Measurements of Normal Thyroid Gland in Sudanese using ultrasonography

A thesis submitted for partial fulfillment of the requirements of M.Sc degree in medical diagnostic ultrasound

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الآية

بسم الله الرحمن الرحيم

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الإسراء: 85
Dedication

Every challenging work needs self-efforts as well as guidance of elders especially those who were very close to our heart.

My humble effort I dedicate to my sweet and loving

Father & mother

Whose affection, love, encouragement and prays of day and night makes me able to get such success and honor

Along with all hard working and respected teachers
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First of all the praises and thanks to Allah the lord of the "Alamin-mankind, jinn's and all that exists.

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Abstract
This is descriptive cross sectional study carried out in Khartoum state, Sudan in different ultrasound departments of Khartoum hospitals and medical diagnostic centers; Bashaier teaching hospital, police center Khartoum north and dr. Arafat ultrasound clinic during the period from July to December 2016. The aims of the study to measure the thyroid volume in normal adult Sudanese people, to correlate effect of residence on the thyroid volume and correlate the volume with gender, age, weight, and height using ultrasound. This study used the international protocol in the work of ultrasound measurements of thyroid volume. The data collected by using data sheet collection in 100 volunteers, not suffering from any thyroid abnormality functionally or morphologically. The data sheet was analyzed by used Statistical Packaged for Social Sciences program (SPSS) and then detected relationships between different variables. The study found that distribution of participants age was high among the age group 18-30 years which represented 61 subjects (61.%). The study also found overall mean volume of the thyroid gland for both lobes in all the subjects studied was11.3cc± 3.8, this value was found agree with mean thyroid volume international standard record (14.93 to 8.46ml). The volume for each thyroid lobe individually in the same volunteer showed that the right lobe measure larger than the left lobe in most of volunteers, the mean volume for the right and left lobes were 6.2cc±2.1 and 5.2cc±1.8 respectively. The mean volume for male and female was = 13.4cc± 3.9 and 8.9cc ±2.4, respectively, that means the volume for male in this study larger than female. There is strong correlation between thyroid volume and the height of individual in both lobes and gender. The study concluded that ultrasound is an excellent imaging modality for measuring the thyroid volume. The study recommended that further studies should be encouraged in order to establish more national reference in thyroid gland measurement using ultrasonography to reduce the percentage of incorrect results.
ملخص الدراسة

هذه دراسة مقطوعية وصفية أجريت في السودان ولاية الخرطوم باقسام الموجات فوق الصوتية بمستشفى بشائر الجامعي. وعيادة دكتور عرفات للموجات فوق الصوتية ومستشفى الشرطة من الفترة من يوليو 2016م إلى ديسمبر 2016م. وكان الهدف من هذه الدراسة قياس حجم الغدة الدرقية وسط السودانيين ومعرفة مدى العلاقة بين الحجم والنوع والعمروالطول ونسبة كثة الجسم باستخدام الموجات فوق الصوتية وأيضا معرفة تأثير التوزيع الجغرافي والتباين العرقي على حجم الغدة الدرقية. استخدمت هذه الدراسة البروتوكول العالمي في عمل الموجات فوق الصوتية لقياس حجم الغدة الدرقية. وقد تم جمع البيانات باستخدام ورقة جمع البيانات لعدد 100 متـطوع وكان أعلى معدل اعصار بين المشاركين في الفئة العمرية من 18 إلى 30 سنة التي تمثل 61 شخص بنسبة 61% ولا يعانون من أي عيوب وظيفية أو خلقية في الغدة الدرقية. ثم حلت بعد ذلك نتائج البيانات باستخدام برنامج الحزم الإحصائية للعلوم الإنسانية في التحليل الإحصائي ومن ثم إيجاد العلاقات بين المتغيرات المختلفة. وجدت الدراسة ان متوسط حجم الغدة الدرقية هو 3.8±3.3 مل، وكانت هذه القيمة تتوافق مع سجل المقارنات العالمية (9.14 إلى 8.46 مل) ووجدت الدراسة أن حجم الفص الأيمن أكبر من حجم الفص الأيسر في معظم المتطوعين. وكان متوسط الحجم للرجال أكبر من متوسط الحجم للنساء 3.9±2.4 مل. كذلك وجدت الدراسة أن هناك ارتباط معترف ماببين حجم الغدة الدرقية وكل من الطول ونسبة كثة الجسم لكل الجنسين. واختتمت الدراسة بالقول ان الموجات فوق الصوتية تقنية تصوير ممتازة لعمل قياسات الغدة الدرقية. كما أوصت الدراسة بتشجيع البحوث المهتمة بقياسات الغدة بإستخدام الموجات فوق الصوتية وذلك بغرض زيادة القياسات المرجعية وذلك لتقليل نسبة النتائج غير صحيحة.
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table no</th>
<th>Table name</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4.1)</td>
<td>Gender distribution</td>
<td>25</td>
</tr>
<tr>
<td>(4.2)</td>
<td>Residence distribution</td>
<td>26</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES AND GRAPHS

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Figure name</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2-1)</td>
<td>Thyroid gland anatomy</td>
<td>5</td>
</tr>
<tr>
<td>(2-2)</td>
<td>Relationships of thyroid gland</td>
<td>6</td>
</tr>
<tr>
<td>(2-3)</td>
<td>Regulation of thyroid hormones secretion</td>
<td>10</td>
</tr>
<tr>
<td>(2-4)</td>
<td>Thyroid US. The position of the patient</td>
<td>11</td>
</tr>
<tr>
<td>(2-5)</td>
<td>Transverse gray scale ultrasound of the normal thyroid gland.</td>
<td>13</td>
</tr>
<tr>
<td>(2-6)</td>
<td>Longitudinal gray scale ultrasound of the normal thyroid gland</td>
<td>13</td>
</tr>
<tr>
<td>(2-7)</td>
<td>Transverse gray scale ultrasound of the left lobe of thyroid.</td>
<td>14</td>
</tr>
<tr>
<td>(2-8)</td>
<td>Transverse gray scale ultrasound of the midportion of the right lobe of thyroid</td>
<td>14</td>
</tr>
<tr>
<td>(2-9)</td>
<td>Transverse gray scale ultrasound of the right lower neck.</td>
<td>15</td>
</tr>
<tr>
<td>(2-10)</td>
<td>Transverse gray scale ultrasound of the right carotid space.</td>
<td>15</td>
</tr>
<tr>
<td>(2-11)</td>
<td>Thyroid US. Basic scanning planes (1) transverse.</td>
<td>17</td>
</tr>
<tr>
<td>(2-12)</td>
<td>Thyroid US. Basic scanning planes (2) longitudinal</td>
<td>17</td>
</tr>
<tr>
<td>(2-13)</td>
<td>Thyroid US. Basic scanning planes (3) oblique.</td>
<td>17</td>
</tr>
<tr>
<td>(2-14)</td>
<td>Thyroid US. Measurements of the widths, the depths, and the lengths of thyroid lobes, as well as the thickness of the isthmus</td>
<td>18</td>
</tr>
<tr>
<td>(4.1)</td>
<td>scattered plots illustrate the relation between the age and thyroid volume</td>
<td>27</td>
</tr>
<tr>
<td>(4.2)</td>
<td>scattered plots illustrate the relation between the weight and thyroid volume</td>
<td>28</td>
</tr>
<tr>
<td>(4.3)</td>
<td>scattered plots illustrate the relation between the height and thyroid volume</td>
<td>29</td>
</tr>
<tr>
<td>(4.4)</td>
<td>scattered plots illustrate the relation between the body mass index and thyroid volume</td>
<td>30</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------</td>
<td></td>
</tr>
<tr>
<td>CNS</td>
<td>Central Nervous System</td>
<td></td>
</tr>
<tr>
<td>GH</td>
<td>Growth Hormone</td>
<td></td>
</tr>
<tr>
<td>LLV</td>
<td>Left lobe volume</td>
<td></td>
</tr>
<tr>
<td>MNG</td>
<td>Multinodular Goiter</td>
<td></td>
</tr>
<tr>
<td>RLV</td>
<td>Right lobe volume</td>
<td></td>
</tr>
<tr>
<td>$T_3$</td>
<td>Triiodothyronine</td>
<td></td>
</tr>
<tr>
<td>$T_4$</td>
<td>Thyroxin</td>
<td></td>
</tr>
<tr>
<td>TIRADS</td>
<td>Thyroid Imaging Reporting and Data System</td>
<td></td>
</tr>
<tr>
<td>TSH</td>
<td>Thyroid Stimulating Hormone</td>
<td></td>
</tr>
<tr>
<td>TTV</td>
<td>Total thyroid Volume</td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>page NO</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>والاية</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Dedication</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>III</td>
<td></td>
</tr>
<tr>
<td>Abstract (English)</td>
<td>IV</td>
<td></td>
</tr>
<tr>
<td>Abstract (Arabic)</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>List of tables</td>
<td>VI</td>
<td></td>
</tr>
<tr>
<td>List of figures</td>
<td>VII</td>
<td></td>
</tr>
<tr>
<td>List of abbreviation</td>
<td>VIII</td>
<td></td>
</tr>
<tr>
<td>List of contents</td>
<td>XI</td>
<td></td>
</tr>
<tr>
<td><strong>CHAPTER ONE: INTRODUCTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1. Introduction</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1.2. The problem of study</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1.3 objectives</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>CHAPTER TWO: LITERATURE REVIEW</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1. Anatomy of the thyroid glands</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>2.2 Thyroid gland physiology</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2.3 Ultrasound Technique of Thyroid Gland</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2.5. Background studies</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>CHAPTER THREE: METHODOLOGY</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-1. Study design</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-2. Study area</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-3. Duration of study</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-4. Population of study</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-5. Sampling and sample size</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-6. Inclusion criteria</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-7. Exclusion criteria</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3-8. Study variable</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3.9 Method of Data collection</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>3.10. Data analysis</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>3.11 Data presentation</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>3.12 Data storage</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>3.13 Expenses</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>3.14 Ethical consideration</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>3.15 Materials and methods</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>CHAPTER FOUR: THE RESULTS</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>4.1. Results</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 Discussion</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>5.2 Conclusion</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>5.3 Recommendations</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Ultrasound images</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter One
Chapter one

1-1 Introduction

Ultrasound has become one of the primary imaging modalities for the assessment of the major glands of internal secretion within the cervical region. The thyroid gland is among the most commonly imaged glands using ultrasound due to the limitation of clinical examination. Thyroid is one of largest endocrine gland in the body, it control how quickly the body burns energy and make protein and how sensitive the body should be to other hormone. Thyroid ultrasonography is non-invasive diagnostic exam which provide immediate information in the structure and the characteristics of gland. Ultrasonography is one of well excepted and sensitive imaging modality for diagnosis and follow up thyroid disorder. (1)

The advantage of the using ultrasound imaging it is mobility and low cost as well as ability to measure the dimension of the gland, check for the presence of masses or cyst and evaluate the structure and echogenicity of the parenchyma. There for thyroid ultrasound examination provides and objective and precise method for detection of change in the size of the nodule, evaluation of feature which include hypoechoic or hyperechoic and composition, cystic, solid or mixed as well as presence or absence of coarse or a halo and irregular margins. Ultrasound of thyroid must be done early to discover the abnormality if present and look for suitable solution also its accurate modality for detecting thyroid gland abnormality. (2)

The possibility of obtaining an estimate of the thyroid gland volume is generally considered to be an important in several pathologic situations such as thyroiditis and multinodular goiter, thyroid ultrasound was initially thought to be the essential imaging test for the thyroid gland providing clinically important information of
benign and malignant conditions, focal masses or diffuse masses, single or multiple cystic or solid masses, thyroid measurement is the primary physical signs and symptoms which explain if the thyroid normal or abnormal, the sonographers ability to recognize anatomical structures within the neck is extremely useful in identifying thyroid structure and to understand the anatomic variation of the thyroid lobes and their measurement, the sonographer must be able to identify the thyroid anatomy correctly on the ultrasound image. (3)
1.2 Problem of study:
The little numbers of our national reference in thyroid gland measurements using ultrasonography because most available measurement came from other nationalities published in references are different in Sudanese.

1.3 General objective:
In order to measure normal thyroid gland in Sudanese.

1.4 Specific objectives:
- To measure thyroid gland volume (right lobe, left lobe) and isthmus.
- To correlate size of thyroid gland with body characteristics (age, gender, height and weight).
- To find dynamic equation to calculate measurement of thyroid using body characteristics.
- To correlate the effect of residence on the thyroid volume.

1.5 Important of the study:
The important of this study is to find an average measurement of the thyroid gland in Sudanese and to correlate volume with body mass index.
Chapter Two
Chapter two

Literature review and background studies

2.1 Anatomy of the thyroid glands:

The thyroid gland begins to develop during the third week as an endodermal thickening in the midline of the floor of the pharynx. Later, this thickening becomes a diverticulum that grows inferiorly into the underlying mesenchyme and is called the thyroglossal duct. Then the duct elongates, and its distal end becomes bilobed. Finally, the duct becomes a solid cord of cells, and as a result of epithelial proliferation, the bilobed terminal swellings expand to form the thyroid gland. The thyroid gland now migrates inferiorly in the neck, and by the seventh week, it reaches its final position in relation to the larynx and trachea.\(^{(4)}\)

The thyroid gland is made up of two lobes located along either side of the trachea and connected across the midline by the isthmus. Each lobe is pear shaped, with its apex being directed upward as far as the oblique line on the lamina of the thyroid cartilage; its base lies below at the level of the fourth or fifth tracheal ring.\(^{(4)}\)
2.1.1 Relation of the lobe:

2.1.1.1 Anterolateral:
The sternothyroid, the superior belly of the omohyoid, the sternohyoid, and the anterior border of the sternocleidomastoid.\(^4\)

2.1.1.2 Posterolaterally:
The carotid sheath with the common carotid artery, the internal jugular vein, and the vagus nerve.\(^4\)
2.1.1.3 Medially:
The larynx, the trachea, the pharynx, and the esophagus. Associated with these structures are the cricothyroid muscle and its nerve supply, the external laryngeal nerve. In the groove between the esophagus and the trachea is the recurrent laryngeal nerve.\(^\text{(4)}\)

The rounded posterior border of each lobe is related posteriorly to the superior and inferior parathyroid glands and the anastomosis between the superior and inferior thyroid arteries.\(^\text{(4)}\)

2.1.2 Relations of the isthmus:

2.1.2.1 Anteriorly:
The sternothyroids, sternohyoids, anterior jugular veins, fascia, and skin.\(^\text{(4)}\)

2.1.2.2 Posteriorly:
The second, third, and fourth rings of the trachea. The terminal branches of the superior thyroid arteries anastomose along its upper border.\(^\text{(4)}\)

Fig2.2 Relationships of thyroid gland\(^\text{(4)}\)
2.1.3 Blood supply:

2.1.3.1 The arteries:

1- Superior thyroid artery
Is branch of the external carotid artery, descends to the upper pole of each lobe, accompanied by the external laryngeal nerve. (4)

2- Inferior thyroid artery
Is branch of the thyrocervical trunk, ascends behind the gland to the level of the cricoid cartilage. (4).

3- Thyroid ima artery
If present, may arise from the brachiocephalic artery or the arch of the aorta. It ascends in front of the trachea to the isthmus. (4)

2.1.3.2 The veins:

1- Superior and middle thyroid veins
Drains into the internal jugular vein (4)

2- The inferior thyroid veins
The two sides anastomose with one another as they descend in front of the trachea. They drain into the left brachiocephalic vein in the thorax (4)

2.1.4 Lymph drainage:
The lymph from the thyroid gland drains mainly laterally into the deep cervical lymph nodes. A few lymph vessels descend to the Para tracheal nodes. (4)

2.1.5 Nerve supply
Superior, middle, and inferior cervical sympathetic ganglia. (4)
**2.2 physiology of Thyroid gland:**

The major thyroid secretory cells, known as follicular cells, are arranged into hollow spheres, each of which forms a functional unit called a follicle. The follicular cells produce two iodine-containing hormones derived from the amino acid tyrosine: tetra iodothyronine (T4, or thyroxine) and triiodothyronine (T3). These two hormones, collectively referred to as thyroid hormone, are important regulators of overall basal metabolic rate. Interspersed in the interstitial spaces between the follicles is another secretory cell type, the C cells, which secrete the peptide hormone calcitonin. Calcitonin plays a role in calcium metabolism and is not related to T4 and T3.\(^5\)

**2.2.1 Thyroid hormone is the main determinant of the basal metabolic rate and exerts other effect:**

All body cells are affected either directly or indirectly by thyroid hormone. The effects of T3 and T4 can be grouped into several overlapping categories:

**2.2.1.1 Effect on Metabolic Rate and Heat Production**

Thyroid hormone increases the body’s overall basal metabolic rate (BMR), or “idling speed”. It is the most important regulator of the body’s rate of O2 consumption and energy expenditure under resting conditions.

Closely related to thyroid hormones overall metabolic effect is its cardiogenic effect (calorogenic means “heatproducing”). Increased metabolic activity results in increased heat production.\(^5\)

**2.2.1.2 Sympathomimetic effect:**
Any action similar to one produced by the sympathetic nervous system is known as a Sympathomimetic effect (Sympathomimetic means “sympathetic mimicking”). Thyroid hormone increases target-cell responsiveness to catecholamine’s (epinephrine and norepinephrine), the chemical messengers used by the sympathetic nervous system and its hormonal reinforcements from the adrenal medulla. Thyroid hormone accomplishes this permissive action by causing a proliferation of catecholamine target-cell receptors. Because of this action, many of the effects observed when thyroid hormone secretion is elevated are similar to those that accompany activation of the sympathetic nervous system.\(^5\)

**2.2.1.3 Effect on the Cardiovascular System:**

Through its effect of increasing the heart’s responsiveness to catecholamine’s, thyroid hormone increases heart rate and force of contraction, thus increasing cardiac output.\(^5\)

**2.2.1.4 Effect on Growth and the Nervous System:**

Thyroid hormone is essential for normal growth because of its effects on GH and IGF. Thyroid hormone not only stimulates GH secretion and increases production of IGF by the liver but also promotes the effects of GH and IGF on the synthesis of new structural proteins and on skeletal growth. Thyroid-deficient children have stunted growth that can be reversed by thyroid replacement therapy. Unlike excess GH, however, excess thyroid hormone does not produce excessive growth. Thyroid hormone plays a crucial role in the normal development of the nervous system, especially the CNS, an effect impeded in children who have thyroid deficiency from birth. Thyroid hormone is also essential for normal CNS activity in adults.\(^5\)
2.2.2 Thyroid hormone is regulated by the hypothalamus pituitary thyroid axis:

Thyroid-stimulating hormone (TSH), the thyroid tropic hormone from the anterior pituitary, is the most important physiologic regulator of thyroid hormone secretion. Almost every step of thyroid hormone synthesis and release is stimulated by TSH. In addition to enhancing thyroid hormone secretion, TSH maintains the structural integrity of the thyroid gland. In the absence of TSH, the thyroid atrophies (decreases in size) and secretes its hormones at a very low rate. Conversely, it undergoes hypertrophy (increases the size of each follicular cell) and hyperplasia (increases the number of follicular cells) in response to excess TSH stimulation.

The hypothalamic thyrotropin-releasing hormone (TRH), in tropic fashion, “turns on” TSH secretion by the anterior pituitary, whereas thyroid hormone, in negative-feedback fashion, “turns off” TSH secretion by inhibiting the anterior pituitary and hypothalamus. Like other negative-feedback loops, the one between thyroid hormone and TSH tends to maintain a stable thyroid hormone output. (5)
2.3 Ultrasound Technique of Thyroid Gland:

2.3.1 Preparation:

Special preparation of the patient for thyroid US is not required. (7)

2.3.2 Position:

The patient is positioned supine, with the head thrown back and a bolster under the shoulders. Seriously ill patients may sometimes be examined in a sitting position with the head thrown back.
2.3.3 Probe:

Thyroid US is performed using a linear probe with a frequency of 5–17 MHz (most often 7.5–12 MHz). A 3.5–5 MHz convex probe is sometimes more convenient for measurements of large thyroids. A sector probe with a frequency of 2.5–5 MHz may be required for the sub sternal thyroid. (7)

2.3.4 Method of scanning:

Thyroid gland scanned in sagittal, transverse and oblique planes for both right and left lobes with probe positioned on the front surface of the neck and moved from the breastbone to hyoid bone, in order to optimally visualized the both thyroid lobes as well as the isthmus, common carotid artery and internal jugular vein. (8)

2.3.5 Sonographic Appearance:

The thyroid gland is homogeneously fine textured with medium to high levels of echogenicity. The echogenicity is usually greater than the normal neck muscles. The capsule is the hyperechoic line that forms the margins of the gland. It should be smooth and well defined. On transverse section, a normal gland has a concave
(or straight) anterior border, indented by the sternothyroid muscle. Longitudinal section through a normal gland also demonstrates a flat or minimally bulged anterior border. The superior thyroid artery and vein are located at the upper pole of each lobe. The inferior thyroid vein is located at the lower pole of each lobe. The inferior thyroid artery is located posterior to the lower third of each lobe. “These arteries (1-2 mm diameter) and their accompanying veins (6-8 mm diameter) course between the thyroid lobes and the longuscoli muscles."

Fig 2.5 Transverse grayscale ultrasound of the normal thyroid gland.
Note the isthmus (1), right and left lobes (2), strap muscles (3), sternocleidomastoid muscles (4), esophagus (5), longus coli muscles (6), and the common carotid arteries (7), trachea (8). The normal thyroid parenchymal echoes are fine, homogeneous, and hyperechoic.
Fig 2.6 Longitudinal gray scale ultrasound of the normal thyroid gland (white arrows). Note the normal homogeneous, fine, hyper echogenicity of the thyroid parenchyma. (9)

Fig 2.7 Transverse gray scale ultrasound of the left lobe of thyroid. (9)
Note the isthmus (1), trachea (2), left lobe (3), esophagus (4), left longus colli muscle (5), left common carotid artery (6), left internal jugular vein (7), left strap muscles (8), and sternocleidomastoid muscle (9).
Fig 2.8 Transverse gray scale ultrasound of the midportion of the right lobe of thyroid. Note the right sternohyoid muscle (1), sternothyroid muscle (2), sternocleidomastoid muscle (3), longus colli muscle (4), and scalenus anterior muscle (5).

Fig 2.9 Transverse gray scale ultrasound of the right lower neck. Note the right sternocleidomastoid muscle (1), strap muscles (2) omohyoid muscle (3), common carotid artery (4), and scalenus anterior muscle (5).
Note the vagus nerve (1) posterior to and between the common carotid artery (2) and internal jugular vein (3). On transverse scans, the vagus nerve is seen as a small echogenic structure with central hyper echogenicity.\(^9\)

**2.3.6 Measurement:**

The size and shape of the thyroid gland vary with gender, age, and body surface area, with females having a slightly larger gland than males. In tall individuals, the lateral lobes of the thyroid have a longitudinally elongated shape on sagittal scans, whereas in shorter individuals, the gland is more oval. As a result, the normal dimensions of the gland have a wide range of variability.\(^{10}\) Size assessment is based on the linear dimensions and the volumes of the lobes. It is important to measure the linear dimensions only in the transverse or longitudinal sections of the thyroid lobes that show the maximum value.\(^{10}\)

The longitudinal lobe dimension (the length or height of the lobes) is the largest size of the lobe. It is actually obtained in the plane that deviates from the anatomical longitudinal plane of the neck. In the newborn, the gland measures 18
to 20 mm long, with an antero-posterior (AP) diameter of 8 to 9 mm. By age 1, the mean length is 25 mm and the AP diameter is 12 to 15 mm. The normal adult thyroid measures 40 to 60 mm in length, 13 to 18 mm in AP diameter. The gland is considered enlarged when the AP diameter measures greater than 20 mm. The isthmus is the smallest part of the gland with an AP diameter of 2 to 6 mm. Among the linear parameters, the AP diameter is the most precise because it is relatively independent of possible dimensional asymmetry between the two lobes.

Volumes are calculated using the standard formula for an ellipse (length x width x thickness x 0.529).
Fig 2.13 Thyroid US. Basic scanning planes (3) oblique. (10)
Fig 2.14 Thyroid US. Measurements of the widths, the depths, and the lengths of thyroid lobes, as well as the thickness of the isthmus.\(^{(10)}\)

2.4 **Background studies:**

**Study1** In study done by Mohamed, Abdelmoneim Suleiman, Bushra Ahmed, Alsafi Abdella, and Khaled Eltom under title Local Reference Ranges of Thyroid Volume in Sudanese Normal Subjects Using Ultrasound, in Journal of Thyroid Research, July 2011. A total of 103 subjects studied consist of 28 (27.18%) females and 75 (72.82%) males. The mean age of the subjects was 21.79 years with a range of 19–29 years. The volume was calculated by using ellipsoid model, the height, the width, and the depth of each lobe are measured and multiplied. The obtained result was then multiplied by a correction factor, which is \(\pi/6\) or 0.524. The overall mean volume of the thyroid gland for both lobes in all the subjects studied was 6.44 ± 2.44. The mean volume for both lobes in females and males was 5.78ml ± 2 (1.96) and 6.69ml ± 2.56, respectively. The mean volume of the right and left lobes of the thyroid gland in all subjects studied were 3.38ml ± 2 (1.37) and 3.09ml ± 2 (1.24), respectively. The right thyroid lobe volume was greater than the left. The mean thyroid volume of the right lobe among the females
studied was 3.03mL, and the left was 2.75mL. The values were greater for the right than the left lobe. In males, the right and the left lobes of the thyroid gland volumes were 3.51mL and 3.21mL, respectively. The values were greater for the right than the left lobe and more than that of the females. In conclusion, 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 sexes. The mean thyroid volume in the males is greater than that in the females. (11)

**Study2** In study done by A Ahidjo, A Tahir, M Tukur. Under title *Determination Of Thyroid Gland Volume Among Adult Nigerians.* In The Internet Journal of Radiology. 2005. study examined one hundred and forty-three subjects were studied consisting of 72 (50.30%) females and 71 (49.70%) males, with mean age of the subjects was 38.60 13.10 years. The thyroid gland volume was calculated using the formula (volume= length x width x thickness x 0.479 (correction factor). The overall mean volume of the thyroid gland for both lobes in all the patients studied was 8.55cm$^3$ ±1.82. The mean volume for both lobes in females and males were 7.58cm$^3$ and 9.72cm$^3$ respectively. The mean volume of the right and left lobes of the thyroid gland in all the patients studied were 4.48cm$^3$ and 4.07cm$^3$ respectively. The right thyroid lobe volume was higher than the left (p = 0.000). The mean thyroid volume of the right lobe among the females studied was 4.04cm$^3$ and the left was 3.54cm$^3$. The values were higher for the right than the left lobe (p = 0.000). In males, the right and left lobes of the thyroid gland volumes were 5.12cm$^3$ and 4.60cm$^3$ respectively. The values were higher for the right than the left lobe (p = 0.000) and more than that of the females (p=0.000). In conclusion, 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 sexes. The mean thyroid volume in the males is greater than that in the females.\(^{(12)}\)

**Study 3** in study done by Namik Kemal, and Gaziantep, under title Regional Reference Values of Thyroid Gland Volume in Turkish Adults, in pub med.gov. Mar/Apr 2015. 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±9.97 years. The thyroid gland volume was calculated using the formula: 

\[
T_{\text{vol lobe}} = \text{AP diameter} \times \text{ML diameter} \times \text{CC diameter} \times 0.479 \text{ (conversion factor); (AP diameter – depth; ML diameter – width; CC diameter – length).}
\]

The overall mean thyroid volume in all patients who were examined was 12.98±2.53mL. The mean thyroid volume in females and males was 12.09±2.05mL and 14.53±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).\(^{(13)}\)

**Study 4** In study done by Mahrulk Kamran, Nuzhat Hussan, Mohammad Ali, Farah Ahmad, Farheen Raza, Nosheen Zehra, Sanobar Bughio. Under title Correlation of Thyroid Gland Volume with Age and Gender in a Subset of Karachi Population Pakistan Journal of Medicine and Dentistry, 2014. study employing 421volunteers aged 21 years and above went through the ultrasound (US) examination of their thyroid gland (TG) after being confirmed euthyroid by their serum thyroid stimulating hormones (TSH) evaluation. Anteroposterior, craniocaudal and mediolateral diameter of each lobe of thyroid was calculated. Volume of each lobe of thyroid was then calculated by WHO recommended formula: 

\[
Anteroposterior \times \text{Craniocaudally} \times \text{Mediolateral} \times 0.479.
\]

Total TGV was taken by summing up the volume of both lobes. Transverse dimension and anteroposterior dimension of isthmus were also noted. Participants were divided
into 5 age groups with a 10 year difference starting at 21. TGV in the study was found to be $6.26 \pm 2.89$ ml. Males had significantly higher TGV $6.78 \pm 2.88$ ml as compared to females $5.7 \pm 2.79$ ml ($P=0.00$). Volume of right lobe was significantly greater than that of left lobe ($P=0.00$) in both the genders. TGV increased significantly with age till 60 years ($P<0.05$) and after the age of 60 years it decreased ($P=0.035$).

The study concluded that Mean volume of thyroid gland in this studied population is not only smaller than that of the Western countries but is also much smaller than the neighboring country Iran. The study has also proved that there was a significant decrease in mean thyroid gland volume after the age of 60 years.\(^{(14)}\)
Chapter Three
Chapter three: Methodology

3.1 Study design:
Descriptive cross sectional study deal with adult Sudanese who have normal thyroid gland.

3.2 Study area:
The study was conducted in Khartoum state; in following diagnostic ultrasound centers; Bashair teaching hospital, Altamaioz teaching hospital, Dr. Arafat ultrasound clinic and Police hospital (Khartoum north).

3.3 Duration of study:
The study is carried out during the period from July to December 2016.

3.4 Population of study:
All adult Sudanese people have no thyroid symptoms.

3.5 Sampling and sample size:
Study sample were 100 adult Sudanese with normal thyroid gland were selected by using simple random sampling technique.

3.5 Inclusion criteria:
Study was included every adult Sudanese with normal thyroid gland

3.6 Exclusion criteria:
The study were excluded children, every adult Sudanese which use drug that may interfere with thyroid gland, any one that known had thyroid abnormality and pregnant women.

3.7 Study variables:
Age, gender, height, weight, gland length, gland width and gland AP diameter

3.8 Method of Data collection:
Data was collected by:
Ultrasound scanning of thyroid gland and data collection sheet which designed to include all variables that satisfy the study.

**3.9 Data analysis:**

The data was analyzed by software program (SPSS)

**3.10 Data presentation:**

The data was represented in form of tables, Figures and graphs using Microsoft office word program.

**3.11 Data storage:**

All data was storage in personal computer and patient data collection sheet.

**3.12 Materials and methods:**

**Equipment:**

All participants examined by using; MINDARY, Diagnostic Ultrasound System – model: DC-6, issued date-2008-09, version:2.1. with probe frequency (convex 2.5-6MHz) & (linear 6-8Mhz).

Madison SonoAce x4 Ultrasound System with probe frequency (linear 7.5Mhz).

**3.12.1 Methods & Technique**

A total of 100 adult participants with asymptomatic thyroid gland screened by neck ultrasound protocol. None of the participants had any clinical evidence of thyroid abnormality at the time of ultrasound examination.

Verbal consent was obtained from all participants, and the study protocol was approved by the ethics committee of our institution. The examination was performed without preparation.

To visualized thyroid gland optimally the subjects were examined in supine position, with pillow placed under their shoulders to extend the neck slightly, allowing the head to rest on the examination table. After applying ultrasound jell over the thyroid area. The transducer was directly placed on the skin over the
thyroid gland, and an image of each lobe was obtained in transverse, longitudinal, and oblique planes to optimally visualize both lobes. Scan for thyroid was done begin with transducer transverse, at midline of neck just superior to sternal notch, and move the transducer superiorly till the hyoid bone, and lateral in both side right and left until beyond the right and left common carotid arteries and internal jugulars veins.

Move transducer slightly superior and toward the patient right lateral enough to view the right lobe from its superior and inferior margin.

Measurements of the thyroid lobes and isthmus was performed for all participants as follows: the widths in transverse view from the lateral end to the medial end near the trachea at level just anterior to common carotid artery, the depths in transverse view from the boundary with strap muscle interiorly to the boundary with longus colli muscle posterior, and the lengths obtained in longitudinal or oblique views of thyroid lobes from the superior to inferior end of each gland, as well as the thickness of the isthmus measured in transverse view.

3.13 Expenses:

Some resources that was used in study was provided by ultrasound departments in where thyroid examination was carried out, and some on my own expense.

3.14 Ethical consideration:

Participants was informed about the plan of dissemination and publication of research findings, also they were assured that data will be released only after elimination of all identifications, and verbal consent was obtained.
Chapter Four
Chapter four: Results

Table (4.1) Gender frequency distribution

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Figure (4.1) Gender frequency distribution
Table (4.2) Residence distribution

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Figure (4.2) Residence distribution
Graph (4.1) scattered plots illustrate the relation between the age and thyroid volume.
Graph (4.2) scattered plots illustrate the relation between the weight and thyroid volume.
Graph (4.3) scattered plots illustrate the relation between the height and thyroid volume.
Graph (4.4) scattered plots illustrate the relation between the body mass index and thyroid volume
Chapter Five
Chapter five

Discussion, conclusion and recommendations

5.1. Discussion

This study was done to measure the normal thyroid volume among adult asymptomatic Sudanese population as well as assessment relationship between the thyroid gland volume and body characteristics (age, gender, height and weight) and to study the effect of residence in thyroid volume (the study conducted on 100 participants with asymptomatic thyroid gland investigated using ultrasound. Gender distribution (54%) were males and (46%) were females.

Regarding participant age group highest frequency (61%) in age group (18-30 years), and lowest frequency (1%) in age group more than 70 years, this agrees with (Mohamed Yousef et al, 2011), their study depend mainly on the young adult.\(^{11}\)

About distribution of participant height range; highest height range between (160-170cm) (44%) participants, lowest height range were (140-150cm) was (3%).

Consider the distribution of mean volume for the right and left lobes were 6.2cc±2.1 and 5.2cc±1.8 respectively, this means that the volume of the right lobe was greater than the left lobe this agree with (Mohamed Yousef, et al 2011), (Ahidjo, et al 2005) and (Namik Kemal, and Gazianta 2015).\(^{11,12,13}\)

This asymmetry of thyroid lobe volume due to position of esophagus, handedness and other morphological causes. Consider the mean volume for whole thyroid gland, study found that the overall mean volume of the thyroid gland for both lobes in all the subjects studied was 11.3cc±3.8, this value agrees (Namik Kemal, and
Gaziantep, 2015\textsuperscript{(13)}, and disagrees with (Mohamed Yousef et al,2011) and (A Ahidjo et al, 2005)\textsuperscript{(11,12)} due to their studies include very young adults which the mean age was 21.79 years and this study the mean age was 30 years.

Regarding the overall mean volume of the thyroid gland, the study found that the mean volume for male and female was = 13.4cc± 3.9 and 8.9cc ±2.4, respectively. This result shows that the mean volume of thyroid gland was higher in males than females. (2-tailed) =0.05, this agrees with (Mohamed Yousef et al\textsubscript{4}, 2011), (A Ahidjo et al\textsubscript{2}, 2995), and (Namik Kemal, and Gaziantep, 2015)\textsuperscript{(11, 12, 13)} due to different in body composition of men and women ,we hypothesized that lean body mass is better determinant of thyroid volume than body weight.

Regarding subject height, the study found strong correlation between thyroid volume and the height of individual, significant in both lobes and both gender. This agreed with study done by (Nam, ik Kemal, and Gaziantep, 2015)\textsuperscript{(13)} who have found a significant correlation between the thyroid volume and height. Where thyroid volume increase by0.24 ml for every one cm increment for height. Thyroid volume =0.24×height-28.5. R = (0.053).

In correlation between the age of the participants and thyroid volume, the study found that there was no correlation between the thyroid volume and age r= 0.27 this result disagrees with (Mahrukh Kamran et al 2014)\textsuperscript{(14)} whose found that TGV increased significantly with age till 60 years (P<0.05) and after the age of 60 years it decreased, this due to numerous morphological and physiological changes of thyroid gland during the process of aging, subclinical disturbances of thyroid function are more frequent in general population as well as in elderly people.

According to area, this study found the smallest mean thyroid volume in the area of western Sudan and largest mean volume in the area of northern Sudan disagree
with local references due to small sample size (just 12 volunteer) from western Sudan in this study and advice further studies should be done with large samples to confirm the actual results.

Regarding BMI, the study found that there is significant relation between the thyroid volume and body mass index Sig. (2-tailed) =0.05, this result agrees with previous studies. Where thyroid volume increases by 0.178ml for every one kg/m$^2$ increment for BMI by this equation:

Thyroid volume =0.178×BMI+7.1
5.2 Conclusion

The study concluded that ultrasound is an excellent imaging modality for measuring the thyroid volume.

The study established that the volume of the right lobe of thyroid gland is larger than the volume of left thyroid lobe in both gender. It agrees with most of previous studies that the overall volume of the thyroid gland in male is larger than female.

The study concluded that there was significant relation between thyroid gland volume and body mass index and strong correlation between thyroid volume and height.
5.3 Recommendations

1. Further studies should be encouraged in order to establish more national reference in thyroid gland measurement using ultrasonography.

2. For accurate sonographic assessment of thyroid gland, the thyroid length should be measured using convex probe especially for those who had thyroid length can't measured in one image using linear probe.

3. Awareness about the symptoms of the thyroid diseases should be peaked up in our community so our efforts must solidarity with who concern with thyroid gland society activities.

4. Further studies should be done with large samples to confirm the actual result of the thyroid measurement.

5. Further studies should be done in thyroid volume for pediatric.
References

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Appendix(I): Ultrasound images from the sample of the study

Image (1) : Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(2): Transverse ultrasound image for both thyroid lobes showed: how to measure the thickness and width of the thyroid lobes.
Image(3): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(4): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(5): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(6): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(7): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(8): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(9): Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image(10) : Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes.
Image (11) Transverse ultrasound images for both thyroid lobes showed; how to measure the thickness and width of the thyroid lobes
Image(12): Longitudinal ultrasound image for right thyroid lobe showed how to measure the length of gland by using convex probe.
image(12) Longitudinal ultrasound images for left thyroid lobe showed; how to measure the length of gland by using convex probe.
Image(13): Transverse ultrasound image for isthmus showed how to measure the thyroid isthmus.
Image(14): Transverse ultrasound images for isthmus showed; how to measure the thyroid isthmus.
Appendix (II)

Data collection sheet

The National Ribat University

Faculty of Postgraduate Studies and scientific research

Data Collection Sheet

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A=age  B=gender  C=weight(kg)  D=height(cm)  E=residence  
F=BMI  G=isthmus thickness(cm)  H=Echogenicity  I=Texture  J=length of the rt lobe  K=Height of the Rt lobe  L=Width of the rt lobe  M=volume of Rt lobe  N=length of lt lobe  O=height of lt lobe  P=width of lt lobe  Q=volume of lt lobe.