

## Determinants of Thyroid Volume as Measured By Ultrasonography in Healthy Sudanese Population

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### Abstract:

*This study was carried out to describe the thyroid volume in Healthy Sudanese's subjects aged 6-18years by ultrasound and to correlate this volume with some anthropometric measures.*

**Methods:** *Sonographic studies of thyroid volume and anthropometric measures were recorded in a sample of 400 healthy subjects 186 boys and 214 girls aged 6–18 years, from four towns (Khartoum, Gedaref, Port Sudan, and Kassala), Sudan.*

**Results:** *The overall mean volume  $\pm$  SD of the thyroid gland in all the patients studied was  $4.66 \pm 1.23$ ml; it was higher in boys (4.73ml) than in girls (4.60ml), The mean volume of the right and left lobes were  $2.30 \pm 0.61$  mL and  $2.16 \pm 0.60$  mL, respectively. The mean of thyroid volume for Khartoum, Gedaref, Port Sudan, and Kassala population,  $5.73 \pm 0.60$ ml,  $4.45 \pm 1.15$ ,  $4.5 \pm 0.132$ ml,  $3.96 \pm 0.96$ ml, respectively. Thyroid volume was found to significantly correlate with weight and age.*

**Conclusions:** *The thyroid volume obtained in this study was in the lower range of the values reported in previous studies. The volume of the right lobe of the gland was greater than the left in both genders. The mean thyroid volume in the males is greater than that in the females, a local reference of thyroid volume for (Khartoum, Gedaref, Port Sudan, and Kassala) Sudan was established, and further studies are required to establish national references thyroid volume in Sudan.*

**Key words:** Thyroid volume, Ultrasound, Healthy, Sudanese

## **Introduction**

The thyroid is an important endocrine gland that plays a significant role in human development. Its size and shape vary widely in normal individuals. Several factors are involved in the growth of the thyroid gland, including dietary iodine intake, age, gender, smoking and some anthropometric measures such as weight, height, body mass index (BMI), waist-to-hip ratio (WHR), body fat (BF) and body surface area (BSA) <sup>1, 2</sup> . Evaluation of thyroid size is important in the diagnosis and management of thyroid disorders and iodine deficiency disorders. Thyroid size can be estimated manually, but this method is open to subjectivity and can be difficult especially for young children. Ultrasonography is a non-invasive method which provides a three-dimensional measurement of the thyroid gland and is currently the method of choice for evaluating thyroid size. Age-and sex-related normative data obtained from healthy individuals is a prerequisite for diagnosing thyroid enlargement (goiter) or thyroid hypoplasia. Furthermore, evaluation of cystic and solid lesions, three dimensions of each lobe, the thickness of the isthmus and echogenicity of the gland are all possible by ultrasonography.

Normative data of thyroid volumes showing variations with age, regional factors and iodine status of the population have been reported in different populations <sup>3-7</sup>. At present, only limited data are available for the Sudanese's population on thyroid volumes and no study to date included subjects from the 6 years period up to 18 years of age. In the present paper, we aimed to describe the thyroid volume in Healthy Sudanese's subjects aged 6-18years by ultrasound and to correlate this volume with some anthropometric measures.

## **Subjects and Methods**

### **Subjects**

Sonographic studies of thyroid volume and anthropometric measures were recorded in a sample of 400 healthy subjects 186 boys and 214 girls aged 6–18 years, from four towns (Khartoum, Gedaref, Port Sudan, and Kassala) Sudan, between June 2017 and June 2018.

### **Method**

Subjects were interviewed face-to-face by trained professionals using a structured questionnaire. A standardized questionnaire was used to collect data on demographic characteristics (age, gender, and place of residence), anthropometric parameters, and hormonal history, personal medical history, and family medical history in first-degree relatives.

The Ethics Committee of College of Medical Radiologic science, Sudan University of Science and Technology, Khartoum, Sudan, approved the study, Written informed consent was obtained from the parents of each subject. All subjects agreed and signed an informed consent form for participating in the study.

Thyroid volume measurement was estimated by 3D ultrasonography using a linear 7.5-MHz probe. During the ultrasound examination, subjects lay in a supine position with the neck hyperextended and the shoulders were supported by a pillow. All the ultrasound examinations were conducted and interpreted by the same experienced sonologist. The volume of one lobe of the thyroid was expressed in ml and estimated by the formula: volume of one lobe = length × depth × width ×  $\pi/6$ . The total thyroid volume was obtained by adding the volumes of both lobes, and isthmus.

Thyroid palpation was performed. Subjects having no known thyroid disease, surgery and chronic disease were included in the study, while those having a palpable thyroid

gland in the clinical examination and those showing nodules and/or heterogeneous parenchyma in thyroid ultrasonography were excluded.

### **Statistical Analyses**

Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS) program (Version 21.0; SPSS Inc., Chicago, IL, USA). The relationships of thyroid volume with age and body weight were evaluated using the Pearson's correlation test.

### **Results**

400 subjects (186 male, 214 female) were included in this study, Demographic and ultrasonographic data of the subjects for age groups are presented in Table 1. Thyroid volumes and the three dimensions of the right and left lobes and of the isthmus Table 2.

The correlations between thyroid volume and chronological age in Figure 1, between thyroid volume and body weight in Figure 2. Thyroid volume was found to positively correlate with weight and age.

The overall mean volume  $\pm$  SD of the thyroid gland in all the patients studied was  $4.66 \pm 1.23$ ml; it was higher in boys (4.73ml) than in girls (4.60ml), The mean volume of the right and left lobes were  $2.30 \pm 0.61$  mL and  $2.16 \pm 0.60$  mL, respectively. The mean of thyroid volume for Khartoum, Gedaref, Port Sudan, and Kassala population,  $5.73 \pm 0.60$ ml,  $4.45 \pm 1.15$ ,  $4.5 \pm 0.132$ ml,  $3.96 \pm 0.96$ ml, respectively. Thyroid volume was found to significantly correlate with weight and age.

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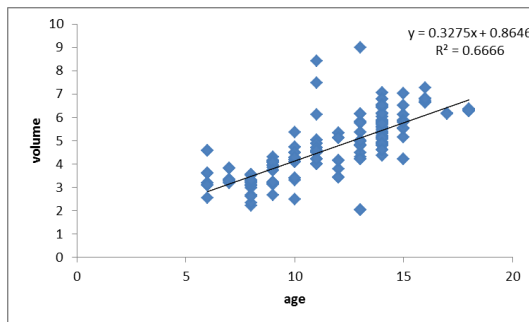
**Table 1: anthropometrics parameters of the subjects**

	N	Minimum	Maximum	Mean	Std. Deviation
Age	400	6.0	18.0	11.583	3.0687
Weight	400	12.0	110.0	41.364	21.2341
isthmus	400	.11	.40	.2289	.04121
Rt lobe size	400	1.00000	4.50000	2.30	.61
Lt Lobe size	400	.84000	4.20000	2.16	.60
Thyroid Volume	400	2.02	9.00	4.66	1.23

**Table 2: Correlations of Demographic and ultrasonographic data of the subjects**

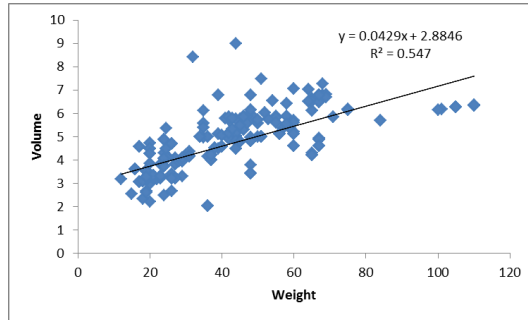
		Age	Weight	isthmus	Rt lobe size	Lt Lobe size	Thyroid Volume
Age	Pearson Correlation	1	.877**	.433**	.819**	.823**	.816**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	400	400	400	400	400	400
Weight	Pearson Correlation	.877**	1	.507**	.746**	.710**	.740**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	400	400	400	400	400	400
isthmus	Pearson Correlation	.433**	.507**	1	.471**	.461**	.495**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	400	400	400	400	400	400
Rt lobe size	Pearson Correlation	.819**	.746**	.471**	1	.916**	.952**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	400	400	400	400	400	400
Lt Lobe size	Pearson Correlation	.823**	.710**	.461**	.916**	1	.956**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	400	400	400	400	400	400
Thyroid Volume	Pearson Correlation	.816**	.740**	.495**	.952**	.956**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	400	400	400	400	400	400

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



**Figure 1. The scattered plot of Pearson’s correlation of thyroid volume against the subject’s age**

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**Figure 2. The scattered plot of Pearson’s correlation of thyroid volume against the subject’s weight**

**Table 3: Anthropometric parameters of the female subjects**

	N	Minimum	Maximum	Mean	Std. Deviation
Age	214	6.0	18.0	11.075	3.0449
Weight	214	12.0	105.0	38.379	18.7241
isthmus	214	.11	.35	.2263	.03968
Rt lobe size	214	1.00000	4.50	2.26	.65
Lt Lobe size	214	1.04000	4.20	2.12	.59
Thyroid Volume	214	2.20	9.000	4.60	1.24

**Table 4: Correlations of Demographic and ultrasonographic data of the subjects**

		Age	Weight	isthmus	Rt lobe size	Lt Lobe size	Thyroid Volume
Age	Pearson Correlation	1	.887**	.445**	.791**	.822**	.822**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	214	214	214	214	214	214
Weight	Pearson Correlation	.887**	1	.586**	.747**	.734**	.761**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	214	214	214	214	214	214
isthmus	Pearson Correlation	.445**	.586**	1	.487**	.486**	.516**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	214	214	214	214	214	214
Rt lobe size	Pearson Correlation	.791**	.747**	.487**	1	.925**	.981**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	214	214	214	214	214	214
Lt Lobe size	Pearson Correlation	.822**	.734**	.486**	.925**	1	.977**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	214	214	214	214	214	214
Thyroid Volume	Pearson Correlation	.822**	.761**	.516**	.981**	.977**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	214	214	214	214	214	214

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

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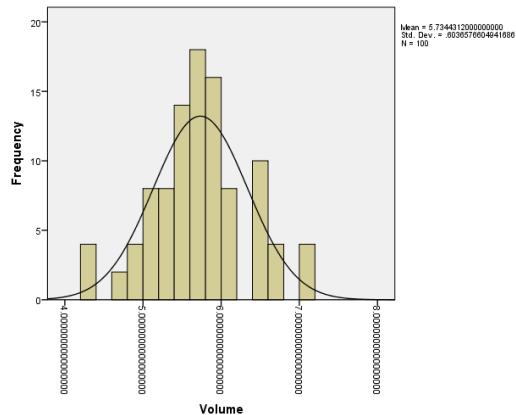
**Table5: Anthropometric parameters of the male subjects**

	N	Minimum	Maximum	Mean	Std. Deviation
Age	186	6.0	18.0	12.167	2.9989
Weight	186	15.0	110.0	44.798	23.3802
isthmus	186	.14	.40	.2318	.04282
Rt lobe size	186	1.17000	3.77000	2.3400262	.56148170
Lt Lobe size	186	.84000	3.61560	2.2006082	.61339182
Thyroid Volume	186	2.02	7.49	4.73	1.22

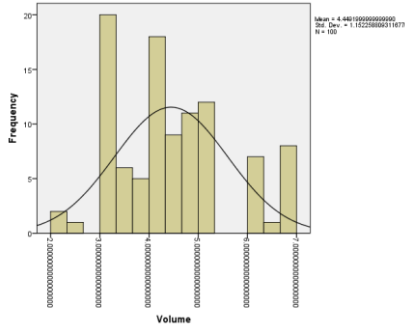
**Table6: Correlations of Demographic and ultrasonographic data of the subjects**

		Age	Weight	isthmus	Rt lobe size	Lt Lobe size	Thyroid Volume
Age	Pearson Correlation	1	.873**	.413**	.869**	.830**	.821**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	186	186	186	186	186	186
Weight	Pearson Correlation	.873**	1	.436**	.773**	.693**	.734**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	186	186	186	186	186	186
isthmus	Pearson Correlation	.413**	.436**	1	.453**	.431**	.470**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	186	186	186	186	186	186
Rt lobe size	Pearson Correlation	.869**	.773**	.453**	1	.914**	.918**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	186	186	186	186	186	186
Lt Lobe size	Pearson Correlation	.830**	.693**	.431**	.914**	1	.933**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	186	186	186	186	186	186
Thyroid Volume	Pearson Correlation	.821**	.734**	.470**	.918**	.933**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	186	186	186	186	186	186

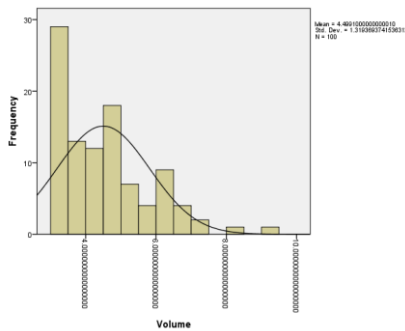
\*\* . Correlation is significant at the 0.01 level (2-tailed).



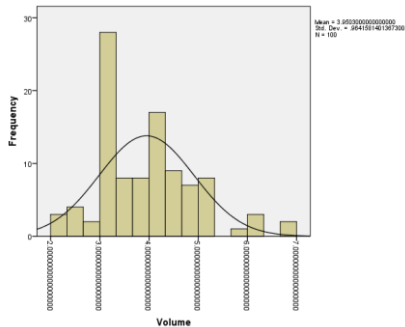
**Figure 3: The mean volume of the thyroid gland Khartoum**



**Figure 4: The mean volume of the thyroid gland of Gadaref**



**Figure 5: The mean volume of the thyroid gland of Port Sudan**



**Figure 6: The mean volume of the thyroid gland of Kassala**

## Discussion

The purpose of this study was to describe the thyroid volume in Healthy Sudanese's subjects aged 6-18years by ultrasound and to correlate this volume with some anthropometric measures.



Normative values of thyroid size have been studied previously throughout the world <sup>8,9</sup>. These data showed a wide range of differences among their results, most likely due to regional and ethnic factors as well as to the iodine status of the population. Zimmermann et al <sup>10</sup> reported reference values for thyroid volume by ultrasound in iodine-sufficient schoolchildren from various nationalities, re-emphasizing the importance of establishing local data for each country. Furthermore, regional differences in thyroid size even in the same country have been reported both from Italy and Turkey for the adult population <sup>11-13</sup>. Thus, it is obvious that normative data on thyroid size needs to be updated. The current study provides reference data on thyroid volume in Sudanese's population and aged from 6 to 18 years.

The overall mean thyroid gland volume combined for both lobes and sexes obtained from this study was 4.66 mL. There was no previous local study for comparison to the best of our knowledge. But in Africa, Anele <sup>14</sup> studied the thyroid gland volume among Nigerians. This value showed the thyroid dimensions to be slightly lower than the Western values <sup>14,16</sup>. This study has shown that the right thyroid lobe volume (2.30mL) was greater than the left (2.16mL) with the significant statistical difference between the right and the left lobe volumes in both sexes. This finding is in agreement with previous studies done among the Caucasians and the Chinese <sup>17</sup>.

The total mean values for the females (4.60mL) and the males (4.73mL) have shown the thyroid gland to be greater in males compared to females. Anele <sup>14</sup> found no significant difference in the thyroid volume between males and females. This finding differs from our study and most of the previous studies <sup>18</sup>.

These findings indicate that there is a need for renewal of thyroid normative data also in the coming years in Sudan. The current study also confirmed this finding in subjects

younger than 18 years. In an iodine-sufficient population, an age-related increase in thyroid gland volume for both sexes was reported in healthy adults <sup>19</sup>. In addition, Gomez et al <sup>20</sup> showed that body surface area accounts for much of the variation of thyroid volume and that male had higher volumes than females.

To our knowledge, this is the first study reporting normative data on thyroid volume covering a wide age range in Sudan. Although the data are based on a population residing in limited regions of the country, Khartoum is the largest city of the country with a high immigration rate from all over the country. Thus, we believe that our data can serve as a reference for other regions of the country where regional data are not available. On the other hand, we realize that sample size is a limitation of the current study and we believe that there is a need for future studies on larger samples. The thyroid volume obtained in this study was in the lower range of the values reported in previous studies (Table 7).

**Table 7: Comparison of thyroid volume studies.**

Author	Gender	Age range (years)	Number of subjects	Thyroid volume (mL) ± SD	Country
Current study	186 M 214 F	6-18	400	4.66± 1.23ml	Sudan
Yousef et al <sup>21</sup>	75 M 28 F	19–29	103	6.44 ± 2.44	Sudan
Khojaly et al <sup>22</sup>	50 M 50 F	6-18	100	5.03± 0.92 mL	Sudan
Ivanac et al. <sup>23</sup>		20–38	51	10.68 ± 2.83	Croatia
Ahidjo et al <sup>24</sup>	71 M 72 F	23–69	143	8.55 ± 1.82	Nigeria

In conclusion, in view of a need to evaluate thyroid size in comparison with normative data obtained from age-matched subjects from the same population for the diagnosis of either goiter or hypoplasia/dysgenesis. The thyroid volume obtained in this study was in the lower range of the values reported in previous studies. The volume of the right lobe of the gland was

greater than the left in both genders. The mean thyroid volume in the males is greater than that in the females, a local reference of thyroid volume was established, and further studies are required to establish national references thyroid volume in Sudan.

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