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Original Article

Ultrasound-based thyroid volume of Cambodian adults

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Abstract

Background: Accurate assessment of the thyroid gland size is essential for diagnosing and managing thyroid disorders. While ultrasonography is a non-invasive and cost-effective method for evaluating thyroid volume, no reference values currently exist for the adult Cambodian population.

Objective: This study aimed to determine normative ultrasound-based thyroid volume values in euthyroid Cambodian adults, hypothesizing that thyroid volume varies significantly by sex and between lobes.

Materials and Methods: A prospective cross-sectional study was conducted on 513 adults (307 females, 206 males) aged 18–78 years at the a National Hospital between April and November 2020. Inclusion criteria included normal thyroid parenchyma and absence of nodules on ultrasound. Volumes of both lobes were calculated using the ellipsoid formula: height (cm) x thickness (cm) x width (cm) x π/6. Data were analyzed using Excel and SPSS version 26, with significance set at $p<0.05$.

Results: The mean thyroid volume was 7.52 ± 2.75 mL. Males had significantly larger thyroid volumes (8.05 ± 2.87 mL) than females (7.16 ± 2.60 mL) ($p<0.05$). The right lobe (4.27 ± 1.55 mL) was significantly larger than the left lobe (3.25 ± 1.33 mL) in both sexes ($p<0.05$).

Conclusion: This is the first study to establish ultrasound-based reference values for thyroid volume in Cambodian adults. The findings confirm that thyroid volume is greater in males than females and that the right lobe is typically larger than the left. These values provide a valuable baseline for clinical assessment and future research in Cambodia.

Keywords: Ellipsoid model, Parenchymal texture, Sonography, Thyroid echogenicity, Thyroid gland, Thyroid hypertrophy, Thyroid hypoplasia, Thyroid nodule.

Introduction

A precise estimation of the thyroid size is central to the evaluation and management of thyroid disorders. Given a diagnosis of goiter, ultrasound measurement is a relatively accurate means [1,2,3]. Ultrasound – commonly seen as a quick, safe and non-invasive way to epidemiologically estimate thyroid volume – has become one of the most oft-used imaging modalities to assess cervical region-residing internal secretory glands [4,5].

The limitations of physical examination have made ultrasound an attractive tool for visualizing the thyroid gland. Though Computed tomography (CT) and Magnetic Resonance are also effective tools in such visualization, they are relatively costly [3]. Information such as sex, age-related thyroid volume, and data from healthy product consumption is crucial for the diagnosis of thyroid hypertrophy or hypoplasia. As of now, numerous thyroid biometric studies shed lights on variations including age, gender, environmental factors, and iodine status of the population [2,3,6,7]. For example, a study by Brunn et al found out that a modified correction of 0.479 would make a more accurate evaluation of thyroid volume, compared with the previously recognized correction factor of $\pi /6$ or 0.524 [6]. Yet, the study relied on measuring the volume of cadaver glands that had been submerged in water [6]. The ellipsoid model, which measures and multiplies the height, width, and depth of each lobe to calculate the thyroid gland volume, generates a result that is then multiplied by a correction factor [8].

The local standard volume of thyroid has been non-existent in Cambodia thus far. Hence, the purpose of this study is to sonographically determine normal thyroid volume values in euthyroid adults in Cambodia.

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Materials and methods

This study was carried out as a prospective cross-sectional study at the Medical Imaging Department of the Khmer-Soviet Friendship Hospital, Phnom Penh in Cambodia. The study, which took place between 1 April to 30 November 2020, included 513 adults, including 307 females and 206 males. The subjects' ages range from 18 to 78 years old with a mean age of 37.5 ± 13.39 years.

Upon informed consent, all participants answered a questionnaire and underwent a clinical examination to rule out unrecognized thyroid pathology, from which only participants without a clinical sign of thyroid pathology, without clinically palpable thyroid nodules, with normal parenchyma texture, and without thyroid nodules on ultrasound were included in the study. Participants with clinical evidence of thyroid disease, anomaly of thyroid echogenicity and thyroid nodules were excluded from this research. Also, menstruating women, women in pregnancy, women who gave birth in the previous 12 months and those with any systemic disorder were out of this research scope. The ultrasound system used in the research was a real-time greyscale ultrasound machine (HS60, Xario 200 and Aplio 200), equipped with a 7.5 MHz 2D linear ultrasound probe transducer performed by a radiologist. The participants were examined while lying on their backs with their cervical spines hyperextended, and ultrasound gel being applied in the thyroid region.

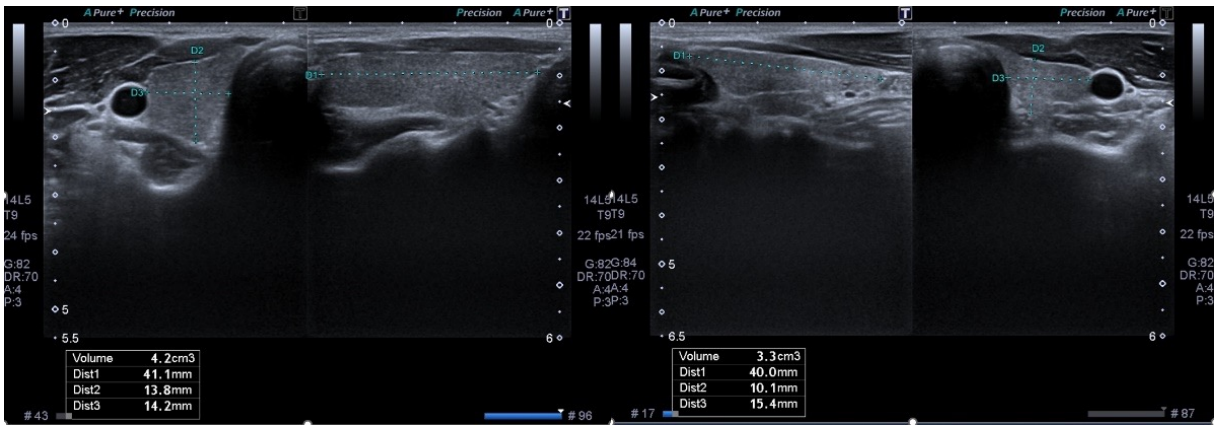

Figure 1. *Ultrasound image of thyroid volume of a 40-year-old female adult.*

The thyroid gland's volume results from the summation of the right lobe volume and the left lobe volume (Figure 1). The volume of each lobe was measured using the ellipse formula: height (cm) x thickness (cm) x width (cm) x π/6. Through a longitudinal section, the height (or length) of the lobe was measured by placing the transducer at the anterolateral part of the neck through the sternocleidomastoid muscle in order to obliquely obtain the greater vertical axis of the lobe between its upper pole and its lower pole.

Calipers were placed at the extreme edges of the upper pole and the lower pole to obtain the greatest distance between the two poles. The transducer was placed transversely on the anterior part of the neck at the thyroid isthmus level to achieve cross section. Whereas placing the calipers between the anterior and posterior edges of the lobe at the height of the middle of isthmus helps measure thickness (anteroposterior diameter), placing them between the lateral and medial edges of the lobe assists with measuring the width (or transverse diameter).

The data was collected and analyzed using both excel 2010 and IBM SPSS Statistic Version 26 to improve the validity of the analysis. Thyroid volume was expressed as the mean standard deviation value. Results were considered significant at $p<0.05$.

The study was approved by a University of Health Science, the National Ethics Committee for Health Research, Khmer-Soviet Friendship Hospital under the study.

Results

The study covers a total of 513 participants, 307 (59.8%) of whom are females and 206 (40.2%) are males, representing a healthy Cambodian, commensurate with history, palpation and sonography. The subjects' average age is 37.3 ± 13.38 years with a range of 18-78 years. The average thyroid volume in all of the participants under the study is 7.52 ± 2.75 mL. The average thyroid volume is 7.16 ± 2.60 mL, and 8.05 ± 2.87 mL in females and males respectively ($p<0.05$). Amongst all the participants, the average thyroid gland volume is 4.27 ± 1.55 mL, and 3.25 ± 1.33 mL for the right and left lobes respectively. For females, the volumes of the right and left thyroid lobes are 4.05 ± 1.47 mL and 3.10 ± 1.26 mL respectively while for males, the volumes of the right and left thyroid lobes are 4.59 ± 1.61 mL and 3.46 ± 1.41 mL respectively. All participants are found to have more volume in the right thyroid lobe than the left ($p<0.05$) (Table 1).

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Table 1. *Thyroid gland volume (mean and SD).*

Subjects (number)	Thyroid volume (mL)	Right lobe (mL)	Left lobe (mL)
Females (307)	7.16 ± 2.60	4.05 ± 1.47	3.10 ± 1.26
Males (206)	8.05 ± 2.87	4.59 ± 1.61	3.46 ± 1.41
All (513)	7.52 ± 2.75	4.27 ± 1.55	3.25 ± 1.33

Based on the correlation analysis in Table 2 shows that total volume is positively associated with body size measures, with weak to moderate correlations with weight ($r = 0.275$, $p < 0.001$), height ($r = 0.206$, $p < 0.001$), and body surface area (BSA) ($r = 0.291$, $p < 0.001$). Weight and height are moderately correlated ($r = 0.461$, $p < 0.001$), while BSA demonstrates very strong associations with both weight ($r = 0.954$, $p < 0.001$) and height ($r = 0.703$, $p < 0.001$). All correlations are statistically significant at the 0.01 level, indicating reliable relationships within the sample.

Table 2. *Correlation analysis of the volume, weight, height, and BSA.*

		Total Volume	Weight	Height	BSA
Total Volume	Pearson Correlation	1	0.275**	0.206**	0.291**
	Sig. (2-tailed)	-	0.000	0.000	0.000
Weight	Pearson Correlation	0.275**	1	0.461**	0.954**
	Sig. (2-tailed)	0.000	-	0.000	0.000
Height	Pearson Correlation	0.206**	0.461**	1	0.703**
	Sig. (2-tailed)	0.000	0.000	-	0.000
BSA	Pearson Correlation	0.291**	0.954**	0.703**	1
	Sig. (2-tailed)	0.000	0.000	0.000	-

***. Correlation is significant at the 0.01 level (2-tailed).*

Discussion

A precise measurement of the thyroid gland size is requisite for the evaluation and management of thyroid disorders. Sonography accesses the thyroid gland at ease thanks to its superficial anatomical location and unique echogenicity compared to adjacent soft tissues [9].

Volume measurement of the thyroid gland – given its conical form – is predicated upon the use of an ellipsoid model, that is, height x width x thickness x a correlation factor [9]. Several similar studies present huge variations in their results, suggesting that the thyroid size hinges on regional, environmental, ethical factors and especially on the iodine status of the population (Table 3). In this study, average thyroid volumes for women and men are 7.16 ± 2.60 mL and 8.05 ± 2.87 mL respectively. As of now, research publications in Cambodian on thyroid volumes has been non-existent. Interestingly, the findings show that the size of thyroid volumes in this study is lower than the ones found in studies conducted in Iran [1]. One of the reasons for such difference is probably the large size, heavy weight and a large body surface area of the Iranian population. On top of it, the thyroid volume size found in this study is also smaller than that found in studies conducted in Belgium, Denmark, Croatia, Turkey [5,8,10,11].

Table 3. *Comparison of thyroid volume studies.*

Author	Gender	Age range (years)	Number of subjects	Thyroid volume (mL) ± SD	Country
our study	206 M 307 F	18-78	513	7.52 ± 2.75	Cambodia
Adibi A, et al. [1]	123 M 77 F	37.27 ± 11.8	200	9.53 ± 3.68	Iran
Chanoine JP, et al. [5]		17-20	256	11.6 ± 4.4	Belgium
Hegedüs L, et al. [8]	139 M 132 F	13-91	271	18.6 ± 4.5	Denmark
Ivanac G, et al. [10]		20-38	51	10.68 ± 2.83	Croatia
Sahin E, et al. [11]	169 M 292 F	18-61	461	12.98 ± 2.53	Turkey
Yousef M, et al. [12]	75 M 28 F	19-29	103	6.44 ± 2.44	Sudan
M Arun Prasad, et al. [3]	24 M 76 F	18-60	100	5.95 ± 3.23	North India
Turcios S, et al. [13]	21 M 79 F	18-50	100	6.6 ± 0.26	Cuba
Hsiao YL, et al. [14]	115 M 48 F	17-79	163	7.7 ± 3.3	China
Nguyen TT [15]	54 M 150 F	18-25	204	7.44 ± 2.09	Vietnam

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In a study in Sudan from 2007 to 2010, Yousef M, et al. measured an average thyroid volume among volunteers, which is lower than the one in this study, and found that an average thyroid volume for both sex is 6.44 ± 2.44 mL, in which 5.78 ± 1.96 mL and 6.69 ± 2.56 mL is for female and male respectively. Yet, the sample size of the study is lower, 103 subjects, with the age range from 19 to 29 years old, which further attests to the notion that age constitutes an important factor in thyroid volume variations [12]. Furthermore, the results of this study also prove that the thyroid volume size is bigger than that found in studies conducted in North India and Cuba [3,13].

Results from two other studies in China by Hsiao YL, et al. and in Vietnam by Nguyen TT with an average thyroid volume of 7.7 ± 3.3 mL and 7.44 ± 2.09 mL respectively, also prove that the values are aligned with the findings of our study. This may be explained by the similar weight, height and body surface area of the general Chinese and Vietnamese population [14,15].

Similar to several previous studies, we discovered that males have a larger thyroid gland (8.05 ± 2.87 mL) than females (7.16 ± 2.60 mL). This gender difference is statistically significant ($p<0.05$). We concluded that the sex difference in thyroid gland volume is greater in males than in females due to structural anatomy, regardless of Body Mass Index (BMI) [11,16,17].

The thyroid lobe volumes collected in this investigation revealed that the right thyroid lobe volume is bigger than the left, with a statistically significant difference between the right and the left lobe volumes in both sexes. These results are consistent with those of other studies [13,15].

The mean thyroid gland volume in males is larger than in females. The right thyroid lobe volume is larger than left in both sexes. These findings confirm and echo those of the majority of earlier studies. Nonetheless, ultrasound is a method influenced by factors such as the observer, genetics, and environment, which can affect thyroid volume.

Limitations in this study include its single-center design, the absence of normal thyroid function tests, and nutritional lack of information on nutritional status or residence in iodine-deficient areas, all of which may influence thyroid gland size.

Conclusion

This research shows that a typical and average thyroid gland volume of adults in Cambodia is 7.52 ± 2.75 mL, wherein the sizes are 7.16 ± 2.60 mL and 8.05 ± 2.87 mL for females and males respectively. As elaborated earlier, this marks the first ever research study on thyroid volumes using ultrasonography in Cambodia. Beneficial for relevant referencing in the country, these figures further contribute to efforts in developing the national reference values.

As the thyroid volume is associated with anthropometric measurements, and genetic and environmental factors, we believe that future additional research is needed to establish national thyroid volume references in Cambodia and Southeast Asia.

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