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Establishment of Local Reference of Spleen Length in Sudanese Normal School age Children Sonographically

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Methods: 215 healthy school-aged children (7–13 years) from city centers were evaluated. Gender, age, weight, height, BMI, and abdominal circumference were determined for each case. The sonographic examination for spleen length was performed with a high resolution real time scanner (SSD-500 Aloka Medical System) fitted with a 3.5MHz convex transducer; all of the measured spleens had a normal position, shape, and echo texture. The children were classified into 7groups according to age and gender.

Results: 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 (*P*-value 0.000), the mean length of spleen in females is greater than in males. A significant relation was found between spleen length and age, weight, height, abdomen circumference and BMI.

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Conclusion: The spleen length obtained in this study was in different range of values reported in previous studies and a local reference of spleen length was established. We hope that this study contributes to daily clinical practice in ultrasound clinics for interpretation of sonographic examinations for Sudanese school age children regarding the spleen length.

I. 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. [1]

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. A rapid increase in spleen size, secondary to sequestration of red blood cells, platelets and other haematological elements, was observed in neonates on extracoporal membrane oxygenation [2, 3, 4]

There are several studies about normal internal organs character [5, 6] All of these are from the populations of Caucasoid and from the populations of Asian, Japan, China, Korea, and India. In the past, Thailand normally used references from American or European references. The problem is that the differences of these factors make the indicators different: race, body structure, genetic, environment, living condition, life style, and food. [7, 8].

Spleen size varies widely according to age also many diseases can affect its size, including infections and malignancy.. [9,10]

The variations in the anthropometric features of various populations, races and regions are an established fact. The climate of the zone and the socio-economic status of Sudan, make the population of this region special. There is no comprehensive anthro-pometric study on the normal measurements of spleen by ultrasonography in Sudanese, and therefore, it was thought to be important to undertake the present study to evaluate the normal measurements of spleen in the school age Sudanese population.

Radiography and radionuclide studies expose the patient to X and gamma radiation [10,11,12,13]. Ultrasonography is the method of choice for the diagnosis of the abdominal pathologies [14]. Sono-graphy is routinely used to determine the internal structures of the body because the examination is real time, three-dimensional and independent of organ function .Ultrasonography is a non-invasive, established, safe, quick and accurate method for the measurement of spleen size. [13]

In Sudan, There is absence of domestic reference for spleen length; and 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 study lies in finding the normal length of spleen and to determine its correlation with gender, age, height, weight, body mass index (BMI) and abdominal circumference.

II. Materials and Methods

The study was done in Alsidigah School and Hamza Ebn Abdmutalib School in Bhari city from January 2012-February 2012.

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a) *Ultrasound Machine*

The sonographic examination performed with a high resolution real time scanner (SSD-500 Aloka Medical System Co, Ltd, Tokyo, Japan) with a 3.5MHz convex transducer.

b) *Sample*

A total of 215 (104 males, 111 females) healthy Sudanese children with normal spleen position, shape and echo texture. Any abnormal spleen position, shape and echo texture, children affected with malaria, malignant spleen diseases, benign spleen conditions, traumatic spleen were excluded.

c) *Measurement Technique for spleen*

Spleen Length was taken by measuring the longest dimension in coronal plane. Longitudinal dimensions in the coronal plane were obtained with the subject in supine or slightly right lateral decubitus position; longitudinal size measurement was performed between the most supero medial and the most infero lateral points of the spleen.

III. Results

Table 1 : Spleen length measurement classes, frequency and percentage

Spleen	Frequency	Percentage
6.5-7.4	28	13.0%
7.5-8.4	43	20.0%
8.5-9.4	56	26.0%
9.5-10.4	67	31.2%
≥ 10.5	21	9.8%
Total	215	100.0%

Table 2 : Descriptive statistics for subject's physical data and spleen length measurement

	BMI	Weight (Kg)	Abdominal circumference	Height (M)	Spleen (cm)
Mean	16.8	32.5	58.2	137.9	9.0
Std. Deviation	±3.4	±10.1	±7.1	±11.0	±1.2
Minimum	10.4	16.0	43.0	112.0	6.7
Maximum	33.6	71.0	83.0	167.0	11.7

Table 3 : mean values of the variables according to age

Variable	Age							Total	*P*-Value
	7	8	9	10	11	12	13		
BMI	14.4 ± 2.0	14.7 ± 2.2	18.0 ± 4.5	17.0 ± 2.8	16.7 ± 2.7	18.1 ± 2.9	18.9 ± 3.6	16.8 ± 3.4	0.000*
Weight	22.9 ± 3.6	24.1 ± 4.8	32.9 ± 9.3	33.1 ± 7.5	33.5 ± 6.0	38.8 ± 7.7	44.5 ± 10.2	32.5 ± 10.1	0.000*
Abdominal circumference	53.9 ± 4.1	53.5 ± 5.2	60.2 ± 8.5	59.3 ± 6.4	58.8 ± 5.3	59.1 ± 6.8	63.8 ± 7.1	58.2 ± 7.1	0.000*
Height	126.1 ± 5.5	127.6 ± 5.4	134.7 ± 4.3	139.0 ± 7.4	141.4 ± 5.1	146.0 ± 6.5	152.8 ± 8.9	137.9 ± 11.0	0.000*
Spleen	7.9 ± 0.7	7.7 ± 0.6	8.9 ± 1.3	9.3 ± 0.8	9.4 ± 0.6	9.9 ± 0.7	10.1 ± 0.7	9.0 ± 1.2	0.000*

Table 4 : mean values of the variables according to gender

Variable	Gender		Total	P-Value
	Male	Female		
BMI	16.6 ± 2.3	16.9 ± 4.2	16.8 ± 3.4	0.580
Weight	31.6 ± 7.8	33.4 ± 11.8	32.5 ± 10.1	0.195
Abdominal circumference	57.2 ± 5.6	59.3 ± 8.1	58.2 ± 7.1	0.029*
Height	136.9 ± 10.5	138.8 ± 11.4	137.9 ± 11.0	0.203
Spleen	8.7 ± 1.1	9.3 ± 1.1	9.0 ± 1.2	0.000*

From above table we have significant difference between males and females in (Spleen and Abdomen circumference) P-value was less than 0.05, that means the mean length of Spleen and Abdomen circumference) in females was more than mean length of Spleen & Abdominal circumference) in males, respectively.

Table 5 : mean values of the variables according to age & gender

Age	Gender	BMI*	Weight	Abdomen circumference	Height	Spleen
7	Male	15.6 ± 1.8	23.7 ± 3.4	53.5 ± 4.1	123.7 ± 6.9	8.0 ± 0.8
	Female	13.6 ± 1.7	22.3 ± 3.7	54.3 ± 4.2	127.9 ± 3.5	7.9 ± 0.5
8	Male	15.7 ± 1.6	26.0 ± 3.7	54.3 ± 3.1	128.4 ± 5.7	7.5 ± 0.6
	Female	13.7 ± 2.3	22.1 ± 5.2	52.7 ± 6.8	126.8 ± 5.1	7.8 ± 0.5
9	Male	16.5 ± 1.6	29.5 ± 3.9	57.1 ± 4.9	133.7 ± 4.5	7.9 ± 0.7
	Female	19.6 ± 5.9	36.3 ± 11.8	63.3 ± 10.3	135.7 ± 4.1	9.9 ± 0.9
10	Male	16.7 ± 2.2	31.9 ± 4.3	58.7 ± 4.3	138.1 ± 5.8	8.6 ± 0.4
	Female	17.3 ± 3.3	34.2 ± 9.7	59.9 ± 8.1	140.0 ± 8.9	10.0 ± 0.3
11	Male	16.1 ± 2.2	32.3 ± 5.5	57.3 ± 4.5	141.3 ± 5.8	9.2 ± 0.7
	Female	17.3 ± 3.0	34.7 ± 6.4	60.4 ± 5.7	141.5 ± 4.6	9.5 ± 0.3
12	Male	18.3 ± 3.2	37.8 ± 8.3	57.8 ± 6.8	143.2 ± 4.4	9.7 ± 1.0
	Female	18.0 ± 2.7	39.8 ± 7.2	60.3 ± 6.8	148.6 ± 7.2	10.0 ± 0.3
13	Male	17.7 ± 2.4	40.3 ± 8.5	61.5 ± 7.0	150.3 ± 9.7	9.8 ± 0.7
	Female	20.2 ± 4.3	48.6 ± 10.3	66.1 ± 6.6	155.3 ± 7.5	10.5 ± 0.5

*Values are expressed as Mean ± SD. *Body Mass Index (BMI)*

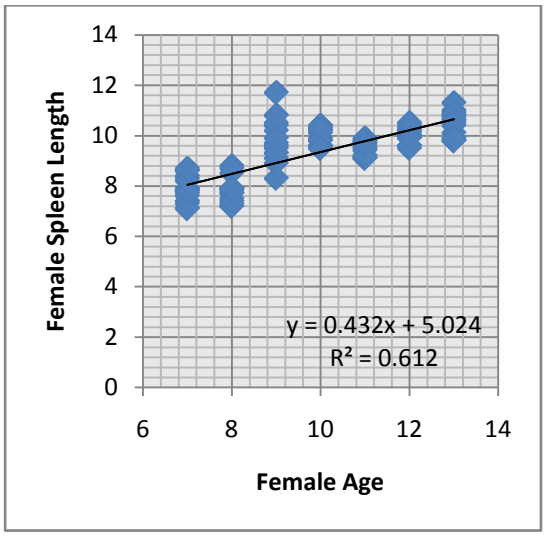
Table 6 : Proximity Matrix of correlation between variables

	Correlations	BMI	Spleen	Weight	Abdomen circumference
BMI	Pearson Correlation	1.00	0.54	0.88	0.84
	P-value	.	0.000	0.000	0.000
Spleen	Pearson Correlation	0.54	1.00	0.71	0.55
	P-value	0.000	.	0.000	0.000
Weight	Pearson Correlation	0.88	0.71	1.00	0.85
	P-value	0.000	0.000	.	0.000
Abdomen circumference	Pearson Correlation	0.84	0.55	0.85	1.00
	P-value	0.000	0.000	0.000	.
Height	Pearson Correlation	0.43	0.72	0.79	0.56
	P-value	0.000	0.000	0.000	0.000

From above table (6) it was noticed that all p-values are less than 0.05 that means that there is relationship between the variables. The Pearson Correlation denotes values of the correlation either positive (+) or negative (-) as follows:

- *0.90 – 1.00 very strong relationship.*
- *0.70 – 0.89 strong relationship.*
- *0.50 – 0.69 middle relationship.*
- *0.00 – 0.49 weak relationship*

[A]



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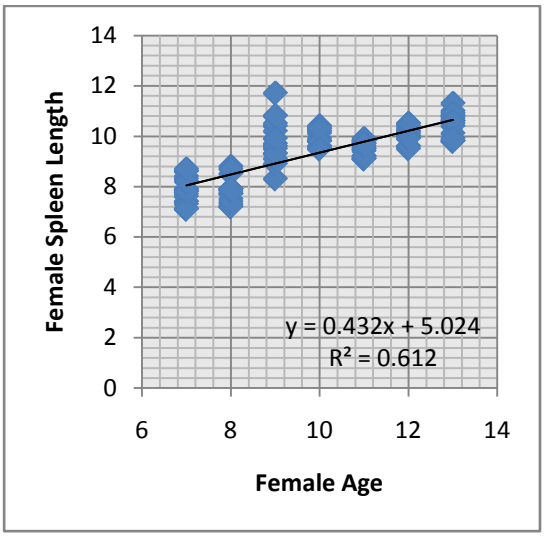
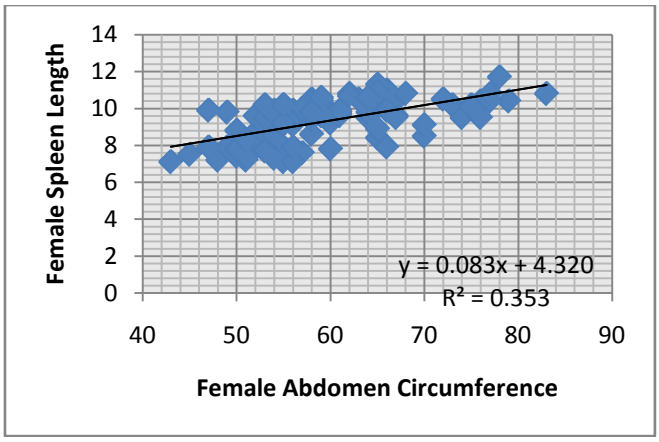
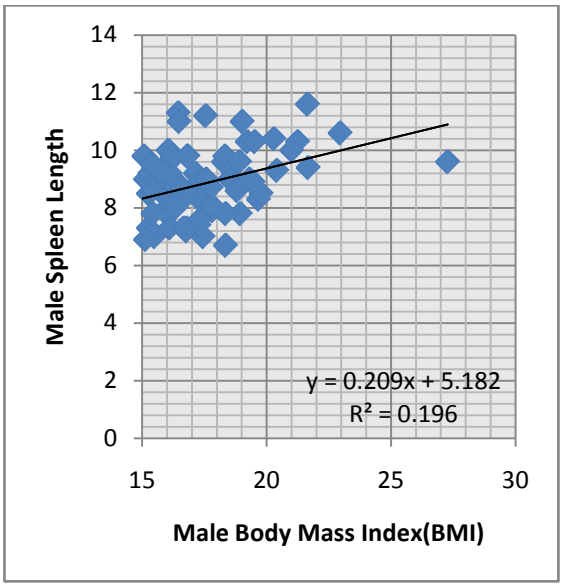


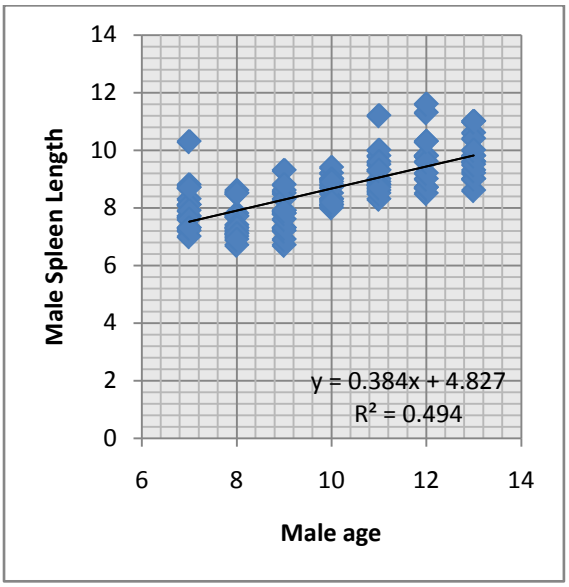


[C]

Figure 1 : [A,B,C]Scatter plot diagram shows the linear relationship between spleen length measured in (cm)and female BMI, age and abdomen circumference respectively



[A]



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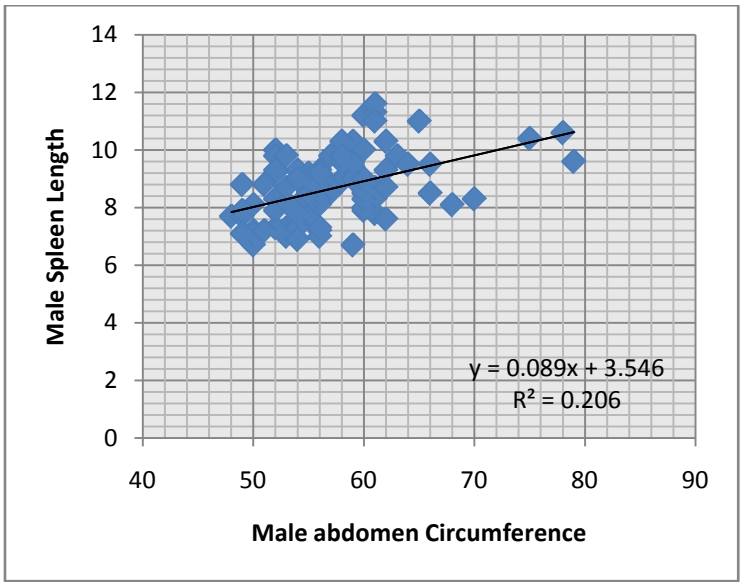

[C]

Figure 2 : [A,B,C] Scatter plot diagram shows the linear relationship between spleen length measured in (cm)and Male BMI, age and abdomen circumference respectively

IV. Discussion

Ultrasound is simple and reliable in measuring the abdominal visceral organs without the risk of ionizing radiation. Measuring the volume is time-consuming and impractical in daily use and the longitudinal measuring of these organs is used as part of routine abdominal sonographic scanning for purposes of determining the normal anatomy [15]. Therefore, the longitudinal measurement was used because it is more practically considered.

The length of the spleen is an adequate indicator of size for most purposes and provides a useful baseline for monitoring changes in disease status. Establishing normal parameters is mandatory for defining the pathologic changes in size of the spleen, in routine sonographic examinations of children.[15]

This study included 104(48.4%) males, 111(51.6%) females of school children with ages from 7 up to 13.When measuring the spleen;28 out of 215 (13.0%)got spleen length of 6.5-7.7 cm,43(20%)of 5-8.4cm, 56(26%) of 8.5-9.4cm,67(31.2%)of 9.5-10.4 and measurements greater than 10.5 were found in 21(9.8) of the sample, The mean spleen measurement was found to be 9.0 ±1.2 (max11.7, min6.7),normal spleen has been investigated by only a few researchers [16].When comparing our results with other similar results ,we found that Sudanese children have less length than USA in all group of ages but greater than Greek [16], Indian [17] and Turkish populations [18]

When comparing the spleen length measurement with age in all group of ages it was found to be 7.9,7.7,8.9,9.3,9.4,9.9,10.1,9.0 cm for the ages 7,8,9,10,11,12,13 respectively and the relation is significant between the spleen length and this group of children ages at *p* value 0.000.

DeLand [19] stated that the spleen showed variation according to sex and age. He reported that spleen in females was smaller than males in all age groups. But Niederau et al.[20] in their sonographic study, which was carried out on adults, found that spleen size decreased with increasing age.

In our study a significant difference was detected between males and females in spleen length and abdomen circumference measurements because *P*-value was found to be less than 0.05, that means the mean measurements values of spleen and abdomen circumference in females are greater than males and were found to be 9.3 ± 1.1 and 59.3 ± 8.1, 8.7 ± 1.1and 57.2 ± 5.6 respectively .

The study showed that the BMI, height, weight abdominal circumference have significant relation with the spleen length in all these group of ages.

From table (6) we noticed that all *p*-values are less than 0.05, that means there is a relationship between the variables. The Pearson Correlation denotes value of the correlation either positive (+) or negative (-) as follows: 0.90 – 1.00 very strong relationship, 0.70 – 0.89 strong relationship, 0.50 – 0.69 middle relationship, 0.00 – 0.49 weak relationship.

Scatter plot diagrams showed the linear relationship between spleen length measured in (cm) and females and males, BMI, abdomen circumference (AC) and age respectively. The equations showed that the for BMI and AC ,the spleen length was increased proportionally and by applying the following equations the spleen length can be estimated for these group of ages and known BMI and AC as :

For female Spleen length (cm) =(0.432 X Age) + 5.024 . For male Spleen length (cm) =(0.384 X Age) + 4.827. For female Spleen length (cm) =(0.172 X BMI) + 6.368,For male Spleen length (cm) =(0.209X BMI) + 5.182,For female Spleen length (cm) =(0.083 X AC) + 4.320,For male Spleen length (cm) =(0.089X AC) + 3.546.

In conclusion, the spleen length obtained in this study was in different range of values reported in the previous studies. The mean spleen length in females is greater than males .

By applying the above equations the spleen length can be estimated. A local reference of spleen length was established; further studies are required to establish national reference of spleen length and volume in Sudan for both children and adults.

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