Determination of Relationship between Thyroid Gland Volume and Anthropometric Indices

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Authors’ contributions

This work was carried out in collaboration among all authors. The author AJS designed the study and literature review, author POI co-designed the study, author SMD managed the analysis and literature review, author AAS performed statistical analysis and the author HAA managed literature review. All authors read and approved the final manuscript.

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ABSTRACT

Objective: To sonographically determine the thyroid gland volume in normal adults in Jos University Teaching Hospital, as well as how it relates to anthropometric factors.

Background: The thyroid gland is one of the largest endocrine glands in the body weighing about 10-25g. It regulates the rate of metabolism and controls the growth and rate of function of many other systems in the body. These it does, by producing thyroid hormones, principally thyroxine (T₄) and triiodothyronine (T₃). The accurate estimation of the size of the thyroid is very important for the evaluation and management of thyroid disorders. Thus, knowing the normal size in a geographic location would form a baseline for detecting abnormalities. Ultrasonography is a cheap, readily available, easy to perform and non-invasive method to image the thyroid gland, hence its use in this resource-limited setting.

Methods: This is a cross-sectional study of sonographic measurement of thyroid gland volume on 400 normal (healthy) adults in Jos, Plateau State, Northern part of Nigeria. All examinations were

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performed using LOGIC 5, a real-time ultrasound machine using a 10MHZ linear transducer and ultrasound transmission gel to act as a coupling gel. Measurements of each lobe and isthmus were obtained in longitudinal (length), transverse (width) and depth (breath) in centimetres (cm). Blood samples were taken for thyroid function tests. The weight and heights were obtained. The data obtained were statistically analyzed using SPSS software version 17. The results were presented in forms of tables, graphs and chart.

**Results:** The mean thyroid volume for males 6.03 cm³±2.22 was higher than that of females 5.62 cm³±2.14. The mean right lobe volume (RLV) was 3.09 cm³±1.47 and that of males and females were 3.16 cm³±1.34 and 3.04 cm³±1.55 respectively. The mean left lobe volume (LLV) was 2.69 cm³±1.37 and that of males and females were 2.89 cm³±1.32 and 2.57 cm³±1.39 respectively. The right lobe volume was significantly greater than the left lobe (p=0.000). The total mean isthmus volume was 0.27 cm³±0.31. The mean isthmus volume in males 0.3±0.28 is significantly higher than that of females 0.24±0.23 (p=0.025). The BMI increases in females with increasing age. BMI and BSA are higher in males.

**Conclusion:** The volume obtained in this study was slightly lower than those reported by previous studies in Nigerian adults. The right lobe volume was higher than that of the left and the volume was higher in males compared to females. Anthropometric parameters were noted to affect the thyroid volume.

**Keywords:** Anthropometric Indices; thyroid gland; endocrine gland; ultrasonography.

**1. INTRODUCTION**

Ivanac et al. [1] studied fifty-one randomly selected healthy female adult students in a prospective study. The mean age of subjects was 22 (range 20–38). Mean thyroid volume was 10.68±2.83 ml (range 5.71–17.09 ml). The results show that thyroid volume was best correlated with height (r=0.37; p=0.001), followed with body surface area (r=0.28; p=0.017). The thyroid volume was normal in all of the subjects. The limitation of the study includes the fact that only female population was selected, the thyroid volume was calculated as a sum of lobe volumes and isthmus volume and the fact that Zagreb, a region in Croatia, was in an earlier investigation indicted as one with iodine deficiency problem, thus accounting for the apparently slightly elevated figures. Servet, et al. [2] in a study to determine the thyroid volume and its relation with isthmus thickness in Turkey recruited a total of 251 healthy volunteers. Mean total thyroid volume was 13±6.27 ml (men; 15.87±7.18, women; 10.94±4.53, p<0.05). Mean Isthmus thickness was 3.23±1.10 mm (men; 3.42±1.14, women; 3.10±1.05). Total thyroid volume was correlated with height, weight, age, body mass index (BMI) and isthmus thickness. In general thyroid, volume was bigger in men when compared to women and bigger for right lobe compared to the left one. Normal values of thyroid volumes were determined for age groups. They concluded that ultrasonography was useful in the determination of volumes of the thyroid gland or and that values were different in various countries.

Studies done in children showed TTV was lower than that of adults. Children are associated with growth, accounting for the increase in TTV with the increase in age. This likely due to the growth of the thyroid gland with age. Suwaid, et al. [3] in a study in Kano among children noted the increase in TTV with the increase in age. He used a 7.5 MHZ transducer, as against the 10 MHZ used in this study. The study was done among children, accounting for the low values obtained. The thyroid volume in children should be smaller than those in adults. The values obtained were also lower than that of Caucasians. Marchie, et al. [4] in a study in Benin City, in Edo State among school children, obtained TTV of 2.32 cm³. 6.5 MHZ transducer was used in this study The TTV in their study was lower than the Caucasian studies. Delange et al. [5] evaluated thyroid volume and urinary iodine in twelve European School children in a prospective study. Thyroid volume was measured by ultrasonography. The mean age was 10.4 (S.D. 2.4) years for boys and 10.5 (S.D. 2.5) years for girls. This work produced updated recommendations for the normal volume of the thyroid measured by ultrasonography as a function of age, sex and body surface area in iodine-replete school children in Europe. Although the survey included a substantial number of countries, it does not give a picture of Europe as a whole, as all European countries could not be involved because of the lack of resources. Similarly, the studies in each country were by no means nationwide and, consequently, not necessarily representative of the country as a whole, as they were limited to a
few sites which were occasionally selected based on different criteria. Barrer, et al. [6] in a study done in France noted that the thyroid volume does not increase in volume among the elderly. This may be due to the ageing process. The thyroid gland has two lobes that are joined together by the isthmus. They are usually of different sizes, with the right being larger. The vascular supply of the right is larger than that of the left [7]. The right lobe is larger than the left in the study done by Suwaid, et al. [3] among school children. Marchie, et al. [4] and Anele [8] found no difference in sizes between the right and left lobes in children and adults. Ahidjo, et al. [9], found a difference in the sizes of the lobes. The right lobe was higher than the left lobe. The mean volume for both lobes in males and females were 4.48 cm$^3$ and 4.07 cm$^3$ respectively. The right thyroid lobe volume was higher than the left (p=0.000). Ying and Yung [10] in a prospective study of 106 healthy subjects with no history of thyroid diseases or thyroid surgery, and without family history of thyroid diseases were recruited in the study aimed at investigating the association of handedness and position of esophagus with thyroid size asymmetry using 41 men and 65 women: Age range of the subjects was 16–59 years old (mean age 5-37.1 years). For normal thyroid, the right lobe (6.8 ml) was significantly larger than the left lobe (5.66 ml) (P < 0.05). Right-handed subjects (mean, 7.11 ml) had a significantly larger right lobe than left-handed subjects (mean, 5.82 ml) (P < 0.05). There was no significant difference in the left lobe volume between right-handers (mean, 5.81 ml) and left-handers (mean, 5.18 ml) (P > 0.05). Subjects with an oesophagus deviated to the left (mean, 7.15 ml) had a significantly larger right lobe than those with a centrally located oesophagus (mean, 5.7 ml) (P < 0.05). There was no significant difference in the left lobe volume between subjects with different oesophageal positions (deviated to left: mean 5.76 ml; centrally located: mean, 5.19 ml) (P > 0.05). Thyroid asymmetry is suggested to be related to the unilateral differentiation of the hypothalamus on the thyroid gland. However, besides the association of the CNS and thyroid gland asymmetry, the asymmetry of paired organs may also be associated with the presence and the size of their adjacent organs. For example, it has been found that the right kidney is significantly smaller than the left kidney, and the asymmetry of renal size is suggested to be related to the smaller size of the spleen than the liver and thus, the left kidney has more space for growth. In the neck, the oesophagus commonly deviates to the left. Hence, the hypothesis that the smaller size of the left thyroid lobe may be related to the position of the oesophagus. The study found scanty information about the association of handedness with thyroid lobe volume asymmetry. The limitation of this study is the small sample size of left-handers and subjects with the centrally located oesophagus. Moreover, no subject with oesophagus deviated to the right was recruited. Another limitation of this study was that the subjects are mainly in the younger population. The thyroid isthmus is the part of the thyroid gland that connects the lower thirds of the right and left lobes. It usually covers the second and third rings of the trachea. The isthmus may be absent in which the two lobes are not connected as noted by Taty-Anna, et al. [11]. The size of the isthmus is usually assessed separately from the thyroid lobes. Ivanac et al. [1] summed up the thyroid lobes volume with that of the isthmus. This was a drawback of this study. Servet, et al. [2] assessed the isthmus separately. The mean isthmus thickness was 3.23±1.10 mm (men; 3.42±1.14, women; 3.10±1.05).

Males have a larger thyroid gland than females. Ahidjo, et al. [9] observed that the mean volume for both lobes in females and males were 7.58 cm$^3$ and 9.72 cm$^3$ respectively. The male thyroid volume was higher than the females (p=0.000). Adibi, et al. [12] noted that the male's thyroid volume (10.73 ± 3.44 ml) was significantly higher than the females one (7.71 ± 2.63 ml) (P<0.001). However, Anele [8] in his study observed that there was no difference in volume between males and females. The knowledge of the fact that sex plays a role in determining the thyroid volume is essential in interpreting results obtained based on the sex of the patient. Growth is seen with an increase in age in human. The thyroid gland increases with the growth of man. Suwaid, et al. [3] observed that the thyroid volume increases with increase with age. There has been a steady increase in the mean thyroid lobe volume with an increase in age. The mean thyroid volume at 6 years is 2.94±0.79 cm$^3$ and increases to 8.55±2.79 cm$^3$ at 13 years. Marchie, et al. [4] showed a strong correlation between the median thyroid volume and subjects' age (r = 0.804, P <0.001). Anele [8] also found a strong correlation between subjects' age and median thyroid gland volume. Barrer, et al. [6] also noted...
an increase in thyroid volume with an increase in age. They, however, observed that the increase ceases after the age of 65 years. No volume increase was noted in the elderly.

The weight of an individual was noted to affect the thyroid volume. Suwaid, et al. [3] showed a correlation between weight and thyroid volume are 0.799, the P-value is 0.000. They found an increase in thyroid volume with an increase in weight. Servet, et al. [2] showed an increase in thyroid volume with increase with weight. The increase was statistically significant.

The volume of thyroid gland increases with an increase in height and BSA as growth takes place. Adibi [12] observed a strong correlation between thyroid volume, and height and body surface area (\(r=0.48, P<0.001\)). Kayastha, et al. [13] showed that thyroid volume can best be correlated with BSA. Marchie\(^4\) et al showed an increase in median thyroid volume (TV) with BSA.

Body mass index (BMI) is a measure of the increase in weight concerning the height of an individual. Thyroid volume increases with BMI. Servet\(^2\) et al in their study found a good correlation between the thyroid volume and BMI, which was statistically significant. The most study done on thyroid volume in Nigeria did not correlate thyroid volume with BMI. This was a major drawback. This is why I am assessing it to get a baseline in adult Nigerians.

Another study by Adibi [12] in healthy adults of Isfahan, a centrally located city in Iran, an iodine replete area using 200 subjects (123 Males, 77 females, average age: 37.27±11.80 Years). The overall thyroid volume was 9.53±3.68 ml. Males thyroid volume (10.73±3.44 ml) was significantly higher than the females one (7.71±2.63 ml) (P<0.001). The ranges were thyroid volume 3-23.9 ml, 3.6-23.9 ml and 3-14.3 ml in all, males and females, respectively. Thyroid volume values more than 97 percentile of this reference range were 10.14 ml, 11.48 ml and 8.37 ml in all, males and females respectively, and were considered goitre on sonographically. Thyroid volume had a positive correlation with age (\(r=0.163, P=0.022\)), but did not have a correlation with serum TSH, UIC and BMI, in both sexes. There was a strong correlation between thyroid volume, and height and body surface area (\(r=0.48, P<0.001\)). It was documented that thyroid volume is higher in male sex and increases with age, and have a positive correlation with body surface area and height.

2. MATERIALS AND METHODS

2.1 Study Area

Jos is the capital city of Plateau State. Plateau state has over 30 different ethnic groups. The 2006 Nigerian census put the population of Plateau State at 3,178,712, [14]. Jos University Teaching Hospital (JUTH) is one of the three teaching hospitals in the North-Central Zone of Nigeria. It serves as a referral centre for the neighbouring states of Bauchi, Gombe, Benue, Kogi, Nassara, Tareba, Adamawa and parts of Kaduna State.

2.2 Study Population and Design

This was a hospital-based Cross-sectional study that was done in the Department of Radiology, Jos University Teaching Hospital (JUTH), a tertiary health institution situated in the central part of Jos, for twelve months (June 2011-June 2012).

2.3 Inclusion Criteria

- Patients that consented to have the procedure (sonographic evaluation of thyroid gland volume and laboratory assessment of thyroid function)
- Patients referred for ultrasound examination, other than a thyroid ultrasound scan.
- Patients 18 years and above
- Patients with normal laboratory values of T3 (0.6-2 ng/ml), T4 (45-115 ng/ml) and TSH (0.3-6.5 ng/ml)

2.4 Exclusion Criteria

- Female during menstruation, pregnancy or who have delivered within the last twelve (12) months
- Subjects with anterior neck swelling or clinical evidence of thyroid/endocrine disorder
- Subjects with previous thyroid surgery.
- Subject with abnormal laboratory values of T3, T4 and TSH.
- Subjects who did not consent to participate in the study

2.5 Sample Size Determination

The sample size was determined using Fisher’s statistical [15] formula \(n = \frac{z^2 pq}{d^2}\) for a population greater than 10,000 and it was calculated to be 384 as shown below:
The formula \( n = \frac{z^2pq}{d^2} \)

where

- \( n \) = Desired sample size.
- \( z \) = Standard deviation, using set at 1.96, which correspond to 95% confidence level.
- \( p \) = Proportion in target population estimated to have a particular characteristic. If no reasonable estimate, 50% (0.5) is used.
- \( q = 1.0 - p \)
- \( d \) = degree of accuracy desired, usually set at 0.05

Therefore \( n = 1.96^2 \times 0.5 \times 0.5 / 0.05^2 = 384 \). However, a sample size of 400 was used.

### 2.6 Technique

The procedure was explained to all participants, and informed consent was obtained. A data sheet was completed for all participants in which the ages were obtained and weights and heights were obtained by the participants climbing a weighing scale and standing by a wall that was marked in meters. The weight and height of each participant were then measured without shoes or heavy clothes before the scan was done. The body mass index (BMI) in Kilogram/meter square (Kg/m²) [16] was then calculated from the weight and height [17]. The participants were asked questions on the history of previous thyroid disease or surgery as stated in the questionnaire. Questions on alcohol consumption, cigarette smoking and parity of women were asked as seen in the questionnaires. Patients were examined in a supine position with a pillow placed under the shoulders to aid in the extension of the head. All examinations were performed using LOGIC 5, a real-time ultrasound machine fitted with a 10MHZ linear transducer. Ultrasound gel was applied over the anterior neck (thyroid area) and the transducer placed directly on the skin over the thyroid area. Images of each lobe and the isthmus were obtained in the transverse (Fig 1) and longitudinal planes (Fig 2). Longitudinal (length), as well as transverse (width) and depth (AP), were measured in centimetres (cm). The right and left thyroid volume data were obtained and analyzed separately. The isthmus was not included in the sum. The lobe volume (cm³) was calculated from the equation of Brunn, et al. [18,19] using the ellipsoid model formula by multiplying the length (L) by width (w) by depth (d) in cm by a correction factor 0.52 and the lobe volumes are summed. The isthmus volume was calculated from \( V_{isthmus} \) (cm³) equals length \( l_{isthmus} \) by width \( w_{isthmus} \) by depth \( d_{isthmus} \) all in cm multiplied by 0.479 [20]. Total Thyroid volume (cm³) = total sum of lobe volumes (cm³).

![Fig. 1. Sonogram acquired in the transverse plane at the level of the thyroid cartilage (C6 level) illustrating the measurement of the transverse diameter of the thyroid lobe](image-url)
Fig. 2. Longitudinal ultrasound scan of the thyroid, showing the measurement of the longitudinal (LS) and anteroposterior diameters of the thyroid lobe

Isthmus volume (cm$^3$) = length $\text{isthmus} \times$ width $\text{isthmus} \times$ depth $\text{isthmus} \times 0.52$

The body surface area was calculated using the formula of Dubois and Dubois [21]

Body surface area BSA (m$^2$) = Weight $^{0.425}$ x Height $^{0.725}$ x 71.84 x $10^{-4}$

and Body mass index (BMI) (Kg/m$^2$) was calculated from weight/height$^2$.

- Blood samples were taken for thyroid function tests (T3, T4 and TSH) in which results that were not within normal range were not included. The normal laboratory values of T3 (0.6-2 ng/ml), T4 (45-115 ng/ml) and TSH (0.3-6.5 ng/ml)
- Underweight < 20 kg/m$^2$
- Normal weight 20-25 kg/m$^2$
- Overweight >25 kg/m$^2$
- BSA CATEGORIZED [22]
- Normal \(1.91 \text{ m}^2\) (male) \(1.6 \text{ m}^2\) (female)
- Abnormal >1.91 m$^2$ (male) 1.71 m$^2$ (female)

2.7 Data Analysis

The data obtained from the structured questionnaire was entered into a computer to generate a computerized database for subsequent analysis and processing using SPSS version 17. Statistical parameters such as student’s test were used for the association between different variables. P-value of 0.05 or less was considered statistically significant. The results were presented in the form of tables, chart and graphs.

3. RESULTS

A total of 400 adults were recruited comprising 150 (37.5%) males and 250 (62.5%) females (Fig. 3). The number of females was more than males.

Table 1a and 1b are the age-sex distribution patterns of the anthropometric indices in the male and female subjects in the study population.

The total mean age for the subjects was 38.45 ± 14.09 years. The mean age for males was 42.91 ±7.1 years (range 18-85) and for females, was 35.61±11.06 years (range of 18-75). (Table 1a and 1b).The modal age in the females and males subjects are the greater than 50 years old (56%) and the age group of 30-39 years (92%) respectively.

The total mean height was 1.61±0.07 meters (m) with a range of 1-1.8 meters. The mean heights
of the males (1.64±0.06) are greater than the females (1.59±0.07) with the greatest height of 1.66±0.04 and 1.60-1.70 m in <20 age groups on both sexes. The height of the males is higher than that of the females for the corresponding age groups.

The total mean weight was 68.82±13.30 (range 38-112 kg) and the mean weights for males and females were 69.17±12.32 kg and 68.48±13.59 kg. (Table 1a and 1b). There was an increase in weight with age group up to 40-49 years in both sexes. The weights in males are more than that of the females in the corresponding age groups, except age group 40-49 years where the females' weight is higher. The less than 20 years age have the least weight 63.80±11.79 kg, while the 40-49 years have highest weight (74.68±13.07 kg) for male subjects.

Table 1a and 1b also shows the Age Vs BMI in the study population.

The total mean body mass index (BMI) 26.6±5.95 kg/m² (range 15.82-87), whereas the mean male and female BMI were 25.74±4.71 and 27.13±6.54 respectively (Table 1). The less than 20 years age groups had the lowest BMI (23.18±1.27) and the highest BMI (27.48±4.45) was noted on the 40-49 age group. In females, a steady increase in BMI was noted across the age groups. The BMI was noted to be higher in females than males from the 30-39 age groups upward. The BMI was greater than 25 kg/m² in both sexes from 30-39 years age groups upward, which is overweight.

Table 1a and 1b also shows the Age Vs BSA in the study population.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Frequency (%)</th>
<th>Age Mean±SD</th>
<th>Height Mean±SD</th>
<th>Weight Mean±SD</th>
<th>BSA Mean±SD</th>
<th>BMI Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>5</td>
<td>17.6±0.9</td>
<td>1.66±0.04</td>
<td>63.80±1.79</td>
<td>1.61±0.04</td>
<td>23.18±1.27</td>
</tr>
<tr>
<td>21-29</td>
<td>40</td>
<td>24.9±2.5</td>
<td>1.64±0.6</td>
<td>63.15±9.46</td>
<td>1.67±0.10</td>
<td>23.65±4.78</td>
</tr>
<tr>
<td>30-39</td>
<td>30</td>
<td>35.1±2.8</td>
<td>1.65±0.07</td>
<td>69.40±13.74</td>
<td>1.76±0.18</td>
<td>25.52±4.71</td>
</tr>
<tr>
<td>40-49</td>
<td>19</td>
<td>44.7±3.1</td>
<td>1.65±0.05</td>
<td>74.68±13.07</td>
<td>1.81±0.16</td>
<td>27.48±4.45</td>
</tr>
<tr>
<td>≥50</td>
<td>56</td>
<td>61.8±9.4</td>
<td>1.63±0.06</td>
<td>71.95±12.04</td>
<td>1.77±0.15</td>
<td>26.99±4.38</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>42.91±7.1</td>
<td>1.64±0.06</td>
<td>69.17±12.32</td>
<td>1.75±0.15</td>
<td>25.74±4.71</td>
</tr>
</tbody>
</table>

Fig. 3. Pie chart of sex distribution of study subjects

Table 1a. Age and frequency distribution of male study subjects according to anthropometric indices
There is a steady increase in thyroid volume for females with a p=0.930. The total mean thyroid volume with an increase in volume with age was statistically significant in males, with a p=0.637. However, there is a statistically significant increase in thyroid volume when the volumes of 20-29 and 30-39 years age groups are compared. The male has a p=0.032 and the females p=0.041.

The total mean isthmus volume was 0.27 cm$^3$±0.31 and that of males and females are 0.32±0.28 and 0.24±0.23 cm$^3$. There is a steady increase in volume with age in both sexes, except for the 40-49 years in males. The increase is statistically significant in males, with a p=0.025. The increase is not statistically significant in females, with a p=0.457.

The total mean thyroid volume for males was 6.30 cm$^3$±2.37 (range 1.38-11.34). The lowest volume of 5.80±1.51 cm$^3$ was seen in 20-29 years age groups and the highest of 6.28±3.31 cm$^3$ in 50 years age group. No statistically significant increase in thyroid volume with an increase in age.

Table 2a and 2b show the age-sex distribution pattern of the male and female subjects in the study population.

The total mean thyroid volume was 6.03±2.49 (range 1.38-11.34). There is a steady increase in thyroid volume with an increase in age. The lowest total means the volume of 5.52 cm$^3$ was seen in 20-29 years age groups, whereas the highest of 6.12 cm$^3$ was noted on the greater than 50 years age groups. There was no statistically significant increase in thyroid volume with an increase in age.

The total mean thyroid volume for females was 5.65 cm$^3$±2.61 (1.38-15). There is a steady increase in thyroid volume with an increase in age groups from 21-29 years age groups. The lowest is 5.24±2.35 cm$^3$ in 21-29 years and the highest was 5.96 cm$^3$ in greater than 50 years. The increase was however not statistically significant, with a p=0.037. However, there is a statistically significant increase in thyroid volume when the volumes of 20-29 and 30-39 years age groups are compared. The male has a p=0.032 and the females p=0.041.

The total mean isthmus volume was 0.27 cm$^3$±0.31 and that of males and females are 0.32±0.28 and 0.24±0.23 cm$^3$. There is a steady increase in volume with age in both sexes, except for the 40-49 years in males. The increase is statistically significant in males, with a p=0.025. The increase is not statistically significant in females, with a p=0.457.

Table 2a and 2b also show that the total mean right lobe volume was 3.2 cm$^3$±1.47 and that of the male was 3.37±1.34 and female 3.08±1.55. There is an increase in volume with an increase in age in both sexes from 20-29 years age group upward. The lowest value is 3.09 cm$^3$±1.17 in the 21-29 years age group and the highest in the greater than or equal 20 years in males. There was no statistically significant increase in volume with increased age (p=0.65). The lowest value in female was 2.98±1.43 cm$^3$ in the age group of 40-49 years and the highest is 3.22±1.93 cm$^3$ in the age group of greater than 50 years. There was no statistically significant increase in right lobe volume with an increase in age.

### Table 1b. Age and frequency distribution of female study subjects according to anthropometric indices

<table>
<thead>
<tr>
<th>Age group</th>
<th>Frequency (%)</th>
<th>Age Mean±SD</th>
<th>Height Mean±SD</th>
<th>Weight Mean±SD</th>
<th>BSA Mean±SD</th>
<th>BMI Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>10</td>
<td>18.20±0.63</td>
<td>1.63±0.03</td>
<td>59.30±11.98</td>
<td>1.60±0.14</td>
<td>22.37±4.92</td>
</tr>
<tr>
<td>21-29</td>
<td>70</td>
<td>25.44±2.56</td>
<td>1.59±0.05</td>
<td>60.11±10.70</td>
<td>1.61±0.14</td>
<td>23.65±4.14</td>
</tr>
<tr>
<td>30-39</td>
<td>92</td>
<td>34.37±2.85</td>
<td>1.60±0.06</td>
<td>73.14±12.40</td>
<td>1.76±0.15</td>
<td>28.77±4.89</td>
</tr>
<tr>
<td>40-49</td>
<td>41</td>
<td>43.39±2.99</td>
<td>1.61±0.07</td>
<td>73.41±14.26</td>
<td>1.77±0.16</td>
<td>28.55±5.89</td>
</tr>
<tr>
<td>≥50</td>
<td>37</td>
<td>54.00±9.88</td>
<td>1.56±0.12</td>
<td>69.70±12.81</td>
<td>1.69±0.18</td>
<td>29.37±10.65</td>
</tr>
<tr>
<td>Total</td>
<td>250</td>
<td>35.61±11.06</td>
<td>1.59±0.07</td>
<td>68.48±13.59</td>
<td>1.70±0.16</td>
<td>27.13±6.54</td>
</tr>
</tbody>
</table>

Table 2a. Age and sex distribution pattern of thyroid volume in male subjects

<table>
<thead>
<tr>
<th>Age</th>
<th>Right(Mean±SD)</th>
<th>Left(Mean±SD)</th>
<th>Mean total thyroid Vol(Mean)</th>
<th>Isthmus Vol</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>3.83±0.33</td>
<td>2.34±0.67*</td>
<td>6.17±0.66</td>
<td>0.17±0.14*</td>
</tr>
<tr>
<td>21-29</td>
<td>3.09±0.79</td>
<td>2.71±0.98</td>
<td>5.80±1.51</td>
<td>0.22±0.19</td>
</tr>
<tr>
<td>30-39</td>
<td>3.19±1.52</td>
<td>3.09±1.91</td>
<td>6.28±3.31</td>
<td>0.26±0.24</td>
</tr>
<tr>
<td>40-49</td>
<td>3.22±1.17</td>
<td>3.30±1.26</td>
<td>6.52±2.16</td>
<td>0.42±0.36</td>
</tr>
<tr>
<td>≥50</td>
<td>3.30±1.63</td>
<td>3.44±1.22</td>
<td>6.74±2.47</td>
<td>0.34±0.33</td>
</tr>
<tr>
<td>P</td>
<td>0.652</td>
<td>0.619</td>
<td>0.930</td>
<td>0.025</td>
</tr>
<tr>
<td>Total</td>
<td>3.32±1.34</td>
<td>2.976±1.32</td>
<td>6.302±2.37</td>
<td>0.30±0.28</td>
</tr>
</tbody>
</table>
Table 2b. Age and sex distribution pattern of thyroid volume in female subjects

<table>
<thead>
<tr>
<th>Age group</th>
<th>Right (Mean SD)</th>
<th>Left (Mean SD)</th>
<th>Mean Total Thyroid Vol (Mean)</th>
<th>Isthmus Vol</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>3.06±0.89</td>
<td>2.29±0.43</td>
<td>5.35±0.81</td>
<td>0.20±0.17</td>
</tr>
<tr>
<td>21-29</td>
<td>3.02±1.58</td>
<td>2.22±1.02</td>
<td>5.24±2.35</td>
<td>0.24±0.23</td>
</tr>
<tr>
<td>30-39</td>
<td>3.15±1.46</td>
<td>2.63±1.34</td>
<td>5.80±2.32</td>
<td>0.25±0.23</td>
</tr>
<tr>
<td>40-49</td>
<td>2.98±1.43</td>
<td>2.73±1.24</td>
<td>5.91±2.51</td>
<td>0.31±0.25</td>
</tr>
<tr>
<td>≥50</td>
<td>3.22±1.93</td>
<td>2.74±2.08</td>
<td>5.96±3.87</td>
<td>0.34±0.16</td>
</tr>
<tr>
<td>P</td>
<td>0.927</td>
<td>0.059</td>
<td>0.637</td>
<td>0.457</td>
</tr>
<tr>
<td>Total</td>
<td>3.08±1.55</td>
<td>2.57±1.38</td>
<td>5.65±2.61</td>
<td>0.24±0.23</td>
</tr>
</tbody>
</table>

The total mean left lobe volume (LLV) was 2.77 cm³±1.35 and that of males and females are 2.98 cm³±1.32 and 2.57 cm³±1.38 respectively (Table 2a and 2b). There was no significant increase in LLV with the increase in age in males. The lowest measured 2.34±0.67 cm³ in the less than 20 years age groups and the highest was 3.44±1.22 cm³ in the greater or equal 50 years age group was noted ( p= 0.619). There is a steady increase in LLV with the increase in age groups in females. The lowest value is 2.29±0.43 in the less than 20 age groups and the highest is 2.74±2.08 in the greater than or equal to 50 years age group. However, the p-value was not statistically significant 0.059. There is increase thyroid volume with an increase in age as seen in the scattergram (Fig 4)

4. DISCUSSION

The knowledge of the normal thyroid volume is essential in evaluating diseases affecting the gland. A nomogram of thyroid volume in our environment is important to serve as a reference point in managing patients with thyroid pathologies.

This study showed that the mean thyroid volume was lower than the values recorded by other investigators among Caucasians [23,20]. Ahidjo, et al. [9] in Maiduguri found the overall thyroid volume of 8.55±1.82 cm³, while that of males and females were 9.72 cm³ and 7.58 cm³ respectively. Ivanac, et al. [1] in Zagreb obtained thyroid volumes that were higher than what was obtained in this study. In their study, the thyroid volume was 10.68±2.83 cm³. The reason for this difference values may be attributed to improved intake of table salt [24]. The value obtained in this study is about the same with the study done by Kayastha, et al. [13], in which the mean thyroid volume was 6.629±2.502 cm³ in a mountainous area that has good iodization programme of food supplements. However,
Suwaid, et al. [3] in Kano, Northwestern Nigeria, obtained mean thyroid volume of 5.3±2.50 cm$^3$ and 4.79±2.38 cm$^3$ for boys and girls respectively, which were lower than the mean values in this study. This was because the study was conducted on children who are still growing. Increasing use of iodine supplementation in this country in recent years could be one of the factors reducing the iodine deficiency prevalent in the country and thus reducing the total thyroid volume.

The male thyroid volumes (6.30±2.37) were higher than that of females (5.65±2.61). This finding was similar to that of other investigators [16]. This may be due to the fact males have increased body mass index than females of the same age. However, Anele T$^8$ and Marchie et al$^4$ found no significant difference between males and females thyroid volumes.

The mean right lobe volume was higher than that of the left, and it was statistically significant. Similar findings were noted by other investigators [9,3,25,6]. This increase may likely be due to increased vascularization of the right lobe compared to the left [3].

The mean heights of males were higher than that of females. There was a positive correlation between thyroid and isthmus volume with height. Similar findings were noted by other investigators [9,26,1,17].

Thyroid volume increases steadily with increase in age in the females and male subjects. This increase was however not statistically significant. Similar findings by Suwaid, et al. [3] and Barrer, et al. [6] were statistically significant. It was thought that thyroid volume increases with age up to 65 years as noted by Barrer, et al. [6]. The thyroid volume was higher in the less than 20 years compared with 20-29 years age groups in both sexes. The increase was not statistically significant. No obvious reason was found for such. It was however thought to be due to a growth spurt at less than 20 years age groups.

The isthmus volume was higher in males (0.30±0.28) compared to females (0.24±0.23) and also increased with age. Servet, et al. [2] in Turkey obtained values that were similar to this study. They recorded a positive correlation between the mean isthmus volume with age, weight, height and BSA. The mean total isthmus
volume was 0.45±0.31 and that of males and females was 0.44±0.34 and 0.46±0.29 respectively. However, the mean isthmus volume in this study was lower than what they obtained in their study. The reasons attributed to the difference in thyroid lobes volume in this study compared with others may also be applicable here.

Barrer, et al. [6] in France observed the increase in thyroid volume with Body surface area (BSA), which was statistically significant. In their study, thyroid volume best correlated with BSA. Kayastha, et al. and Langer P [25] observed the increase in thyroid volume with an increase in BSA. There was an increase in thyroid volume with an increase in BSA in this study, which was not statistically significant. The isthmus volume also increased with BSA. No reason has been attributed for this finding after a search through the literature.

In this study, thyroid volume increases with body mass index (BMI). Other researchers [9,1,2,25,6] also observed an increase in thyroid volume with an increase in BMI. The increase noted in this study was not statistically significant.

5. CONCLUSION

Thyroid gland is seen to increase with age. The thyroid gland is higher in males. The right lobe volume was higher than that of the left and the volume was higher in males compared to females. Anthropometric parameters were noted to affect the thyroid volume.

CONSENT AND ETHICAL APPROVAL

Approval was obtained from the Research and Ethical Committee of Jos University Teaching Hospital. Informed signed consent was obtained from the volunteers before enrollment for the study and they were given the freedom to withdraw from the study at any stage without consequences. The data collected from the participants were recorded serially and kept with the utmost confidentiality.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


