between the gender groups is not evenly distributed. Nonetheless, this finding is consistent with previous studies that often reported higher FT3 levels in males than in females (Mitsumatsu et al., 2023; Strich, Karavani, Edri, Chay, & Gillis, 2017). Their results indicate that while females tend to have elevated TSH, males on the other hand might maintain higher levels of the active thyroid hormones FT3 and FT4. These differences could be attributed to variations in metabolic demands, hormonal influences, or other physiological factors between sexes. This study also revealed a significant negative correlation between age and TSH levels ($r = -0.232$, $p = 0.053$), indicating that as age increases, TSH levels tend to decrease (Table 3), and this finding is consistent with those of previous studies (Hadlow et al., 2013). The results of the present study also indicate that as TSH levels increase, the TI-RADS categories tend to decrease. This finding is consistent with a previous study (Baran & Ataş, 2023).

5. CONCLUSION

The present study concludes that females are more affected by thyroid disorders in the studied region. Based on the findings from this case study in Chattogram, Bangladesh, thyroid disorders are a significant public health concern. The study revealed a high prevalence of both hypothyroidism and hyperthyroidism in the population, with particular vulnerability observed among women and older adults. These results underscore the need for increased awareness, early diagnosis, and effective management strategies to address thyroid disorders in the region. Additionally, the findings highlight

the importance of routine screening and targeted interventions to mitigate the impact of these conditions on public health. Further research is recommended to explore the underlying causes and develop tailored health policies to combat the growing burden of thyroid disorders in Bangladesh.

6. CONTRIBUTION

This study explored the correlation between TSH levels and TI-RADS categories, which may have implications for the early detection of thyroid malignancy. This relationship could help clinicians in the region improve the diagnostic accuracy for thyroid nodules. This research provides the first comprehensive assessment of thyroid disorder prevalence, specifically in the southeastern region of Bangladesh, and includes a Chattogram. The findings offer valuable regional insights into thyroid health, which can inform local public health strategies. The study identified key demographic patterns, particularly highlighting the sex disparity in thyroid disorders.

7. LIMITATIONS

This study has several limitations. First, the small uneven sample size makes it challenging to draw definitive conclusions. Patients were selected from a specific diagnostic centre, so prevalence rates may vary across different settings or hospitals. Additionally, the study duration was limited to five months; data collected over a longer period, such as a year, might provide a clearer picture. Only patients with gland swelling who had not undergone laboratory testing were included. Due to cost constraints, only TSH, FT3, and FT4 tests were conducted to assess thyroid function, while additional tests such as total T3 and T4 were not performed. Furthermore, future research is needed to explore the environmental, dietary, and genetic factors contributing to the prevalence of thyroid diseases in this area.

Ethical approval: This study received ethics approval from the Multimedia University (MMU), Research Ethics Committee.

Clinical trial number: not applicable.

Human ethics and consent to participate declarations: not applicable.

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data availability statement: Data are available on request from the first author Masuda Begum Sampa.

Author contributions: Masuda Begum Sampa: Conceptualization, data collection, methodology, data analysis, writing—original draft preparation, writing—review and editing; Azlina Ab. Aziz and Nor Hidayati Abdul Aziz: Visualization, supervision, funding acquisition. Siddikur Rahman: writing—review and editing. All the authors have read and agreed to the published version of the manuscript.

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