Sudan University of Science and Technology

College of Graduate Studies

Evaluation of Normal Splenic Length in School Age Children using Ultrasonography

تقييم طول الطحال الطبيعي للاطفال في عمر المدرسة باستخدام الموجات فوق الصوتية

A thesis Submitted for Partial Fulfillment of the Requirements of M.Sc. Degree in Medical Diagnostic Ultrasound

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الاية

(وَإِذَا مَرِضْتُ فَهُوَ يَشْفِينِ)

سورة الشعراء الاية (٨٠)

Dedication

To my parents who have never failed to give me financial and moral support, for giving all my need during the time I developed my stem.

To my brother and sisters, who have never left my side.

To my husband (Rafie Banga) for his supporting.

Finally, ask Allah to accept this work and add it to my good works

Acknowledgement

First full of thanks to Allah…

And a lot of thanks and great fullness to my supervisor **Dr. BabikerAbd El Wahab** for his help and guidance…

Abstract

This was a descriptive cross sectional study carried out in AL zaeem Al Azhary privet primary school - Khartoum state and Al hamya primary school in western kurdufan state from November 2016 to March 2017, which aimed to evaluate splenic length in school age children using
Ultrasonography.

There were 85 child (20 males and 24 females) from Khartoum state , and (23 male 21 female) from western kutdufan using, all those children had age ranged from six to thirteen years old and were of normal spleen, any child had age above thirteen years old or had any splenic disorder was excluded from this study.

Trans-abdominal scanning was done for all cases using Fukuda Denshi with curvilinear probe of 2 to 3.5 Megahertz.

Data collected using special data collection sheet designed to evaluate child age, weight, height and splenic length. For analyzing of collected data study used Statistical Package for the Social.

Study resulted that mean weight of children under study from Khartoum was 26.2 ± 7 (Kgs), while the mean weight of children under study from Kordofan was 25.8 ±6.4 (Kgs), mean height of children under study from Khartoum was 1.3 ±0.12 meter, while mean height of children under study from Kordofan was 1.5 ±0.12 meter .mean height of children under study was 1.5 ±1.3 meter .the study resulted that the mean length for khartum child was 8.909±1.072 and for kordufan child 8.561±0.019

Study concluded that there was no liner association between splenic length and age, weight ,height. and there was strong significant correlation between splenic length age ,weight,height in both states

Study recommended that further studies should be done with increased number of cases and introduced other Sudan states

الخلاصة

كانت هذة دراسة وصفية مقطعية أجريت في مدرسة الزعيم الازهري الأبتدائية–ولاية الخرطوم ومدرسة الحامية في ولاية غرب كردفان من نوفمبر ٢٠١٦ الى مارس ٢٠١٧ , والتي تهدف الي تقيم طول الطحال للأطفال في عمر المدرسة باستخدام التصوير بالموجات فوق الصوتية .

كان هناك ٨٥ طفلا (٢٠ذكر و٢٤ انثى) من ولاية الخرطوم , و(٢٣ ذكر ٢١ انثى) من غرب كردفان ,وكان كل هؤلاء الأطفال تتروح أعمارهم بين ٦ الى ١٣ سنه لديهم طحال طبيعي ,واي طفل عمره اكثر من ثلاثة عشر عاما او لديهم مشكال في الطحال تم استبعادهم من هذة الدراسة .

تم اجراء المسح عبر البطن لجميع الحلات باستخدام جهاز فوكودا دينشي مع محول الطاقة من ٢ الى ٣,٥ ميغا هرتز.

البيانات التي تم جمعها باستخدام ورقة جمع البيانات الخاصة المصممة لتقيم عمر الطفل والوزن والطول وطول الطوحال , حللت البيانات باستخدام الحزمة الاحصائية للعلوم الاجتماعية.

قد نتج عن الدراسة ان متوسط وزن الاطفال الخاضعين للدراسة من الخرطوم بلغ ٢٦,٢ ± ٧كيلوغرام,بينما كت متوسط وزن الاطفال في غرب كردفان ٢٥,٨± ٦,٤ كيلوغرام,بلغ طول الاطفال من الخرطوم ١,٣±١,٢ متر وطول الاطفال من غرب كردفان ١,٥ ± ١,٢متر

اظهرت نتائج ان متوسط طول الطوحال لاطفال في ولاية الخرطوم ٧,٩٠٩±١,٠٧٢ وفي ولاية غرب كردفان ٨,٥٦١± 0.019.

خلصت الدراسة الى انه لاتوجد علاقة خطية بين طول الطحال ووزن وعمر وطول الطفل لكن يوجد ارتباط كبير بين طول الطحال وعمر ووزن وطول الطفل.

أوصت هذه الدراسة بضرورة اجراء دراسات بحثية أخرى يتم فيها توسيع الفترة وتشمل بيانات أكثر للحصول على نتائج أكثر دقة.

Table of Contents

List of tables

List of Figures

Introduction

1.1 Introduction:

The spleen is the largest organ in the reticulo endothelial system. Spleen size can be used as an indicator of disease activity in a variety of disorders of the reticulo endothelial system. The spleen responds to different pathologic states by dimensional changes. Malaria and sickle cell disease with a geographical bias are known to cause changes in spleen size, Spleen length varies widely according to age also Many diseases can affect its size, including infections and malignancy.(Lamb P M, 2002)

Childhood is an important period of growth for many organ systems. Among various growth parameters, spleen length is an important parameter used for the clinical evaluation of spleen growth and abnormalities Therefore, having a reliable reference for spleen size in children is valuable.

There are several methods measuring spleen size including abdominal CT and MRI. However, these approaches have disadvantages such as radiation exposures and high costs. In comparison, ultrasonography is a safe for and simple method for evaluating spleen length

In Sudan, There is absence of domestic reference for spleen length as far as we know, no study was published in the open literature, regarding the spleen length for school age children therefore, the importance of this point was to find out the normal length of spleen and to determine its correlation with gender, age, height, weight (Lamb PM, 2002).

1.2 Problem of the study:

Lack of references which demonstrate the normal splenic length values in Sundance children.

1.3 Objectives:

1.3.1 General objective:

To evaluation normal splenic length in school age children using ultrasonography

1.3.2 Specific objectives:

- To show the effect of age and Wight in splenic length
- To correlate the values of splenic length with gender
- To compare results in children splenic length in Khartoum state with Western Kurdufan state.

Chapter Two
Theoretical background and literature review

2.1 Spleen Anatomy

The spleen consists of a large encapsulated mass of vascular and lymphoid tissue

situated in the upper left quadrant of the abdominal cavity between the fundus of the stomach and the diaphragm. Its shape varies from a slightly curved wedge to a domed' tetrahedron

The shape is mostly determined by its relations to neighboring structures during development. The super lateral aspect is shaped by the left dome of the diaphragm with the inferomedial aspect being influenced stomach. Its long axis lies approximately in the plane of the tenth rib. Its posterior border is approximately 4 cm from the mid-dorsal line at the level of the tenth mostly by the neighboring splenic flexure of the colon, the left kidney and thoracic vertebral spine. Its anterior border usually reaches the mid-axillary line.

The size and weight of the spleen vary with age and sex. It can also vary slightly in the same individual under different conditions. In the adult it is usually 12 cm long, 7 cm broad, and 3–4 cm wide. It is comparatively largest in the young child, and although its weight increases during puberty, by adulthood it is relatively smaller in comparison to the neighboring organs. It tends to diminish in size and weight in senescence. Its average adult weight is about 150 g, although the normal range is wide, between 80 g and 300 g, in part reflecting the amount of blood it contains.

The spleen is supplied exclusively from the splenic artery This is the largest branch of the coeliac axis and its course is among the most tortuous in the body. From its origin the artery runs a little way inferiorly, then turns rapidly to the left to run initially horizontally above the level of the neck of the pancreas, before ascending as it passes more laterally. It is less

steeply inclined than the body and tail of the pancreas and so comes to lie posterior to the superior border of the gland. It lies in multiple loops or even coils which appear above the superior border of the pancreas and descend to lie behind the gland.

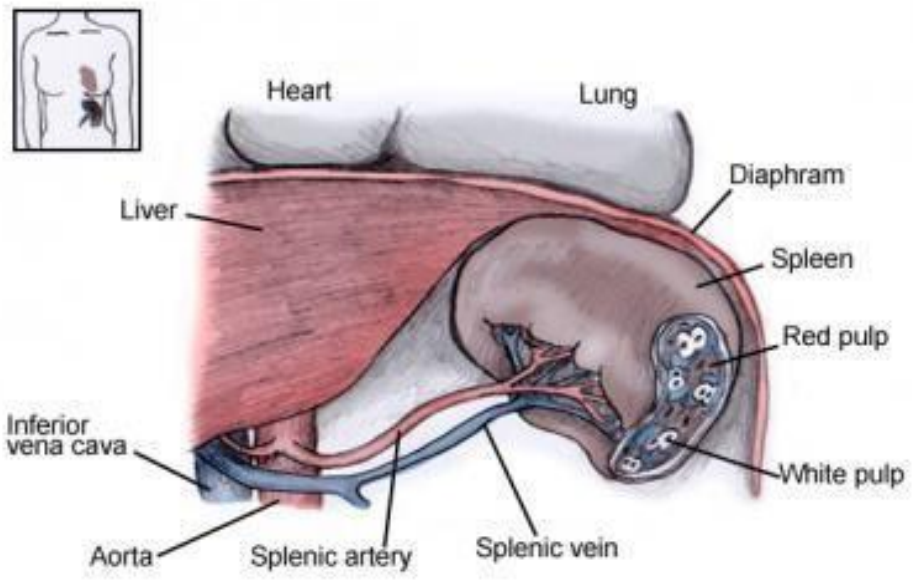
The splenic artery lies anterior to the left kidney and left suprarenal gland and runs in the spleenorenal ligament posterior to the tail of the pancreas. It divides into two or three main branches before entering the hilum of the spleen. As these branches enter the hilum they divide further into four or five segmental arteries that each supply a segment of the splenic tissue. There is relatively little arterial collateral circulation between the segments, which means that occlusion of a segmental vessel often leads to infarctionof part of the spleen. There is, however, considerable venous collateral circulation between the segments, making segmental resection of the spleen practically impossible. The splenic artery gives off various branches to the pancreas in its course and gives off short gastric arteries to the stomach just prior to dividing or from its terminal branches. (Susan Standring,2008)

The splenic vein is formed within the spleenorenal ligament, close to the tip of the tail of the pancreas, by five or six tributaries that emerge from the hilum of the spleen. The tributaries are thin walled and often spread over several centimeters because the hilum is long and thin. This must be remembered during surgical removal of the spleen because the venous tributaries must be divided close to the hilum to avoid injury to the pancreatic tail. They should be ligated in several groups to prevent the risk of avulsion of the veins from the splenic hilum and consequent profuse bleeding before the resection is complete.

The splenic vein runs in the spleenorenal ligament below the splenic artery and posterior to the tail of the pancreas. It descends to the right, and crosses

the posterior abdominal wall inferior to the splenic artery and posterior to the body of the pancreas, receiving numerous short tributaries from the gland as it does so. It crosses anterior to the left kidney and renal hilum and is separated from the left sympathetic trunk and left crus of the diaphragm by the left renal vessels, and from the abdominal aorta by the superior mesenteric artery and left renal vein. It ends behind the neck of the pancreas, where it joins the superior mesenteric vein to form the portal vein. The short gastric and left gastro-epiploic veins drain into the splenic vein through the folds of the gastrosplenic ligament near its origin. (Susan ,2008)

Lymphatic vessels drain along the splenic trabecular and pass out of the hilum into lymphatic vessels that accompany the splenic artery and vein.
They run posterior to the pancreas, close to the splenic artery, and drain into nodes at the hilum and along the splenic artery and into the coeliac nodes. (Susan,2008).



Figure(2-1) spleen Anatomy (Snell,2012)

2.2 Physiology of spleen:

2.2.1 Spleen functions:

The spleen is useful for the production antibodies against antigen present in blood and it is the only organ that performs such functions, Other organs may produce antibodies against antigens seen or present in tissue. The spleen also produces large amounts of B and T lymphocytes through its white pulp. It is the largest site for macrophage aggregations and phagocytic function in the body. It therefore removes old or bad blood cells and platelets and it destroys bacteria and foreign organisms by a process of opsonization and also phagocytosis to include its function of producing antibodies. The spleen stores about 33% of all platelets in the entire body and It is involved in hematopoiesis in the fetus and may be implicated in extra medullary hematopoesis in certain disease conditions in the adult. In addition to these functions the spleen also serves in many lower animals, and to a little extent in man a reservoir for storing up blood which may then be released into circulation when it is required, as in sudden loss of blood etc. (http://www.oluwologunranti.com, 2016.)

2.2.2 Microcirculation in the spleen:

The open system suggests that there is no continuity between the ellipsoids and the sinusoids. Blood from the ellipsoids are discharged into the reticulum of the spleen from where they are absorbed into the sinusoids. The compromise theory which suggests that both mechanisms take place.

The sinusoids make up the red pulp of the splenic pulp. They are connected to the venules as per any of the mechanisms above and from the venules they discharge their blood into the splenic vein. The sinusoids are lined by special endothelial cells which are babana shaped and contain myofibrils that allow them to contract thereby opening up channels by which blood is discharged into the splenic substance. They are called stave cells. Red blood

cell pass through the sinusoidal spaces. When they are old, they are unable to pass across and they are then destroyed by the splenic macrophagic system.

(http://www.oluwologunranti.com, 2016.)

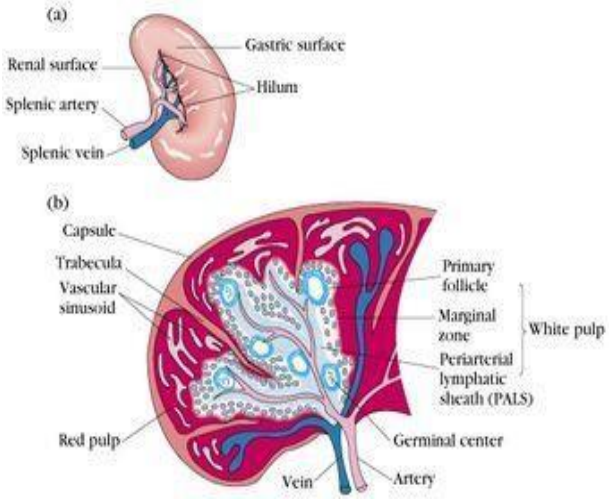


Figure 2.2 Splenic anatomy and physiology (http://www.oluwologunranti.com, 2016.)

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2.3 Ultrasound technique:

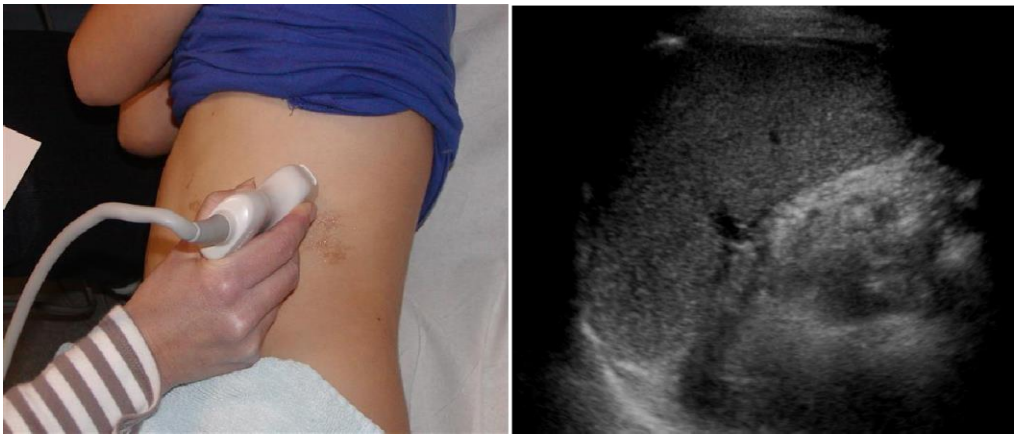
The left upper quadrant may be imaged as the sonographer carefully manipulates the 2.5 MHz curvilinear transducer between costal margins to image the left kidney, spleen, and diaphragm. The sector transducer may fit between the intercostal margins better than the larger curved-array transducer. The spleen generally lies in an oblique pathway in the posterior left upper quadrant; therefore, the transducer may be placed in the intercostal margin and with a slow anterior to posterior sweep may demonstrate the long axis of the spleen.(Sandra,2012).

When the patient is lying supine, the problem of overlying air-filled stomach or bowel anterior to the spleen may interfere with adequate visualization; thus the patient should be rotated into a steep right decubitus position to permit better transducer contact between the ribs without as much bowel interference. The patient should be instructed to raise his or her left arm over his or her head to further open up the intercostal spaces to allow the transducer better access to the spleen. The right lateral decubitus, or axillary, position enables the sonographer to scan in an oblique fashion between the ribs.(Sandra,2012)

Variations in patient respiration may also facilitate imaging of the spleen; deep inspiration causes the lungs to expand with air and displaces the diaphragm; the lungs may expand so fully that the cost phrenic angle is obscured and visualization of the spleen is impeded. The sonographer should observe the patient's breathing pattern and modify the amount of inspiration to adequately image the spleen without interference from the air-filled lungs. At least two images of the spleen should be recorded in the longitudinal and transverse plane.The longitudinal plane should demonstrate the left hemi diaphragm, the superior and inferior margins of the spleen, and the upper pole of the left kidney. The sonographer should

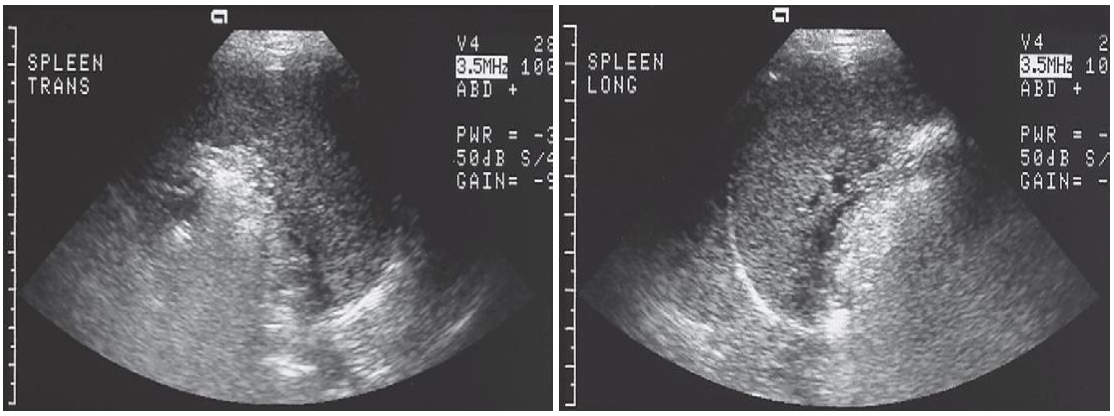
look at the left pleural space superior to the diaphragm to see if fluid is present in the lower costal margin. The long axis of the spleen is measured from its superior-to-inferior border.(Sandra,2012)

After the longitudinal oblique scan is completed, the transducer is rotated 90 degrees to survey the spleen in a transverse plane. The sonographer should obtain at least one transverse image at the hilum of the spleen. The sonographer should observe the flow of the splenic artery and vein with color Doppler. .(Sandra ,2012)



A B

Figure 2.3 (a) Intercostal scan plane(b) Normal spleen. (www.radiologykey.net,2016).



A **B**

Figure 2.4 Normal spleen. Long (**A)** and transverse **(B)** images of the normal spleen. (www.radiologykey.net,2016)

2.4 Ultrasound appearance of the spleen:

The normal spleen has a fine, homogeneous texture, with smooth margins and a pointed inferior edge. The texture of the spleen is actually considered to be more echogenic than that of the liver. As the spleen enlarges, echogenicity further increases. The shape of the spleen has considerable variation. The spleen has two components joined at the hilum: a super medial component and an inferlateral component. On transverse scans, it has a “crescent” inverted comma appearance, usually with a large medial component and a thin component extending anteriorly. This part of the spleen may be seen to indent the fundus of the stomach. Moving inferiorly, only the lateral component is imaged. On longitudinal scans, the superior component extends more medially than the inferior component. The superomedial component or the inferolateral component may enlarge independently. The irregularity of these components makes it difficult to assess mild splenomegaly accurately (Sandra ,2012).

Figure 2.5 shows left coronal view of the normal spleen. (www.radiologykey.net,2016)

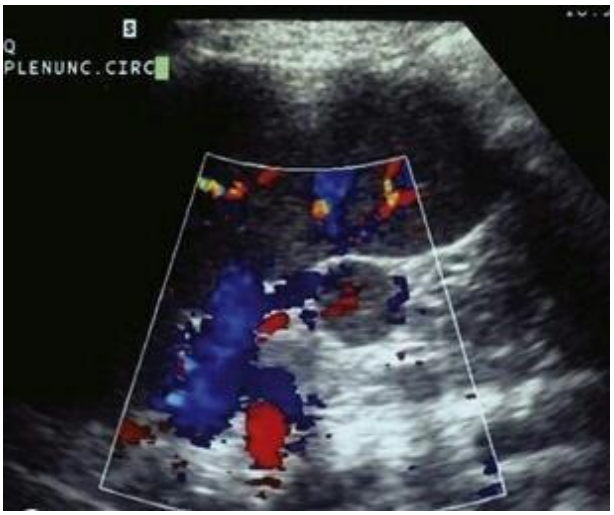


Figure 2.6 The circulation of the splenunculus derives from the main splenic artery and drains into the main spleen vein (www.radiologykey.net,2016)

2.5 Ultrasound measurements:

The spleen is of variable size and shape (e.g., “orange segment,” tetrahedral, triangular) but generally is considered to be ovoid with smooth, even borders and a convex superior and concave inferior surface. The size of a normal spleen depends on gender, age, and body-height. The wide range of what a normal sized adult spleen is, combined with its complex three dimensional shape makes it particularly difficult to establish a normal range of sonographic measurements. (Devin dean,2005)

2.5.1 Measurement for adults:

A study of almost 800 normal adults found that in 95% of patients, the length of the spleen was less than 12 cm, the breadth less than 7 cm and the thickness less than 5 cm. (devin dean,2005)

Measurement technique is illustrated in the following diagram (Fig 2.7)The measurements are obtained by measuring the longest dimension in a sagittal, parasagittal or coronal plane, Thickness on a transverse scan the hilar thickness is measured from the hilum perpendicular to the medial concave surface and the lateral convex surface and width on a transverse scan the width is measured as the greatest dimension perpendicular to the thickness. (devindean,2005)

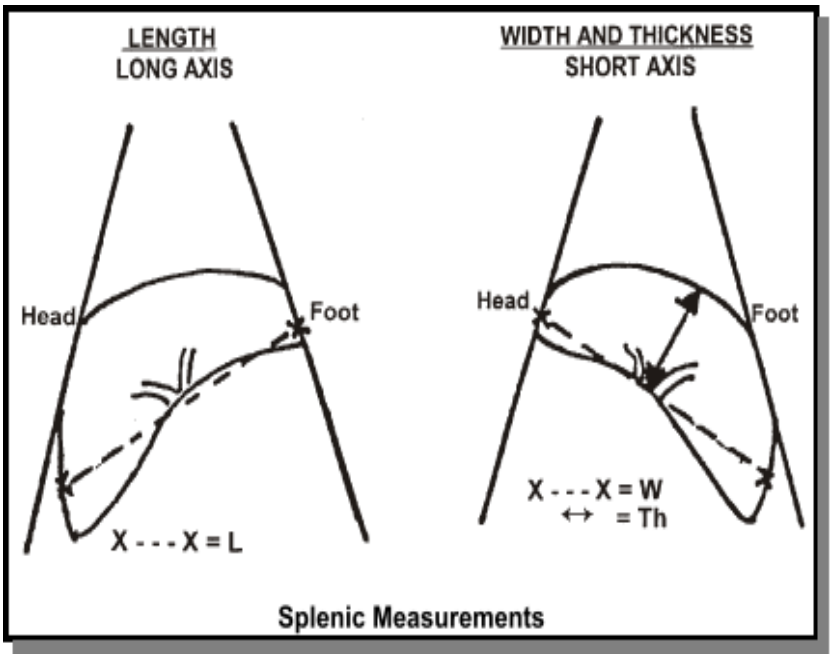


Figure 2.7 Sonographic measurements of the spleen . (Devin dean,2005)

2.5.2 Measurement for children

The protocols to measure the spleen in the children much like they measuring the spleen in the adult. .(Rose bruyn,2005)

Table 2.1 Normal spleen size in 230 infants and children.(Rose bruyn,2005)

	Length of spleen (cm)			
Age (number)	10th percentile	Median	90th percentile	Suggested upper limit
0–3 months (*n* = 28)	3.3	4.5	5.8	6.0
3–6 months (*n* = 13)	4.9	5.3	6.4	6.5
6–12 months (*n* = 17)	5.2	6.2	6.8	7.0
1–2 years (*n* = 12)	5.4	6.9	7.5	8.0
2–4 years (*n* = 24)	6.4	7.4	8.6	9.0
4–6 years (*n* = 39)	6.9	7.8	8.8	9.5
6–8 years (*n* = 21)	7.0	8.2	9.6	10.0
8–10 years (*n* = 16)	7.9	9.2	10.5	11.0
10–12 years (*n* = 17)	8.6	9.9	10.9	11.5
12–15 years (*n* = 26)	8.7	10.1	11.4	12.0
15–20 years (*n* = 17)				
Female	9.0	10.0	11.7	12.0
Male	10.1	11.2	12.6	13.0

2.6 Previous study:

MahaNouri et al (2012) established a local ultrasonic splenic length which can be used as reference for Sudanese healthy school age children.This study conducted in 215 (104 males, 111 females) healthy school-aged Sudanese children (7–13 years) and the results showed that there is significant relation between spleen length and age, weight, height and BMI. The mean length of the spleen was found to be 9.5-10.4cm.There was significant difference between the spleen length in males and females (Pvalue 0.000), the mean length of spleen in females is greater than in males

Stylianos D. Megremis et al (1996_2001) investigated with ultrasonography (US) normal spleen length in healthy children. The study comprised 512 Greek children 274 girls and 238 boys) with ages ranging from 1 day (full- term neonate) to 17 years. The results showed that Spleen length was highly correlated with age, height,andweight,;there was no statistically significant difference between the sexes. The exact pattern of these relationships was nonlinear (polynomial type of third order for age, height, and weight). Multiple regression analysis indicated that age, height, and either weight or BSA had significant positive associations with spleen length. The spleen lengths among the sample of 58 children whose height and weight were outside the normal ranges of growth parameters did not influence the proposed upper limits (almost all were within the 90% UCLs with respect to height and weight for the mainsample).

HusamEldinYassien(2015-2016) measured the normal spleen in Sudanese school age children using ultrasound. The study conducted in 120 (55 males,65 females) healthy school-aged Sudanese children (6-15) year and the results showed that there is no obvious difference in measurements between female and male and there is statistically significant correlation between age and the spleen length.

Study done by **SharifaSuliman**in 2017 the aim of the study is toMeasure the Normal Spleen in Primary School Age using Ultrasonographconducted in(151 children 80 F and 71 M)And the result showed A significant relation was found between spleen measurements and age, weight, height and body mass index, also a significant difference between the spleen measurements in males and females was found with the mean spleen measurements in males is greater than infemales.

Chapter Three
Methodology

3.1 Design of the study:

This was a descriptive study designed to measure spleen length in Sudanese children using B-mode ultrasonography.

3.2 Population of the Study:

The study included volunteers in ages of6-13 years of both genders with no morphological abnormalities or other pathology.

3.3 Sample size and type:

The sample of this study consist of 85 volunteers, 44 volunteer from Khartoum state (20 male and 24 female), and 41 volunteers from western Kurdufan state (23 male and 21 female).

3.4 Study area and Duration:

This study have carried out in Khartoum state and western Kurdufan state, In Khartoum state the data collected at Alzaeem Alazhary private primary school, in western Kurdufan, the data collected In Babanusa city at Alhamya primary school. The data collected during period from November to March2017

3.5 Inclusion criteria:

Allhealthy males and femalesSudanese children with normal spleen position, shape and echo texture from 6 to 13 years old

3.6 exclusion criteria:

Any abnormal spleen position, shape and echo texture, children affected with malaria, malignant spleen diseases, benign spleen conditions, traumatic spleen or any other spleen pathology was excluded

3.7 Equipments:

The data collected by Fukuda Denshi Ultrasound machine, using curve linear transducers, frequencies of 2.5 - 5 MHz have

3.8 Technique:

The spleen was examined with real time curvilinear transducer in sagittal and transverse planes, proper time gain compensation ,frequency, overall gain and depth were used and the procedure was explained to the children. Each individual was examined in right lateral decubitus position and in order to make the examination more transparent, inspiration was used, also a reasonable amount of coupling gel was applied to the desired area to make good contact between the probe and the skin surface to prevent the total reflection of ultrasound beam back to the probe surface due to mismatching and to allow free movement of the transducer face over skin, then the probe was placed along the lower left costal margin from the ninth to eleventh ribs, parallel with the intercostal spaces which was used as a scan window and Splenic Length(the maximum distance between the dome of the spleen and the splenic tip) was taken in a sagittal plane

3.9 Data collection:

The data was collected using data collecting sheet design especially for the study which includes the following variables:

Child's weight, age, gender, height, spleen length,

3.10 Method of data analysis:

The data analyzed using SPSS and EXIL under windows, by finding the correlation, liner association and significant differences between spleen length a and age, gender, height, weight, BMI and geographic area.

3.11 Ethical Clearance:

Permission of departments and at the area of the study granted as well as volunteers parents' permission to use the collected data for scientific purposes; volunteers' details will not be disclosed.

Results

Table (4.1) Frequency distribution of age for children in Khartoum state

Age	Frequency	Percent	Valid Perce	Cumulative
6	9	20.5	20.5	20.5
7	11	25.0	25.0	45.5
8	7	15.9	15.9	61.4
9	5	11.4	11.4	72.7
10	8	18.2	18.2	90.9
11	4	9.1	9.1	100.0
Total	44	100.0	100.0	
Minimum = 6,maximum= 11,mean=8.0909,std deviation=1.66				

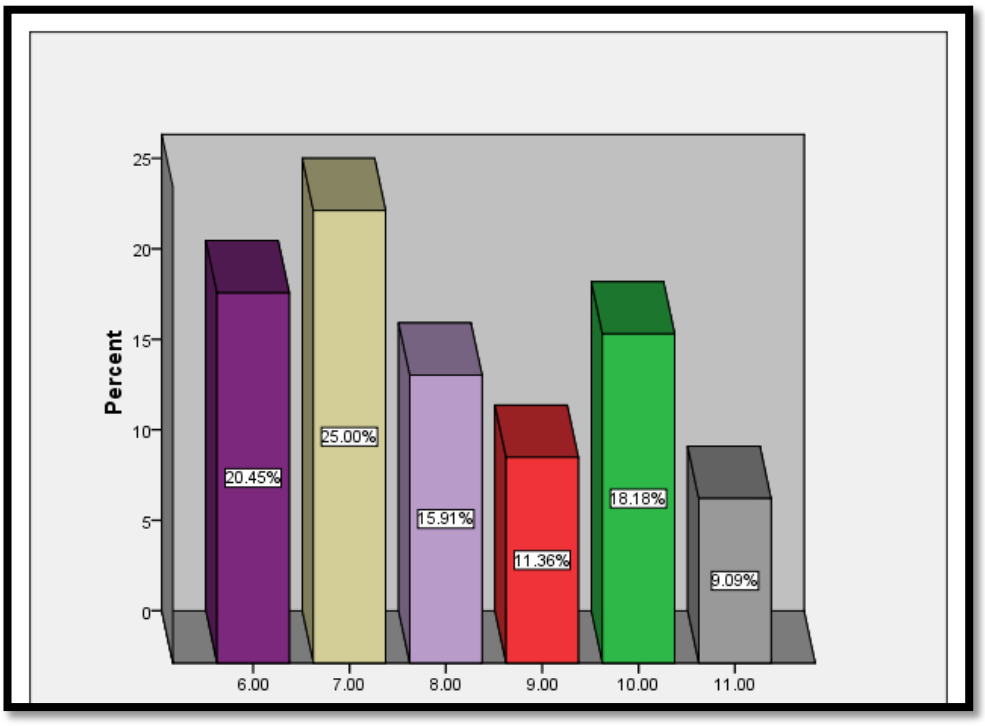


Figure (4.1): shows frequency distribution of age of children in khartoum

Table (4.2) Frequency distribution of gender for children in Khartoum state

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	24	54.5	54.5	54.5
Male	20	45.5	45.5	100.0
Total	44	100.0	100.0	

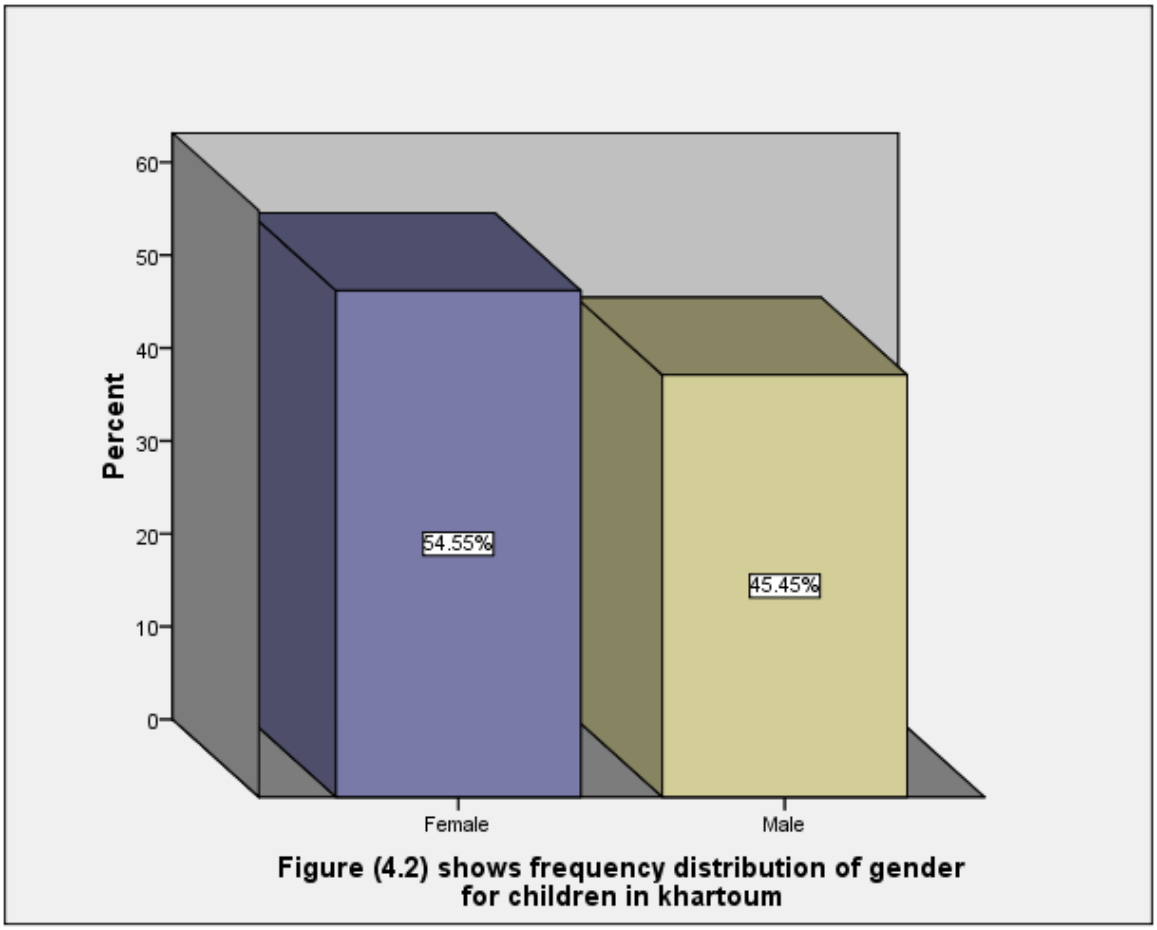


Figure (4.2) shows frequency distribution of gender for children in khartoum

Table (4.3) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleen in Khartoum state

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Weight of children	44	17	49.1	26.1909	6.99295
Height of children	44	1	1.48	1.2718	0.11618
Length of spleen	44	5.8	9.9	7.9091	1.07288
Valid N (listwise)	44				

Table (4.4) correlation between age, weight, height of children and length of spleen in Khartoum state

		Age	weight	Height	Length
Age of children	Pearson Correlation	1	.702**	.833**	.612**
	Sig. (2-tailed)		0	0	0
	N	44	44	44	44
Weight of children	Pearson Correlation	.702**	1	.747**	.657**
	Sig. (2-tailed)	0		0	0
	N	44	44	44	44
Height of children	Pearson Correlation	.833**	.747**	1	.569**
	Sig. (2-tailed)	0	0		0
	N	44	44	44	44
Length of spleen	Pearson Correlation	.612**	.657**	.569**	1
	Sig. (2-tailed)	0	0	0	
	N	44	44	44	44
**. Correlation is significant at the 0.01 level (2-tailed).					

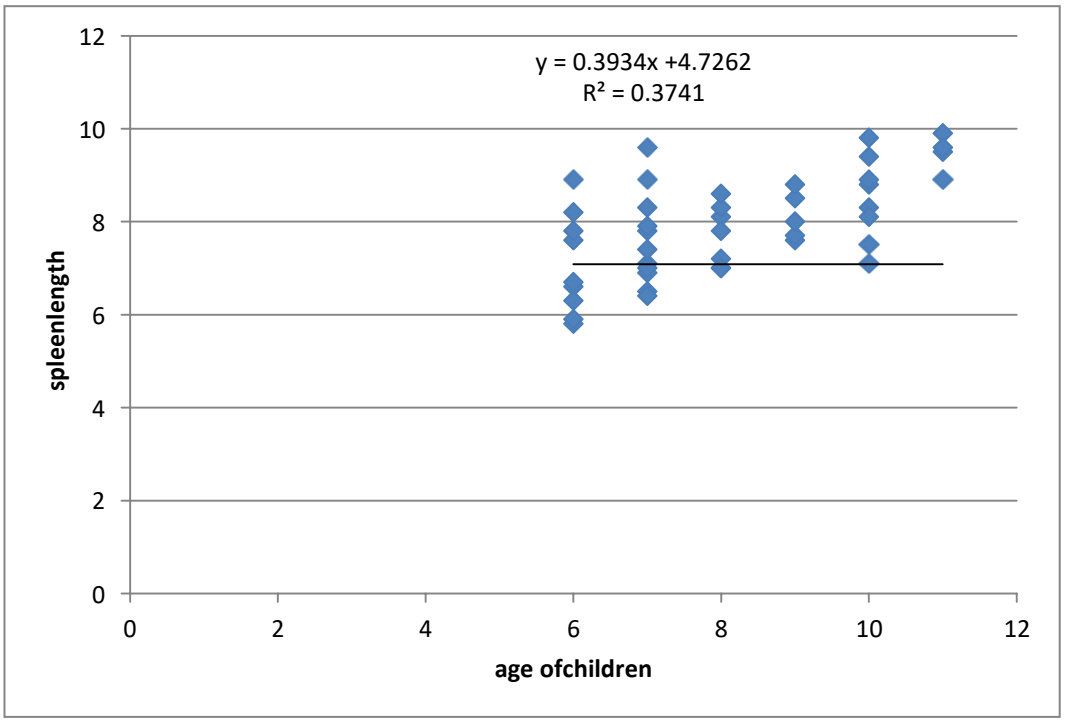


Figure (4.3) scatter plot shows relationship between spleen length and age of children in Khartoum state

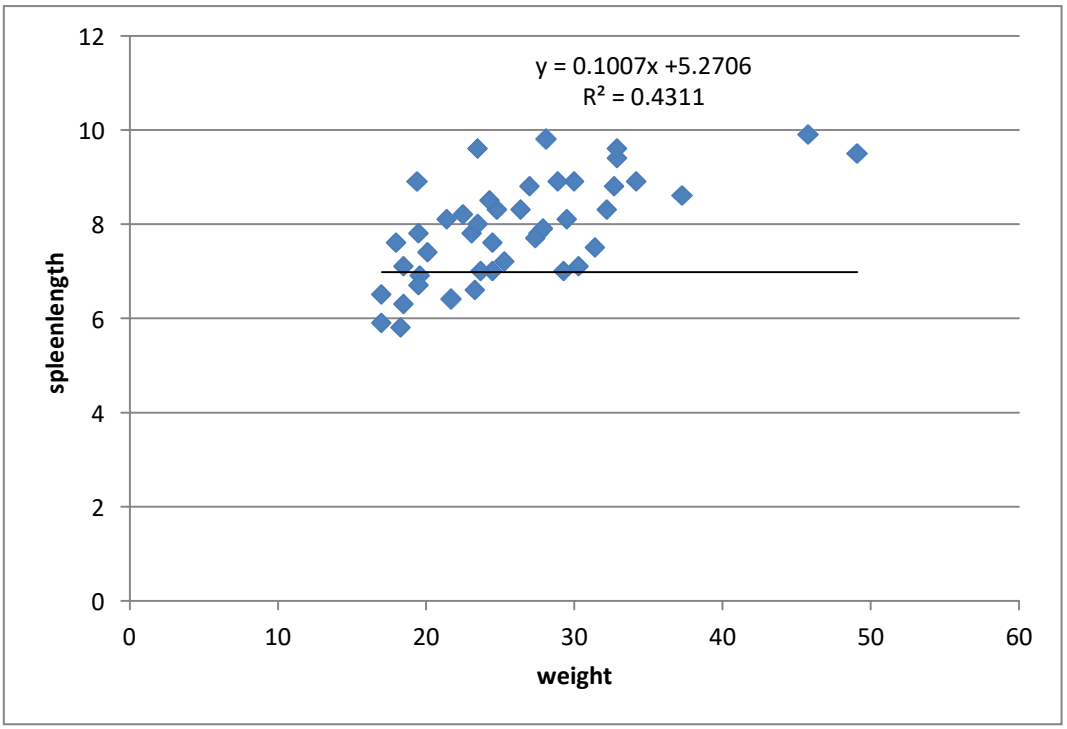


Figure (4.4) scatter plot shows relationship between spleen length and weight of children in Khartoum state

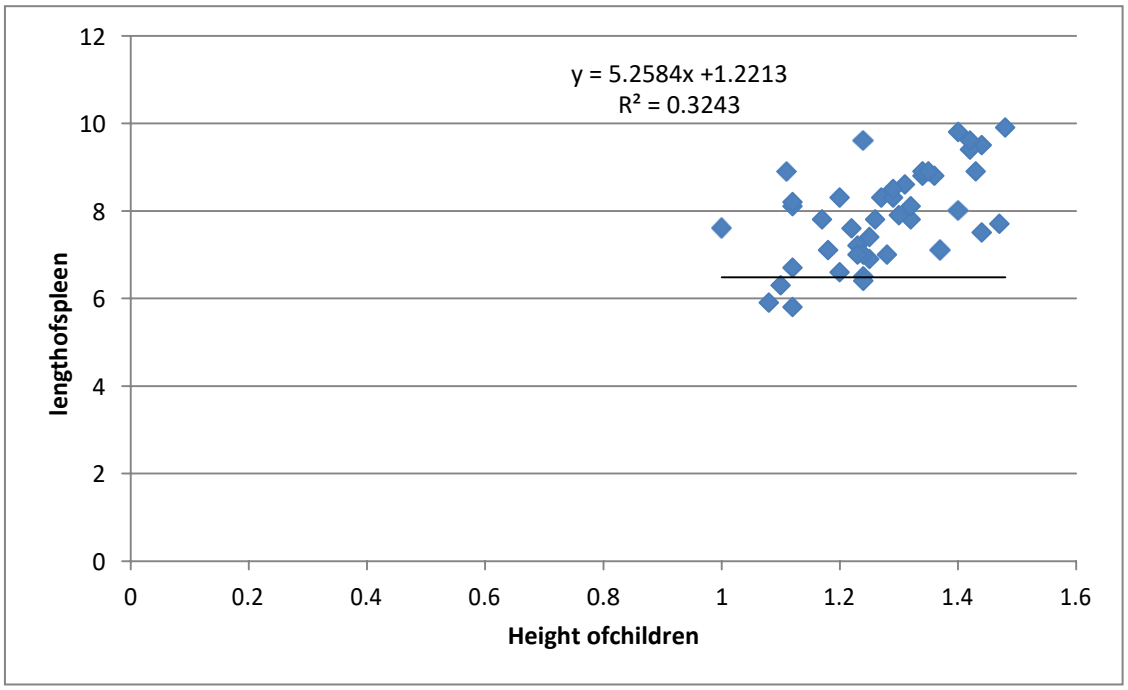


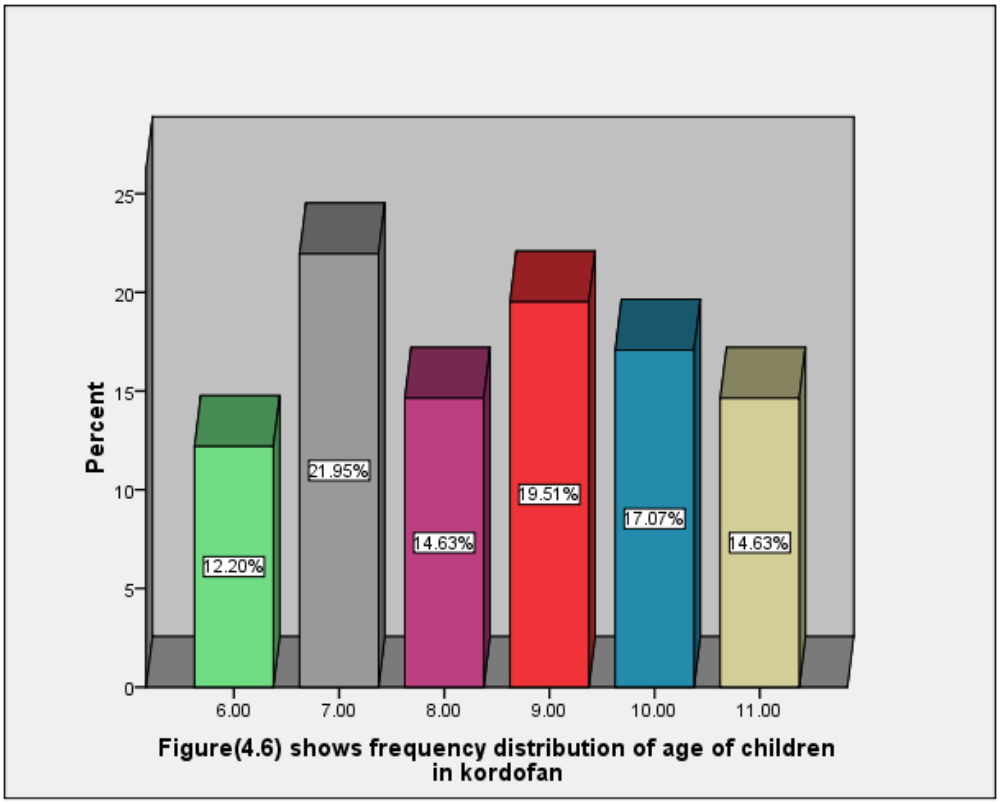
Figure (4.5) scatter plot shows relationship between spleen length and height of children in Khartoum state

Table (4.5) Frequency distribution of age for children in Kordofan state

Age	Frequency	Percent	Valid Percent	Cumulative Percent
6	5	12.2	12.2	12.2
7	9	22	22	34.1
8	6	14.6	14.6	48.8
9	8	19.5	19.5	68.3
10	7	17.1	17.1	85.4
11	6	14.6	14.6	100
Total	41	100	100	
Minimum =6,maximum=11,mean= 8.5122,Std.Deviation=1.64502				

Table (4.6) Frequency distribution of gender for children in Kordofan state

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	21	51.2	51.2	51.2
Male	20	48.8	48.8	100
Total	41	100	100	



Figure(4.6) shows frequency distribution of age of children in kordofan

Table (4.7) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleen in Kordofan state

		Age	weight	Height	length
Age of children	Pearson Correlation	1	.875**	.456**	.615**
	Sig. (2-tailed)		0	0.003	0
	N	41	41	41	41
Weight of children	Pearson Correlation	.875**	1	.480**	.655**
	Sig. (2-tailed)	0		0.001	0
	N	41	41	41	41
Height of children	Pearson Correlation	.456**	.480**	1	0.013
	Sig. (2-tailed)	0.003	0.001		0.934
	N	41	41	41	41
Length of spleen	Pearson Correlation	.615**	.655**	0.013	1
	Sig. (2-tailed)	0	0	0.934	
	N	41	41	41	41
**. Correlation is significant at the 0.01 level (2-tailed).					

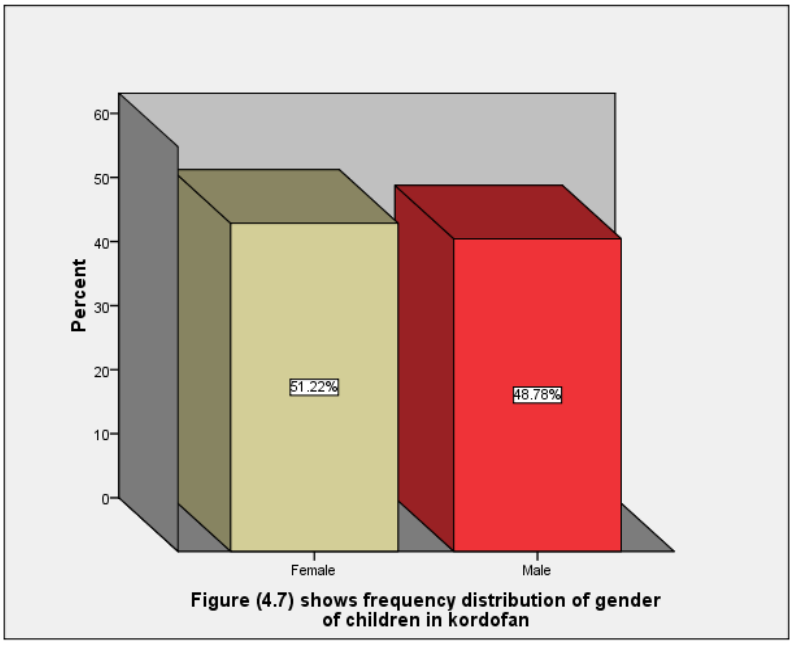


Figure (4.7) shows frequency distribution of gender of children in kordofan

Table (4.8) correlation between age, weight, height of children and length of spleen in Kordofan state

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Weight of children	41	16	40	25.7561	6.39445
Height of children	41	1.12	1.9	1.3237	0.14205
Length of children	41	6.4	10	8.561	0.91921
Valid N (listwise)	41				

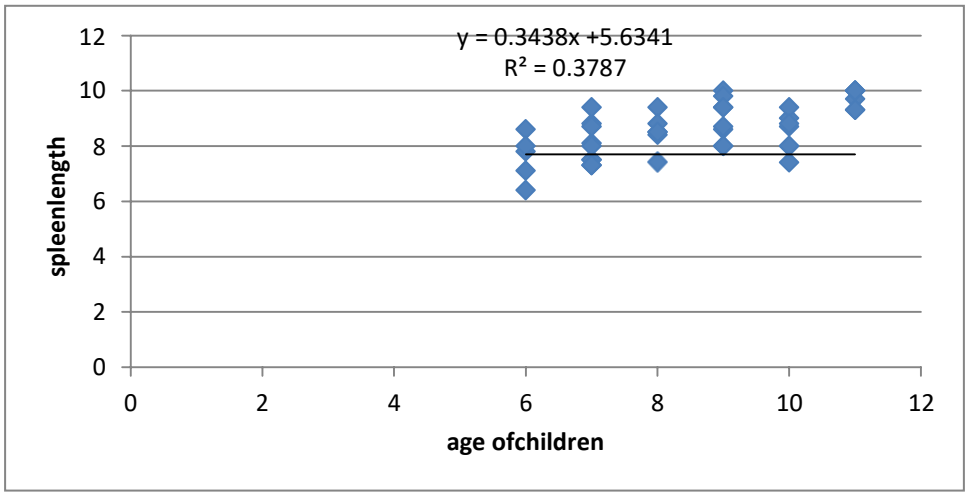


Figure (4.8) scatter plot shows relationship between spleen length and age of children in Kordofan state

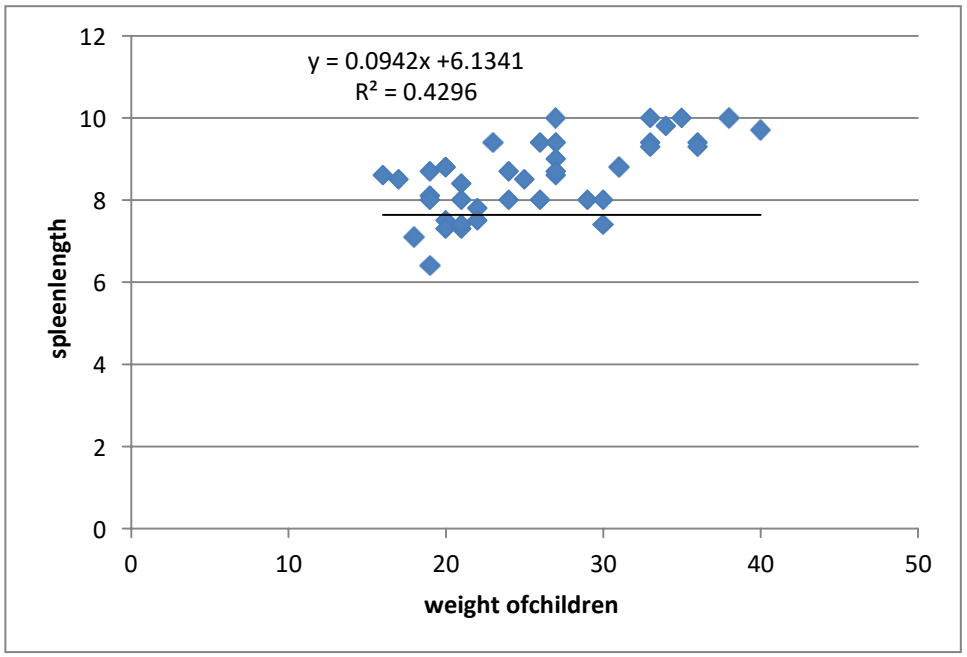


Figure (4.9) scatter plot shows relationship between spleen length and weight of children in Kordofan state

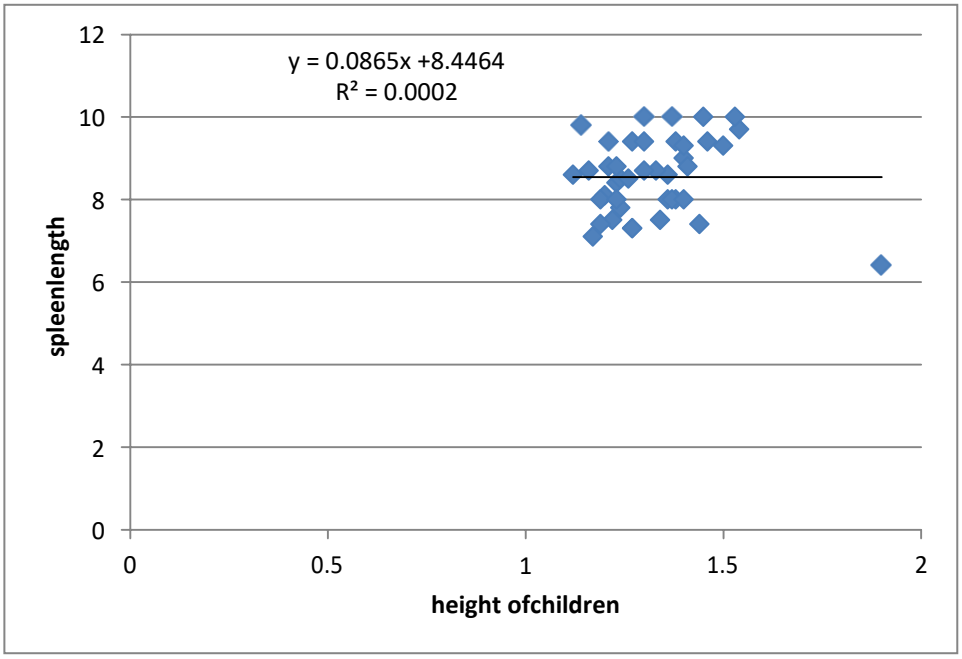


Figure (4.10) scatter plot shows relationship between spleen length and height of children in Kordofan state

Table (4.9) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleenfor female in Khartoum state

Variable	N	Minimum	Maximum	Mean	Std. Deviati
Age	24	6.00	11.00	8.2083	1.69344
Weight	24	17.00	49.10	26.8167	8.23533
Height	24	1.00	1.48	1.2746	.12339
Length	24	5.80	9.90	7.7125	1.03138
Valid N (listwise)	24				

Table (4.10) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleenfor male in Khartoum state

Variable	N	Minimum	Maximum	Mean	Std. Deviati
Age	20	6.00	11.00	7.9500	1.66938
Weight	20	17.00	34.20	25.4400	5.24258
Height	20	1.08	1.42	1.2685	.10999
Length	20	5.90	9.80	8.1450	1.09999
Valid N (listwise)	20				

Table (4.11) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleenfor female in Kordofan state

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age	21	6.00	11.00	8.6190	1.62715
Weight	21	16.00	40.00	26.3333	6.61312
Height	21	1.12	1.90	1.3276	.17108
Length	21	6.40	10.00	8.8857	.87937
Valid N (listwise)	21				

Table (4.12) Minimum, maximum, mean and Std. Deviation for weight, height of children and length of spleenfor male in Kordofan state

Variable	N	Minimum	Maximum	Mean	Std. Deviati
Age	20	6.00	11.00	8.4000	1.69830
Weight	20	17.00	38.00	25.1500	6.26834
Height	20	1.17	1.53	1.3195	.10787
Length	20	7.10	10.00	8.2200	.85199
Valid N (listwise)	20				

Table (4.13) Means for weight, height of child and splenic length with age comparing between kordofan and Khartoum state

State	Age	No	Weight	Height	Length
Khartoum	6	9	19.55+_2.07	1.11+_0.0559	7.0889+_1.082
Kordofan		5	19.2000+_2.38	1.32+_0.32	7.58+_0.849
Khartoum	7	11	24.69_+5.85	1.25+_0.04834	7.618+_1.004
Kordofan		9	20.33+_1.4	1.23+_0.052	8.066+_0.75332
Khartoum	8	7	25.72+_5.26	1.237+_0.058	7.71+_0.65429
Kordofan		6	21.666+_3.32	1.25+_0.0653	8.500+_0.6511
Khartoum	9	5	25.34+_1.744	1.348_+0.0968	8.12_+0.5167
Kordofan		8	28.12+_3.482	1.300+_0.0742	8.9875_+0.775
Khartoum	10	8	30.02+_2.2606	1.366+_0.05125	8.4875+_0.91875
Kordofan		7	29.57+_3.69	1.40_+0.0419	8.4714+-0.6945
Khartoum	11	4	39.4500+_9.41	1.4425+_0.0263	9.475+_0.41932
Kordofan		6	35.833_+2.786	1.465+_0.07007	9.716+_0.343

Table (4.14) show the mean measurements values of spleen length in males and female in khartoum state

		Spleen Length					Total
		6	7	8	9	10	
Gender	Female	3	7	8	4	2	24
	Male	2	3	8	4	3	20
Total		5	10	16	8	5	44

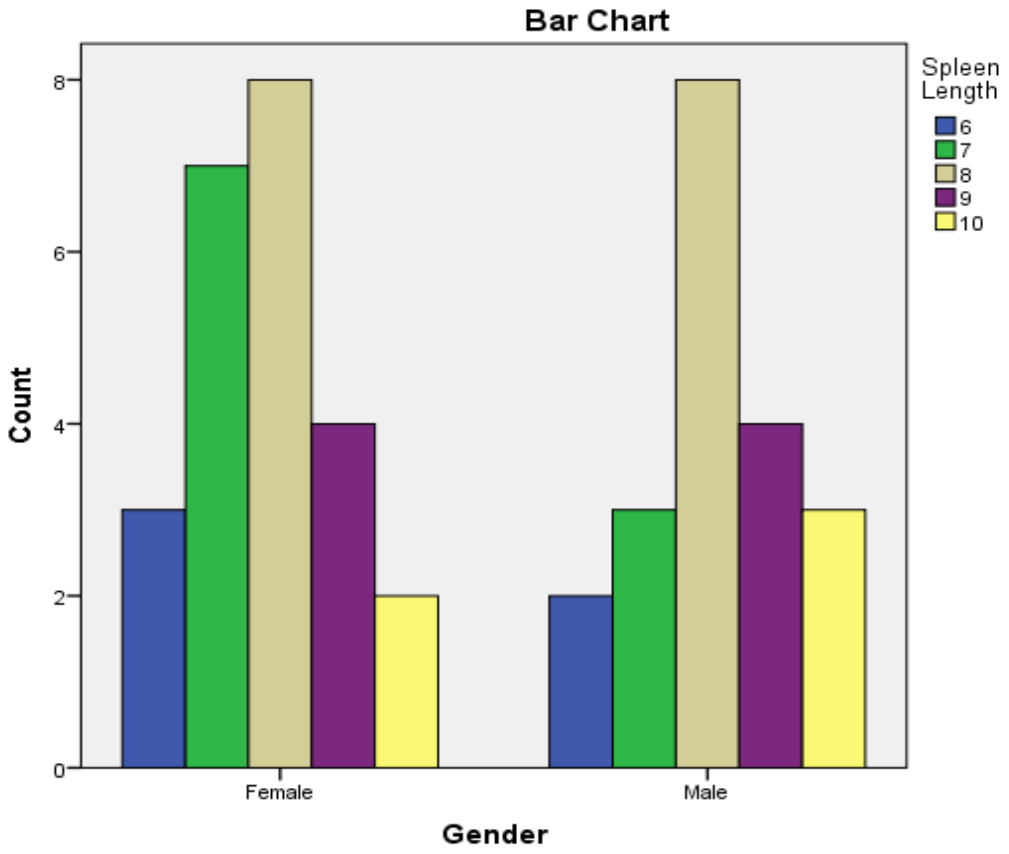


Figure (4.11):show the mean measurements values of spleen length in males and female in khartoum state

Table(4.15):show the mean measurements values of spleen length in males and female in kurdofan state

	Spleen Length					Total
	6	7	8	9	10	
Female Gender	1	0	3	13	4	21
Male	0	5	9	4	2	20
Total	1	5	12	17	6	41

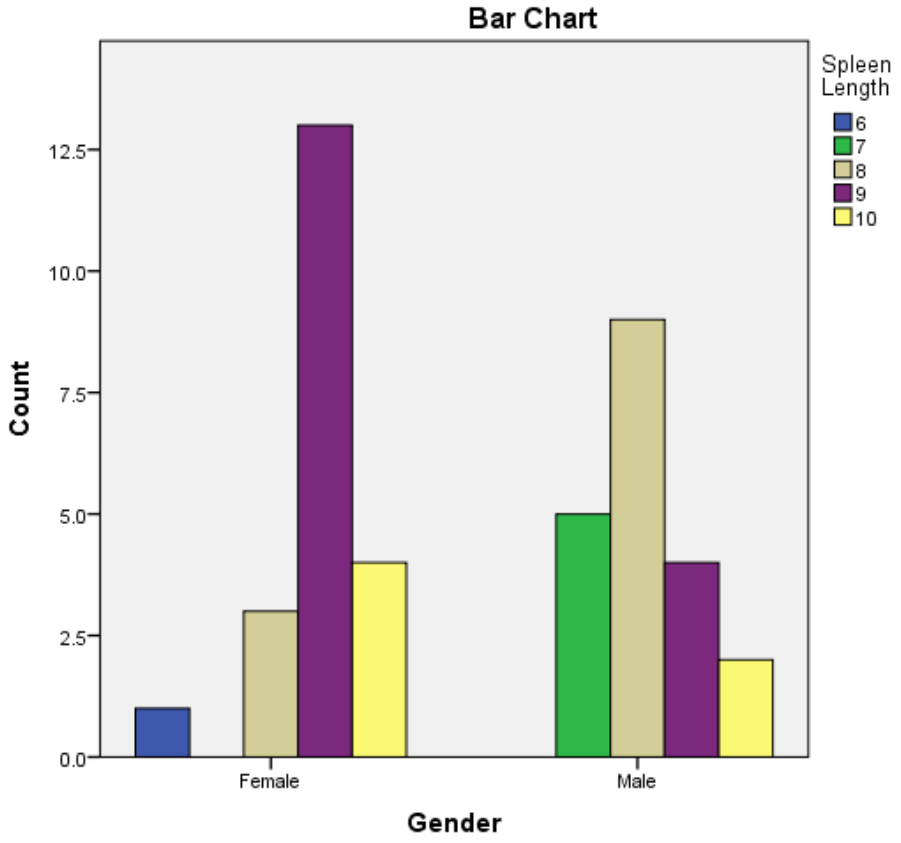


Figure (4.12):show the mean measurements values of spleen length in males and female in kurdofan state

Chapter Five

Discussion, Conclusion and Recommendations

5.1 Discussion:

Table 4.1 show frequency distribution of age for children in Khartoum state were the children with 7 years was more frequently then children with 6 years, and the children with 11 years was less frequently 4 times as shown in fig4.1.

Table 4.2 show gender frequencies for all patients were the female represent 54.5% and the male 45.5% as shown in figure 4.2.

Table 4.3 show statistical parameters of children in Khartoum state in Mean ± SD for weight 26.19±6.99 Kg, for the high 1.27±0.11 cm and the length of spleen 7.9±1.07 cm.

Figure 4.3 show correlation between spleen length and age of children in Khartoum state were the relation value (R^2=0.37) show moderate relation which agreed with study done by MahaNouri et al, with HusamEldinYassien and Stylianos D. Megremis et al.

Figure 4.4 scatter plot show correlation between spleen length and weight of children in Khartoum state were the relation value (R^2= 0.43) show moderate relation which agreed with study done by MahaNouri et al and with Stylianos

D. Megremis et al.

Figure 4.5 show scatter plot for correlation between spleen length and high of children in Khartoum state were the relation value (R^2= 0.32) show moderate relation which agreed with study done by MahaNouri et al and Stylianos D. Megremis et al.

Table 4.4 show correlation between age and weight and high of children in Khartoum state were the p.value (0.000) show a significant difference between age, weight, high and spleenlength.

Table 4.5 show frequency distribution of age for children in Kurdufan state were the children with 7 years was more frequently (9 times) and the children with 6 years was less frequently 6 times as shown in fig 4.6.

Table 4.6 show gender frequency for all patients in kurdfan state were the female represent 51.2% and the male 48.8% as shown in figure 4.7.

Table 4.7 show statistical parameters of children in Kurdufan state in Mean ± SD for weight 25.75±6.39 Kg, for the high 1.32±0.14 cm and the length of spleen 8.56±0.91 cm.

Figure 4.8 show correlation between spleen length and age of children in Kurdufan state were the relation value (R^2=0.37) show moderate relation our result agreed with Stylianos D. Megremis et al andMahaNouri et al.

Figure 4.9 scatter plot show correlation between spleen length and weight of children in Kurdufan state were the relation value (R^2= 0.42) show moderate relation our result agreed with Stylianos D. Megremis et al and MahaNouri et al.

Figure 4.10 show scatter plot for correlation between spleen length and high of children in Kurdufan state were the relation value (R^2= 0.002) show very weak relation which dis agree with the result of Stylianos D. Megremis et al and MahaNouri et al this is almost due to sample variation.

Table 4.8 show correlation between age and weight and high of children in Kurdufan state were the p.value (0.000) show a significant difference between age, weight, high and spleen length, except length of spleen with high was no significant difference (p.value=0.934)

The study found that there is significant difference was detected between males and females in spleen measurements with the mean measurements values of spleen length in males are greater than females as seen in Table (4.14),(4.15) and figures (4.11) and(4.12).this result agreed with study done by SharifaSuliman and disagreed with MahaNouri et al, and this mainly due to increase weight infemale

5.2 Conclusion:

This study made among 85 healthy volunteers in ages ranged from 6-13 years old in two different states in Sudan. The data collected in data collecting sheet. The mean length for khartum child with stander div.909+-1.072 and for kordufan child8.561+_0.019.

The study found that there was no linear association between splenic length and age ,weight and height.

The study found that there was strong significant correlation between splenic length and age ,weight and height.

5.3 Recommendations:

- All health care centers and pediatric clinics must be provided by ultrasound units.
- Every child should be examined once by ultrasound as routine to observe internal organs growth during childhood.
- In the Sudan there are different types of races, and this may affect different organs measurements, there for further studies should be done for these variables including different areas and tribes in the Sudan, and in Sudanese adult population.
- The splenomegaly in all ultrasound clinics detected just by the length measurement of the spleen, but the spleen measurements must include the width and the thickness to get the splenic volume and weight.

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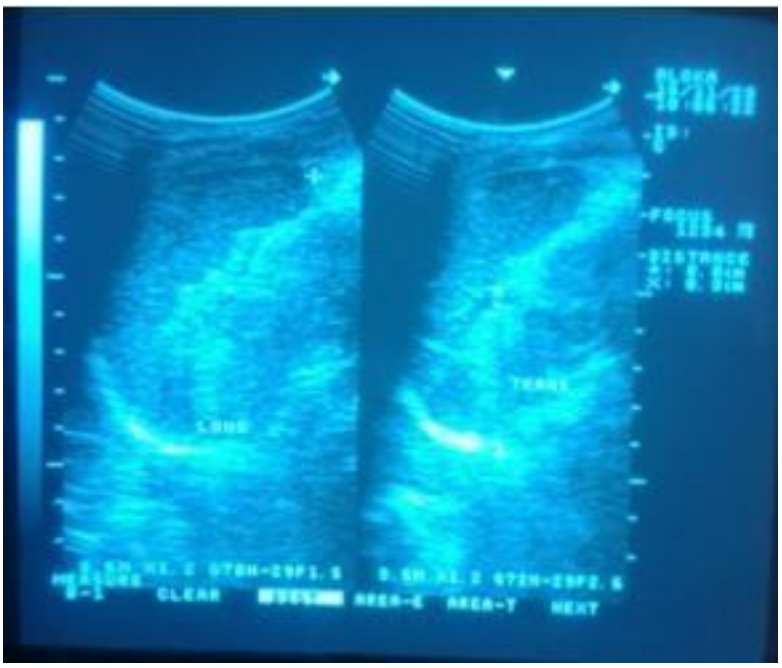
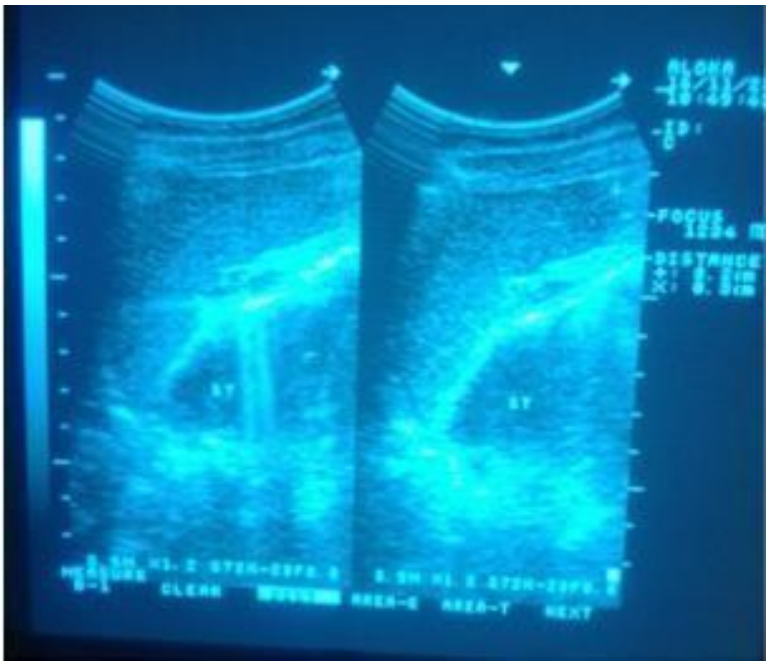
Appendices A



(A)

(B)

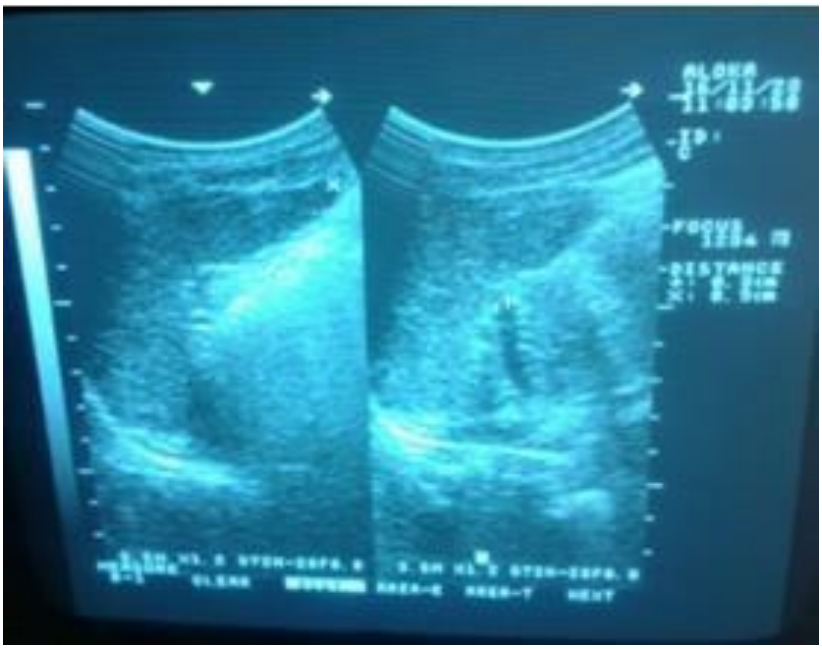
Image A-1 (A) Sagittal and(B) transverse U/S image of spleen for female in 8 years age, 121 height and 25 Kg weight



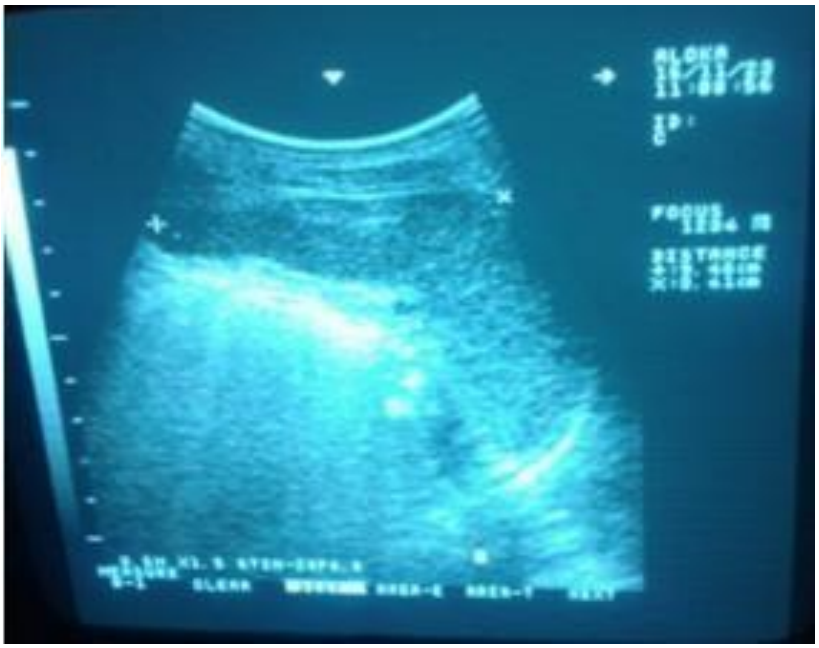
(A)

(B)

Image A -2 (A)Sagittal and(B) transverse U/S image of spleen for female in 10 years age, 135 height and 36 Kg weight.

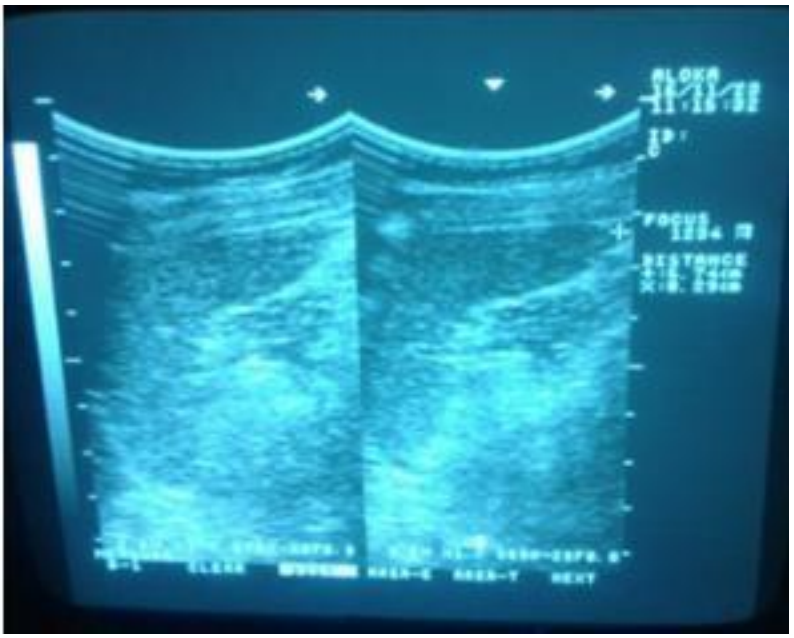


(A)

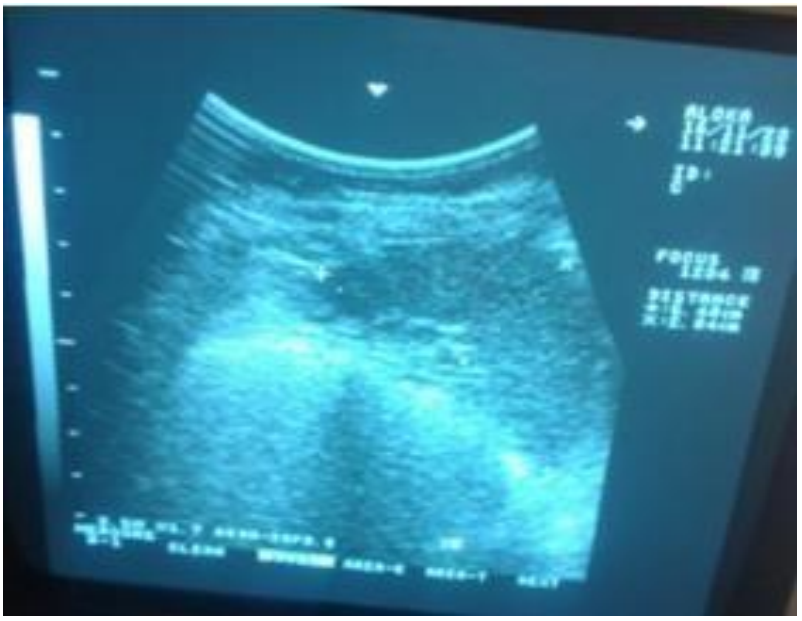


(B)

Image A-3: (A) Sagittal and(B) transverse U/S image of spleen for female in 10 years age, 134 height and 27Kg weight

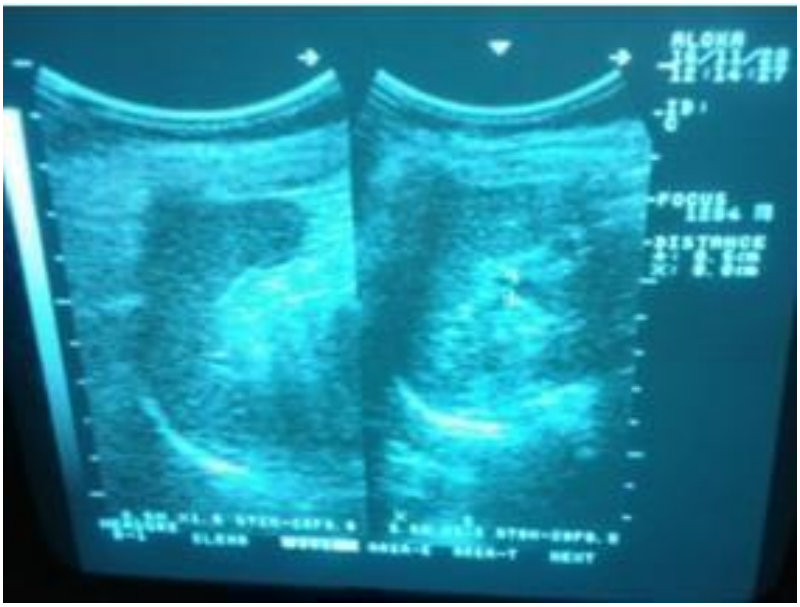


(A)



(B)

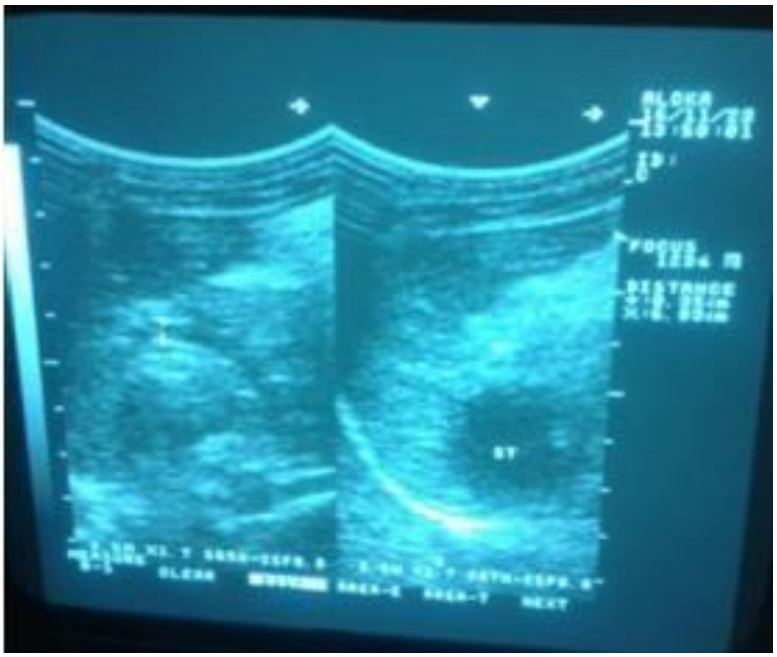
Image A-4: (A) Sagittal and(B) transverse U/S image of spleen for female in 8 years age, 126 height and 28 Kg weight.



(A)

(B)

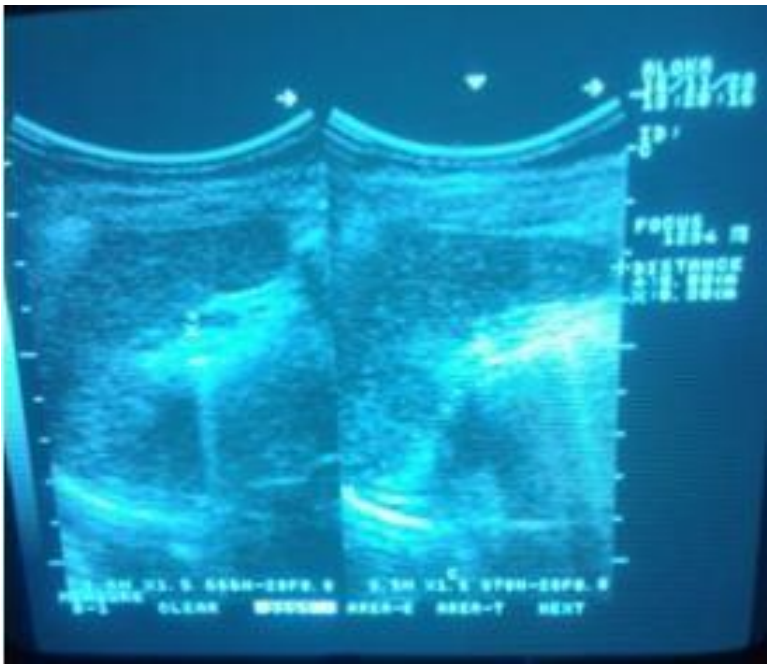
Image A-5: (A) Sagittal and (B) transverse U/S image of spleen for female in 13 years age, 126 height and 28Kg weight.



(A)

(B)

Image A-6: (A) Sagittal and(B) transverse U/S image of spleen for female in 6 years age, 121 height and 21Kg weight.



(A)

(B)

Image A-7: (A) Sagittal and(B) transverse U/S image of spleen for female in 12 years age, 145 height and 40 Kg weight.

AppendicesB:

Sudan University of Science and Technology
College of Graduate Studies

Evaluation of Splenic Length in School Age Children using ultrasonography

A thesis Submitted for Partial Fulfillment of the Requirement of MS.c Degree in Medical Diagnostic Ultrasound

Data Collection Sheet

number	Age	Gender	weight	Height	Spleen length