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Estimation of thyroid gland volume using ultrasonography and its relation to anthropometric measurements in a population of northern part of West Bengal

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Abstract: *Background:* Anthropometric data and thyroid gland volumetric analysis has been previously correlated with varying results and hence this study focusses on strengthening those data among the population of Northern part of West Bengal .*Objectives:* Assess the thyroid volume in different aspects (total thyroid volume, volume of right and left lobes individually) and gather various anthropometric and demographic data from study population. Establish significant correlation between the study parameters, if any. *Methods and Material:* Thyroid volumetric analysis was done using Ultrasound guidance and anthropometric data were collected following standardised protocols with the help of appropriate tools. Demographic data were collected using pre-formed and pre-tested questionnaire. *Results:* Volume of thyroid gland was found to be correlated with Body Surface Area, height, and weight of an individual. Additionally, there was significant sexual dimorphism in thyroid volume and right lobe of thyroid was more voluminous than the left one. *Conclusions:* Complexities of anthropometric relationship with thyroid volume has been a topic of interest for ages. Further correlations need to be searched with other demographic parameters like iodine consumption, ethnicity, and socio-economic status of an individual.

Keywords: Total Thyroid Volume, Body Surface Area, Body Mass Index.

Introduction

Thyroid gland related diseases have been prevalent worldwide since time immemorial and the role of thyroid gland in neurological development of neonates needs no additional mention. Studies [1-7] have proved the importance of correlating adult thyroid volume with regular human anthropometric data. Since the 1980s, ultrasound has been widely used for evaluation of the thyroid, because it is a non-invasive method that is accessible and does not expose patients to radiation, allowing the diagnosis and follow-up of patients with thyroid diseases [8-11].The nomogram may vary in different geographical regions and there is a scarcity of same from our region.

Material and Methods

100 study participants with normal thyroid profile within a specific age group of 20-50 years were selected from the Department of Biochemistry at North Bengal Medical College and Hospital after evaluation of thyroid function test and those with address within North Bengal (Districts of Darjeeling, Jalpaiguri, Kalimpong, Cooch Behar, Alipurduar, North and South Dinajpur and Malda), as per subject inclusion criteria, were considered as study population.

An ethical clearance was duly obtained from the Institutional Ethics Committee regarding the data collection and pursuance of the study (vide IEC clearance letter bearing Memo

No:IEC/NBMC/2021-22/4 dated 19/02/2021). Samples were taken by complete enumeration method, after excluding the population in the exclusion criteria. The reference value for normal thyroid function was selected as per the guidelines laid by Salaam AJ et al[12]. The persons having abnormal laboratory findings related to thyroid function test or prior history of thyroid/neck surgeries or beyond the mentioned age groups or even pregnant and menstruating females were excluded from the study. Finally, the unwilling candidates were also excluded from the study itself.

The study parameters included volumes of each lobe, the isthmus and cumulative volume of the whole thyroid gland as well as the anthropometric data of the concerned candidate (height, weight, BMI, BSA) as per the study requirements. Anthropometric measurements were taken with specific tools like weighing scale and stadiometer, while ultrasound guided thyroid volume estimation was done by a radiologist with more than 10 years of experience in the concerned field using LOGIC P-9, a real-time ultrasound machine fitted with a L3-12 MHZ linear transducer. Body Mass Index and Body Surface Area were calculated with respective standard formulae [13-14].

The measurements of the maximal width (medio-lateral) and depth (antero-posterior) of the transverse section of each lobe were taken. The gland was then scanned longitudinally beginning in the sagittal plane holding the transducer perpendicular just above the sternal notch. The image that showed the lobe at its greatest length (cranio-caudal), was frozen and captured. The scanning was then repeated for the opposite lobe and the measurements were taken. Images of the isthmus were also obtained in the transverse and longitudinal planes. Longitudinal (length) as well as transverse (width) and depth (Antero-Posterior) were measured in centimeters (cm). In this way, right and left lobe volumes and the isthmus volume were obtained and analyzed separately.

The volume of each lobe (cm3) was calculated from the equation of Brunn et al [15-16] using the ellipsoid model formula by multiplying the length (L) with width (W) and depth (D) in cm with a correction factor 0.52. The isthmus volume was calculated from V isthmus (cm3) equals length isthmus by width isthmus by depth isthmus all in cm multiplied by 0.479. Total Thyroid volume (cm3) was thus obtained by summing up the lobe volumes and isthmus volume.

The statistical analysis was done using SPSS Version 24.0 (Chicago, Inc, USA). The values were represented in Number (%) and mean ± SD. To test the significance of two means, the student t-test was used. Also, a paired t-test was used as we needed the difference between two variables for the same subjects. The ANOVA (analysis of variance) test was used to compare the within group and between group variances amongst the study groups. Also, bivariate correlation using Karl Pearson correlation coefficient (r) was used, where value of r ranged from –1 to +1, with +1 indicating perfect positive correlation and –1 indicating perfect negative correlation. The p-value < 0.05 was regarded as statistically significant.

Results

38% of the study participants were male while 62% were female. Maximum number of individuals belonged to the age group of 31-40 years (42%) while the least number of individuals were from the age group of 41-50 years (19%). Table 1shows that the highest number of study participants belonged from Darjeeling district followed by Jalpaiguri and Alipurduar.

Table-1: Distribution of study participants according to districts (n=100)

Districts	Frequency	Percentage
Darjeeling	49	49
Jalpaiguri	16	16
Alipurduar	12	12
UttarDinajpur	8	8
DakshinDinajpur	3	3
Malda	9	9
CoochBehar	2	2
Kalimpong	1	1
Total	**100**	**100**

The relative distribution pattern of height and weight among study participants (n=100) are shown in the Figure 1 and 2 respectively.

Fig-1: Histogram showing relative frequency of height distribution among subjects

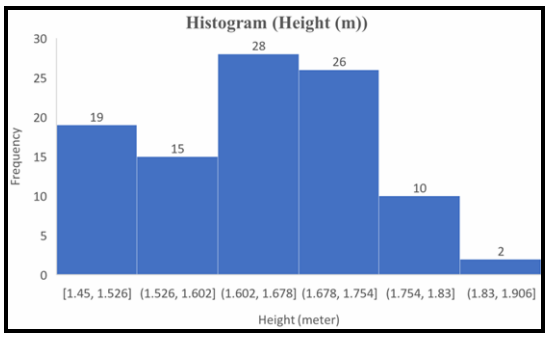
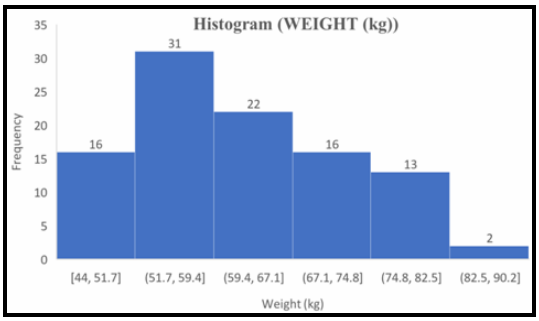


Fig-2: Histogram showing relative frequency of weight distribution among subjects



68% individuals had normal BMI within the range of 18.5-24.9 kg/m^2 and maximum number of individuals (85%) had Body Surface Area within the range of 1.5-2.5 m^2.

Figures 3 and 4 show the mean right lobe and left volume among 100 study participants were 4.51 ± 1.25 mL and 4.41 ± 1.23 mL respectively. The sexual differences between thyroid volumes are depicted in Table 2.

Fig-3: Right lobe volume distribution of thyroid gland among subjects (n=100)

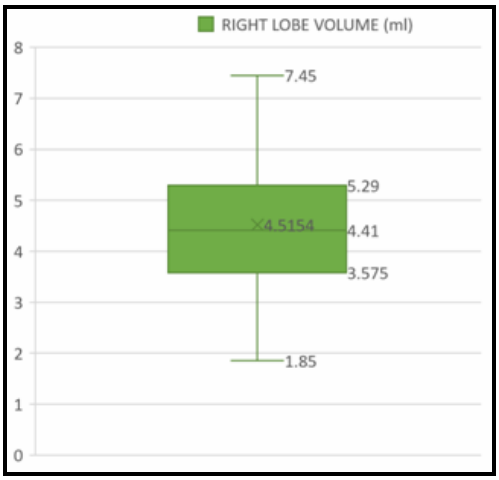


Fig-4: Left lobe volume distribution of thyroid gland among subjects (n=100)

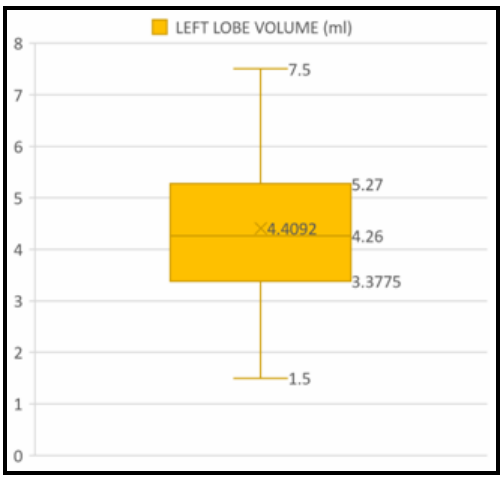


Table-2: Sexual dimorphism between the mean volume

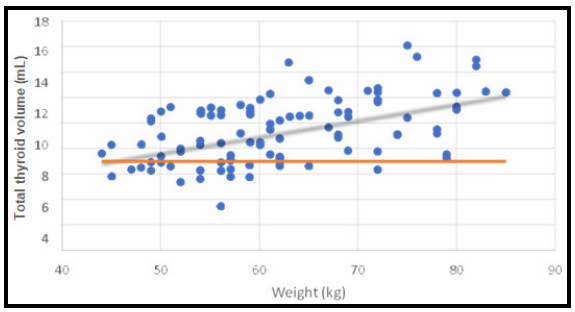
Volume (mL)	Male (mean ± SD)	Female (mean ± SD)
Left Lobe	5.04 ± 1.23	4.03 ± 1.08
Right Lobe	5.11 ± 1.33	4.14 ± 1.06
Isthmus	0.56 ± 0.38	0.41 ± 0.31
Total	10.70 ± 6.25	8.48 ± 3.45

A statistically significant correlation was found between the height of study participants and total thyroid volume, as well as the weight and total thyroid volume, as shown in Table 3 and Figure 5 respectively.

Table-3: Association of total thyroid volume with height of thyroid gland

Height (m)	Total thyroid volume (ml)			
	Mean	SD	95% CI	
			Upper	Lower
1.45-1.55 (n=25)	6.97	2.56	8.02	5.914
1.56-1.65 (n=32)	8.13	2.54	9.02	7.24
1.66-1.75 (n=31)	10.95	2.56	11.86	10.04
1.76-1.85 (n=12)	13.16	2.64	14.75	11.57
p<0.0001; r=0.848				

Fig-5: Correlation between total thyroid volume and weight of study participants



A statistically significant strong correlation was found between BSA and total thyroid volume of the study participants. The same has been represented in Table 4.

Table-4: Association of total thyroid volume with BSA

BSA(m^2)	Total thyroid volume (mL)			
	Mean	SD	95% CI	
			Upper	Lower
<1.5 (n=14)	7.31	1.67	7.86	6.76
1.5-2.5 (n=85)	10.30	2.10	10.84	9.72
>2.5 (n=1)	13.57	1.32	15.67	11.47
p<0.0001; r=0.657				

Discussion

In our study, the mean total thyroid volume was close to the one estimated by Lagarto AF [17] while it was lower than another study by Seker S and Tas I [18] using ultrasound. Kayastha P et al. [19], reported the overall lower thyroid volume. Another study done by Aggarwal N and others among asymptomatic Indian young adults showed a lower volume of thyroid gland [20]. The mean volume of right lobe was significantly higher than left lobe as evidenced by other workers as well [21-23]. Sexual dimorphism was established with mean volume of thyroid gland being higher in males, as finding consistent with previous studies. However, difference of opinion exists in the work done by Anele T and Marchie T et al [23-24]. Studies by Lagarto AF [17] and Kayastha P et al [19] were in concurrence with present study regarding the positive correlation between thyroid volume and height of the subject.

The volume of thyroid gland was found to be positively correlated to body weight in our study which was consistent with the results of Aggarwal N et al [20], Sari R et al [25], Svensson J et al [26] and Barrère X et al [27]. Our findings confirmed a positive correlation between thyroid volume and BSA, but not BMI. Our findings were in accordance with previous observations made by Turcios et al [28] but Brahmbhatt et al [29] however made very different observations in two Indian subpopulations (Baroda and Dang) of ages 6 to 15 years. They observed no significant association between total thyroid volume and the key anthropometric parameters (weight, height, BMI and BSA).

Conclusion

The results suggest that total thyroid volume was significantly higher in males than in females. The volume of right lobe was significantly higher than that of left. A subsequent increment in total thyroid volume was observed with progressive quartiles of height, weight, BSA but not across different categories of BMI. All these associations with regards to the total volume of thyroid gland for each of the anthropometric variables were statistically significant. Correlations of total thyroid volume with height were mild and significant, while with weight and BSA were moderate and significant.

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