

# Regional Reference Values of Thyroid Gland Volume in Turkish Adults

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## SUMMARY

**Introduction** It is important to know the size of the thyroid gland, and its normal value may vary among different geographic regions.

**Objective** In this study, we aimed to establish reference ranges for thyroid volume in euthyroid adults and to compare these results with the literature data.

**Methods** Between June 2011 and June 2012, 461 patients with normal laboratory results (serum TSH, anti-TG, anti-TPO antibodies and urine iodine level) that underwent thyroid gland ultrasound examination were retrospectively analyzed. Two hundred and 92 patients were females and 169 were males; the age range was 18-61 years with mean age  $30.84 \pm 9.97$  years. Length, breadth and thickness were measured, and the volume of each lobe was estimated using the ellipsoid formula.

**Results** The overall mean thyroid volume in all patients who were examined was  $12.98 \pm 2.53$  mL. The mean thyroid volume in females and males was  $12.09 \pm 2.05$  mL and  $14.53 \pm 2.55$ , respectively ( $p < 0.05$ ). The right thyroid lobe volume was greater than the left in all patients of both sexes. In addition, the study establishes a significant correlation between the thyroid volume and height, weight and body surface area of the subjects of both sexes ( $p < 0.05$ ). In the light of our findings we can provide reference values in order to evaluate patients who have thyroid hyperplasia or who are considered as normal.

**Conclusion** We consider that further studies are necessary to establish national references thyroid volume for each country.

**Keywords:** thyroid; ultrasound; thyroid volume

## INTRODUCTION

Accurate estimation of thyroid size is important for the evaluation and management of thyroid disorders. The ultrasonographic measurement of thyroid size is more accurate than palpation for the diagnosis of goitre [1]. According to its superficial anatomical location, the thyroid gland is easily accessible by sonography. Ultrasound is commonly used in epidemiologic studies, as a quick, safe, and non-invasive technique to estimate thyroid volume [2, 3, 4]. Computed tomography and magnetic resonance imaging provide structural information of the thyroid gland just like ultrasound but are relatively more expensive. In areas without significant iodine deficiency disorders, where the prevalence of visible goiter is low, the sensitivity and specificity of palpation are poor and goiter prevalence can be estimated using thyroid ultrasound [5, 6]. In recent decades, sonography has improved with the development of high frequency transducers, which allow a more detailed study of the thyroid gland [7]. On the other hand, intra and inter-observer variation can lead to differences in volume calculation on ultrasound. Small differences in ultrasound technique may introduce substantial errors in the measurements of thyroid volume, and the inter-observer variation can be high, even among experienced examiners [8]. Volumetric evaluation of the thyroid gland is

based on the use of the ellipsoid model. Hence, a value is obtained that replaces the clinical evaluation of volume. With the ellipsoid model, the length, width, and depth of each lobe are measured and multiplied. The obtained result is then multiplied by the correction factor [9].

## OBJECTIVE

Several factors are known to be involved in the regulations of thyroid volume and different reports of the thyroid volume normal range are presented for different populations [10]. Suggestions are presented as to population-specific references for thyroid volumes and their determinants for each area [11]. In Turkey, there is absence of domestic reference for thyroid volumes. The aim of this study was to set normal values of thyroid volume in euthyroid adults of Turkey sonographically.

## METHODS

This study was conducted as a retrospective cross-sectional study at the Nuclear Medicine Department of Gaziantep 25 Aralık Hospital. A total of 461 adults, consisting of 292 females and 169 males were included in the study. The age of the subjects ranged from 18-61 years; mean age was  $30.84 \pm 9.97$  years. The study was

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retrospective and extended during the period June 2011 – June 2012. The study was approved by the University Medical Faculty Ethics Committee.

The criteria of subjects included in the study were: normal laboratory results (serum TSH, Anti-TG, Anti-TPO antibodies and urine iodine level), normal ultrasonography of thyroid parenchymal texture and absent nodule confirmed by sonography. Subjects with anterior neck swelling or clinical evidence of thyroid disease were excluded from the study. The following subjects were also excluded from the study: smokers, persons on lithium, phenytoin, oral contraceptive drugs, women during menstruation, pregnant women or women who had delivered within the last 12 months and persons with any systemic disorder.

Data were collected on age, sex, height, weight, thyroid size by sonography. Body weight and height were measured using standard anthropometric techniques. For the measurements of weight and height, the subjects removed their shoes and emptied their pockets. In all subjects body weight (kg) and height (cm) were measured to determine the body surface area (BSA). The BSA was calculated by the DuBois and DuBois formula [12]:

$$\text{BSA (m}^2\text{)} = 0.007184 \times \text{height (cm)}^{0.725} \times \text{weight (kg)}^{0.425}$$

The ultrasound system which is a grey scale real-time ultrasound machine (Logiq 5 Pro, General Electric (GE) Healthcare, Milwaukee, USA), fitted with a 7.5 MHz transducer, was used for the study. The patients were examined in a supine position with hyperextended cervical spine. Ultrasound gel was applied over the thyroid area. The transducer was directly placed on the skin over the thyroid gland and the images of each lobe were obtained in transverse and longitudinal planes. The craniocaudal and the sagittal dimensions of both lobes were measured on the longitudinal image. The transverse dimension was measured on the transverse image. The thyroid gland volume was calculated using the formula below (AP diameter – depth; ML diameter – width; CC diameter – length):

$$\text{Tvol lobe} = \text{AP diameter} \times \text{ML diameter} \times \text{CC diameter} \times 0.479 \text{ (conversion factor)}$$

## Statistics

The data was collected and analyzed using SPSS for Windows version 11. Thyroid volume was represented by the value of median and mean  $\pm$  standard deviation. Student T-test was used for comparison in both sexes and Pearson's correlation coefficient was used to relate the thyroid volume to height, weight and BSA.  $P < 0.05$  was taken as significant.

## RESULTS

We studied 461 subjects, of whom 292 (63.3%) were females and 169 (36.7%) males, representative of healthy population, according to history, palpation, ultrasonography and laboratory results. The mean age of the subjects

**Table 1.** Volume (mean and SD) of thyroid glands in females, males and all cases

Subjects (number)	Thyroid volume (mL)	Right lobe volume (mL)	Left lobe volume (mL)
Females (292)	12.09 $\pm$ 2.05	6.48 $\pm$ 1.84	5.61 $\pm$ 1.58
Males (169)	14.53 $\pm$ 2.55	8.17 $\pm$ 1.53	6.36 $\pm$ 1.44
All (461)	12.98 $\pm$ 2.53	7.01 $\pm$ 1.94	5.97 $\pm$ 1.76

was 30.84 $\pm$ 9.97 years with a range of 18–61 years. The overall mean thyroid volume in all the patients who were studied was 12.98 $\pm$ 2.53 mL. The mean thyroid volume in females and males was 12.09 $\pm$ 2.05 mL and 14.53 $\pm$ 2.55 mL, respectively ( $p < 0.05$ ). The mean volume of the right and left lobes of the thyroid gland in all of the patients were 7.01 $\pm$ 1.94 mL and 5.97 $\pm$ 1.76 mL, respectively. In females, the right and the left lobes of the thyroid gland volumes were 6.48 $\pm$ 1.84 mL and 5.61 $\pm$ 1.58 mL. In males, the right and the left lobes of the thyroid gland volumes were 8.17 $\pm$ 1.53 mL and 6.36 $\pm$ 1.44 mL. The right thyroid lobe volume was greater than the left in all patients of both sexes ( $p < 0.05$ ). Table 1 shows the volume of the thyroid glands in females, males and all cases.

In our study, thyroid volume (mL) was positively correlated with weight, height and BSA in both sexes by Pearson's correlation which is presented in Graphs 1 and 2 ( $p$  values). By analysis the following results were obtained.

### Males

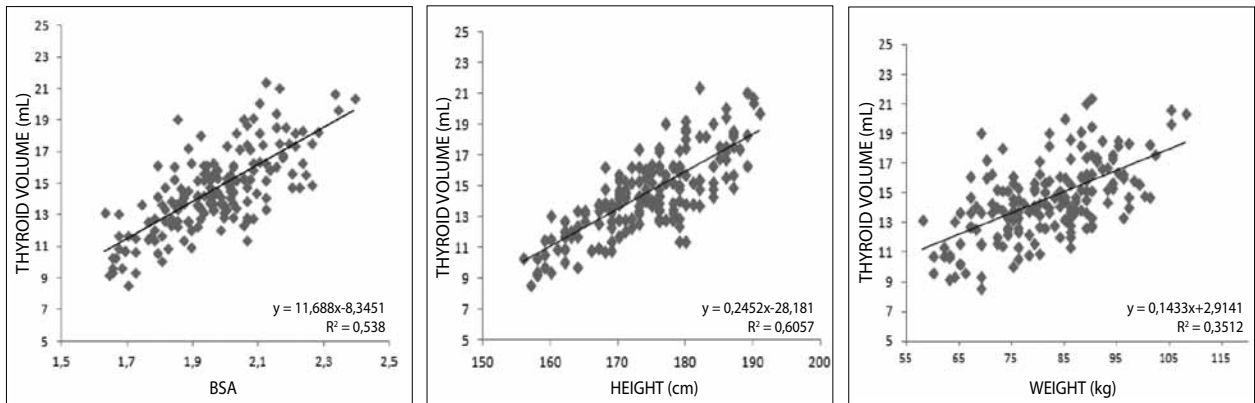
Pearson's correlation coefficient ( $r$ ) showed strong, positive correlation between thyroid volume and subject's height ( $R: 0.78$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ) with a linear regression equation of  $y = 0.2452x - 28.191$ ,  $R^2 = 0.6057$ , where  $y$  is total thyroid volume (TTV) and  $x$  is height.

Pearson's correlation coefficient ( $r$ ) of thyroid volume against subject's weight and BSA, respectively, showed a moderate positive correlation of thyroid volume with weight ( $R: 0.59$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ) and BSA ( $R: 0.73$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ). With a linear regression equation for weight as  $y = 0.1433x + 2.9141$ ,  $R^2 = 0.3512$ , where  $y = \text{TTV}$  and  $x = \text{weight}$  and or BSA  $y = 11.688x - 8.3451$ ,  $R^2 = 0.538$ , where  $y = \text{TTV}$  and  $x = \text{BSA}$ .

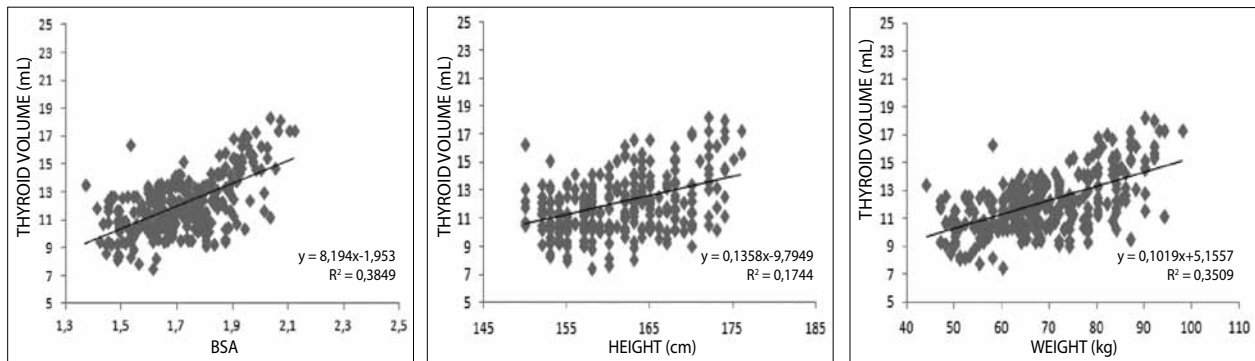
### Females

Pearson's correlation coefficient ( $r$ ) showed weak, positive correlation between thyroid volume and subject's height ( $R: 0.42$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ) with a linear regression equation of  $y = 0.1358x - 9.7949$ ,  $R^2 = 0.1744$ , where  $y = \text{TTV}$  and  $x = \text{height}$ .

Pearson's correlation coefficient ( $r$ ) of thyroid volume against subject's weight and BSA, respectively, showed



**Graph 1.** The scattered plot of Pearson's correlation of thyroid volume against the subject's body surface area (BSA), height and weight in males



**Graph 2.** The scattered plot of Pearson's correlation of thyroid volume against the subject's body surface area (BSA), height and weight in females

a moderate positive correlation of thyroid volume with weight ( $R: 0.59$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ) and BSA ( $R: 0.62$ ,  $p < 0.00001$  and the result is significant at  $p < 0.05$ ). With a linear regression equation for weight as  $y = 0.1019x + 5.1557$ ,  $R^2 = 0.3509$ , where  $y = TTV$  and  $x =$  weight and or BSA  $y = 8.194x - 1.953$ ,  $R^2 = 0.3849$ , where  $y = TTV$  and  $x =$  BSA.

## DISCUSSION

As mentioned earlier, accurate estimation of thyroid size is important for the evaluation and management of thyroid disorders. According to its superficial anatomical location and the gland which has a different echogenicity compared with adjacent soft tissues, the thyroid gland is easily accessible by sonography [13].

Some factors such as iodine intake, genetic and geographic region affect the values of thyroid volume. Especially, consumption of oral iodine is the most important factor in thyroid volume and function. Therefore, patients with normal urinary iodine levels have included in our study.

Also, it is known that thyroid volume values vary in some physiological condition such as pregnancy. The thyroid size was found to increase during pregnancy and decreases up to 12 months postpartum period [14, 15]. The menstrual cycle also seems to associate with cyclical alteration of thyroid size in healthy women [15, 16]. That is why these subjects were excluded from our study.

In our study, the overall mean volume of the thyroid gland in all the patients was  $12.98 \pm 2.53$  mL. According to our knowledge, there was no previous local study for comparison in our country. The thyroid volume among the Chinese that was studied by Hsiao and Chang [17] was  $7.7 \pm 3.3$  mL, and this value is slightly lower than ours. This may be explained by the short height of the Chinese population in general because, as already established, the height of an individual correlates well with the thyroid size [17, 18]. As further discussed, in our study a strong positive correlation was found between the subject's height and thyroid volume. Also, our values are higher than those reported by studies conducted in Sudan, Nigeria and Iran populations [19, 20, 21]. The TTV in our study was obviously lower than that in Hegedus et al. study, which was conducted in Copenhagen with reported volumes found 19.6 mL and 17.5 mL in males and females, respectively [22]. It could be speculated that the Danish subjects were in fact iodine deficient to some degree or could be explained by the tall height of the Danish population [23].

It has been shown in many other studies such as these, the thyroid volume is associated with anthropometric measurements such as height and weight. In our study, the thyroid volume was positively related to body weight, height and BSA.

Especially in the males, a strong positive correlation between the subject's height and thyroid volume was found ( $R: 0.78$ ,  $p < 0.00001$ ).

Of course, the thyroid volume could not be entirely explained by weight and height, but also the thyroid volume is determined by other factors such as ethnicity. Genetic background and environmental factors could contribute to the variations of the results in these different geographic areas [21]. Therefore, previous reports suggest the need for population-specific reference.

Similarly to most previous studies, we found that the thyroid gland to be greater in males ( $14.53 \pm 2.55$  mL) compared to females ( $12.09 \pm 2.05$  mL). This difference between both sexes was statistically significant ( $p < 0.05$ ). We conclude that the sex difference in the thyroid volume due to the structural anatomy is larger in males than that in females irrespective of BMI [10, 17, 22].

The volumes of the thyroid lobes obtained in this study showed that the right thyroid lobe volume was greater than the left and with significant statistical difference between the right and the left lobe volumes in both sexes ( $p < 0.05$ ). These findings are similar to other studies [17, 24, 25, 26].

The mean thyroid volume in the males was greater than in the females. The volume of the right lobe of the gland was greater than the left in both sexes. These findings were similar to most of previous studies. On the other hand, ultrasonography is a technique dependent on the observer, and also genetic and environmental factors have influence on the thyroid volume.

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## CONCLUSION

In this study, we present the normal values of adults' thyroid volumes in the south-east region of Turkey. The overall mean volume of the thyroid gland in all the patients was  $12.98 \pm 2.53$  mL, which was found to be significantly correlated with subjects' height, weight and BSA. Thyroid gland volume values were significantly different between males and females. The mean thyroid volume in females and males was  $12.09 \pm 2.05$  mL and  $14.53 \pm 2.55$  mL, respectively. To our knowledge, this is the first reference of thyroid volume measured by ultrasonography in Turkey. These values are recommended as reference values for use in south-east region of Turkey. According to this data, we tried to contribute to the establishment of the reference values in our country.

As the thyroid volume is associated with anthropometric measurements, genetic and environmental factors, we consider that further studies are necessary to establish national references for thyroid volume in Turkey and other countries.

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## Регионалне референтне вредности волумена штитасте жлезде код одраслих особа у Турској

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### КРАТАК САДРЖАЈ

**Увод** Важно је познавање величине штитасте жлезде, као и чињенице да њене нормалне вредности могу да се разликују зависно од географске регије.

**Циљ рада** Циљ истраживања је био да се утврде граничне референтне вредности волумена штитасте жлезде код еутиреоидних особа, а затим ови резултати упореде с подацима из литературе.

**Методе рада** Од јуна 2011. до јуна 2012. године ретроспективно је анализиран 461 болесник с нормалним лабораторијским резултатима (*TSH* у серуму, анти-*TG* анти-*TPO* антитела и вредности јода у мокраћи) који је подвргнут ултразвучном прегледу штитасте жлезде. Испитивану групу болесника чиниле су 292 жене и 169 мушкараца старости од 18 година до 61 године и средње старосне доби од 30,84±9,97 година. Мерени су дужина, ширина, дебљина и волумен лобуса штитасте жлезде помоћу формуле за елипсу.

**Резултати** Целокупна средња вредност волумена штитасте жлезде код свих испитаника била је 12,98±2,53 ml. Само код жена била је 12,09±2,05 ml, а код мушкараца 14,53±2,55 ml ( $p<0,05$ ). Волумен десног лобуса био је већи од левог код свих болесника без обзира на пол. Сем тога, истраживањем је код испитиваних особа оба пола утврђена значајна корелација између волумена штитасте жлезде и висине, тежине и целокупне телесне површине испитаника ( $p<0,05$ ). У светлу налаза наших испитивања можемо да наведемо референтне вредности у сврху вредновања болесника с хиперплазијом штитасте жлезде или оних код којих се ове вредности сматрају нормалним.

**Закључак** Сматрамо да је потребно да се обаве даља истраживања, како би се утврдиле националне вредности волумена штитасте жлезде за сваку поједину земљу.

**Кључне речи:** штитаста жлезда; ултразвук; волумен штитасте жлезде

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