

Comprehensive Evaluation of Thyroid Gland Volume in Relation to Sex, Age and Body Surface Area among Bangladeshi Population

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ABSTRACT

Background: Thyroid gland morphometry, with a focus on volume, is a crucial and highly valuable metric in clinical practice. Ultrasonography can easily access the thyroid gland. This study aimed to appraise the normal thyroid gland volume in relation to sex, age and Body Surface Area (BSA) among Bangladeshi population of Chattogram district.

Materials and methods: This cross-sectional study evaluated total thyroid gland volume of 200 (100 male, 100 female) Bangladeshi population of Chattogram district. It was conducted in the department of Anatomy, Chittagong Medical College, during July 2022-June 2023. Thyroid ultrasound was conducted by expert sonologists. The statistical analysis was done using SPSS version 26 and at 95% level of significance, p-value was considered significant if it was <0.05.

Results: Total thyroid gland volume (Range: 3.87±1.63 to 3.02±0.93 ml) decreased from third to fourth decade and also from fifth to sixth decade. For the various age groups, the mean of total thyroid gland volume was not different significantly ($p > 0.05$). In male, the total thyroid gland volume was greater than in female and this was highly significant statistically ($p=0.000$) Spearman's correlation test revealed that total thyroid gland volume was positively correlated with BSA ($p=0.000$).

Conclusion: Result of the present study offers a normative reference data regarding normal thyroid gland volume of Bangladeshi population to help the clinicians and surgeons to deal with numerous thyroid pathologies.

Key words: Age; Body surface area; Reference value; Sex; Thyroid gland volume; Ultrasonography.

Introduction

In the human body, thyroid gland is the biggest endocrine gland, made up of two lobes that are symmetrical and are joined by a median isthmus, is situated anteriorly in the lower neck between the fifth cervical and first thoracic vertebrae.¹ In hale and hearty individuals, usually the size and shape of the glands

vary. Sex, age, Body Mass Index (BMI) Body Surface Area (BSA) and reproductive status etc. are substantial in determining the size of the thyroid gland.²

The thyroid's morphometry, with its volume, is a decisive factor that needs to be evaluated. It is useful in the diagnosis and follow-up of a number of thyroid disorders.^{3,4} Thyroid size and volume can be estimated using a variety of techniques, including palpation in live subjects as well as computed Tomography (CT) radionucleotide study, ultrasound, Magnetic Resonance Imaging (MRI) and also through post mortem dissection. Though palpation is an easy and inexpensive procedure, it is challenging to accurately describe thyroid size.^{5,6} Advanced imaging methods are relatively more costly.^{7,8} Due to its non-invasive, safe, non-ionizing, quick, inexpensive, readily available and enormously informative nature, thyroid gland ultrasonography has largely superseded other imaging modalities.^{7,9} Sonography precisely measures the thyroid gland's size and volume. It is also possible to recognize a variety of irregularities in the gland and its adjacent structures.¹⁰ Moreover, minimally invasive surgical procedure necessitates the most precise estimation of this gland's mass on which to operate.²

The size of the thyroid gland varies with geographic location.⁴ Previously, in Bangladesh, regarding morphometry of thyroid gland, most of the studies were based mainly on postmortem findings that lack in

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Date of Submission : 24th May 2025
Date of Acceptance : 12th June 2025

reflecting the normal physiological status. Till to date, there is very scarce published data about the reference values of normal adult thyroid dimensions from our country.¹¹ Therefore, the present study was intended to create reference data of thyroid gland volume using ultrasonography among adult population of Bangladesh and analyse the data to discover any significant difference in relation to age, sex and body surface area.

Materials and methods

This cross-sectional analytical study was conducted through a duration of one year, starting from July 2022, including 200 normal adult Bangladeshi people (100 male, 100 female) of Chattogram district. Ethical approval was issued from Ethical Review Committee of Chittagong Medical College. Study population were patients attending in Radiology and Imaging department of Chittagong Medical College Hospital (CMCH) Institute of Nuclear Medicine and Allied Sciences (INMAS) and Parkview Hospital Limited, Chattogram according to enrollment criteria. Participants who were Bangladeshi by birth and had normal thyroid ultrasonography, as testified by expert sonologists, were enrolled. Hormonal assay confirmed the thyroid status of the subjects to be normal thyroid subject for this study. Individuals with symptoms of tremors, hoarseness of voice, raised heart rate, heat or cold intolerance, rapid weight loss in spite of increased appetite, undergoing neck surgery or radiotherapy, who had visible or palpable masses in the neck or received treatment for thyroid conditions and positive family history of thyroid cancer were excluded from the study. The 2D Ultrasound examination was performed with EPIQ ELITE multipurpose ultrasound machine (PHILIPS) at a frequency of 22-2 MHz, using CL 18-4 probes. Subjects were surveyed in supine position and remarks were made by expert sonologists. The measurements were calculated with the measuring scale in image analyzing software. Volume of each lobe was calculated separately using the formula.¹²

Volume (cm³) = Width (cm) × Length (cm) × Depth (cm) × 0.523.

The thyroid volume was assessed by the summation of the both lobes' volumes. The volume of the isthmus was excluded. The total gland volume was represented by mean (± standard deviation). Body surface area was calculated by Du Bois formula¹³:

$$BSA (m^2) = (W^{0.425} \times H^{0.725}) \times 0.007184$$

Shapiro-Wilk test tested the normality of the data ($p > 0.05$). Comparisons of total thyroid gland volume in relation to various age groups were analyzed by Kruskal-Wallis Test and in relation to sex were analyzed by Mann-Whitney U test. To correlate thyroid

gland volume to body surface area, Spearman's correlation coefficient was used.

Results

Out of 200 participants, there were equal number of males and females. The respondents' age ranged from 18-59 years with the mean age of 31.81(±10.28) years. There is decrease in total thyroid gland volume from third to fourth decade and also from fifth to sixth decade. The highest and least recorded values of 3.87±1.63 ml and 3.02±0.93 ml was observed at the 21-30- and 51-60-years age decades respectively. Kruskal-Wallis Test showed that the mean total thyroid gland volume was not significantly different for the various age groups (Table I).

Table I Comparison of total thyroid gland volume among different age groups (n=200)

Measurement	Age groups (Years)					p value
	18-20	21-30	31-40	41-50	51-60	
	(n=27)	(n=81)	(n=59)	(n=20)	(n=13)	
Total thyroid gland volume (ml)	3.87±1.94	3.87±1.63	3.64±1.85	3.77±1.72	3.02±0.93	0.626

*($p > 0.05$ = not significant)

In male, the total thyroid gland volume was greater than in female. According to Mann-Whitney U test this dissimilarity was statistically very highly significant ($p < 0.001$) (Table II).

Table II Comparison of the total thyroid gland volume in relation to sex (n=200)

Measurement	Male	Female	p value
	(n=100)	(n=100)	
Total thyroid gland volume (ml)	4.42±1.92	3.05±1.13	0.000

($p < 0.001$ = very highly significant)

Scatter diagram with regression line showing weak positive correlation of thyroid gland volume with body surface area (BSA). Spearman's correlation was computed to evaluate the relationship and it was statistically significant [$r(198) = 0.363$; $r^2 = 0.132$; $p = 0.000$].

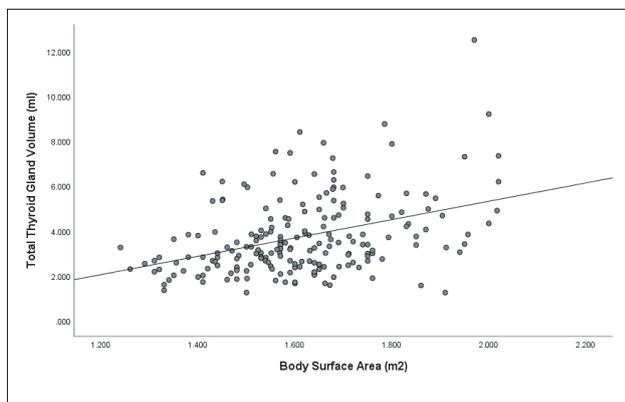


Figure 1 Correlation of thyroid gland volume with body surface area (BSA)

Discussion

During this study, thyroid gland volume of adult Bangladeshi population was measured to find out any significant difference in relation to age, sex and body surface area. Upon reviewing the literature, only a few researches were found that particularly examined the ultrasonographic measurements of the thyroid gland volume.^{11,14}

In the present study, the analysis showed a gradual decline in total thyroid gland volume with growing age, with the highest mean volume (3.87 ± 1.63 ml) observed in the 21–30 years age group and the lowest mean volume (3.02 ± 0.93 ml) in the 51–60 years age group. Despite this descending trend, the differences in thyroid gland volume across various age groups were not statistically significant ($p=0.626$). A cross-sectional study in Iran was carried out on 314 healthy adults aged over 18 years. Thyroid gland volumes were measured by 2D ultrasonography. Subjects were divided into 4 age groups (ranging from <25 to >55 years old) and their mean thyroid volume found in those subgroups ranged from 8.27 ± 3.25 to 7.57 ± 2.32 ml respectively. The values were seen to increase from first to second group and then decrease from third to fourth group. These age-related changes of total thyroid volume were not statistically significant ($p=0.079$). The observation of this study regarding pattern of changes of total thyroid gland volume across different age groups is nearly similar to the present study.¹⁵

In another cross-sectional study performed in Nigeria among 400 adult population with normal thyroid gland, the study population were subdivided into 5 subgroups according to age decades (<20, 20-29, 30-39, 40-49, >50) and mean thyroid volume was assessed in those subgroups by 2D ultrasonography which was 6.17 ± 0.66 , 5.80 ± 1.51 , 6.28 ± 3.31 , 6.52 ± 2.16 , 6.74 ± 2.47 ml respectively. There was steady increase in thyroid

volume with increase in age except in second age decade. This change of total thyroid volume in relation to age decades was not statistically significant ($p=0.930$). The observations made in this study and the current study is not comparable. A larger sample size and racial factors could be the cause of this discrepancy.¹⁶

In present study, a highly significant variation in thyroid gland volume was noted between males and females ($p<0.001$). Mean thyroid gland volume in males was markedly higher than in females. This result aligns with prior research that attributes the larger thyroid volume in males to differences in body size, hormonal influences, and metabolic demands. In another Bangladeshi study (among 160 healthy individuals) showed that ultrasonographic measurements of total thyroid gland volume in male was 7.57 ± 1.18 ml and in female was 6.93 ± 1.08 ml which was statistically highly significant ($p=0.004$).¹⁷ A study in Pakistan, carried out on 208 healthy subjects with normal thyroid gland (106 were males and 102 were females) through 2D ultrasonography, revealed the mean thyroid gland volume in male was 6.7 ± 3.11 ml and in female was 5.8 ± 2.5 ml which was statistically significant ($p=0.021$).¹⁸ Result from a Nigerian study, comprising 150 males and 250 females, revealed that the total thyroid gland volume for males was greater than that of females (6.30 ± 2.37 cm³ vs. 5.65 ± 2.61 cm³).¹⁶ A study in Nepal, carried out on 221 males and 264 females, found total thyroid gland volume for males was 6.84 ± 2.744 ml while and for females was 6.44 ± 2.268 ml. The difference in values were not significant ($p=0.076$).¹⁹ Although the thyroid volume values in both the male and female subjects were higher than those of the current studies, the results of these studies are almost identical to those of the current studies. Different regional, geographical, racial and sample size variations could be the cause of the higher values.

In the present study, significant positive correlation was found between total thyroid gland volume and body surface area (BSA) ($p=0.000$). Significant positive correlation was found in different studies in Nepal ($r=0.444$, $p<0.0001$), Iran ($r=0.48$, $p<0.001$) and also in Turkey ($p<0.05$).^{4,19,20} The findings of these studies were similar to the findings of present study.

Limitations

Result of this study is not generalized for Bangladeshi population due to relatively small sample size and conducting the study in selected areas of Chattogram.

Conclusion

Total thyroid gland volume showed a declining pattern from the third to fourth decade and also from the fifth to sixth decade. For the various age groups, the mean of total thyroid gland volume was not significantly different. The total thyroid gland volume was significantly greater in male than in females. Again, total thyroid gland volume was positively correlated with BSA. These normative data could be beneficial for clinicians in distinguishing physiological from pathological changes in thyroid size, helping in the early diagnosis and appropriate management of thyroid disorders. Further large-scale study might establish comprehensive reference standards for the Bangladeshi population.

Recommendation

Larger sample size from multistage sampling is required for more robust finding of such study.

Acknowledgement

We acknowledge Head of the department of Radiology, CMCH, and the Director of Institute of Nuclear Medicine & Allied Sciences, for their generous and earnest co-operation for data collection.

Disclosure

All the authors declared no competing interests.

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