

## Sonographic Assessment of the Normal Dimensions of Liver, Spleen, and Kidneys in healthy school children

Zohida A. Abdelgabar, Mona Mohammed, Mohamed E. M. Garelnabi  
College of Medical Radiologic Sciences- Sudan University of Science and Technology, Sudan-Khartoum  
\*Corresponding Author: Zohida A. Abdelgabar

**ABSTRACT:-** Assessment of the Normal Dimensions of Liver, Spleen, and Kidneys in healthy school children, were the study conducted in Salsabil kinder guarding & Almaddinah ALmonawara primary school and Karri Secondary school. Which contain demographic information and organs measurements. From the measurements we observed fluctuations in the lengths values between the patients according to their sex. The liver length for male  $11.52 \pm 1.99$  cm and for female  $11.52 \pm 1.88$  cm, the spleen length for male  $8.52 \pm 1.24$  cm and for female  $8.49 \pm 1.09$  cm. also the kidneys length shows a slightly difference between the males and females, were the length of right kidney for male  $8.39 \pm 1.12$  cm and for female  $8.34 \pm 1.03$  cm, while the length of left kidney  $8.67 \pm 1.01$  cm and for female  $8.58 \pm 1.06$  cm. The length of liver, spleen and kidneys can be estimated using linear equations were the rate of length for all patients increase when the age or body mass index increased.

**Keywords:** Sonographic Assessment, liver, spleen, kidneys

### I. INTRODUCTION

Determination of pathologic changes in size of the liver, spleen, and kidney necessitates knowing the normal range of dimensions for these organs in healthy neonates, infants, and children [1]. Correspondingly, there are few studies to define the normal limits of organ dimensions in healthy children [2]. Clinical assessment of changes in visceral organ size is difficult and unreliable [3]. Palpation and percussion are the standard bedside techniques to document liver and spleen size, but are far from accurate to detect small increase in size [4-5]. Radiography, computed tomography and radionuclide imaging expose the patients to ionizing radiation while magnetic resonance imaging is expensive and is not readily available in developing countries [5]. Sonography is a simple and reliable way to visualize and measure abdominal visceral organs without the risk of ionizing radiation [6].

The normal limits of the liver, spleen, and kidneys are important parameters during a sonographic examination [7]. Several studies have been conducted on the establishment of normal liver sizes in pre-school and school children [8-9]. Normogram of the spleen size with respect to height is important in the determination of some pathology associated with changes in its size [10]. It is important to determine the pathologic changes in spleen sizes in the ultrasonographic evaluation of children [11-12]. Since the renal size is affected by several factors, it is necessary to first establish the normal values [13]. The normal values of kidneys dimensions are important parameters during sonographic examinations [14]. Ultrasonography which is a fairly simple method has come into general use as a screening test for the kidneys [15].

### II. METHODS AND MATERIALS

This study was conducted in Salsabil kinder guarding & Almaddinah ALmonawara primary school and Karri Secondary school from July 2017 – September 2017. A total of 134 normal children, 65 boys and 69 girls, were included in this study. Ages ranged from 2 to 16 years with a mean of  $10.1 \pm 3.9$  years. The average height of the enrolled group was  $134.5 \pm 20.5$  cm and the average weight was  $29.5 \pm 14.4$  kg. The average BMI was calculated as  $15.3 \pm 3.4$  kg/m<sup>2</sup>. Age, gender, height and weight were collected. Height (cm) and weight (kg) were measured on the day of US study. BMI was calculated as weight (kg)/height (m<sup>2</sup>). Ultrasonography was performed using a GE –LOGIQ Book XP ultrasound unit with 1-5 MHz convex transducer.

Liver measurements were obtained in a subject lying in the supine position. Longitudinal dimension was obtained in the midclavicular plane for the right lobe. The upper margin of the liver was defined as the uppermost edge under the dome of the diaphragm, whereas the lower margin was defined as the lowermost edge of the lobe. Gall bladder evaluated.

The splenic size (splenic length) was measured sonographically by obtaining an oblique coronal view which included the hilum, during quiet breathing; in the older children, measurements were made while they were holding their breath. The patient was lying in a supine or in a slightly right lateral decubitus position

during ultrasonography. The transducer was placed posteriorly along the long axis of lower left intercostal spaces. The spleen was seen as a uniform homogenous echo pattern. .Longitudinal size measurement was performed between the most superomedial and the most inferolateral points of the spleen.

Kidney measurements were obtained .Longitudinal dimensions of both kidneys were obtain the coronal plane passing through there renal hilum with subjects in the supine or slightly right or left lateral decubitus positions.

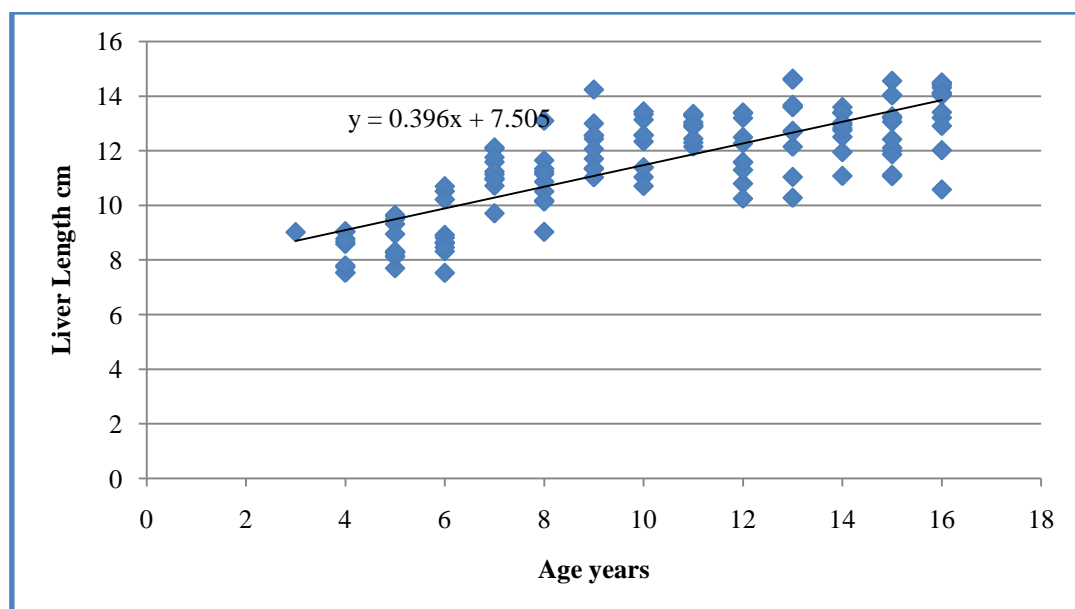
### III. RESULTS AND DISCUSSION:

**Table 1. Show statistical parameters for all patients:**

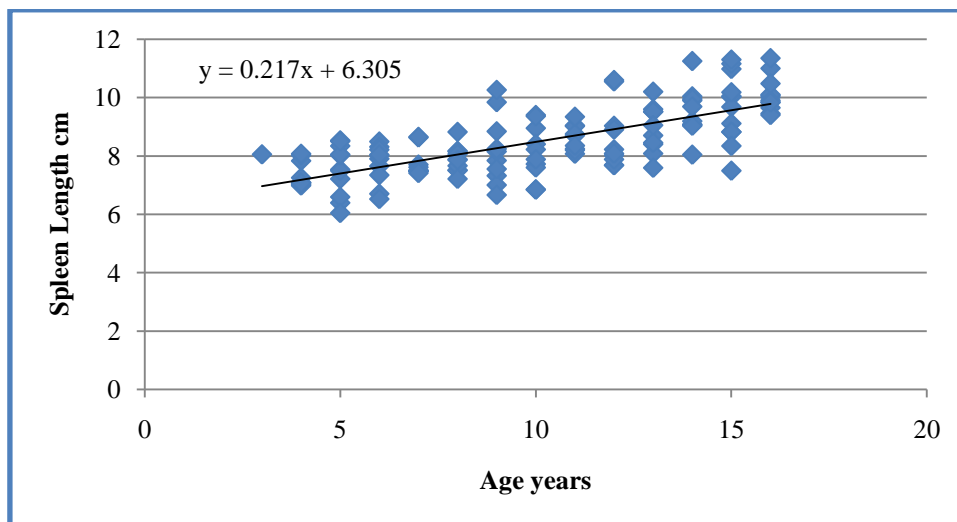
	Mean	Median	STD	Min	Max
<b>Age</b>	10.11	10	3.86	3	16
<b>Weight</b>	29.53	25	14.39	11	81
<b>High</b>	134.48	132	20.48	100	181
<b>BMI</b>	15.35	14.65	3.42	8.9	28.4
<b>Liver length</b>	11.52	11.82	1.93	7.53	14.64
<b>Spleen length</b>	8.50	8.23	1.166	6.04	11.35
<b>RT Kidney length</b>	8.36	8.28	1.07	5.73	11.24
<b>LT Kidney length</b>	8.62	8.55	1.03	6.70	11.33

**Table 2. Show statistical parameters for demographic information and the measurements:**

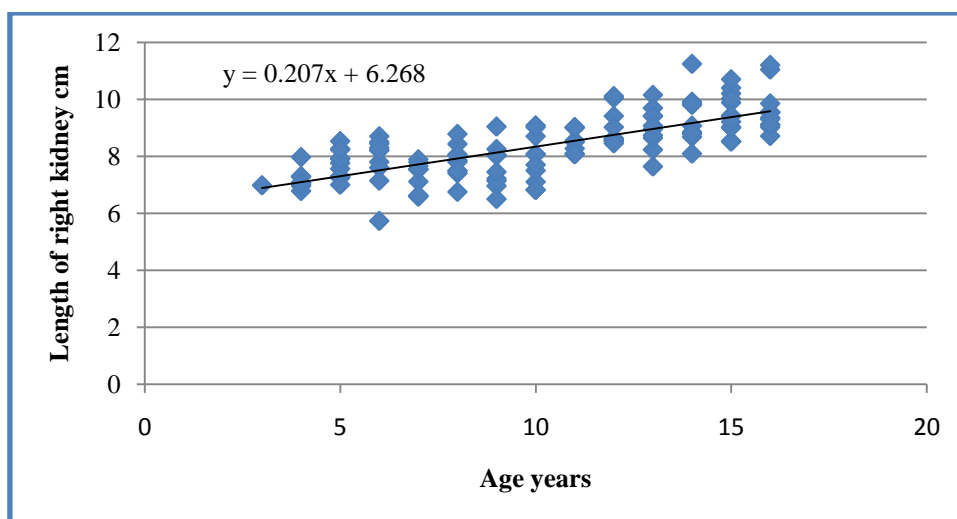
Male						Female				
	Mean	Median	STD	Min	Max	Mean	Median	STD	Min	Max
<b>Age</b>	10.18	10	3.77	4	16	10.04	10	3.97	3	16
<b>BMI</b>	15.05	14.10	3.35	8.9	28.4	15.62	15.10	3.49	10	27.3
<b>Liver length</b>	11.52	12	1.99	7.53	14.50	11.52	11.59	1.88	8.27	14.64
<b>Spleen length</b>	8.52	8.22	1.24	6.39	11.35	8.49	8.24	1.09	6.04	11.25
<b>RT Kidney length</b>	8.39	8.50	1.12	5.73	11.20	8.34	8.23	1.03	6.50	11.24
<b>LT Kidney length</b>	8.67	8.69	1.01	6.77	11.20	8.58	8.39	1.06	6.70	11.33



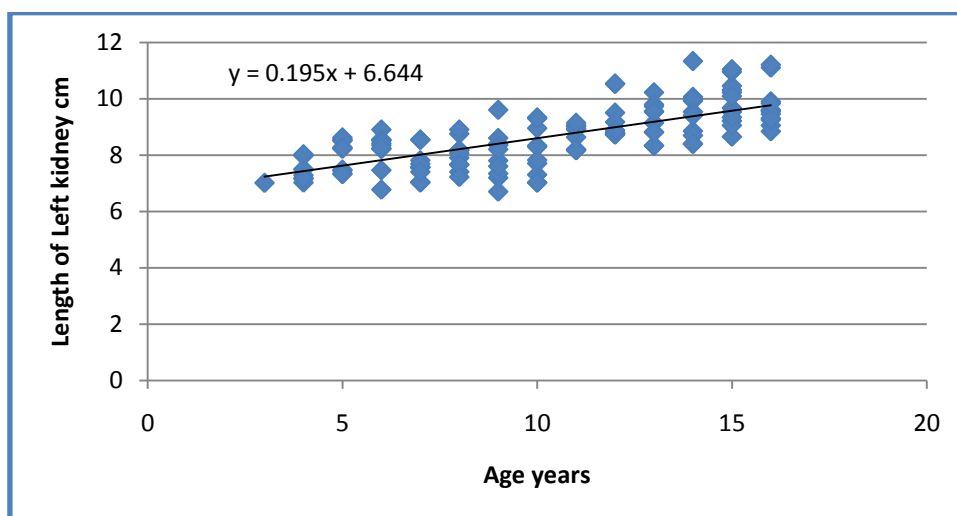
**Figure 1. Correlate between liver length per cmwith patients age per year**



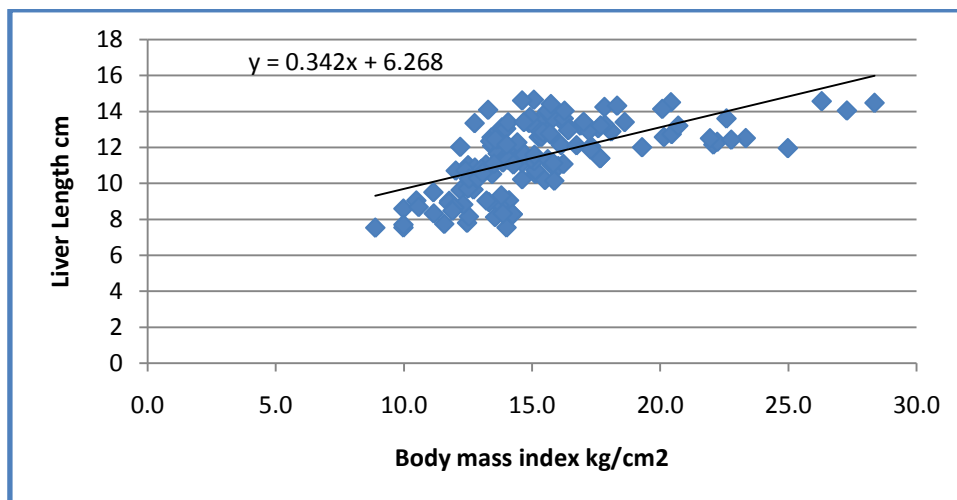
**Figure . Correlate between spleen length per cmwith patients age per years**



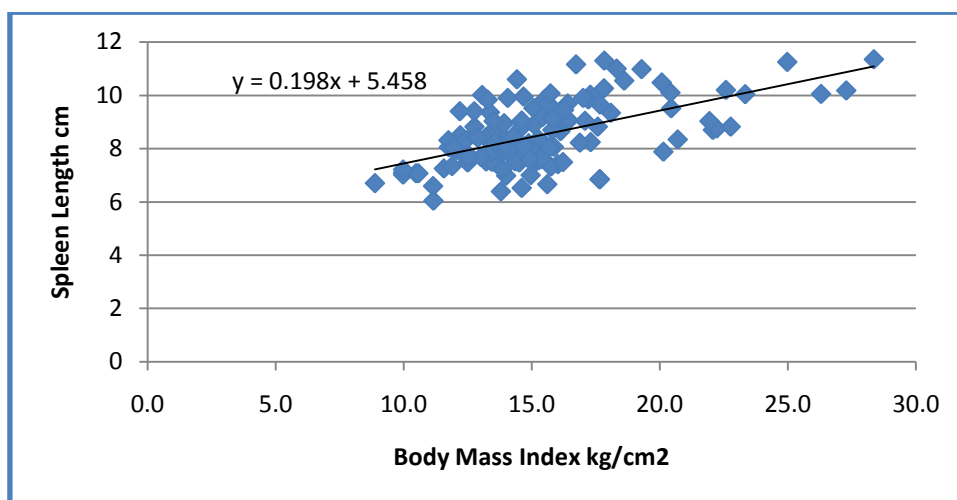
**Figure 3. Correlate between length of right kidney per cmwith patients age**



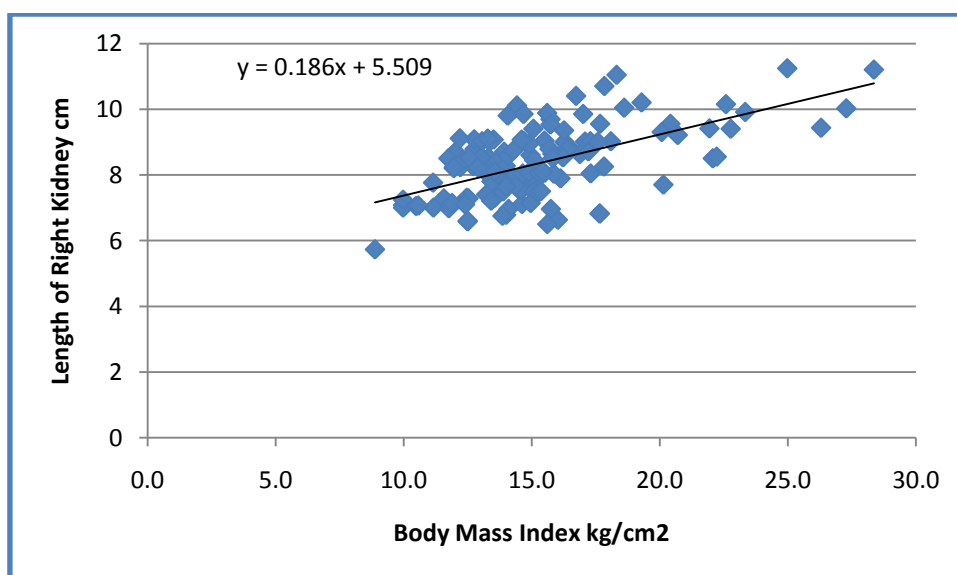
**Figure 4. Correlate between length of left kidney per cmwith patients age**



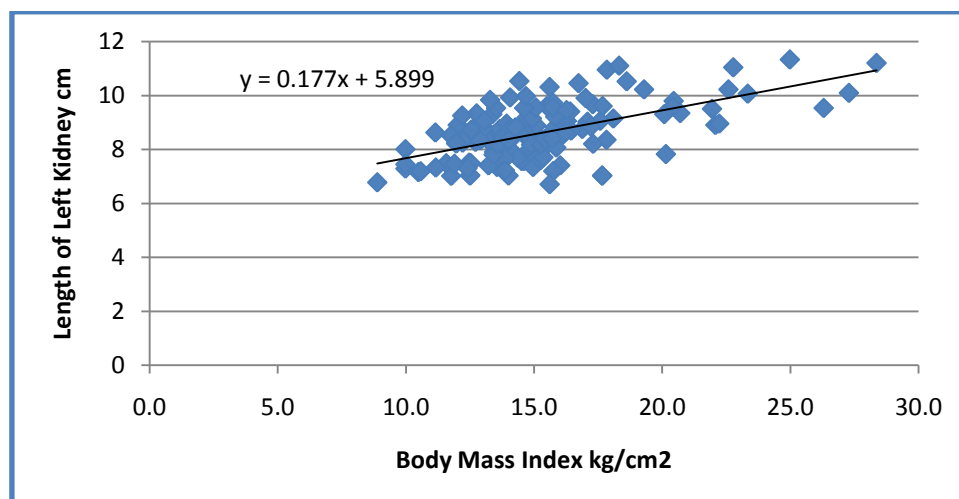
**Figure 5. Correlate between body mass index kg/cm<sup>2</sup> with liver length per cm**



**Figure 6. Correlate between body mass index kg/cm<sup>2</sup> with spleen length per cm**



**Figure 7. Correlate between body mass index kg/cm<sup>2</sup> with length of right kidney per cm**



**Figure 8. Correlate between body mass index  $\text{kg}/\text{cm}^2$  with length of left kidney per cm**

Table 1. Show statistical parameters for all patients, which contain demographic information and the measurements were presented as mean, median, standard deviation, minimum and maximum, were the mean  $\pm$  standard deviation for age was  $10 \pm 3.86$  years, patients weight, high, body mass index was  $29.53 \pm 14.39$  kg,  $134.48 \pm 20.48$  cm and  $15.35 \pm 3.42$   $\text{kg}/\text{cm}^2$ .

The measurements of the liver, spleen and kidneys, were the mean  $\pm$  standard deviation for liver length was  $11.52 \pm 1.93$  cm, for spleen length, length of right kidney and left kidney was  $8.50 \pm 1.166$  cm,  $8.36 \pm 1.07$  cm and  $8.62 \pm 1.03$  cm respectively.

The measurements of abdominal organ according to the gender, were the median age for male  $10 \pm 3.77$  year and for female  $10 \pm 3.97$  year, while the mean of body mass index for male was  $10.05 \pm 3.35$   $\text{kg}/\text{cm}^2$  and for female  $15.62 \pm 3.49$   $\text{kg}/\text{cm}^2$ . for the measurements we observed a fluctuations in the lengths values between the patients according to their sex. The liver length for male  $11.52 \pm 1.99$  cm and for female  $11.52 \pm 1.88$  cm, the spleen length for male  $8.52 \pm 1.24$  cm and for female  $8.49 \pm 1.09$  cm. also the kidneys length shows a slightly difference between the males and females, were the length of right kidney for male  $8.39 \pm 1.12$  cm and for female  $8.34 \pm 1.03$  cm, while the length of left kidney  $8.67 \pm 1.01$  cm and for female  $8.58 \pm 1.06$  cm as shown in table 2.

The length of liver, spleen and kidneys can be estimated using linear equations, were the Correlation between liver lengths per cm with patients age per year, the length of liver increase by rate 0.3968 for each year of the patients as shown in **Fig 1**. In **Fig 2**. Correlate between spleen lengths per cm with patient's age per years where the length of spleen increase by rate 0.2172 for each year of the patients. **Fig 3**. Correlate between lengths of right kidney per cm with patient's age where the length of right kidney increase by rate 0.2071 for each year of the patients.

**Fig 4**. Correlate between lengths of left kidney per cm with patient's age where the length of left kidney increase by rate 0.1954 for each year of the patients. **Fig 5**. Correlate between body mass index  $\text{kg}/\text{cm}^2$  with liver length per cm where the length of liver increase by rate 0.421 for each  $\text{kg}/\text{cm}^2$ . **Fig 6**. Correlate between body mass index  $\text{kg}/\text{cm}^2$  with spleen length per cm where the lengths of spleen increase by rate 0.2329 for each  $\text{kg}/\text{cm}^2$ . **Fig 7**. Correlate between body mass index  $\text{kg}/\text{cm}^2$  with length of right kidney per cm where the lengths of right kidney increase by rate 0.2213 for each  $\text{kg}/\text{cm}^2$ . **Fig 8**. Correlate between body mass index  $\text{kg}/\text{cm}^2$  with length of left kidney per cm where the lengths of left kidney increase by rate 0.2154 for each  $\text{kg}/\text{cm}^2$ .

#### IV. CONCLUSION

Assessment of the Normal Dimensions of Liver, Spleen, and Kidneys in healthy school children, were the study conducted in Salsabil kinder guarding & Almaddinah ALmonawara primary school and Karri Secondary school. which contain demographic information and organs measurements. from the measurements we observed a fluctuations in the lengths values between the patients according to their sex. The liver length for male  $11.52 \pm 1.99$  cm and for female  $11.52 \pm 1.88$  cm, the spleen length for male  $8.52 \pm 1.24$  cm and for female  $8.49 \pm 1.09$  cm. also the kidneys length shows a slightly difference between the males and females, were the length of right kidney for male  $8.39 \pm 1.12$  cm and for female  $8.34 \pm 1.03$  cm, while the length of left kidney  $8.67 \pm 1.01$  cm and for female  $8.58 \pm 1.06$  cm.

*The length of liver, spleen and kidneys can be estimated using linear equations were the rate of length for all patients increase when the age or body mass index increased as shown below:*

$$\text{Liver length cm} = 0.3968 (\text{age/yr}) + 7.5059$$

$$\text{Liver length cm} = 0.3421 (\text{BMI-kg/cm}^2) + 6.2688$$

$$\text{Spleen length cm} = 0.2172 (\text{age/yr}) + 6.3052$$

$$\text{Length of right kidney cm} = 0.2071 (\text{age/yr}) + 6.2687$$

$$\text{Length of right kidney cm} = 0.186 (\text{BMI-kg/cm}^2) + 5.5097$$

$$\text{Length of left kidney cm} = 0.1954 (\text{age/yr}) + 6.644$$

$$\text{Length of left kidney cm} = 0.1773 (\text{BMI-kg/cm}^2) + 5.8995$$

## REFERENCES

- [1]. Konuş OL, Ozdemir A, Akkaya A, Erbaş G, Celik H, Işık S. Normal liver, spleen, and kidney dimensions in neonates, infants, and children: evaluation with sonography. *AJR Am J Roentgenol*. 1998; 171: 1693-1698.
- [2]. Thapa NB, Shah S, Pradhan A, Rijal K, Pradhan A, Basnet S. Sonographic Assessment of the Normal Dimensions of Liver, Spleen, and Kidney in Healthy Children at Tertiary Care Hospital. *Kathmandu university medical journal*. J 2015; 52(4): 286-91.
- [3]. Tamayo SG, Richman LS, Mathews WC, Fullerton SC, Bartok AE, Warner JT et al. Examiner dependence on physical diagnostic tests for the detection of splenomegaly: a prospective study with multiple observers. *J Gen Intern Med* 1993; 8: 69–75.
- [4]. Zhang B, Lewis SM. A study of the reliability of clinical palpation of the spleen. *Clin Lab Haematol* 1989; 11: 7-10.
- [5]. Joshi R, Singh A, Jajoo N, Pai M, Kalantri SP. Accuracy and reliability of palpation and percussion for detecting hepatomegaly: a rural hospital based study. *Indian J Gastroenterol* 2004; 23: 171-174.
- [6]. Megremis SD, Vlachonikolis IG, Tsilimigaki AM. Spleen length in childhood with US: normal values based on age, sex, and somatometric parameters. *Radiology* 2004; 231:129-134.
- [7]. Safak AA, Simsek E, Bahcebasi T. Sonographic assessment of the normal limits and percentile curves of liver, spleen and kidney dimensions in healthy school-aged children. *Journal of Ultrasound Medicine*. 2005;24(10):1359–1364.
- [8]. Dhingra B, Sharma S, Mishra D, Kumari R, Pandey RM, Aggarwal S. Normal values of liver and spleen size by ultrasonography in Indian children. *Indian Pediatr* 2010;47:487–492.
- [9]. Sarac K, Kutlu R, Yakinci C, Durmaz Y, Baysal T, Özgen Ü. Sonographic evaluation of liver and spleen size in school-age children. *Turk J Med Sci* 2000;30:187–90.
- [10]. Eze CU, Agwu KK, Ezeasor DN, Ochie K, Aronu AE, Agwuna KK, Nwadike IU. Sonographic biometry of spleen among school age children in Nsukka, Southeast, Nigeria. *African Health Sciences* 2013; 13(2): 384 – 392
- [11]. Guibaud L. [Sonography of the pediatric abdomen: pancreas and spleen]. *J Radiol* 2001; 82: 755–763.
- [12]. Eze CU, Agwu KK, Ezeasor DN, Agwuna KK, Aronu AE: Sonographic determination of spleen to left kidney ratio among Igbo school age children of south east Nigeria. *Afr Health Sci* 2014; 14: 246–254.

**\*Corresponding Author: Zohida A. Abdelgabar**

**College of Medical Radiologic Sciences- Sudan University of Science and Technology,  
Sudan-Khartoum**