Nigerian Journal of Medical Imaging and Radiation Therapy

SONOGRAPHIC DETERMINATION OF THYROID GLAND VOLUME AMONG APPARENTLY HEALTHY ADULTS IN KANO METROPOLIS.

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ARTICLE INFO

Keywords:
Thyroid Gland,
Ultrasound,
Reference value,
Anthropological Indices.

ABSTRACT

BACKGROUND: Normograms of thyroid gland volume used in our locality are those of other populations. Reference values have been borrowed from other regions despite the recommendations of the WHO for the establishment of regional thyroid gland volume (TGV), for improved accuracy of the diagnosis.

AIM: To establish a reference value of thyroid volume amongst apparently healthy adults in Kano metropolis using ultrasound imaging to guide clinicians in assessing the thyroid gland in pathologies.

METHODOLOGY: Prospective and cross sectional study conducted in Kano metropolis from November 2018 to October 2020. Four hundred adult underwent sonographic scan of the thyroid gland using a medical ultrasound machine equipped with a 7.5 MHz linear probe after being confirmed euthyroid by their serum TSH evaluation. Their demographic information such as; age, gender were obtained. Height was measured using astadiometer and weight measured using a bathroom weighing scale. All data were recorded in a data capture sheet. Data were analyzed using the statistical package for social sciences version 21. Statistical significance was considered at $p < 0.05$.

RESULTS: TGV was found to be 7.6 cm^3± 1.3. Males had significantly higher TGV (7.8 cm^3± 1.15) as compared to females (7.5 cm^3± 1.43) (p=0.00). Volume of right lobe was significantly greater than that of left lobe (p=0.00) in both genders. Overall isthmus anterior posterior and transvers dimensions were 3.1 mm± 1.4 and 21.6 mm± 3.11 respectively. Significant correlation (p=0.000) was found between TGV and participants' age, height, weight, BMI, BSA and TSH.

CONCLUSION: A local reference thyroid gland volume among apparently healthy adult individuals was established and best predicted with increased BSA.

Introduction

Thyroid is the first endocrine gland to develop in the embryo and originated from the primitive pharynx and the neural crest [1]. It is located in the midline of the neck formed by two elongated lateral lobes which are connected by an isthmus [2][3]. The gland is subdivided by capsular septa into lobules containing follicles which are responsible for the synthesis of $T_4$and T_3 hormones by utilizing iodide obtained either from dietary sources or from the metabolism processes [4][5][6].

The thyroid hormones play an essential role in human development such as CNS development [6]. It is required for actions of growth hormone to promote linear growth and bone formation [6]. It increases the basal metabolic rate, oxygen consumption, thermogenesis, and mobilization of carbohydrate, fat and protein as substrates for energy metabolism [7][5][6]. Pathological conditions such as hyperthyroidism can cause increase in thyroid gland size to two or three times' normal size which is associated with several medical conditions such increase response to stimuli, heat intolerance, increased sweating, weight loss, varying degree of diarrhea, muscle weakness, inability to sleep and tremor of the hands [6]. Reduction in thyroid size due to pathology or surgical removal could leads to fatigue, extreme muscular sluggishness, constipation, and mental sluggishness [6].

According to the WHO, the normal overall thyroid gland volume (TGV) ranged from 7.7 to 25 cm^3 in men and from 4.4 to 18 cm^3 in women [7]. However, its size and shape varies greatly in normal individuals [8]. Some physiological and socioeconomic factors such as dietary iodine intake & goitrogens, age, sex, smoking, weight, height, body mass index (BMI), waist-to-hip ratio (WHR), lean body mass (LBM), blood group and body surface area (BSA), reproductive state, alcohol consumption, hormonal changes all affect the thyroid volume in normal individuals [9][10].

Ultrasound scan (US) is one of the various imaging modalities that have been used to determine the TGV. The determination of TGV by ultrasound is a correct and precise method. It has been widely practiced since the 1970s and is now one of the most popular radiological methods for diagnosing thyroid diseases [7]. It is a non-invasive, non-ionizing, rapid, inexpensive, easily available and highly informative technique [7].

Similar studies have been conducted all over the world. In north-east Nigeria Ahidjoe et al. [11] reported that that the overall TGV was 8.55 ±1.82 cm^3. Similarly, In Port Harcourt south-south Nigeria, the mean thyroid volume was reported to be 6.81 ±2.18 cm^3 [12]. In Karachi population the overall TGV was 6.26 ± 2.89 ml [13], and in Cuba it was 6.6 ±0.26 ml [8]. When comparing the volume between males and females, right and left, majority of previous studies concluded that thyroid volume in males was higher than in females and right gland volume is higher than the left with exception of few studies [10]. Several studies have shown that TVG was correlated with the anthropometrical indices [8]. However, BSA is the best predictor for thyroid volume [8][14].

The determination of TGV helps in grading of goiter, calculation of the dose of radioiodine I^{131} needed for treating thyrotoxicosis, assessing patients undergoing long term treatment with drugs which causes goiter or can alter thyroid function tests. The range of TGV for a particular population is required for large scale iodine monitoring programs as recommended by WHO. A few studies have been conducted in the south-south, northcentral and northeast geopolitical zones of Nigeria, but no similar study has been conducted in the northwestern region despite the dietary and geographical differences amongst all the Nigeria's geopolitical zones. Thus, the aim of this study was to determine the reference thyroid gland volume in apparently healthy adults in Kano metropolis.

MATERIALS AND METHOD

The study was prospective and cross sectional conducted in Aminu Kano Teaching Hospital, from November 2018 to October 2020. Four hundred apparently healthy adults were randomly selected from each of the seven local governments that constituted the metropolis, with equal numbers of male and female. Any individual with known clinical thyroid disorders, or whose thyroid function test (TSH) is not within norm range, known diabetics, individuals on thyroid hormone or antithyroid medication, those with palpable, visible neck mass or any form of malignancy, those with sickle cell anemia, individuals with chronic renal or liver disease, pregnant women, women on contraceptives drugs, women during menstruation and pediatrics were all excluded from the study. Participants with abnormal parenchymal echotexture or nodules were also excluded. The approval of the Research Ethical Committee of

AKTH was sought and obtained prior to the commencement of data collection. The participants all signed an informed consent form after agreeing to participate in the study. All the records of the participants were kept in strict confidence.

The participants were interviewed face to face by trained professional were their demographic information such as; age, gender were obtained. Their height was measured in meters (m) using a stadiometer; weight was measured in kilogram (Kg) using a bathroom weighing scale. They all removed their caps and shoes and emptied their pockets before the weight was measured.
Body mass index (BMI) was calculated in (Kg/m^2) using the following formula;

BMI= $\frac{Weight}{Height^2}$

Body surface area (BSA) was calculated using DuBois formulas;

BSA= $w(^{524.0} X\, H^{227.0}\ X)$ 0.007184

Where; W= weight and H=Height

LABORATORY METHOD

To select euthyroid subjects, TSH was done in the laboratory by an experienced laboratory scientist. Three (3 ml) blood samples were collected from each participant following the usual precautions in the collection of venipuncture. The specimen was collected in a plain red top venipuncture tube. No additives or gel barriers were added. The specimen was allowed to clot and centrifuged at about 3500 rpm for 5minutes to separate the serum from the cells. Then refrigerated at 2-8^{o}C until needed. The Elisa Microwells was used to obtain the normal TSH from the serum obtained.

ULTRASONOGRAPHY

Ultrasonography of TG was done with ultrasound machine esaote model Mylab40 equipped with a 7.5 MHz linear probe by two consultant radiologists. Inter and intra observer variability was evaluated prior to the commencement of data collection. All participants were examined in supine position with a pillow under their shoulders to hyperextend the neck. The examiners stood on the right side of the subject. Suitable amount of ultrasound gel was applied on the midpoint of the neck. The linear probe was gently placed directly on the skin over the thyroid gland sliding in transverse plane from the breastbone to the hyoid bone until the thyroid tissue was identified then freeze. From the frozen transverse image, the length of each lobe was obtained. From the transverse plane the probe was medially rotated to 90^{o} to the longitudinal plane to obtain the depth and the width for each lobe in cm. The machine automatically calculated the volume from the length, depth and width in cm^3.Transverse and anterior-posterior dimension of isthmus were taken into the account in millimeter (mm).

STATISTICAL ANALYSIS

Kolmogorov- Smirnov test was applied to check normality of data. Both descriptive and inferential statistics were applied to the data. Means ± standard deviations (SD) of the TGV, right thyroid lobe volume (RTLV), left thyroid lobe volume (LTLV), isthmus anterior-posterior dimension (IAPD) and isthmus transverse diameter (ITVD) were determined using descriptive statistic. Student t- test was used to compare the means TGV, RTLV, LTLV, IAPD and ITVD in both genders. The Correlations of TGV, RTLV, LTLV, IAPD and ITVD with age, sex, height, weight, BMI, BSA and TSH was determined by Pearson's correlation coefficient. Data were analyzed using the statistical package for social sciences (SPSS) version 21 (SPSS Inc., Chicago, Illinois). Statistical significance was considered at $p < 0.05$.

RESULT

The study comprised four hundred (400) participants, two hundred 200 (50%) males and two hundred 200 (50%) females. Male age ranged from 18 to 62 years with a mean age of 37.0 ± 11.08 years while female age ranged from 18 to 60 years with a mean age of 35.2 ± 11.82 years. The overall mean age was 36.1 ± 11.48 years as seen in table 1. The mean height for male and female was 1.6 ± 0.05 m and 1.5 ± 0.77 m respectively with overall mean of 1.6 ± 0.07 m. The mean weight for male was 62.5 ± 10.60 Kg and for females was 56.6 ± 7.49 Kg and the overall mean weight for both genders was 59.5 ± 9.63 Kg. The overall mean BMI was 23.7 ± 3.76 Kg/m^2, male had mean of 24.6 ± 3.69 Kg/m^2 and females had 22.8 ± 3.6 Kg/m^2±. The overall mean BSA was 1.6 ± 0.13 m^2, male had mean of 1.6 ± 0.14 m^2 while female had 1.6 ± 0.11 m^2. Table 1 indicated that the overall mean TSH was 2.8 ± 1.4 mlU/l, male had mean of 2.6l ± 1.40 mlU/l while female had 2.9 ± 1.42 mlU/l. The overall TGV was 7.6 ± 1.3 cm^3. The mean TGV in male was 7.8 ± 1.15 cm^3 and the RTGV and LTGV was 4.1± 0.68 cm^3 and 3.7 ± 0.55 cm^3 respectively (table 2). The mean TGV in female was 7.5 ± 1.43

cm^3 and the RTGV and LTGV was 4.0± 0.79 cm^3 and 3.5 ± 0.72 cm^3 respectively. Male thyroid volume was greater than females and right thyroid volume was greater than left in all genders ($p < 0.05$) (table 4).

Table 3 shows that the overall mean IAPD was 2.9 ± 1.25 mm. The mean IAPD among male and female was 3.1± 1.45 mm and 2.9 mm ± 1.01 respectively. The overall mean ITVD was 21.6± 3.11 mm. The mean ITVD for males and females was 22.0 ± 3.03 mm and 21.4± 3.12 mm respectively (table 3).

Table 6 and 7 indicated that thyroid volume was positively correlated with age, height, weight, BMI, BSA and TSH in both genders by Pearson's correlation.

MALE

Pearson's correlation coefficient (r) showed strong, positive correlation between TGV against subject's BSA, weight and age respectively, ($r= .713^{**}$; p=.000), ($r= .699^{**}$; p=.000), ($r= .666^{**}$; p=.000). However, a moderate, positive correlation between TGV and subject's BMI ($r= .587^{**}$; p=.000) and height ($r= .448^{**}$; p=.000) was seen. A weak, positive correlation between TGV and subject's TSH ($r= .372^{**}$; p=.000) was seen (table 6) all the result were significant at $p<0.05$ (table 6).

FEMALE

Pearson's correlation coefficient (r) showed strong, positive correlation between TGV against subject's BSA ($r= .665^{**}$; p=.000) and weight ($r= .638^{**}$; p=.000). A moderate, positive correlation between TGV and subject's age ($r= .549^{**}$; p=.000) was seen. A weak, positive correlation between TGV and subject's BMI ($r= .357^{**}$; p=.000), height ($r= .295^{**}$; p=.000) and TSH ($r= .372^{**}$; p=.000) was seen (table 7) all the result is significant at $p<0.05$ (table 6).

Table 1: Demographic information of the participants

Variable	Male (n=200)	Female (n=200)	Total (n=400)
Mean Age (years)±SD (range)	37.0± 11.08 (18-62)	35.2± 11.82 (18-60)	36.1± 11.48 (18-62)
Mean Height (m) (range)	1.6± 0.05 (1.4-1.8)	1.5± 0.77 (1.40-1.8)	1.6± 0.07 (1.4-1.8)
Mean Weight (Kg) (range)	62.5± 10.60 (47-80)	56.6± 7.49 (47-80)	59.5± 9.63 (47-80)
Mean BMI (Kg/m^2) (range)	24.6± 3.69 (18.4-31.3)	22.8± 3.62 (15.4- 33.7)	23.7± 3.76 (15.4-33.7)
Mean BSA (m^2) (range)	1.6± 0.14 (1.4-1.9)	1.6± 0.11 (1.3-1.9)	1.6± 0.13 (1.3-1.9)
Mean TSH (mlU/l) (range)	2.6± 1.40 (0.5- 5.60)	2.9± 1.42 (0.2- 5.60)	2.6± 1.4 (0.2- 5.60)

SD= standard deviation;**BIM**= Body Mass Index; **BSA**= Body Surface Area; **LBM**= Lean Body Mass; **TSH**= Thyroid stimulating hormone.

Table 2: Mean thyroid volume according to gender

Variable	Male (n=200)	Female (n=200)	Total (n=400)
Mean RTLV (cm^3)±SD (range)	4.1± 0.68 (2.5- 6.0)	4.0± 0.79 (2.1- 6.0)	4.1± 0.74 (2.1-6.0)
Mean LTLV (cm^3) (range)	3.7± 0.55 (2.1- 5.1.0)	3.5± 0.72 (2.10- 5.1.0)	3.6± 0.65 (2.1- 5.1)

Variable	Male (n=200)	Female (n=200)	Total (n=400)
Mean Total volume (cm^3) (range)	7.8± 1.15 (4.60- 11.1)	7.5± 1.43 (4.2- 11.1)	7.6± 1.3 (4.2- 11.1)

SD= Standard Deviation; **RTLV**= Right Thyroid Lobe Volume; **LTLV**= Left Thyroid Lobe Volume.

Table 3: Mean Isthmus Dimension according to gender

Variable	Male (n=200)	Female (n=200)	Total (n=400)
Mean IAPD (mm)±SD (range)	3.1± 1.45 (1.4- 6.0)	2.9± 1.01 (1.40- 6.4)	2.9± 1.25 (1.4-6)
Mean ITVD (mm) (range)	21.9± 3.03 (12- 29.7)	21.4± 3.12 (12.10- 28.0)	21.6± 3.11 (12.0- 29.7)

SD= Standard Deviation; **IAPD**; Isthmus Anterior Posterior Dimension; **ITVD**= Isthmus Transverse Dimension.

Table 4: Comparison of mean RTLV, LTLV and Total thyroid volume between male and female participants.

Variable	Male (n=200)	Female (n=200)	Total (n=400)	p-value
Mean RTLV (cm^3)±SD (range)	4.1± 0.68 (2.5- 6.0)	4.0± 0.79 (2.1- 6.0)	4.1± 0.74 (2.1-6.0)	0.00
Mean LTLV (cm^3) (range)	3.7± 0.55 (2.1- 5.1.0)	3.5± 0.72 (2.10- 5.1.0)	3.6± 0.65 (2.1- 5.1)	0.00
Mean Total volume (range)	7.8± 1.15 (4.60- 11.1)	7.5± 1.43 (4.2- 11.1)	7.6± 1.3 (4.2- 11.1)	0.00
p-value	0.00	0.00	0.00	

SD= Standard Deviation; **RTLV**= Right Thyroid Lobe Volume; **LTLV**= Left Thyroid Lobe Volume

Table 5: Comparison of mean IAPD and ITRD between male and female participants.

Variable	Male (n=200)	Female (n=200)	Total (n=400)	p-value
Mean IAPD (mm)±SD (range)	3.1± 1.45 (1.4- 6.0)	3.0± 1.01 (1.30- 6.0)	3.1± 1.4 (1.3-6.4)	0.00
Mean ITVD (mm) (range)	21.9± 3.03 (12- 29.7)	21.4± 3.12 (12.10- 28.0)	21.6± 3.11 (12.0- 29.7)	0.00

SD= Standard Deviation; **IAPD**; Isthmus Anterior Posterior Dimension; **ITVD**= Isthus Transverse Dimension.

Table 6: correlation of RTLV, LTLV, TTV, IAPD and ITVD with anthropometric variables in male participants.

Variables	RTLV		LTLV		TTV		ISAPD		ISTVD	
	r	*p*	*r*	*p*	*r*	*P*	*R*	*P*	*R*	*p*
Age (years)	0.636**	0.00	0.586**	0.00	0.660**	0.00	0.044	0.536	0.381**	0.00
Height (m)	0.438**	0.00	0.390**	0.00	0.448**	0.00	-0.078	0.271	0.335**	0.00
Weight (Kg)	0.748**	0.00	0.530**	0.00	0.699**	0.00	-0.018	0.799	0.397**	0.00
BMI (Kg/m²)	.644**	0.00	.427**	0.00	.587**	0.00	0.019	0.792	.297**	0.00
BSA (m²)	0.746**	0.00	0.561**	0.00	0.713**	0.00	-0.036	0.612	0.430**	0.00
LBM	.749**	0.00	0.531**	0.00	0.699**	0.00	-0.018	0.795	0.398**	0.00
TSH (mU/l)	0.291** .	0.00	0.414**	0.00	0.372**	0.00	0.028	0.689	0.146*	0.04

**. Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

Table 7: correlation of RTLV, LTLV, TTV, IAPD and ITVD with anthropometric variables in female participants.

Variables	RTLV		LTLV		TTV		ISAPD		ISTVD	
	r	*p*	*r*	*p*	*r*	*P*	*R*	*P*	*R*	*p*
Age (years)	0.531**	0.000	.499**	0.000	0.549**	0.000	-0.134	0.59	0.453**	0.000
Height (m)	0.297**	0.000	.256**	0.000	0.295**	0.000	0.08	0.92	0.179*	0.09
Weight (Kg)	0.582**	0.000	.619**	0.000	0.638	0.000	0.136	0.54	0.469**	0.000
BMI (Kg/m²)	0.306**	0.000	.368**	0.000	0.357**	0.000	0.116	0.102	0.292**	0.000
BSA (m²)	0.621**	0.000	.630**	0.000	0.665**	0.000	0.111	0.118	0.468**	0.000
LBM	0.584**	0.000	.621**	0.000	0.641**	0.000	0.136	0.55	0.460**	0.000
TSH (mU/l)	0.216**	0.000	0.263**	0.000	0.254**	0.000	-0.89	0.210	0.193**	0.007

**Correlation is significant at the 0.01 level (2-tailed).*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

In our study, the overall mean TGV for both genders was 7.6± 1.3 cm³. Similar studies have been conducted all over the world, of which some findings are smaller than our findings, such as the study conducted in Karachi population, the overall TGV was 6.26 ± 2.89 ml [13]. Yousef et al. [15] found the overall TGV to be 6.69 ± 2.56 ml in Sudanese population. In Cuba, the overall TGV was 6.6 ± 0.26 ml [8]. In Port Harcourt south-south Nigeria the overall TGV was 6.81 ± 2.18 cm³ [12]. In Saudi male's population, the TGV was 7.5 ml ± 2.4 [16]. Some studies highlighted higher values than ours, like the studies conducted among the Chinese was 7.7 ± 3.3 ml [17]. In Iranian population, Nafisi et al. [18] reported TGV to be 8.34 ± 2.37 ml. In north-east Nigeria, Ahidjoe et al. [11], reported that the overall TGV was 8.55 ± 1.82 cm³. Adibi et al. [19], in Isfahan reported that the overall TGV was 9.53 ± 3.68 ml. In Croatia, Ivanac et al. [20] found that TGV in female population to be 10.68 ± 2.83 ml. Seker and Tas [21] in turkey found TGV to be 13 ± 6.27 ml. In Copenhagen, Hegedus et al. [22] reported a mean TGV of 18.6± 4.5 ml.

According to the WHO, the TGV ranged from 7.7 to 25 cm^3 in men and from 4.4 to 18 cm^3 in women [7]. Thus, all of the above studies were within or close to the WHO values, however, from close observation, studies conducted in iodine deficient countries had larger TGV [21][22]. Consumption of oral iodine is the most important factor in regulation of thyroid volume and function [23], other factors include genetic, environmental and geographical factors [23]. Some physiological factors such as pregnancy, menstrual cycle affects the thyroid volume [24][25]. That was the reason we excluded them from the study.

The mean right and left thyroid lobes for both he genders were 4.1± 0.74 cm^3 and 3.6 ± 0.65 cm^3 respectively as shown in table 2. The right thyroid lobe was significantly higher than the left lobe (p=0.000) as seen in table 4 in both genders. The findings are in agreements with most previous studies [11][12][15][21][26][8][20][27][19][14]. It was hypothesized that the smaller size of the left thyroid lobe may be related to the position of the esophagus as it is commonly deviated to the left side thus the right thyroid lobe has more space for growth [28].

In the current study, TGV in males was significantly higher (7.8 ± 1.15 cm^3) than that of females (7.5 ±1.43 cm^3) with p=0.000 as seen in table 4. Majority of the previous studies reported similar findings [11][12][15][21][26][8][20][27][19][26]. The simple explanation could be due to different body habitus between males and females as the later tend to have larger body size than the former (increased body weight and muscle mass). However, other studies found no significant difference in male and female TGV [14][10][8][29]. Tangana et al. [14] hypothesized that, the dissimilarities in the studies could be due to factors such pregnancy and menstruation, that contribute to increasing thyroid volume in women were adjusted during the design stage of their studies.

Table 3 shows that the overall mean isthmus AP dimension was 2.9 ± 1.25 mm and the mean isthmus AP dimension among male and female were 3.1 ± 1.45 mm and 2.9 ± 1.01 mm respectively. The values were significantly higher for males than females (p=0.000) as seen in table 5. Majority of the previous studies did not consider isthmus dimension, however, Sekar and Tas [21] found a value that was closed to the current study as they reported 3.23 ± 1.10 mm as the overall AP dimension, male AP dimension had significantly higher dimension (3.42± 1.4 mm) than female (3.10± 1.05 mm) with (p=0.000) . Kamran et al. [13], also reported 3.7± 1.64 mm as the overall mean AP dimension and that male had significantly higher values than female (p=0.000). In the current study, the overall mean isthmus transverse dimension was 21.6 ± 3.11 mm and the mean isthmus transverse dimension for males and females were 22.0± 3.03 mm and 21.4± 3.12 mm respectively. The values were significantly higher for males than for females (p=0.000) as seen in table 5. Kamran et al. [13] found 15.6± 0.44 mm as the overall mean ISTD, with males values significantly higher than females (p=0.000), which is in line with our studies. The possible reasons for the smaller isthmus dimension in their study could be related to the smaller TGV (6.26 ± 2.89 ml) as compared to our values (7.6cm^3± 1.3) as the TGV correlates positively with isthmus dimensions. Sekar and Tas [21] suggested that the difference values for males and females are related to anthropometric measurements and anatomically larger organs size in males than females.

In the current study, a significant positive correlation was found with age and TGV among male (r= .666**; *p*=.000) and female participants (r= .549**; *p*=.000) respectively, as seen in table 6 and 7. Other studies reported similar findings [19][30][22][31][32][33]. The correlation of TGV with age could be due to lower iodine intake in higher age or tendency of lower serum TSH in advanced age [33]. Turcios et al. [8] findings were contrary to the current study. The possible reason could be due to their small number of sample size and most of the population were young adult women.

Table 6 and 7 demonstrated that height was significantly and positively correlated with male TGV (r= .448**; *p*=.000) and female TGV (r= .295**; *p*=.000) respectively. Other studies reported similar findings [13][30][33][19][34][20][22][35][36][16][37][38][8][21][14].Table 6 and 7 demonstrated that weight was significantly and positively correlated with male TGV (r= .699**; *p*=.000) and female TGV (r= .638**; *p*=.000) respectively. The findings are similar to the findings of previous studies [13][16][22][37][38][8]. However, they are contrary to findings of [20] as the study indicated no linear correlation between TGV and participant's ages. The possible reason could be due to uniformity of the study population been only female gender or because of their age ranged as the study included only those within the age range of 20 to 38 years.

Table 6 and 7 demonstrated that BMI was significantly and positively correlated with male TGV (r= .587**; *p*=.000) and female TGV (r= .357**; *p*=.000) respectively. The findings are in line with Turcios et al. [8] and Hegedus et al. [22] studies. However, Adibi et al. [19], found no correlation between TGV and BMI.
Thyroid volume could not be entirely explained by weight and height and BMI, 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 different geographic areas [19].

Table 6 and 7 demonstrated that TSH was significantly and positively correlated with male TGV (r= .372**; *p*=.000) and female TGV (r= .291**; *p*=.000) respectively. Our findings are in line with the study of Duran et al. [39], as they found (r = 0.435, p < 0.001). However, Adibi et al. [19] found no correlation between TGV and TSH. Progression of the thyroid cell cycle is dependent of TSH and insulin/insulin-like growth factor-1 (IGF-1) [40]. The main regulator of growth and differentiation of thyroid cells is TSH [41]. Thus there is a need for serum TSH levels evaluation prior to determination of thyroid volume.

Table 6 and 7 demonstrated that BSA was significantly and positively correlated with male TGV (r= .713**; *p*=.000) and female TGV (r= .665**; *p*=.000) respectively. Thus, BAS rather than other antropometric parameters was the key parameter for predicting thyroid volume in the study, which is in line with other studies, [8][36][22][20][37][14]. Our findings were in accordance with the WHO/ICCIDD report which indicated thyroid volume as a function of BSA.

Conclusion

A local reference thyroid gland volume among apparently healthy adult individuals was established and best predicted with increased BSA. The volume was higher in male than female gender. The right volume was higher than the left volume.

Recommendation

Similar studies should be replicated in each geological zones with 3D ultrasound machine especially in infants and adolescent. Thyroid function test should be performed prior to thyroid volume evaluation.

Acknowledgement

We like to acknowledge the effort of Dr. C. C. Ohagwuand Dr. Mansur Yahuza for their contribution from the beginning of work to the end. A special acknowledgment goes to all the staff of Radiography BUK/UNIZI and radiologist in Aminu Kano Teaching Hospital.

Conflict of interest

Nil.

Reference

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