Chapter one

1.1 Introduction

The thyroid gland is a vital endocrine gland in our body. It's the most common gland imaging by ultrasound especially in tropical Africa. The thyroid gland is among the most commonly imaged glands using ultrasound because its offer a good presentation over clinical examination; Computed tomography (CT) and magnetic resonance imaging (MRI) provide structural information of the thyroid gland just like ultrasound but are relatively more expensive. Thyroid ultrasound appears suitable in tropical Africa. Where more sophisticated modern imaging techniques may not be readily available or are very expensive, As a result, the World Health Organization (WHO) and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) now consider sonography the diagnostic method for assessment of goiter. It is most often used in assessing the incidence of goiter in Third World populations, especially in children Intra- and inter observer variation can lead to differences in volume calculation, irrespective of the correction factor. Nevertheless, a more optimal correction factor will give a more realistic measurement of thyroid volume. Volumetric evaluation of the thyroid gland is based on the use of an ellipsoid model. Hence, a value is obtained that replaces clinical evaluation of volume. With the ellipsoid model, the height, the width, and the depth of each lobe are measured and multiplied (Ivanac et al 2004).

In Sudan, there is absence of domestic reference for thyroid volumes, and goiter distribution and there are no enough studies, regarding the thyroid volume and goiter in eastern states of Sudan(Ivanac et al 2004)..

1-2 Problem of the study:

In Sudan, there is absence of domestic reference for thyroid volumes, and there are no comprehensive studies. the increase in thyroid volume may be due to several distinct feature of Sudanese habits or related factor although there is no official survey program to detect these factors and its related morbidity, therefore this study was conducted to detect thyroid volume in Sudanese population using medical ultrasound in order to find thyroid measurement for different Sudanese areaa as reference standard.

1-3 Objectives:

The general objective of this study was to find the measurements of thyroid lobes and volume for different Sudanese area as reference standard.

Specific objectives:

- To measure thyroid dimensions; length, Width depth and volume for Rt and Lt lobe including isthmus.
- To find the body characteristics; gender, age, height, weight and BMI
- To find the significant difference between: gender, Port-Sudan and Kordofan thyroid sample measurement, as well as Rt and Lt lobe measurement for
- To correlate thyroid dimensions measurement with body characteristics
- To find a linear relationship between thyroid dimension and body characteristics for dynamic normative dimensions.

1-4 Overview of the study:

This study was consisted of five chapters, chapter one is an introduction, which introduce briefly this thesis and contained (general introduction, problem of study also contain general, specific objectives and overview of the study). Chapter two was literature review which contains (anatomy and physiology, pathology, thyroid ultrasound measurements and previous study). Chapter three was describe the methodology (material, method) used in this study. Chapter four includes results presentation of study finding, chapter five included discussion, conclusion and recommendation for future scope in addition to references and appendices.

Chapter Two
Theoretical background and literature review

2-1 Embryology

The thyroid gland is derived from an embryologic tube called the foramen ceccum. The foramen ceccum originates from the base of the tongue. It grows downward anterior to the trachea and the thyroid cartilage to reach the adult site. the distal end form the thyroid gland and remainder should degenerate and disappear. If the foramen ceccum persists and remains patent, it is called a **thyroglossal duct;** if parts of the tube close, the remaining patent segment are called **thyroglossal cysts.** Thyroglossal cysts are the most common congenital malformation of the neck (Sharp et al 2006).

2-2 Anatomy

The thyroid gland is located in the anterior neck, spanning between the C5 and T1 vertebrae. It is an endocrine gland, divided into two lobes which are connected by an isthmus. It is said to have a butterfly shape. It lies behind the sternohyoid and sternothyroid muscles, wrapping around the cricoid cartilage and superior tracheal rings. It is inferior to the thyroid cartilage of the larynx. The gland is in visceral compartment of the neck, along with the trachea, esophagus and pharynx. The compartment is bound by pretracheal fascia. During development, the thyroid gland initially forms in the floor of the primitive pharynx, near the base of the tongue. It descends down the neck to lie in its adult anatomical position (Sharp et al 2006).

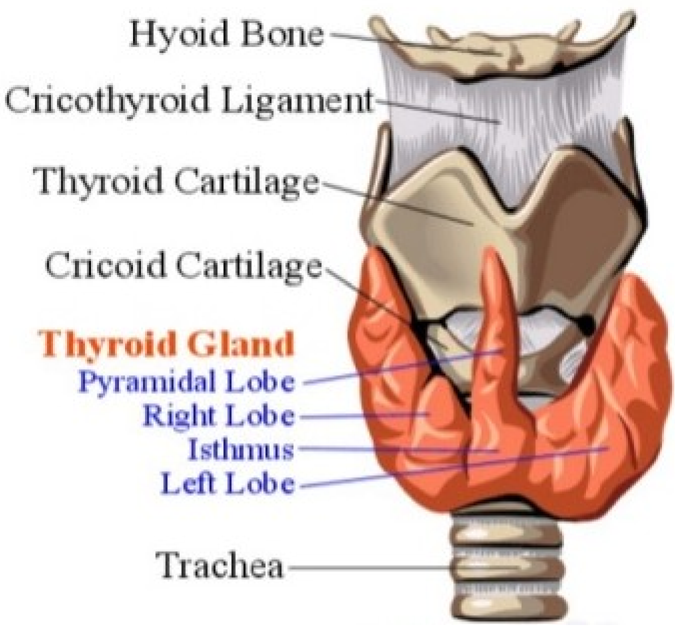


Figure 2-1 thyroid gland www.med.uttawa 2016

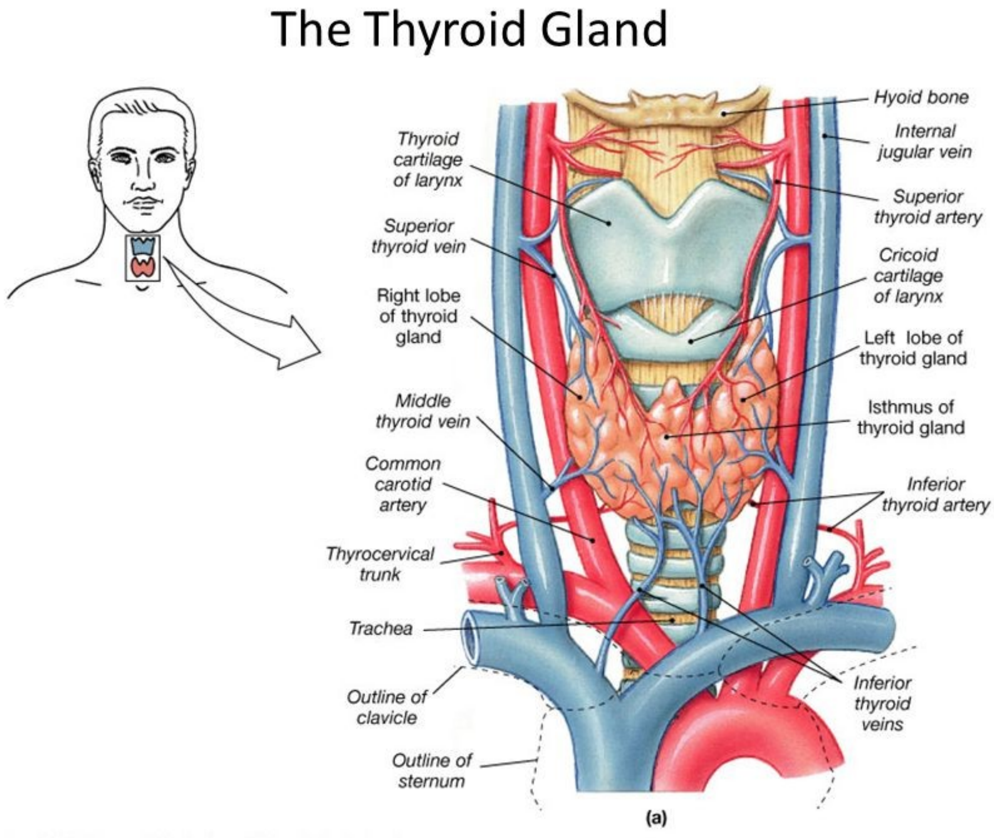


Figure 2-2 thyroid gland

The structure of the thyroid gland:-

The thyroid gland is covered by a thin capsule of connective tissue Microscopically the gland is seen to consist of large number of spherical follicles which are lined with cuboidal epithelium and which contain colloid.The colloid consists of glycoprotein called (thyroglobullen),which is the storage form of the thyroid hormone (thyroxin- triiodothyroneen). In a very active thyroid gland the stores of colloid are small and the follicular epithelial cells becomes hypertrophied and collomonuer. There is also second type of cells, the paraflliculler cell which is present in smaller number than the follicular cells .these cells secret calcitonen.

2-2-1 Blood supply:

Thyroid arteries: the thyroid gland is supplied by two arteries on each side:-

The inferior thyroid artery:-

typically arises from the thyrocervical trunk immediately distal to the vertebral, but on occasion can come proximal to this location, including aortic arch and subclavian arteries. This variant is known as the “Thyroidea Ima.” It primarity supplies the thyroid gland and is in balance with the superior thyroid artery.

The superior thyroid artery:-

is typically the first branch of the external carotid artery. Most of its flow directed into the thyroid bed, with a characteristic thyroid blush on catheter angiography. It is very often seen on a (well-performed) CTA. A superior laryngeal branch often arises from the superior thyroid artery. Penetrating the thyrohyopid membrane along with the superior laryngeal nerve of the vagus nerve, it supplies stuctures of the larynx and hypopharynx. Extensive anastomoses with its contralateral homologue, and with other vessles supplyng this region. The main Sup. Thyroid then divides into multiple branches vascularizing the thyroid gland. It is in balance with the inferior thyroid artery, which typically arises from the thyrocervical trunk, or less commonly from the aorta (thyroid ima) or elsewhere. The superior thyroid artery gets very little press, often a paragraph smaller than this no pictures at all in the major neurointerventional volumes. It is indeed of relatively little importance (Frances et al 2006).

2-2-2 The venous return

The superior thyroid vein

From the upper pole follow the superior artery. either the internal jugular vein or common facial vein

The middle thyroid vein

Short and wide, is usually present. It passes from the middle of the lobe directly into the internal jugular vein.

The inferior thyroid vein

From the isthmus and lower pole from a plexus that lies in the pre tracheal fascia in front of the cervical part of the trachea. The pluxes drains into the brachio-cephalic veins most of it into the left one

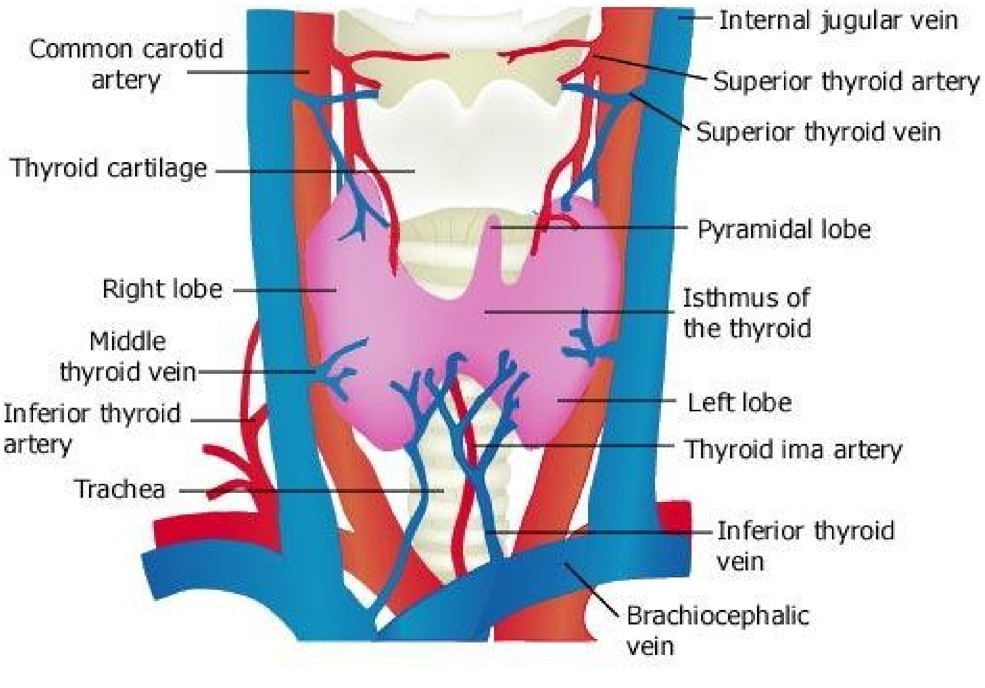


Figure 2-3 thyroid blood supply

2-2-3 Nerve supply

The bulk of sympathetic supply is derived from the middle cervical ganglion and enters the gland on the inferior thyroid artery, some fibers from the superior cervical ganglion travel with the superior thyroid artery. The sympathetic fibers are vasoconstrictor, vagus nerve filaments are traceable to the gland there purpose is unknown (Frances et al 2006).

2-2-4 The lymphatic’s

From the upper pole they enter the anterior superior group of deep cervical lymph nodes . from the lower pole they pass with the inferior thyroid artery back to it is of origin from the subclavian behind the carotid sheath into postro inferior group. A few pass down words into pretracheal nodes, following the course of the thyroid image artery.

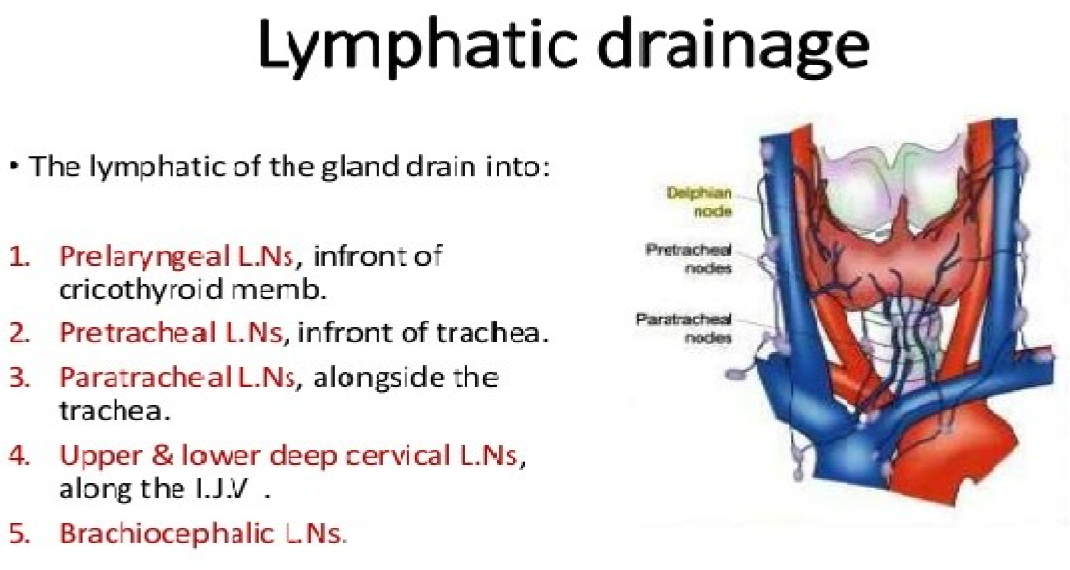


Figure 2-4 lymphatic drainage

2-3 thyroid physiology

The thyroid gland produces the hormones L-thyroxine (T4) and L-triiodothyronine (T3), which regulates metabolic body processes, cellular respiration, total energy expenditure, growth and maturation of tissues, and turnover of hormones, substrates, and vitamins. The gland is composed of a uniform cluster of follicles enclosed by a thin, fibrous capsule surrounded by capillaries. The follicles are the structural, functional, and secretory units of the thyroid gland (Frances et al 2006).

Thyroperoxidase (TPO) is one of the primary enzymes produced in the thyroid. It is synthesized within the endoplasmic reticulum of the thyrocyte and oxidizes iodine, thereby facilitating the formation of T3 and T4. Iodine is a critical component of thyroid hormones and composes 65% of T4 weight and 58% of T3 weight. T3 is the active hormone (3 times the metabolic potency of T4), and T4 is the prohormone, broken down in the tissues to form T3 as needed. Release of the hormones into the bloodstream involves the negative feedback system of the hypothalamic-pituitary-thyroid axis. A low metabolic rate or a decrease in serum T3 and/or T4 levels signals the hypothalamus to secrete thyrotropin releasing hormone (TRH), which travels to the anterior pituitary gland and stimulates secretion of thyroid-stimulating hormone (TSH). An elevated T3 serum level inhibits release of TRH and TSH. Expert opinion on the normal serum TSH level varies from the AACE's 0.3 to 3.0 mIU/L to the National

Academy of Clinical Biochemistry's 0.4 to 2.5 mIU/L. However, most agree that the upper level of normal should not be > 4.12 mIU/L (David et al 2002).

TSH, in turn, stimulates the thyroid gland to manufacture and release stored T3 and T4 until the metabolic rate is normalized. Thyroxine-binding globulin (TBG) is the primary protein that binds to T3 and T4 in the plasma. Unbound or free hormones are available to the tissue. The normal range of serum TSH concentration in the euthyroid population was found to be 0.4 to 2.5 mIU/L by the National Academy of Clinical Biochemistry, and supports the redefined TSH reference range (0.3-3.0 mIU/L) recommended by the AACE. A high serum iodine concentration will also suppress the release of thyroid hormones (David et al 2002)..

2-4 pathology of the thyroid

Thyroid disorder is a general term representing several different diseases involving thyroid hormones and the thyroid gland. Thyroid disorders are commonly separated into two major categories, hyperthyroidism and hypothyroidism, depending on whether serum thyroid hormone levels (T4 and T3) are increased or decreased, respectively. Thyroid disease generally may be sub-classified based on etiologic factors, physiologic abnormalities, etc., as described in each section below.

More than 13 million Americans are affected by thyroid disease, and more than half of these remain undiagnosed. The American Association of Clinical

Endocrinologists (AACE) has initiated a campaign to increase public awareness of thyroid disorders and educate Americans about key periods, from birth to advanced age, when people are at increased risk for developing a thyroid disorder (see below). The diagnosis of thyroid disease can be particularly challenging. Patients often present with vague, general clinical manifestations; in particular, the elderly may not associate the signs and symptoms with a disease process and thus may not bring them to the attention of their primary care provider.The prevalence and incidence of thyroid disorders is influenced primarily by sex and age. Thyroid disorders are more common in women than men, and in older adults compared with younger age groups. The prevalence of unsuspected overt hyperthyroidism and hypothyroidism are both estimated to be 0.6% or less in women, based on several epidemiologic studies. Age is also a factor; for overt hyperthyroidism, the prevalence rate is 1.4% for women aged 60 or older and 0.45% for women aged 40 to 60. For men more than 60 years of age, the prevalence rate of hyperthyroidism is estimated to be 0.13%. A similar pattern is observed for the prevalence rate of hypothyroidism. The prevalence rate of overt hypothyroidism is 2% for women aged 70 to 80,1.4% for all women 60 years and older, and 0.5% for women aged 40 to 60. In comparison, the prevalence rate of overt hypothyroidism is 0.8% for men 60 years and older. The estimated annual incidence of hyperthyroidism for women ranges from 0.36 to 0.47 per 1,000 women, and for men ranges from 0.087 to 0.101 per 1,000 men. In terms of hypothyroidism, the estimated incidence is 2.4 per 1,000 women each year. Overt thyroid dysfunction is uncommon in women less than 40 years old and in men <60 years of age. Complications that can arise from untreated thyroid disease include elevated cholesterol levels and subsequent heart disease, infertility, muscle weakness, and osteoporosis. The issue of routine screening is controversial because cost-effectiveness has not been clearly proven. Although it may not be economically feasible or necessary to test all patients for thyroid dysfunction, there are instances when thyroid screening is appropriate. Pharmacists can counsel patients on the appropriateness of thyroid screening (David et al 2002).

2-5 Previous Study:

Mohammed (2010) established a local reference of thyroid volume in Sudanese normal subjects using ultrasound. A total of 103 healthy subjects were studied, 28 (27.18%) females and 75 (72.82%) males. Thyroid volume was estimated using ellipsoid formula.The mean age and range of the subjects was 21.8 (19–29) years; the mean body mass index (BMI) was 22.3 (16.46–26.07) kg/m2.The overall mean volume ± SD volume of the thyroid gland for both lobes in all the patients studied was 6.44 ± 2.44 mL. Themean volume for both lobes in females and males were 5.78 ± 1.96mL and 6.69 ± 2.56 mL, respectively. The males' thyroid volume was greater than the females'. The mean volume of the right and left lobes of the thyroid gland in males and females were 3.38 ±1.37mL and 3.09 ± 1.24 mL, respectively. The right thyroid lobe volume was greater than the left. The values obtained in this study were lower than those reported from previous studies.

Kyuingkim et al in 2012 concluded that the thyroid volume in schoolchildren aged 6 to 12 years living in Cagayan areas in Philippine.were The mean weight was 9.4±29.7kg the mean thyroid volumes was6.44±2.2m1, The work of Brune et al.] in 1981 was based on volume measurement of cadaver glands subsequently immersed in water. Brune et al. concluded that a modified correction factor of 0.52 resulted in a more accurate assessment of thyroid volume p.kayastha,s,paudel,shesthaetet al in 2010 concluded that Among 485 individuals between 1 to 83 years of age, 221(45.57%) were males and 264(54.43%) were females. Maximum [354 individuals (72.99%)] were from hilly region and minimum [16 individual (3.30%)] were from Himalayan region. Mean thyroid volume was 6.629 + 2.5025 ml. In general, thyroid volume was found to be more in older individuals than in young age group.

Servet Seker et al 2009 the aim of this study to Thyroid is a suitable organ for the investigation with ultrasonography due to its very superficial localization in body. It is also useful in frequent controls of the organ. The thyroid volume is variable among countries and its value in our country was not clearly demonstrated. In this study we aimed to determine the thyroid volume and its relation with isthmus thickness in Turkey.

A total of 251 healthy volunteers were included in the study (105 man, 146 women, age range 15-78. EUB-6000 Hitachi USG device with 10 Mhz lineer probe was used by a dedicated single operator. Craniocaudal length, transverse and mediolateral length (width), antero posterior Length for each lobe and isthmus thickness were measured and recorded.
Mean total thyroid volume was 13±6.27 ml (man; 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, BMI and isthmus thickness. In general all volumes of thyroid gland was bigger in man when compared to women and bigger for right lobe compared to left one. Normal values of thyroid volumes were determined for age groups. Ultrasonography was useful in determination of volumes of the thyroid gland and normal values were different in various countries.

Ertan Sahin et al 2011 important to know the size of the thyroid gland, and its normal value may vary among different geographic regions. In this study, we aimed to establish reference ranges for thyroid volume in euthyroid adults and to compare these results with the literature data. Between June 2011 and June 2012, 461 patients with normal laboratory results (serum TSH, anti-TG, anti-TPO antibodies and urine iodine level) that underwent thyroid gland ultrasound examination were retrospectively analyzed. Two hundred and 92 patients were females and 169 were males; the age range was 18-61 years with mean age 30.84±9.97 years. Length, breadth and thickness were measured, and the volume of each lobe was estimated using the ellipsoid formula.
The overall mean thyroid volume in all patients who were examined was 12.98±2.53 mL. The mean thyroid volume in females and males was

12.09±2.05 mL 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 ($p<0.05$). In the light of our findings we can provide reference values in order to evaluate patients who have thyroid hyperplasia or who are considered as normal. We consider that further studies are necessary to establish national references thyroid volume for each country.

Chapter three
Material and method

3-1 Material:

The data of this study was collected using Toshiba with 7.5 MHZ linear transducer

3-2 Patient population:

Healthy adult Sudanese male and female with normal thyroid that showed no sign of abnormality live in Port-Sudan or Kordofan their age ranged from 18 to 85 years old. This study was carried out in Alneelain University at Almogran Teaching Hospital, Medical Collage in the period from June 2016 to September 2016.

Exclusion criteria

All subjects with anterior neck swelling or if there is any clinical evidence of thyroid disease.

3-3 Sample size and type

The sample taken from two regions in Sudan, 50 taken from people of Kordofan were iodine nutrient assumed to insufficient and 50 taken from Port-Sudan where presence of iodine assumed to be sufficient; and the sample selected conveniently.

3-4 Method of data collection

All the individuals were examined in the supine position with the neck Hyper extended. Using a linear 7.5 MHZ probe in Toshiba machine, transverse and longitudinal section of both lobes of thyroid gland were scanned. Measurement of the maximum length of lobe from the sagittal images were recorded. The maximum transverse diameter (breadth) and the maximum depth of each lobe were recorded from the transverse images . To ensure that the probe was in the same position each time, anatomical landmarks were used. For measurement of thyroid length, The probe was placed longitudinally in the midline of the neck to obtain sagittal view find the maximum s of larynx; the probe was then moved obliquely to find the maximum length of thyroid gland, just medial to the carotid vessels. The transverse views were obtained by using the trachea and carotid vessels as landmarks (figure 3-1) and (3-2).

3-5 Variable of data collection

The data in in this study were collected using the following variable: Age, gender, height weight, thyroid lobes measurement; length, width, depth and volume of Rt and Lt lobe, and thyroid volume as well as isthmus.

3-6Method of data analysis:

Data will be analyzed by using of Excels Microsoft program and SPSS version 21.0 under windows, where the mean dimension of each lobe was measured and significant differences between male and female as well as between Port-Sudan and Kordofan sample was made including the difference between the Rt and Lt lobe. Also correlation and linear relationship between thyroid measurements and body characteristics were investigated.

Chapter four
Results

Table 4-1 the mean and standard deviation of thyroid dimension measured on normal people live in Port-Sudan and Kordofan region

Group Statistics			
Area		Mean	Std. Deviation
length Rt lobe	Port-Sudan	3.476	.4885
	Kordofan	3.668	.6189
width Rt lobe	Port-Sudan	1.488	.1870
	Kordofan	1.624	.2006
depth Rt lobe	Port-Sudan	1.146	.1432
	Kordofan	1.254	.1487
volume Rt lobe	Port-Sudan	3.1622	.96737
	Kordofan	3.9842	1.26847
length Lt lobe	Port-Sudan	3.372	.4916
	Kordofan	4.234	5.0531
width Lt lobe	Port-Sudan	1.376	.1661
	Kordofan	1.486	.1818
depth Lt lobe	Port-Sudan	1.048	.1515
	Kordofan	1.152	.1403
volume Lt lobe	Port-Sudan	2.6114	.80602
	Kordofan	3.2348	1.00195
Thyroid volume	Port-Sudan	5.7374	1.74170
	Kordofan	7.2220	2.23901
Isthmus	Port-Sudan	.2634	.04723
	Kordofan	.2834	.05389

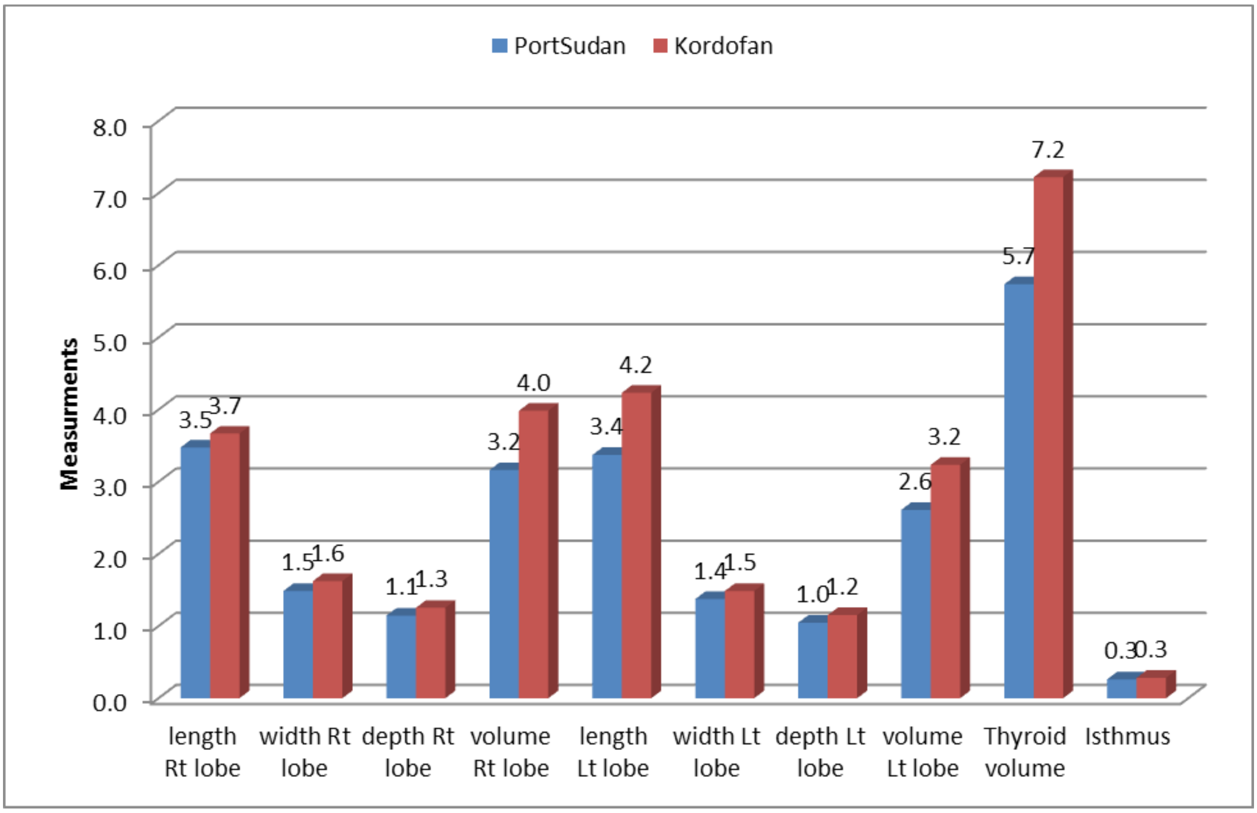


Figure 4-1 a bar graphs shows the distribution of thyroid measurement (mean) for normal sample in Port-Sudan and Kordofan.

Table 4-2 Independent Samples t-test for significant differences of normal thyroid dimension for people live in Port-Sudan and Kordofan

Independent Samples Test Gender	t-test for Equality of Means	
	t	p-values
length Rt lobe	1.722	.088
width Rt lobe	3.507	**.001**
depth Rt lobe	3.699	**.000**
volume Rt lobe	3.644	**.000**
length Lt lobe	1.201	.233
width Lt lobe	3.159	**.002**
depth Lt lobe	3.561	**.001**
volume Lt lobe	3.428	**.001**
Thyroid volume	3.701	**.000**
Isthmus	1.973	**.050**

Table 4-3 the mean and standard deviation of thyroid dimension measured on normal people live in Port-Sudan region

Gender		Mean	Std. Deviation
length Rt lobe	Male	3.400	.5817
	Female	3.552	.3698
width Rt lobe	Male	1.492	.1913
	Female	1.484	.1864
depth Rt lobe	Male	1.124	.1615
	Female	1.168	.1215
volume Rt lobe	Male	3.0244	1.11523
	Female	3.3000	.79202
length Lt lobe	Male	3.304	.5799
	Female	3.440	.3841
width Lt lobe	Male	1.364	.1680
	Female	1.388	.1666
depth Lt lobe	Male	1.036	.1753
	Female	1.060	.1258
volume Lt lobe	Male	2.5540	.90803
	Female	2.6688	.70359
Thyroid volume	Male	5.5548	1.95763
	Female	5.9200	1.51383
Isthmus	Male	.2600	.05323
	Female	.2668	.04120

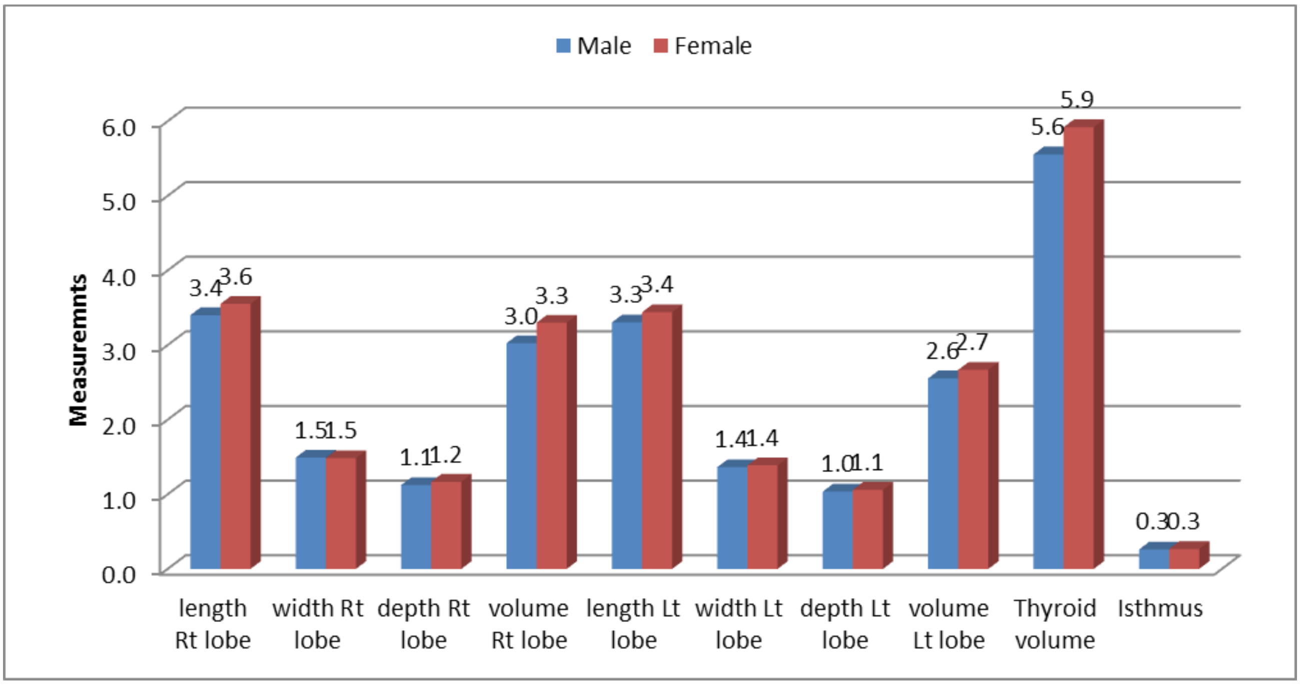


Figure 4-2 a bar graphs shows the distribution of thyroid measurement (mean) for normal sample for male and female in Port-Sudan

Table 4-4 significant t-test to test the significance difference between male and female thyroid dimensions in Port-Sudan sample

Independent Samples Test Gender	Test for equality in mean	
	t	p-value
length Rt lobe	1.103	0.276
width Rt lobe	0.150	0.882
depth Rt lobe	1.089	0.282
volume Rt lobe	1.007	0.319
length Lt lobe	0.978	0.333
width Lt lobe	0.507	0.614
depth Lt lobe	0.556	0.581
volume Lt lobe	0.500	0.620

Thyroid volume	0.738	0.464
Isthmus	0.505	0.616

Table 4-5 the mean and standard deviation of thyroid dimension measured on normal people live in Kordofan region

Gender		Mean	Std. Deviation
length Rt lobe	Male	3.654	.7407
	Female	3.681	.4956
width Rt lobe	Male	1.638	.2123
	Female	1.612	.1925
depth Rt lobe	Male	1.267	.1579
	Female	1.242	.1419
volume Rt lobe	Male	4.1025	1.37978
	Female	3.8750	1.17317
length Lt lobe	Male	3.521	.7354
	Female	4.892	6.9721
width Lt lobe	Male	1.488	.2050
	Female	1.485	.1617
depth Lt lobe	Male	1.171	.1517
	Female	1.135	.1294
volume Lt lobe	Male	3.3371	1.15821
	Female	3.1404	.84511
Thyroid volume	Male	7.4458	2.51015
	Female	7.0154	1.98408
Isthmus	Male	.2896	.06727
	Female	.2777	.03819

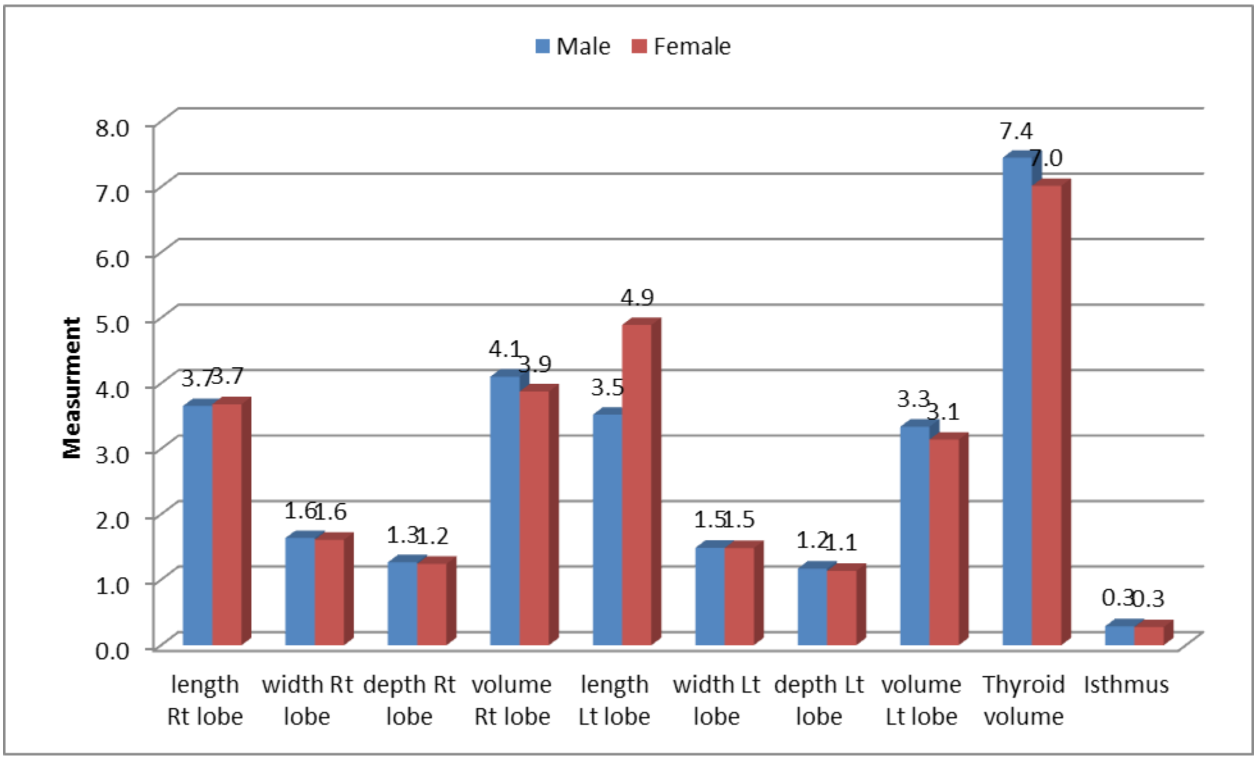


Figure 4-3 a bar graphs shows the distribution of thyroid measurement (mean) for normal sample for male and female in Kordofan

Table 4-6 significant t-test to test the significance difference between male and female thyroid dimensions in Kordofan sample.

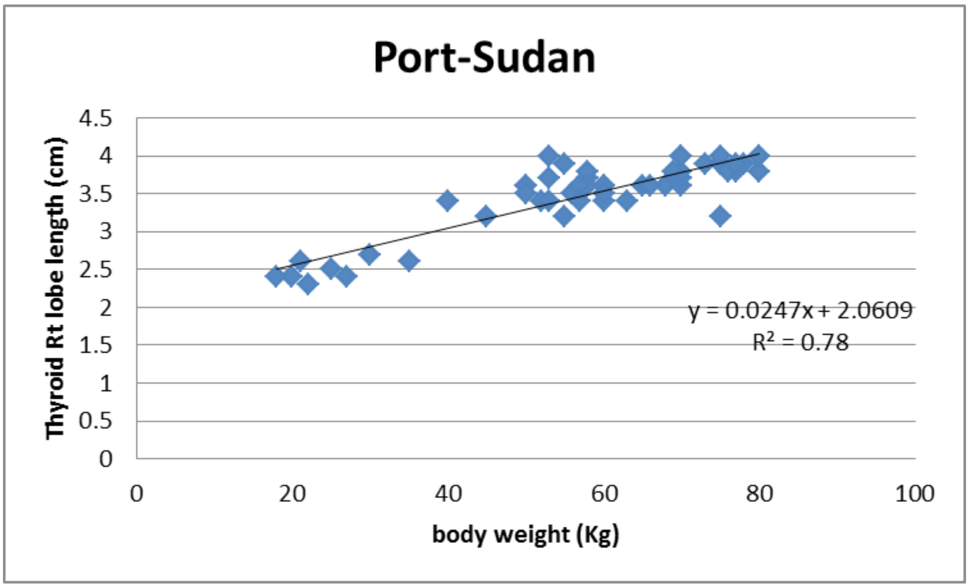
Independent Samples Test Gender	Test for equality in mean	
	t	p-value
length Rt lobe	-.150	.881
width Rt lobe	.454	.652
depth Rt lobe	.575	.568
volume Rt lobe	.630	.532
length Lt lobe	-.958	.343
width Lt lobe	.055	.956
depth Lt lobe	.910	.367
volume Lt lobe	.690	.494
Thyroid volume	.675	.503
Isthmus	.776	.441

Table 4-7 significant t-tests to test the significance difference between Rt lobe and Lt lobe of thyroid measurements in Port-Sudan sample

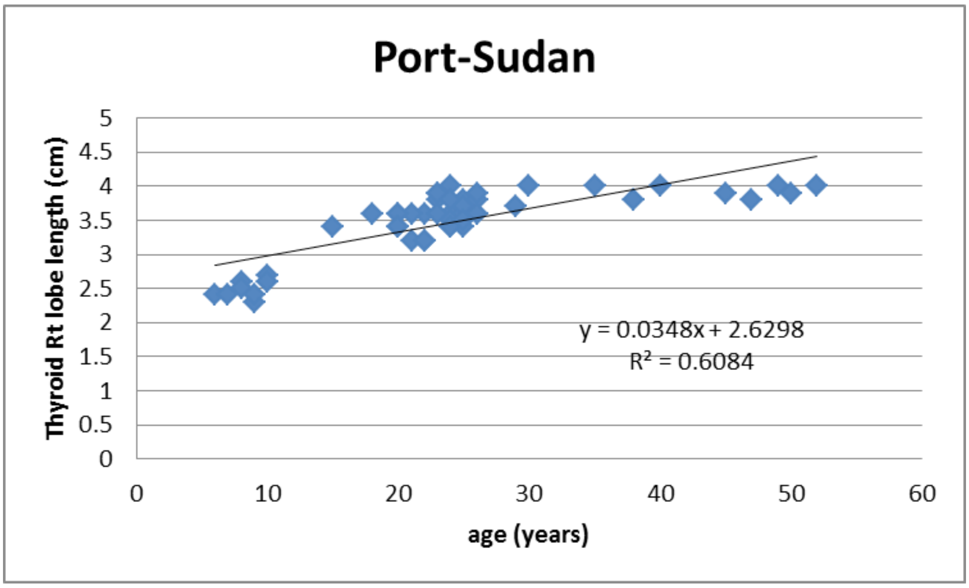
Test of equality of thyroid Rt and Lt lobe		t	p-value
Pair 1	length Rt and Lt lobe	7.768	.000
Pair 2	width Rt and Lt lobe	8.628	.000
Pair 3	depth Rt and Lt lobe	9.705	.000
Pair 4	volume Rt and Lt lobe	10.693	.000

Table 4-8 significant t-tests to test the significance difference between Rt lobe and Lt lobe of thyroid measurements in Kordofan sample

Test of equality of thyroid Rt and Lt lobe		t	p-value
Pair 1	length of Rt and Lt lobe	0.808	.423
Pair 2	width of Rt and Lt lobe	11.419	.000
Pair 3	depth Rt and Lt lobe	8.087	.000
Pair 4	volume Rt and Lt lobe	11.293	.000

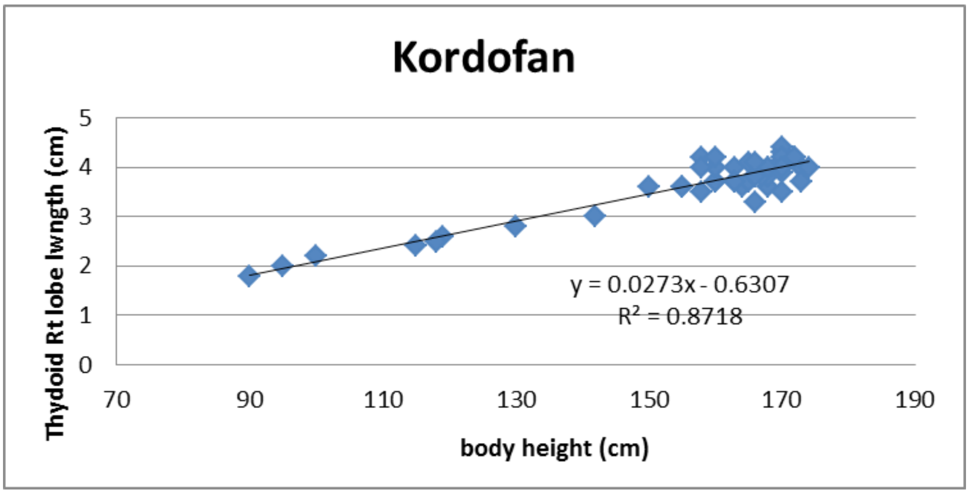


(A)

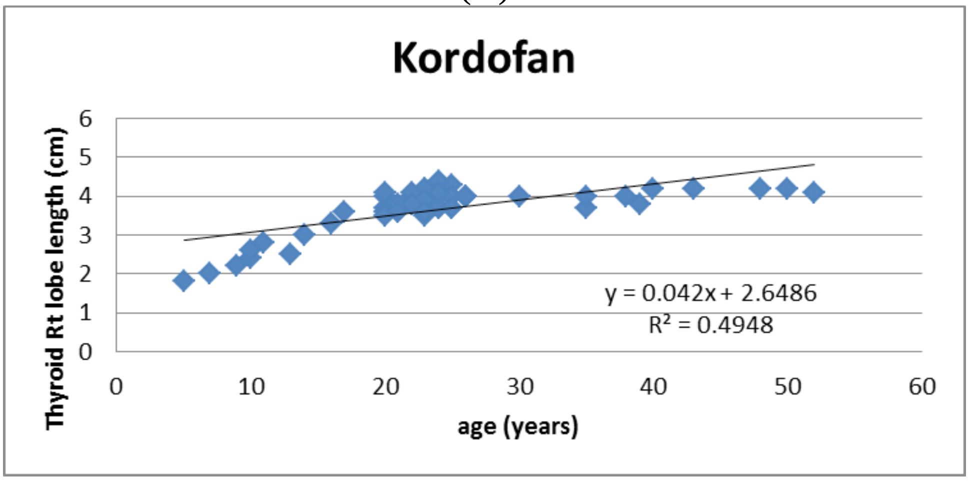


(B)

Figure 4-4 scatter plot shows a direct linear relationship of thyroid Rt lobe length with (A) body height and (B) age Port-Sudan sample



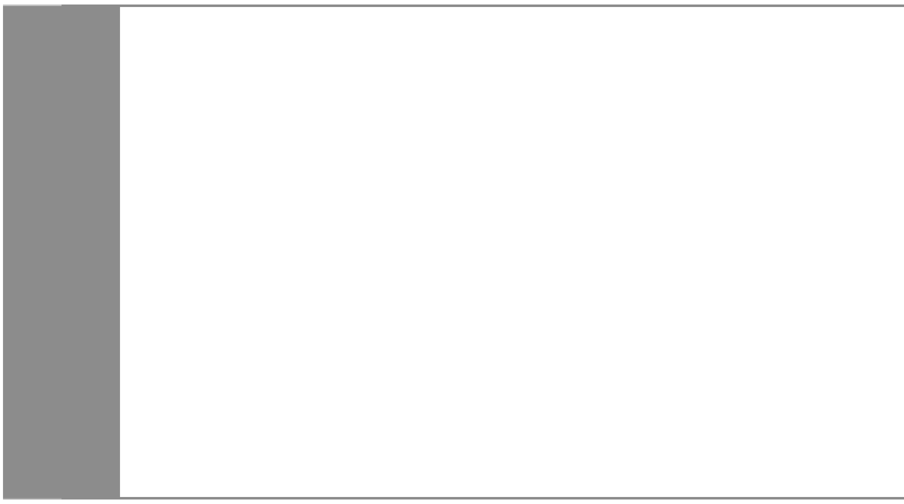
(A)



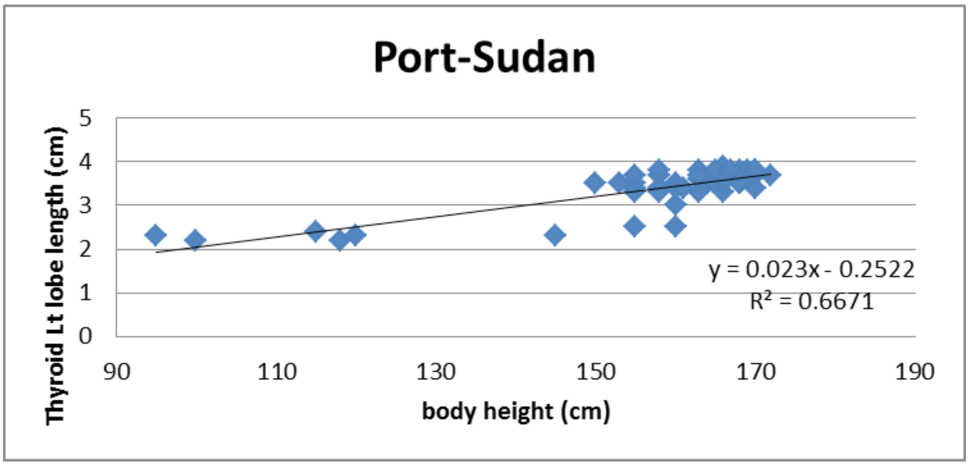
(B)

(C)

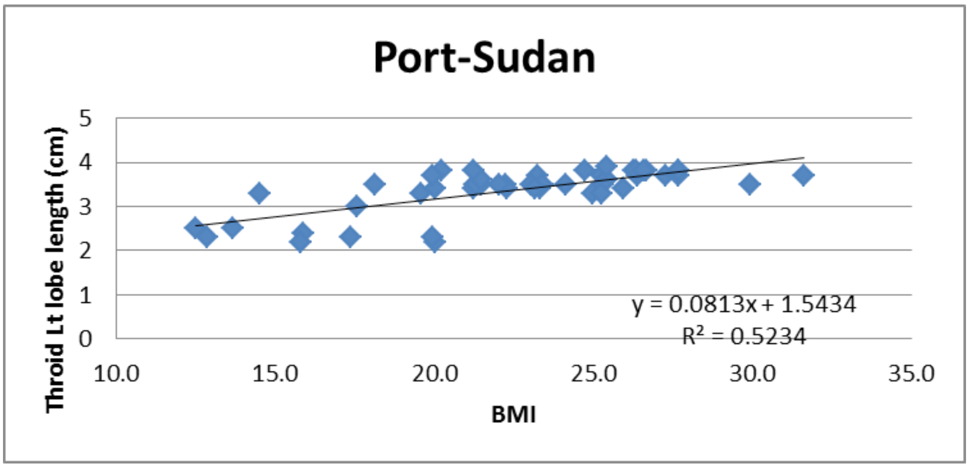
Figure 4-5 scatter plot shows a direct linear relationship of thyroid Rt lobe length with (A) body height, (B) age and (C) BMI, for Kordofan sample.



(A)

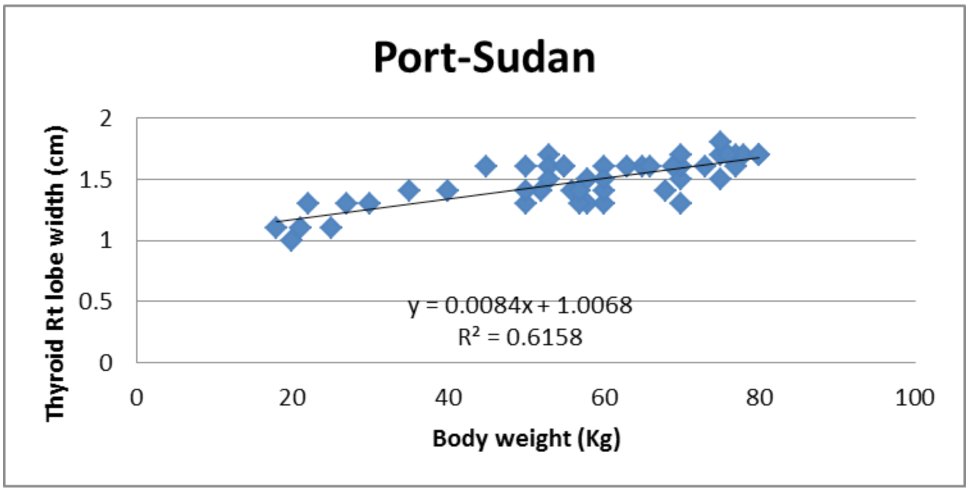


(B)

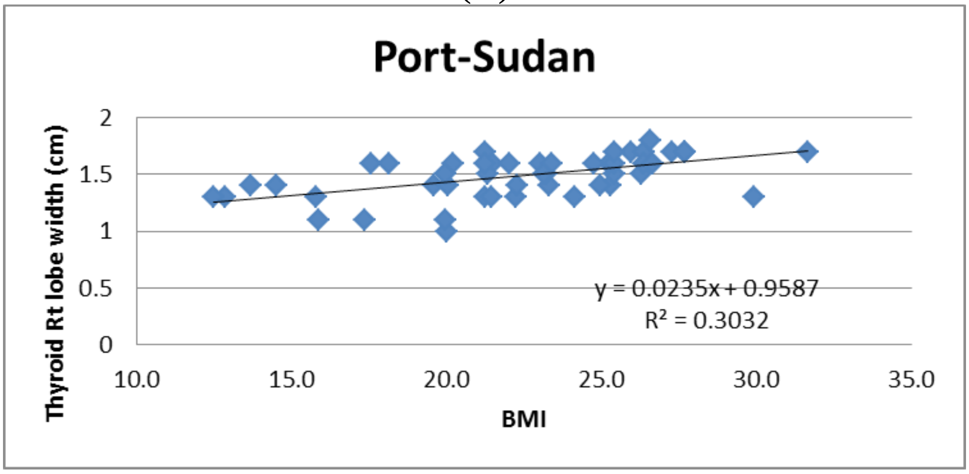


(C)

Figure 4-6 scatter plot shows a direct linear relationship of thyroid Lt lobe length with (A) age, (B) body height and (C) BMI, for Port-Sudan sample.



(A)



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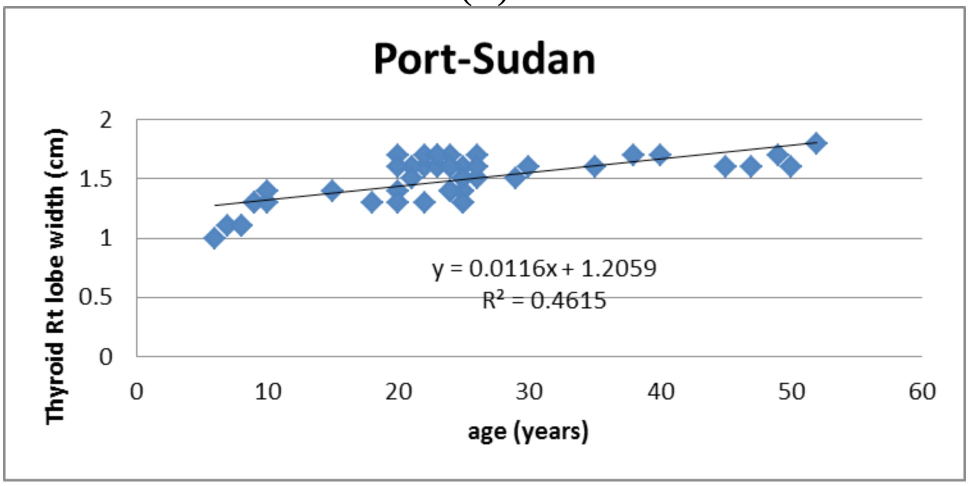
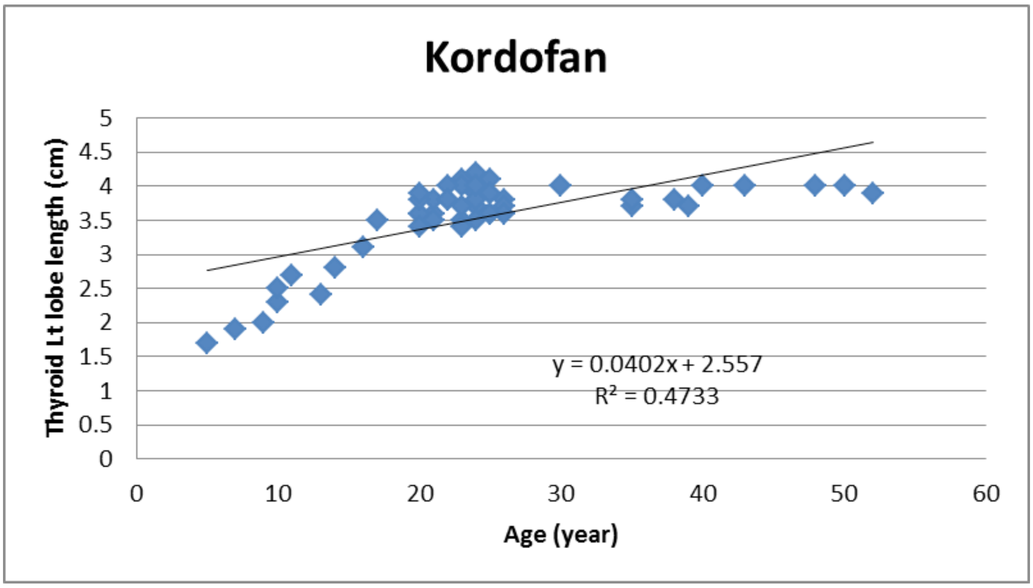
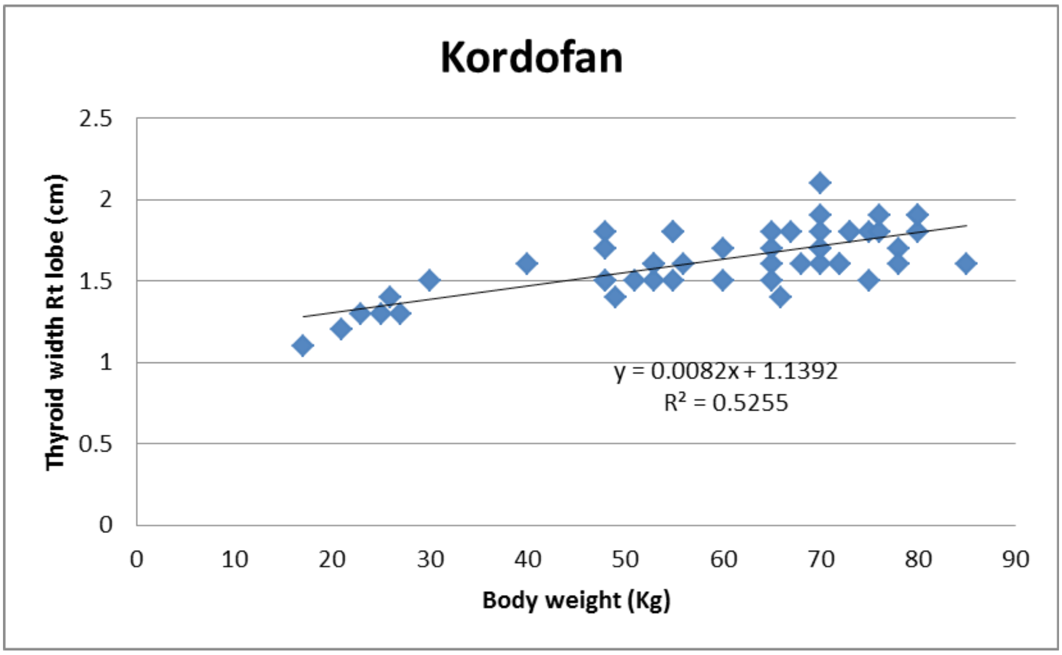


(C)

Figure 4-7 scatter plot shows a direct linear relationship of the thyroid Rt lobe width with (A) body weight, (B) BMI and (C) age, for Port-Sudan sample.

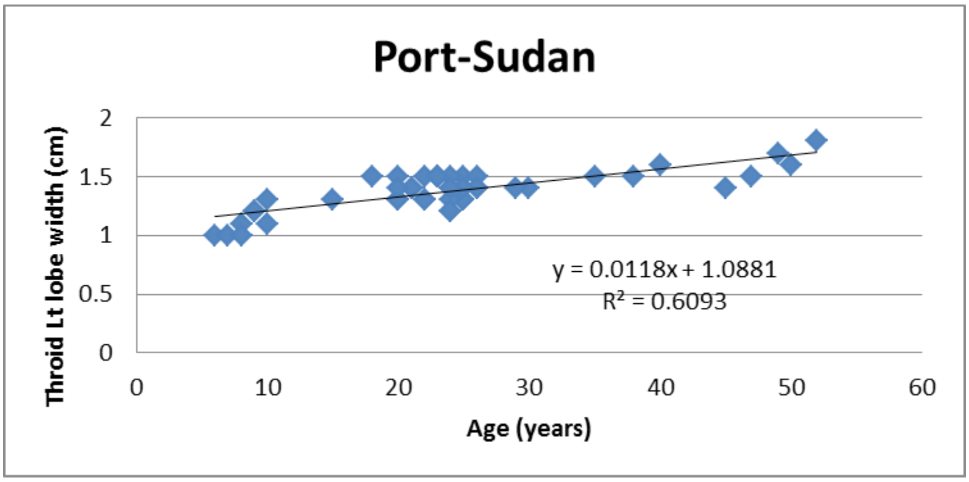


(A)

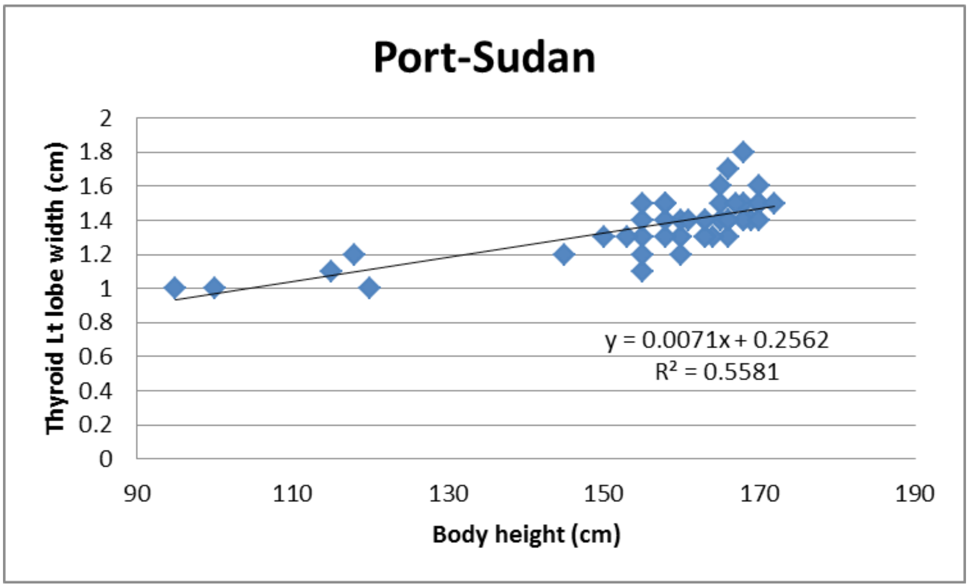


(B)

Figure 4-8 scatter plot shows a direct linear relationship of the thyroid Lt lobe length with (A) age and (B) Thyroid Rt lobe width with body weight for Kordofan sample

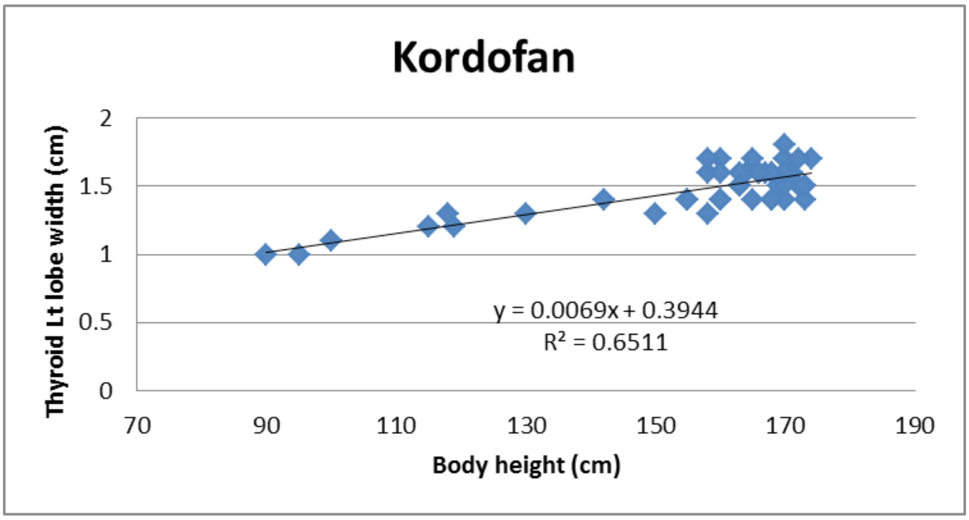


(A)

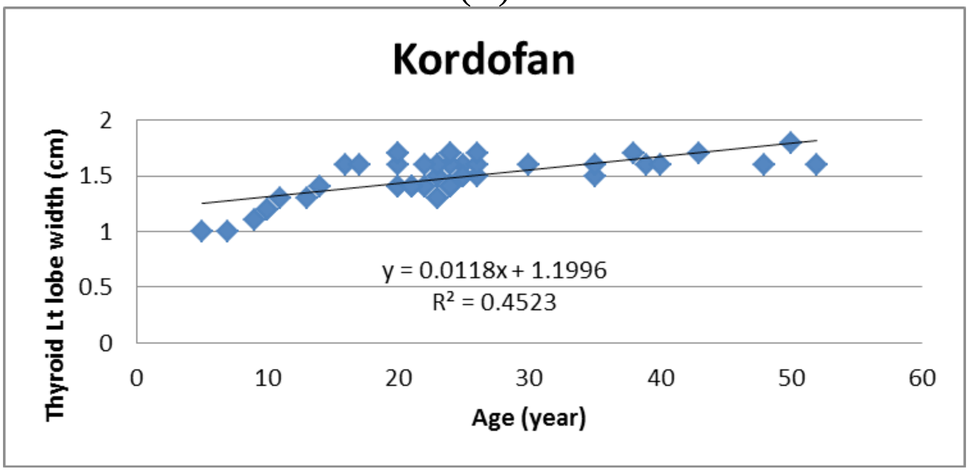


(B)

Figure 4-9 scatter plot shows a direct linear relationship of the thyroid Lt lobe width with (A) age and (B) with body height for Port-Sudan sample

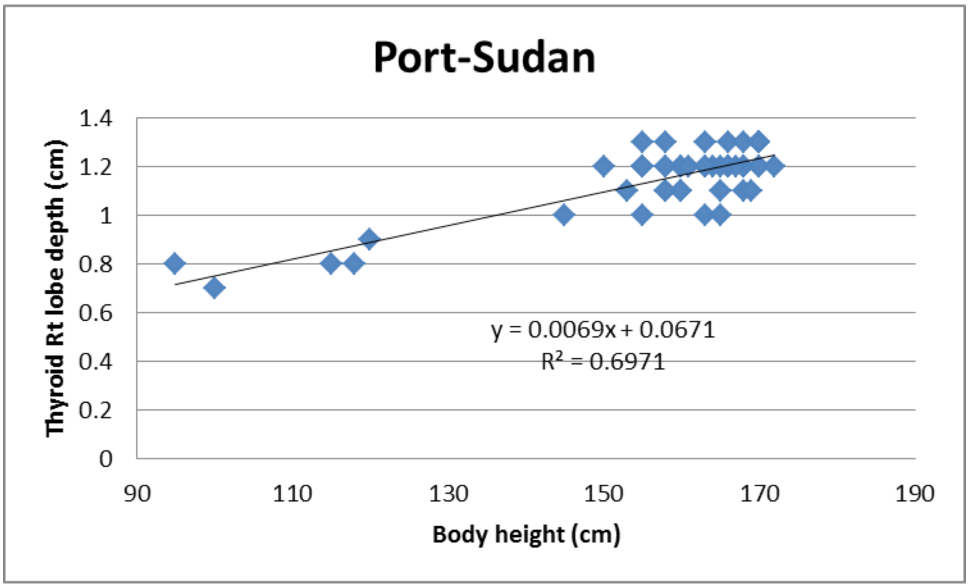


(A)

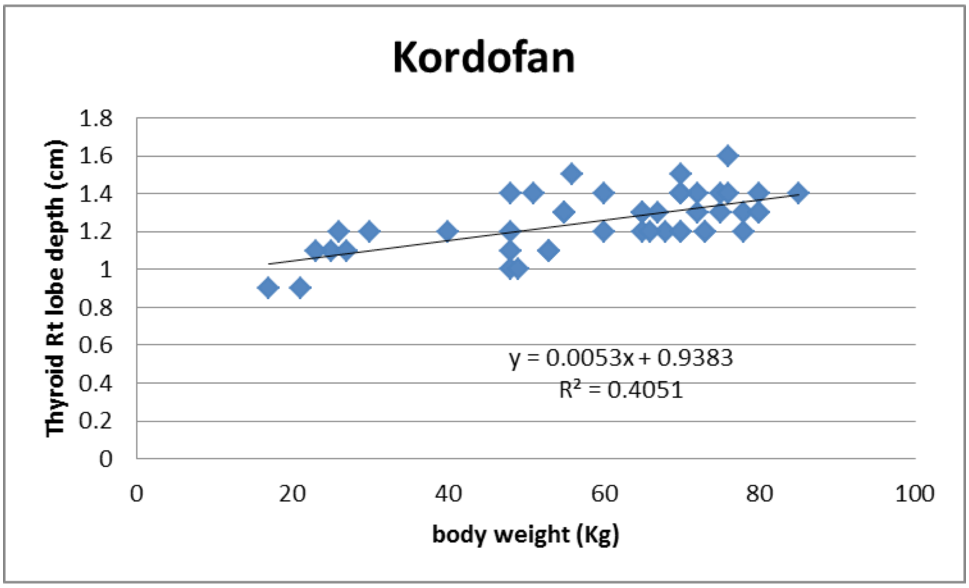


(B)

Figure 4-10 scatter plot shows a direct linear relationship of the thyroid Lt lobe width with (A) body height, and (B) with age, for Kordofan sample.



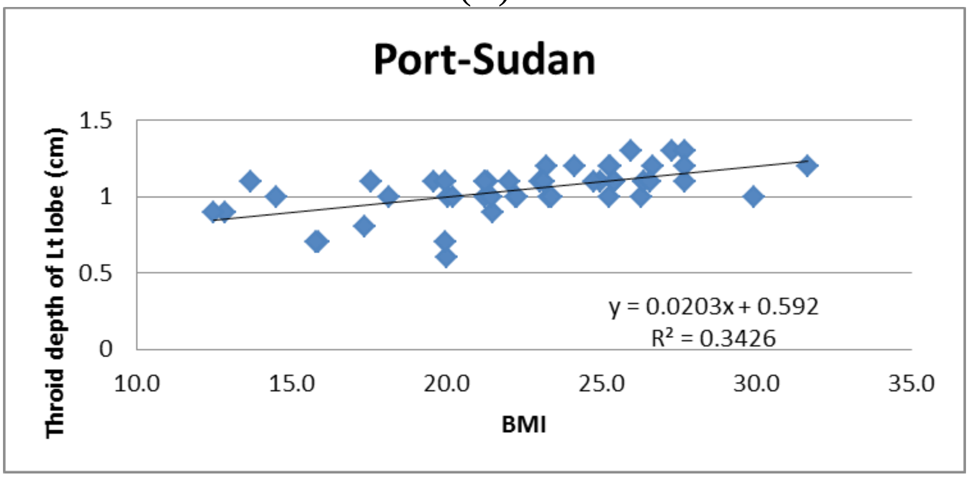
(A)



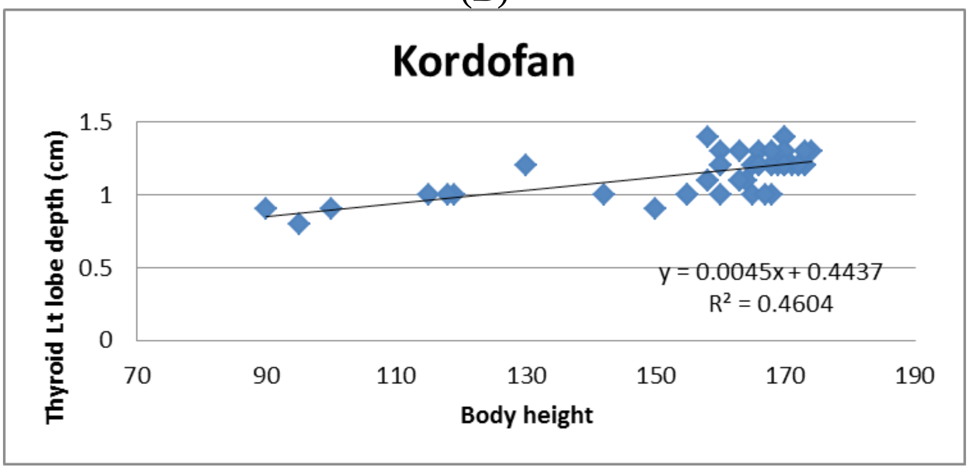
(B)

Figure 4-11 scatter plot shows a direct linear relationship of the thyroid Rt lobe depth with (A) body height Port-Sudan sample, and (B) with body weight, for Kordofan sample.

(A)

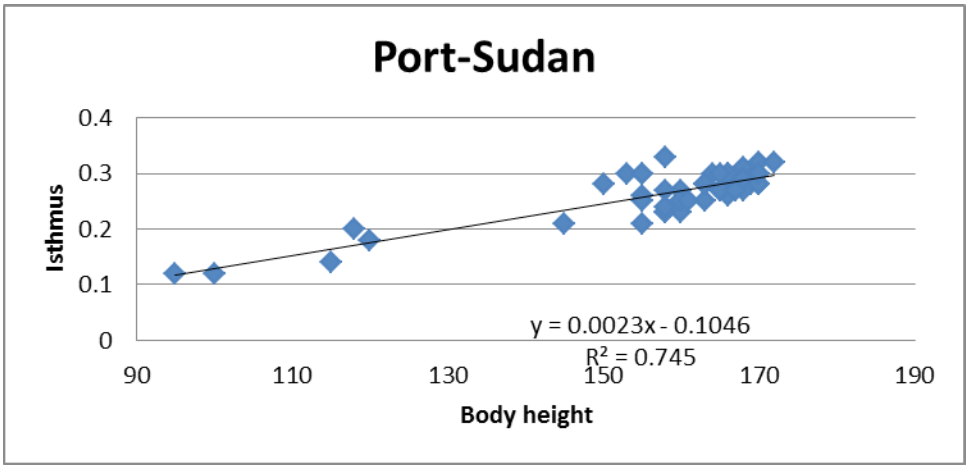


(B)

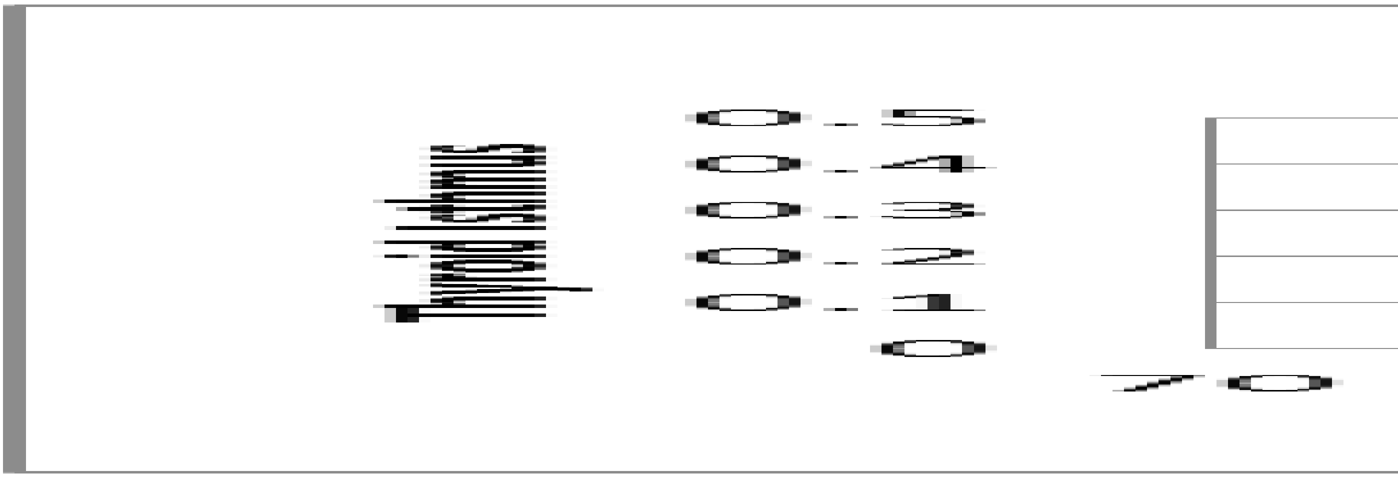


(C)

Figure 4-12 scatter plot shows a direct linear relationship of the thyroid Lt lobe depth with (A) body height, (B) with BMI for Port-Sudan sample and (C) with age, for Kordofan sample.



(A)



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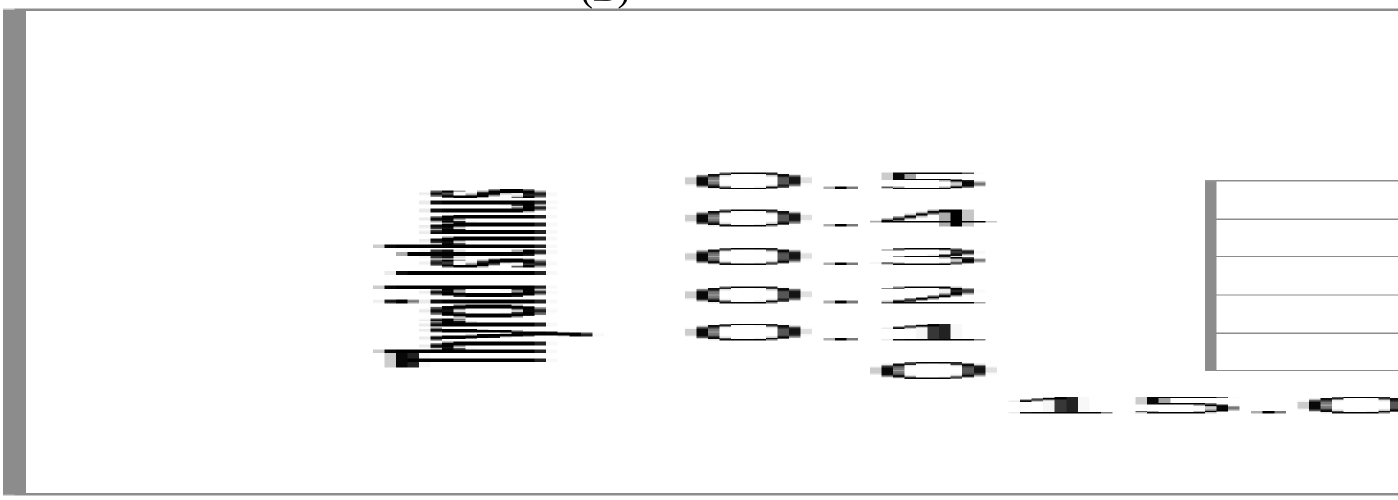
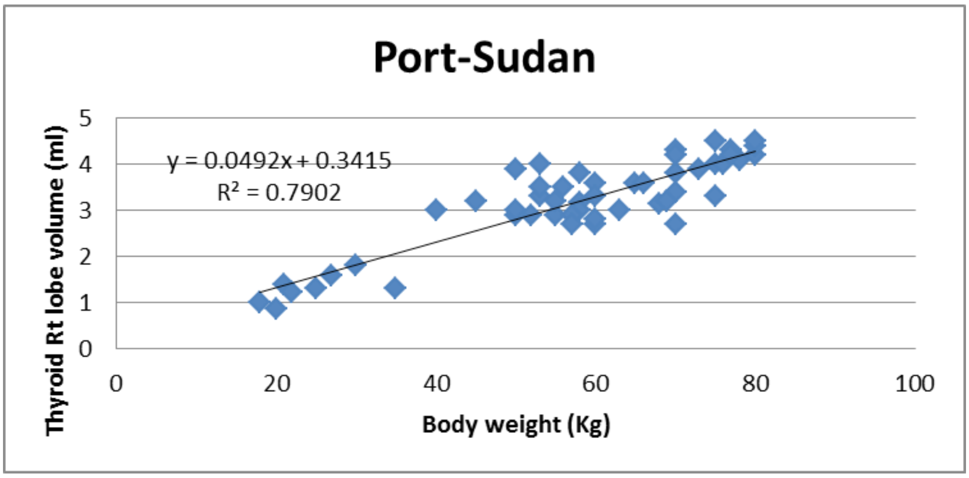
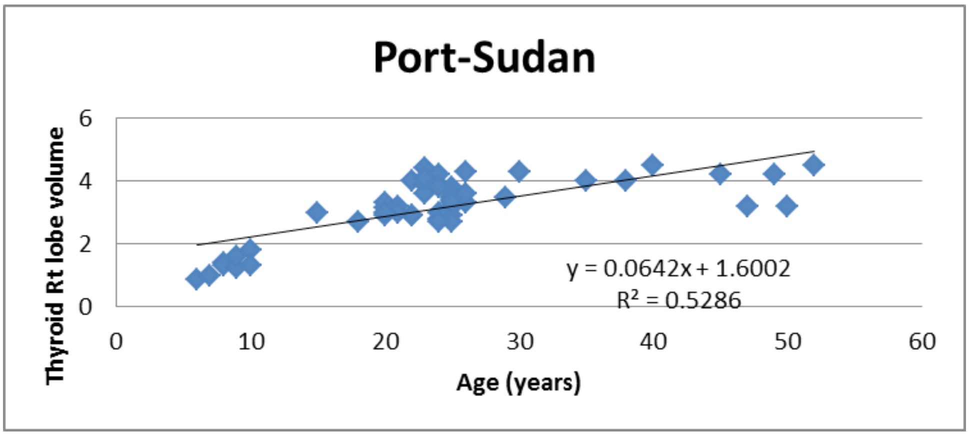


(C)

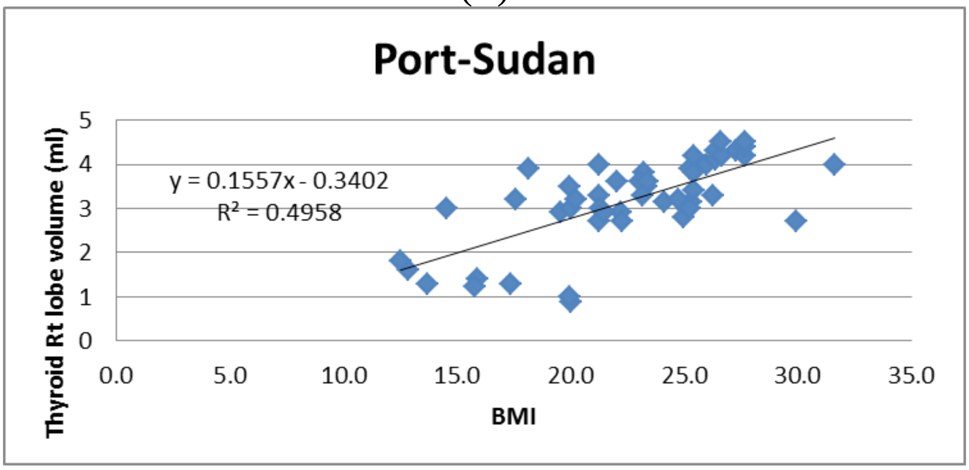
Figure 4-13 scatter plot shows a direct linear relationship of the thyroid isthmus with (A) body height for Port-Sudan sample and for Kordofan sample (B) with body height, and (C) with BMI



(A)

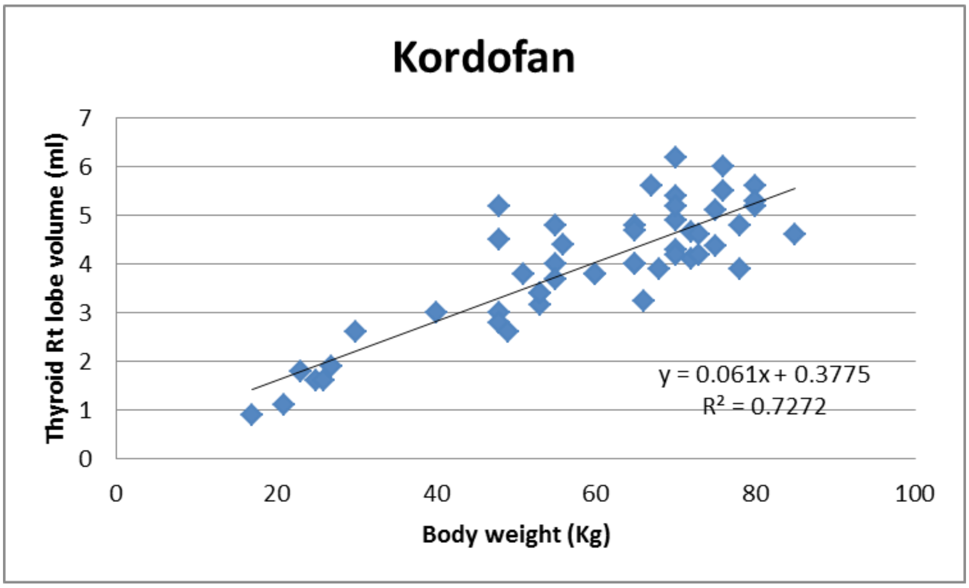


(B)

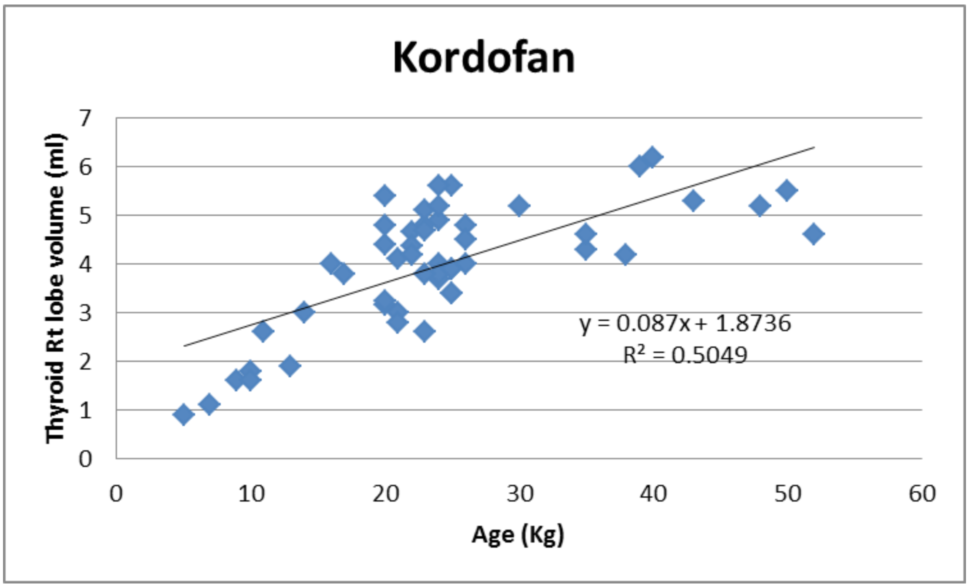


(C)

Figure 4-14 scatter plot shows a direct linear relationship of the thyroid Rt lobe volume with (A) body weight, (B) age and (C) with BMI, for Port-Sudan sample.

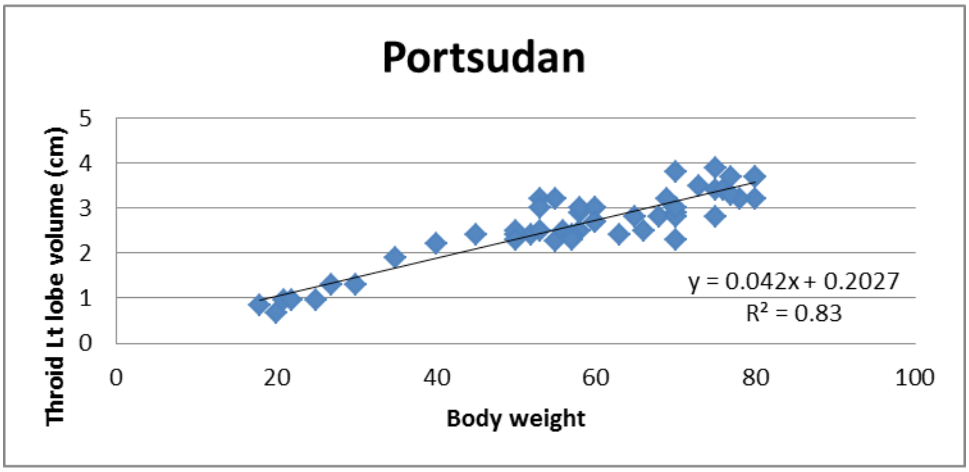


(A)

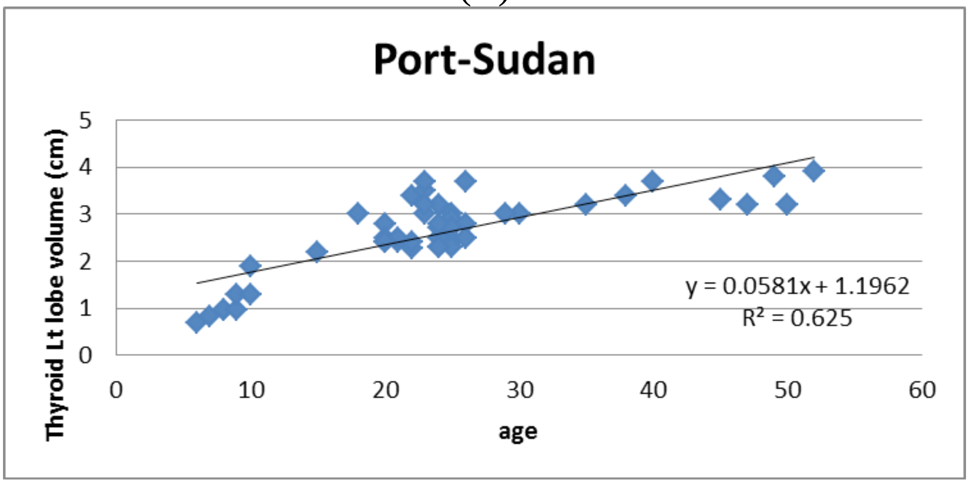


(B)

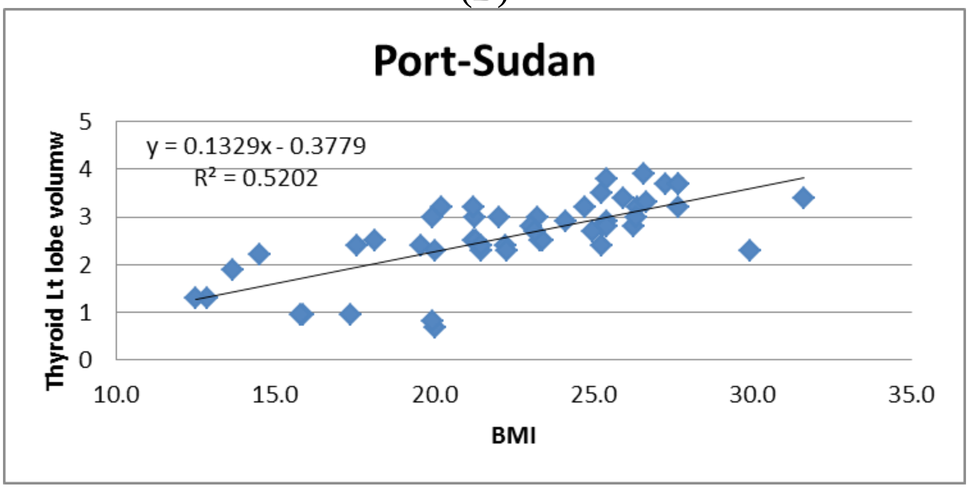
Figure 4-15 scatter plot shows a direct linear relationship of the thyroid Rt lobe volume with (A) body weight, and (B) with age, for Kordofan sample.



(A)

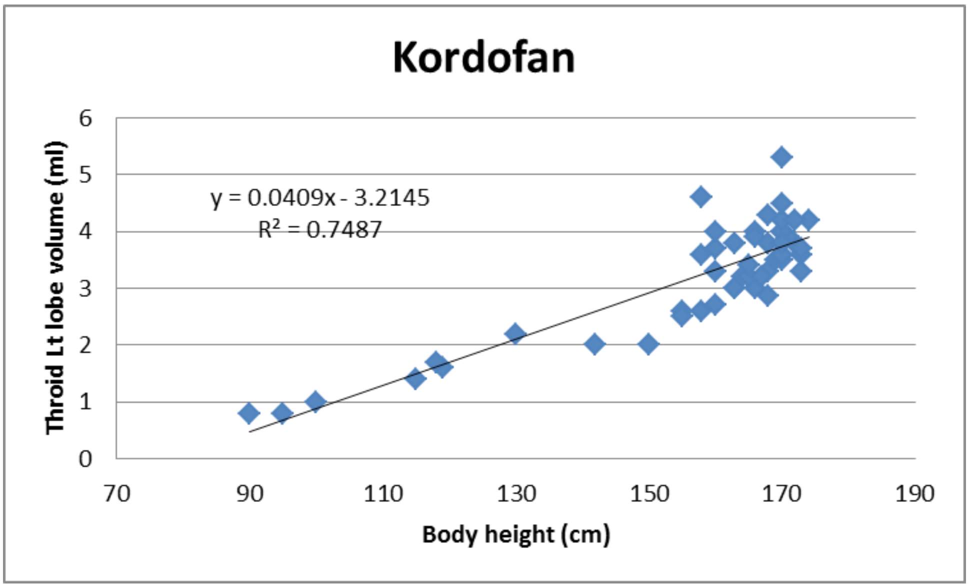


(B)

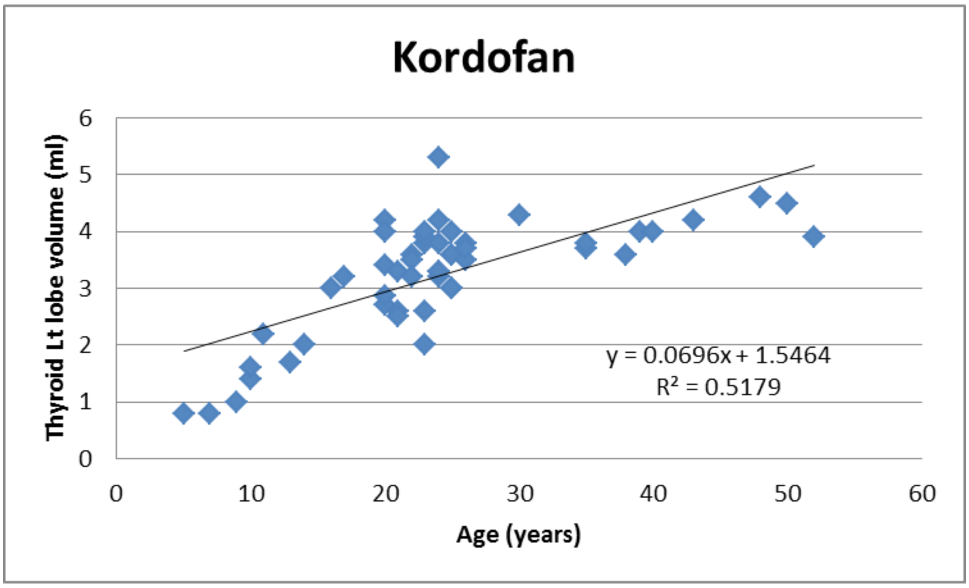


(C)

Figure 4-16 scatter plot shows a direct linear relationship of the thyroid Lt lobe volume with (A) body weight, (B) age and (B) with BMI, for Port-Sudan sample.



(A)



(B)

Figure 4-17 scatter plot shows a direct linear relationship of the thyroid Lt lobe volume with (A) body height, and (B) with age, for Kordofan sample.

Chapter five

Discussion, Conclusion and Recommendations

5-1 Discussion

This study was intended to measure the thyroid dimensions in normal people live in area rich of iodine (Port-Sudan) and in area with low consternation of iodine (Kordofan) to find a normative data for each region and the impact of iodine status in these measurements.

The result of this study showed that, there is a variation in thyroid dimension concerning the length, width, depth and volume of thyroid lobes (Rt and Lt) as well as isthmus between Port-Sudan and Kordofan samples. These differences were generally attributed to Kordofan sample where larger dimension were the issue; this might be due to iodine deficiency (Table and Figure 4-1). These differences were significant at $p = 0.05$ concerning all thyroid parts except the length of the Rt and Lt lobe while isthmus was a border case with a p value equal to 0.05 (Table 4-2). The results also showed slight change between male and female in favor female for Port-Sudan sample (Table 4-3 and Figure 4-2). These differences were inconclusive using t-test at $p = 0.05$; there for booth gender can be treated as one sample (Table 4-4). Similar results also obtained for Kordofan sample between male and female; which mean gender has no role in dimension differences in the same region (Table 4-5, 4-6 and Figure 4-3).

Concerning the differences between the Rt and Lt lobe dimension Port-Sudan sample showed a significant difference between the length, width, depth and volume of thyroid Rt lobe and Lt lobe using t-test at $p = 0.05$ (Table 4-7). Similarly Kordofan sample showed a significant difference between the Rt and

Lt lobe dimension using t-test at p = 0.05 except for the length of the lobe where the difference was inconclusive (Table 4-8).

This study also showed a significant linear association between thyroid lobes dimensions in the two areas with body characteristics (age, body weight, height and BMI); this means the dimensions of thyroid lobes can be predicted using simple and multiple regression equation using these characteristics as independent variable according to the selection of the number of independent variables using stepwise linear regression.

The length of the thyroid Rt lobe in Port-Sudan sample well correlated with body weight and age; i.e. there is a direct linear relationship between these characteristics and length of thyroid Rt lobe; where the length increase by 0.025cm/Kg with body weight and by 0.034 cm/year in respect to age (Figure 4-4 A & b). While for Kordofan sample the length of thyroid Rt lobe well correlated with body weight, age and BMI, therefore the length of thyroid Rt lobe increased by 0.027cm/Kg, 0.042cm/year and by 0.091cm/kg/m^2 for body weight, age and BMI respectively. These increase showed slight increases in Kordofan sample than Port-Sudan one this results goes with the general trend mentioned earlier (Figure 4-5 A, B & C). Thyroid Lt lobe length showed a direct linear relationship with age, body height and BMI, for Port-Sudan sample; it increased by 0.035cm/year of age, 0.023cm/cm of body height and 0.081 for BMI (Figure 4-6, A, B & C). while the thyroid Lt lobe length for Kordofan sample associated with age only, where it shows a direct linear relationship with age and hence the length increased by 0.04cm/year almost similar to Port-Sudan sample (Figure 4-8, A). It is obvious that body weight is not a factor for prediction concerning thyroid Lt lobe length and the common factor was age.

Thyroid Rt lobe width significantly associated with body weight, BMI and age for Port-Sudan sample, similar to the Rt lobe length. The width increases by 0.008cm/Kg, 0.023cm/kg/m^2 and 0.012cm/year, for body weight, BMI and age respectively (Figure 4-7, A, B & C), while for Kordofan sample thyroid Rt lobe width associated with body weight only where the width increased directly by 0.008cm/Kg same as the Rt width for Port-Sudan sample but with larger threshold concerning Kordofan sample; i.e. the starting point of the graph on the y-axis which represent the width (Figure 4-8, B). For Lt lobe in case Port-Sudan sample thyroid width significantly associated in a direct linear relationship with age and body weight; the width increased by 0.012cm/Kg and 0.007cm/years for body weight and age respectively (Figure 4-9, A & B). The relationship in Kordofan sample follows the same essence, where the Lt lobe width associated with body weight and age and hence the width increase by 0.007cm/Kg and 0.012cm/year respectively (Figure 4-10, A & B). Almost in both samples the increases were similar per the effectors.

The depth of thyroid Rt lobe for Port-Sudan sample showed a direct linear relationship with body height where the depth increased by 0.0069cm/cm of body height, Kordofan sample it showed a direct linear relationship with body weight where the depth increased by 0.0053cm/Kg of body weight. The depth for the Rt lobe in both sample depend on different body characteristics (Figure 4-11 A & B). The depth of the Lt lobe for Port-Sudan sample associated with body weight and BMI, where the depth increased by 0.007cm/Kg and 0.02cm/kg/m^2 respectively and for Kordofan sample the depth associated with body weight similar to the Rt lobe where the depth increased by 0.0045cm/Kg (Figure 4-12, A, B & C).

Thyroid isthmus well correlated with body weight for Port-Sudan sample; it increased by 0.0023cm/Kg. While for Kordofan sample there is a direct linear relationship between isthmus with body height and BMI; it increased by 0.002cm/cm of body height and by 0.008cm/kg/m^2 of BMI (Figure 4-13, A, B & C).

The results of thyroid volume which represent a global measure it showed similar relationship with body characteristics. Port-Sudan sample concerning thyroid Rt lobe volume, it showed a direct linear relationship with body weight, age and BMI; the volume increased by 0.049ml/Kg, 0.064ml/years and 0.156ml/Kg/m^2 respectively (Figure 4-14, A, B & C). Kordofan sample showed a direct linear relationship of Rt lobe volume with body weight and age; the volume increased by 0.061ml/Kg and 0.087ml/year (Figure 4-15, A & B). This result dictated that the increased in volume were bigger in Korfofan sample than that of Port-Sudan for the Rt lobe. The volume of the Lt lobe for Port-Sudan sample follow the same pattern as the Rt one where it showed a direct linear relationship with body weight, age and BMI and hence the volume increased by 0.042ml/Kg, 0.058ml/year and 0.132ml/Kg/m^2 respectively (Figure 16, A, B &C). While for Kordofan sample the volume of the Lt lobe showed a direct linear association with body height and age where the volume increased by 0.041ml/cm and 0.07ml/year respectively (Figure 4-17, A & B). Also in respect to age as common factor in case of the Lt lobe volume Kordofan sample showed a larger increases than Port-Sudan sample.

5-2 Conclusion

The main objective of this study was to find a normative measurement of thyroid lobes dimensions as well as to find the effects of iodine presence or deficiency in normal people dimensions. The study consisted of 100 normal cases, 50 from Port-Sudan and 50 from Kordofan. All measurement were done using Toshiba ultrasound machine with 7.5 MHZ linear transducer

The results of this study showed there is no significant differences between male and female in both region while there is a significant differences of thyroid lobe measurement between Port-Sudan sample and Kordofan at p =0.05 using t-test except for the length of the Rt and Lt lobe for both regions.

Thyroid dimensions were significantly bigger in Kordofan sample than Port-Sudan one. Thyroid dimensions showed significant direct linear relationship with the various body characteristics like body weight, height, BMI and age; therefore using linear discriminant analysis multiple regression analysis were generated to estimate thyroid dimension dynamically.

5-3 Recommendation

- Normal thyroid dimensioned for Sudanese should be taken in respect to the area concerning the availability of iodine.
- Normality of thyroid measurement can be estimated using body characteristics as base line for ultrasound measurements.

- Further study can be done for other region in Sudan
- Further study also can be done using similar variable to this study including blood flow indices (PI, RI and PSV) and or thyroid function test (T4, T3 and TSH)

References:

Arthur c. Guyton,M.D and John E.HULL ph.d Text book of medical physiology eleventh edition www.med .uttawa.ca\otolarynology Anatomy coloring book—third edition
WWW.EMEDIONE.COM

Arlen D Meyers, MD, MBA is a member of the following medical societies: American Academy of Facial Plastic and Reconstructive Surgery, American Academy of Otolaryngology-Head and Neck Surgery, American Head and Neck Society

Abdel-Wahab MM, Eltom M, Omer MI, Mukhtar E, Kaballo AM. Prophylaxis nd treatment of endemic goitre in western Sudan with intramuscular iodized oil. Ann Trop Paediatr 2008;4:159-64. PMID:6084463

Ivanac G, Rozman B, Skreb F, Diagnostic ultrasound 3ed edition vol one Elsevier, 2004;28(1):287-91

Donald R. Bernier, Paul E. Christian, James K. Langa, Nuclear Medicine Technology and Techniques, Mosby, 4th edition.

David E., P.A. Vice, F.Clark, The Investigation of Thyroid Disease, The Radiochemical Center Amersham England, P22

Kambal Ali, Endemic Goitre in Darfur Province, M.Sc. Thesis, Faculty of Medicine, University of Khartoum 2009.

Francisco Talavera, PharmD, PhD Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference

Hill, M.A. (2016) Embryology Endocrine - Thyroid Development. Retrieved May 25, 2016, from https://embryology.med.unsw.edu.au/embryology/index.php/Endocrine Thyroid Development

Hassan AM. Studies on simple goiter in Omdurman [dissertation]. Khartoum: University of Khartoum; 2009.

Elnagar B, Eltom M, Karlsson FA, Ermans AM, Gebre-Medhin M, Bourdoux PP. The effects of different doses of oral iodized oil on goiter size, urinary iodine, and thyroid-related hormones. J Clin Endocrinol Metab 2009;80:891-7. doi:10.1210/jc.80.3.891 PMID:7883848

Eltom M. Endemic goiter in Sudan [dissertation]. Uppsala: Uppsala University; 2007.

Frances A. Wier, Cindy L. Farley, CNM, PhD, Clinical Controversies in Screening Women for Thyroid Disorders During Pregnancy, J Midwifery Womens, Health. 2006;51(3):152-158.

Jack DeRuiter ,Endocrine Module (PYPP 5260), Thyroid Section, Spring 2002

Sharp P.F., HG Gemmel and FW Smith, Practical Nuclear Medicine , Third Edition Oril , Springer–Verlag London Limited 2006

Donald R. Bernier, Paul E. Christian, James K. Langa, Nuclear Medicine Technology and Techniques, Mosby, 4th edition.

David E., P.A. Vice, F.Clark, The Investigation of Thyroid Disease, The Radiochemical Center Amersham England, P22

Kambal Ali, Endemic Goitre in Darfur Province, M.Sc. Thesis, Faculty of Medicine, University of Khartoum 2009.

Osman AK, Fatah AA. Factors other than iodine deficiency contributing to the endemicity of goitre in Darfur Province (Sudan). J Hum Nutr 1981;35:302-9. PMID:6168683

Osman AK, Basu TK, Dickerson JW. A goitrogenic agent from millet (Pennisetum typhoides) in Darfur Province, western Sudan. Ann Nutr Metab 2008;27:14-8. doi:10.1159/000176619 PMID:6830139

Appendix:

Appendix A

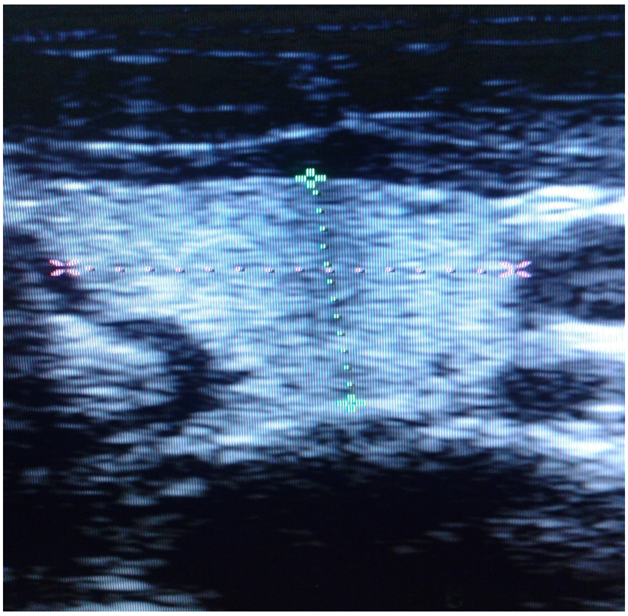
Ri

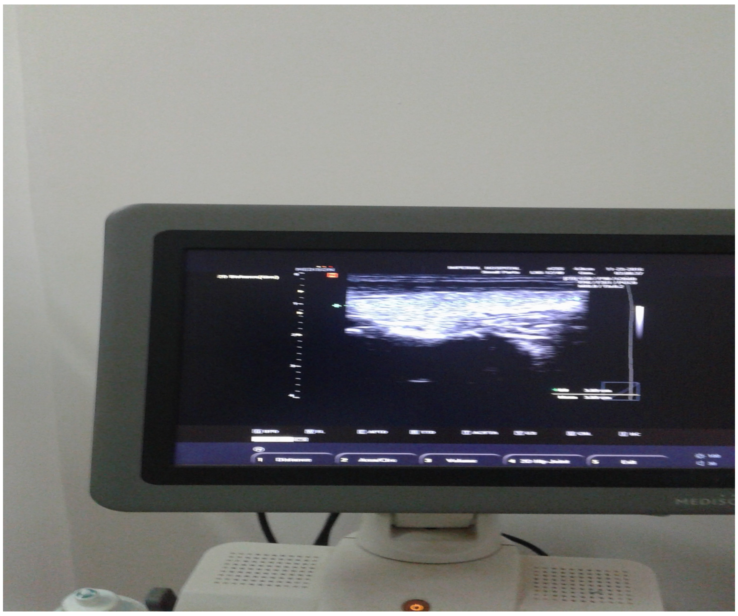
ght lobe measurements depth and width Right lobe measurements of Length

Left lobe measurements depth and width Left lobe measurements of Length

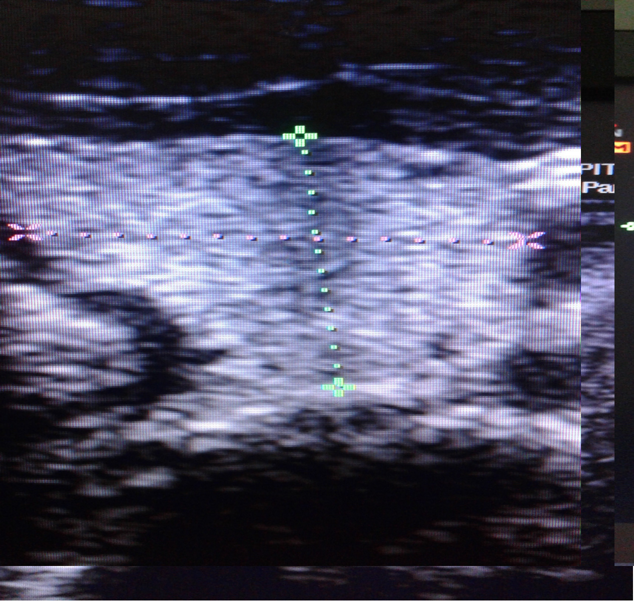
Appendix B

Right lobe measurements depth and width Right lobe measurements of Length





Left lobe measurements depth and width Left lobe measurements of Length



Appendix C:

Right lobe measurements depth and width

Right lobe measurements of Length

Left lobe measurements depth and width

Left lobe measurements of Length