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Relationship between Adult Liver and Spleen Sizes from Sonographic Measurements with Body Mass Index (BMI) in a Nigerian Cross-Section Population in Jos

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Abstract
The Liver and the Spleen are two of the main body organs are normally examined among others in all abdominal ultrasound scans. The correlation between the sizes of these two body organs with Height, Weight, Age and Body Mass Index (BMI) have been investigated with ultrasonic measurements of 50 normal scan data of a cross-section of Nigerian population in Jos. It was found that the liver span significantly correlated with body weight ($r = 0.369$, $p < 0.01$) and BMI ($r = 0.351$, $p < 0.05$) while the Splenic length significantly correlated with only BMI ($r = 0.333$, $p < 0.05$). The age range of the subjects was from 16 –70 years with mean age of 32.98 ± 12.20 years while the mean BMI was 23.16 ± 3.84 kg/m^2. The mean Liver span and Splenic length were found to be 13.46 ± 1.14 cm and 9.79 ± 0.96 cm respectively. The Liver/Spleen Ratio was computed to be approximately 1.4 for the adult Nigerian population in Jos. There were no significant difference in both the Liver span and the Splenic length between the males and the females but males have larger Liver span and Splenic length compared to females. Linear Regression relationships between Liver span and splenic length with BMI as well as between Liver span and Splenic length were established.
Keywords: Liver Span, Splenic Length, Body Mass Index, (BMI), Liver/Spleen Ratio.

1. Introduction

Ultrasound can be described as the sound waves beyond the ordinary limits of human hearing range (20 Hz – 20 kHz). Medical diagnostic ultrasound is a modality that uses ultrasound energy and acoustic properties of the body to produce an image from either a stationary or a moving structure within the body (Bushberg *et al*., 2002). It uses sound waves of frequency range of 1-10 MHz which are generated by the ultrasonic transducers. These ultrasound waves are directed into the patient's body to interact with tissues in accordance with the characteristics of the targeted tissue. The reflection of the ultrasound wave by the structure within the body is the interaction that creates the ultrasonic image on the monitor of the ultrasound machine.

Abdominal ultrasound scan is one of the frequent procedures carried out using pulse-echo technique in most diagnostic ultrasound units of hospitals and diagnostic centres all over the world to determine the parenchyma echo texture, position, shape and pathological conditions of liver, gallbladder, spleen, pancreas and kidneys (Marco *et al*., 2002). It provides real time images of the body organs and does not require anaesthesia and also does not utilize ionising radiation. Therefore it is extremely safe to both the patient and the sonographer. In clinical practice, it is possible to establish the enlargement of the liver (hepatomegaly) or the spleen (splenomegaly) using ultrasound. In some situations both the liver and the spleen could be grossly enlarged (hepato-spleenomegaly). It is therefore necessary to have standard normal sonographic measurements of upper and lower limits of organ dimensions as reference values for every country to guide sonographers for accurate diagnosis (Sarac *et al.*, 2000). This is because it is possible to have variations in body organ sizes depending on ethnicity, body structure, body weight or height from the normal universal limits. The past work done by Kratzer *et al.*, (2003) shows that Body Mass Index (BMI) and body height are the most important factors associated with the liver dimensions. On the other hand, Safrak *et al.*, (2005) reported that no significant difference with respect to sex but strong correlation exist between body weight with the size of both the liver and the spleen. The study done by Konur *et al.,* (1998) also confirms that there were no significant differences in liver length between the two sexes. However, Singh *et al.*, (2011) reported that spleen length increased with increase in the height in both males and females. In another study by Dhingra *et al.*, (2010) shows that the liver and spleen sizes were found to be significantly correlating highly with the height. Tarawneh *et al*., (2009) reported that the best predictor for liver span was height for males and body surface area for females. Udoaka *et al.*, (2013) sonographically evaluated the mean liver and splenic lengths of adult Southern Nigerian population to be 13.13 cm ± 1.09 cm and 9.23 cm ± 1.53 cm respectively.

2. Materials and Methods

In this study, ultrasonic measurements of liver and spleen from randomly selected 50 consented patients from Faith Alive Foundation Hospital, Jos with normal abdominal scans were used. This includes 40 females and 10 males since majority of the patients that came for scans were females. The body weight and height were

measured from the scales provided in the hospital and the age of each subject was recorded. This research was carried out at the Faith Alive Foundation Hospital, Jos, Nigeria and the study was approved by the ethical committee of the hospital. The liver span was determined by the sagittal plane in which greatest longitudinal length of the liver with right kidney being displayed on the monitor. The splenic length was measured as the longest longitudinal length from the dome to the tip of the spleen. All the scans were performed by a single sonographer using an Ultramark 8 scanner with a linear transducer of frequency 3.5MHz.

3. Results and Discussion

Table 1 shows the data of all the study parameters. (Male = 1, Female = 0)

Table1: Data of 50 subjects of all the study parameters

Age (yrs)	Sex	Ht (m)	Wt (kg)	BMI (kg/m^2)	Liver (cm)	Spleen (cm)
50	0	1.61	61.0	25.53	14.0	12.0
20	0	1.65	59.0	21.67	15.4	10.7
21	0	1.66	64.0	23.23	13.0	9.0
32	0	1.72	54.5	18.42	13.5	10.0
50	0	1.61	45.0	17.36	12.5	10.0
32	0	1.62	51.0	19.43	12.5	9.5
24	0	1.72	60.0	20.28	12.0	9.0
23	0	1.66	49.0	17.78	12.0	9.5
49	0	1.72	75.0	25.35	13.0	8.5
30	1	1.66	78.0	28.31	15.5	10.9
48	0	1.68	67.0	23.74	13.0	10.0
67	1	1.55	48.0	19.98	13.6	11.4
22	0	1.63	54.0	20.32	13.1	9.8
30	0	1.61	53.0	20.45	13.0	8.0
Age	Sex	Ht	Wt	BMI	Liver	Spleen
25	0	1.60	50.0	19.53	13.0	8.5
28	0	1.66	54.0	19.60	12.0	9.0
20	0	1.71	62.0	21.20	14.0	10.0
33	0	1.62	80.5	30.67	14.0	10.7
27	0	1.66	55.0	19.96	13.5	9.0
24	0	1.74	75.0	24.77	13.0	9.0
25	0	1.58	59.0	23.63	13.0	9.0
43	0	1.67	97.0	34.78	15.0	11.0
38	0	1.69	80.0	28.01	13.0	8.5
24	0	1.71	57.0	19.49	13.5	9.5
44	0	1.76	65.0	20.98	12.0	8.0
39	1	1.70	79.0	27.34	14.6	10.2
70	1	1.83	99.0	29.56	16.0	11.0
27	1	1.70	59.0	20.42	13.0	10.0
41	0	1.68	71.0	25.16	13.0	9.0
43	0	1.57	52.0	21.10	15.8	11.8
26	0	1.65	76.0	27.92	13.0	10.0
29	0	1.68	56.0	19.84	13.0	8.0
26	0	1.61	63.0	24.31	12.5	9.0
20	1	1.73	77.0	25.73	14.0	11.0
30	0	1.75	68.0	22.20	12.0	9.5
20	1	1.68	65.0	23.03	13.0	10.0
18	1	1.82	76.0	22.94	15.8	10.0
43	0	1.81	72.0	21.98	12.0	10.0
16	1	1.75	52.0	16.98	14.5	9.0
35	0	1.63	59.0	22.21	12.0	9.0
32	0	1.65	67.0	24.61	14.0	11.0
27	0	1.59	67.5	26.70	13.0	11.0
59	0	1.68	79.0	27.99	13.0	9.0
40	0	1.72	62.0	20.96	13.0	10.0
35	0	1.53	58.0	24.78	14.5	10.0
26	0	1.54	45.0	18.98	12.5	9.5
37	0	1.82	72.0	21.74	14.5	10.5
27	0	1.62	72.0	27.44	12.0	10.0
32	1	1.68	80.5	28.52	15.5	10.4
22	0	1.62	55.0	20.96	14.8	10.1

From the above data statistical analysis has been carried out using IBM SPSS Version 20 statistical package. The Table 2 shows the descriptive statistics of all the study parameters.

Table 2: Descriptive statistics of all the study parameters

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	50	16	70	32.98	12.197
HEIGHT	50	1.53	1.83	1.6708	.07073
WEIGHT	50	45.0	99.0	64.700	12.3193
BMI	50	16.98	34.78	23.1574	3.83927
LIVER	50	12.0	16.0	13.459	1.1378
SPLEEN	50	8.0	12.0	9.791	.9635

The age range for the study population is from 16 -70 years with a mean age of 32.98± 12.20 yrs while the mean BMI is 23.16± 3.84 kg/m^2. The mean Liver span = 13.46± 1.14 cm and the mean Splenic length = 9.79± 0.96 cm. However, the mean Liver span and splenic size for male subjects are found to be higher than that of the females. The mean Liver span for males and females are 14.54 cm and 13.19 cm respectively while the mean splenic length for males and females are 10.39 cm and 9.64 cm respectively. There was no significant difference in gender in both Liver span ($p = 0.074$) and Splenic length ($p = 0.251$). For the total subjects, mean Liver/Spleen Ratio=13.459/ 9.791=1.38 (approximately 1.4). For males and females mean Liver/Spleen Ratio are found to be 1.40 and 1.37 respectively (approximately 1.4). From the study by Udoaka *et al.*, (2013) the mean Liver/Spleen Ratio can be computed to be 13.13/ 9.23 = 1.42 (approximately 1.4). This suggests that the Liver size could be 1.4 times larger than the Spleen size.

Table 3 gives the 2-tailed Pearson correlation coefficients of all the study parameters.

Table3: The correlation coefficients of all the study parameters.

Correlations

		AGE	HEIGHT	WEIGHT	BMI	LIVER	SPLEEN
AGE	Pearson Correlation	1	.041	.284*	.283*	.089	.249
	Sig. (2-tailed)		.776	.046	.046	.540	.081
	N	50	50	50	50	50	50
HEIGHT	Pearson Correlation	.041	1	.496**	.053	.120	-.108
	Sig. (2-tailed)	.776		.000	.715	.406	.457
	N	50	50	50	50	50	50
WEIGHT	Pearson Correlation	.284*	.496**	1	.888**	.369**	.231
	Sig. (2-tailed)	.046	.000		.000	.008	.107
	N	50	50	50	50	50	50
BMI	Pearson Correlation	.283*	.053	.888**	1	.351*	.333*
	Sig. (2-tailed)	.046	.715	.000		.012	.018
	N	50	50	50	50	50	50
LIVER	Pearson Correlation	.089	.120	.369**	.351*	1	.584**
	Sig. (2-tailed)	.540	.406	.008	.012		.000
	N	50	50	50	50	50	50
SPLEEN	Pearson Correlation	.249	-.108	.231	.333*	.584**	1
	Sig. (2-tailed)	.081	.457	.107	.018	.000	
	N	50	50	50	50	50	50

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

From the Table 3 it can be seen that Liver span does not correlate with Age and Height in this study while there is significant correlation with Weight ($r = 0.369$, $p < 0.01$) and BMI ($r = 0.351$, $p < 0.05$). The Splenic length does not correlate with Age, Height and Weight but significantly correlates with BMI ($r = 0.333$, $p < 0.05$). However, there is a strong significant correlation between the Liver span and the Splenic length ($r = 0.584$, $p < 0.01$). Fig 1 shows the graph between Liver span and BMI and Table 4 gives the coefficients of Regression line.

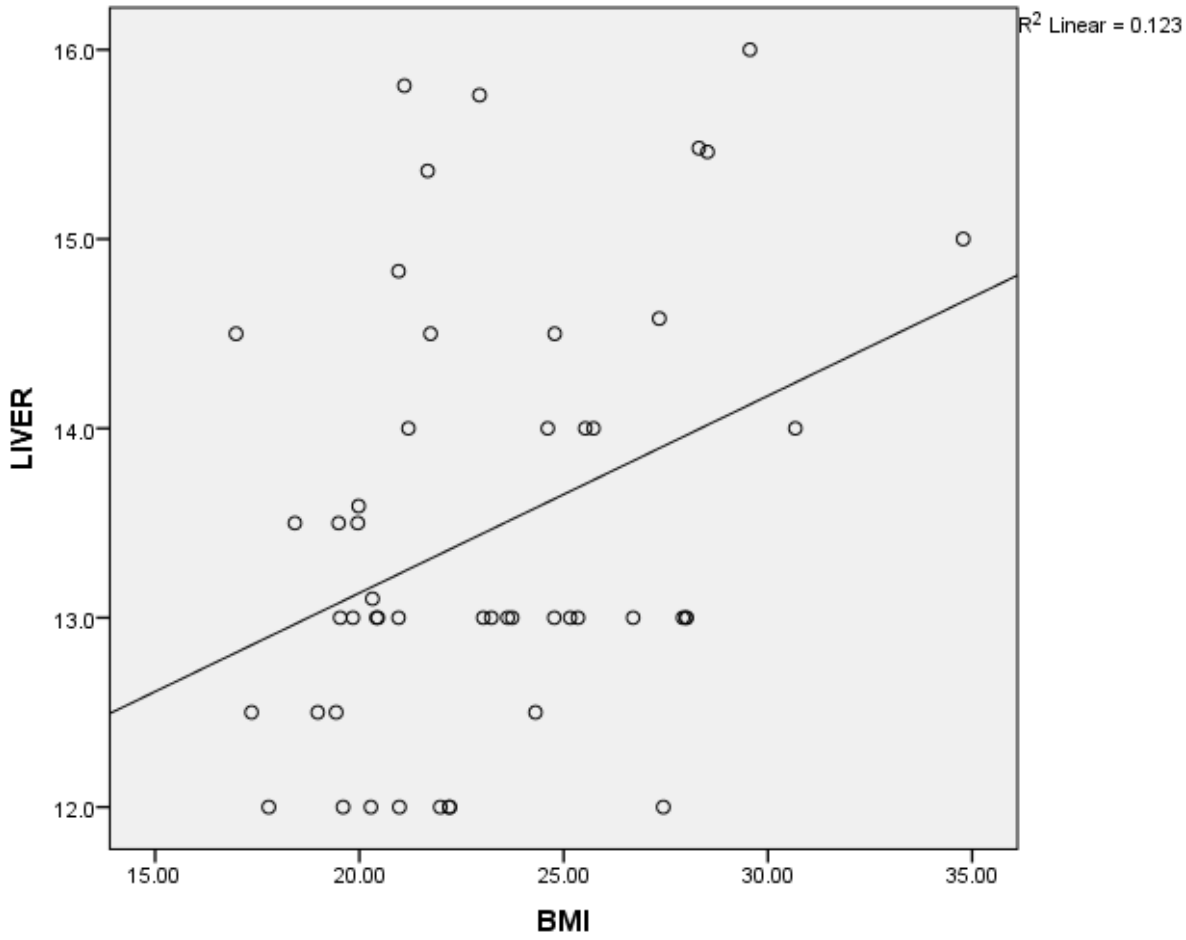

Figure 1. Regression line between Liver span and BMI

Table 4: The coefficients of Regression line between Liver span and BMI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.048	.940		11.755	.000
	BMI	.104	.040	.351	2.600	.012

a. Dependent Variable: LIVER

From table 4, the line of best fit between the Liver span and the BMI can be written as:
Liver span = 11.048 + 0.104 BMI ($p < 0.05$)

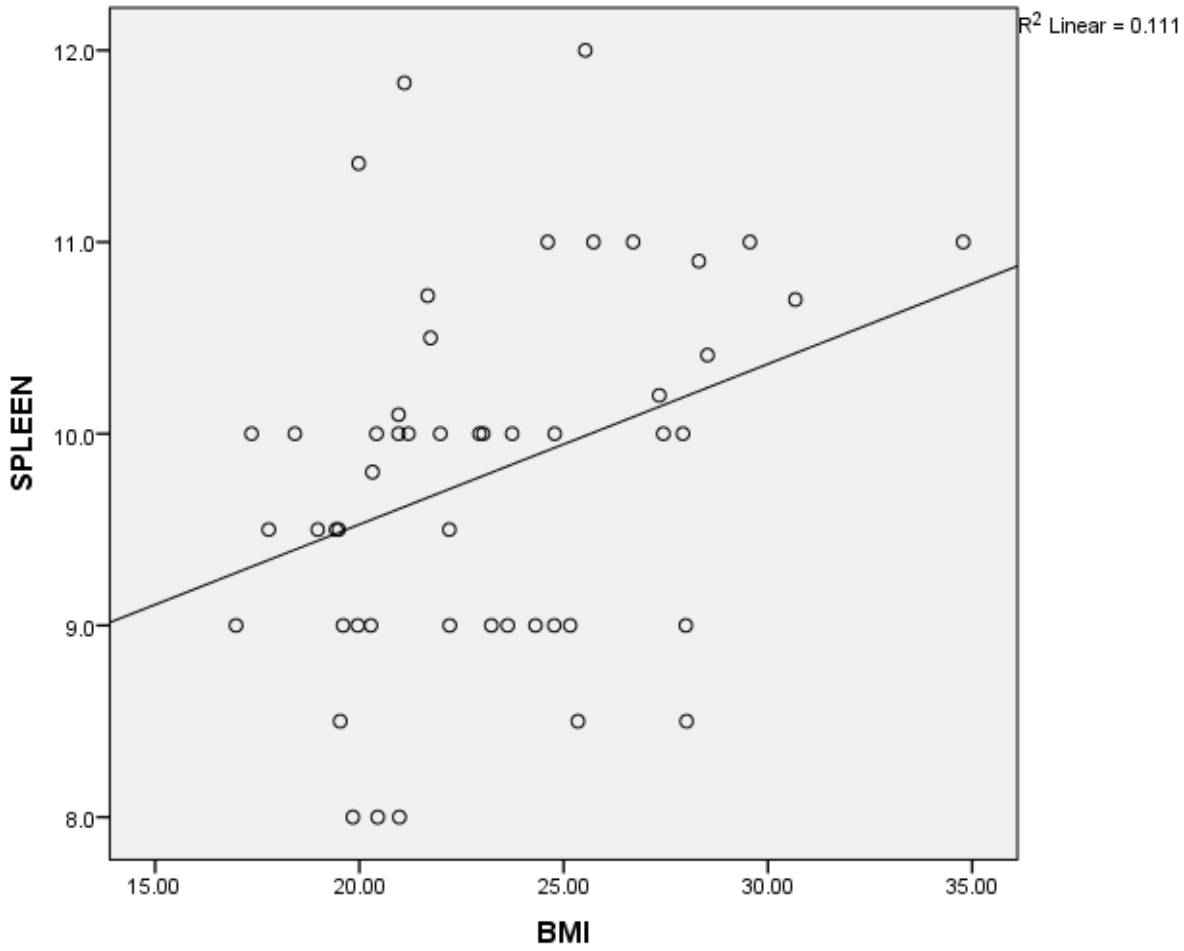

Figure 2: Regression line between splenic length and BMI

Table 5: The coefficients of Regression line between the splenic length and BMI.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.854	.801		9.800	.000
	BMI	.084	.034	.333	2.450	.018

a. Dependent Variable: SPLEEN

Figure 2 shows the graph between splenic length and BMI and table 5 gives the coefficients of Regression line. From the table 5 the line of best fit between splenic length and BMI can be written as:
Splenic Length = 7.854 + 0.084 BMI ($p < 0.05$)

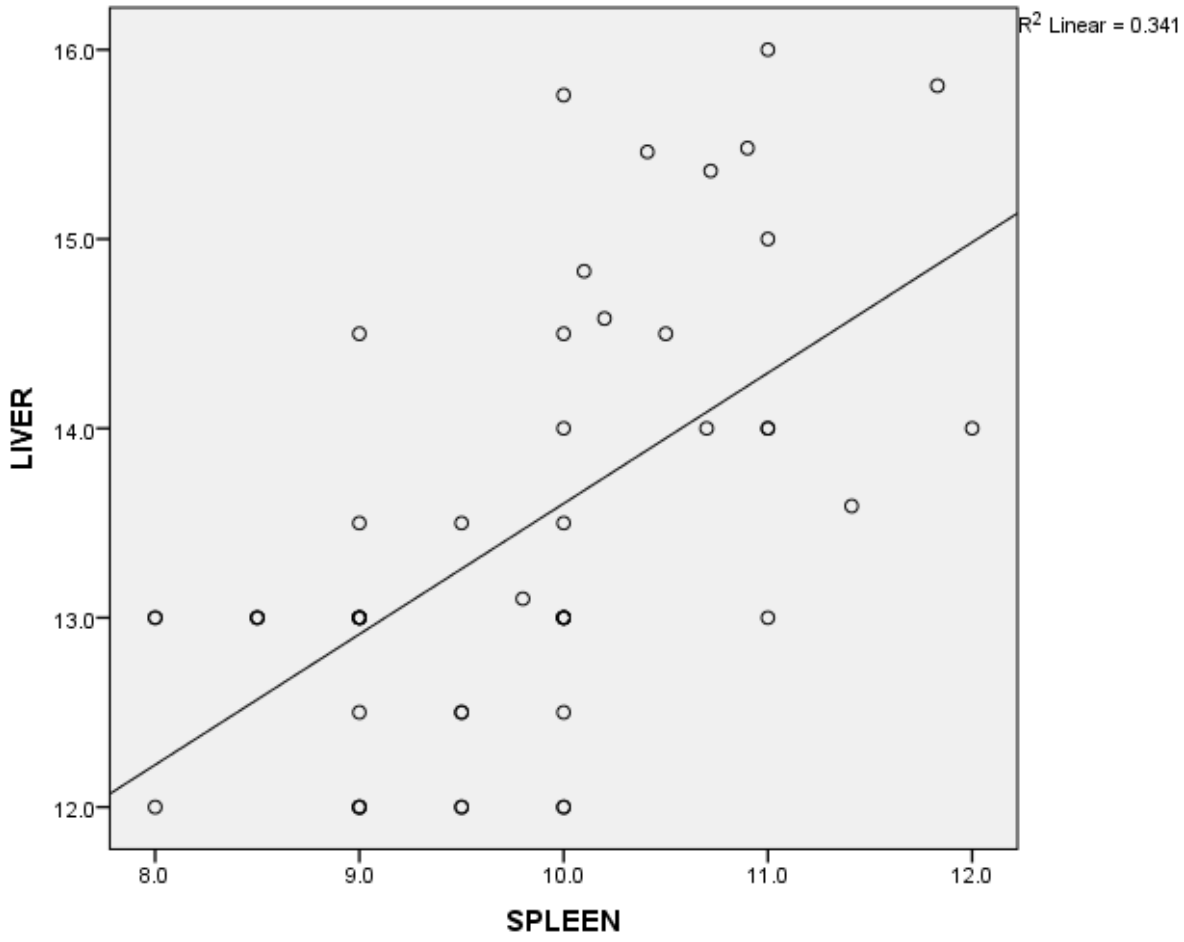

Figure 3: Regression line between the Liver span and the splenic length

Table 6: The coefficients of Regression line between the Liver span and the splenic length

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.704	1.361		4.926	.000
	SPLEEN	.690	.138	.584	4.988	.000

a. Dependent Variable: LIVER

Fig 3 shows the graph between Liver span and splenic length and Table 6 gives the coefficients of the regression line. From the table 6 the relationship between Liver span and Splenic length can be written as:

Liver span = 6.704 + 0.690 Splenic length ($p < 0.001$)

4. Conclusion and Recommendations

The knowledge of sonographic standard normal values of body organs in each local area will help the Sonographer to accurately diagnose the enlargements of such body organs. This study has established three different relationships to guide the Sonographer. (i). Relationship between Liver span/Splenic length with BMI. (ii). Relationship between Liver span and splenic length. (iii). Liver/Spleen Ratio for a cross-section of Nigerian population in Jos. In the city of Jos there exist multi-ethnic groups of people from different states and the participants of this study covered 1/3 of states in Nigeria. We recommend that the study population be increased to cover more states to establish national standard normal values for greater accuracy.

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REFERENCES

Bushberg J. T., Seibert J.A., Leidholdt E.M.Jr, Boone J.M. (2002). Essential Physics of Medical Imaging.Second Edition.Lippincott Williams & Wilkins: 469 – 479.

Dhingra B., Sharma S.,Mishra D., Kumari R., Pandey R.M. and Aggarwai S.(2009). Normal values of Liver and spleen size by ultrasonography in Indian children. *Indian Pediatric **47**:* 487- 492.

Konus O.L., Ozdemir A., Akkaya A., Erbas G .Celik H. and Isik, S.(1998) Normal liver, spleen and kidney dimensions in neonants, infants and children:Evaluation with sonography. *Am.J Roentgenol,* **171**, 1693-1698.

Kratzer W.F., Violetta F., Mason R.A., Haenle M. M., Kaechele V., Rosemerstein study group (2003). Factors affecting liver size: A sonographic survey of 2080 subjects. J.*Ultrasound Med.* **22**, 115-116.

Marco P., Vincenzo M., Rosanna C., Ernsto S., Roberto M., Antonio S., Giuliana F. and Bruno R. (2002). Measurement of Spleen volume by ultrasound scaning in patients with Thrombocytosis: A prospective study. *Blood Journal* **99**(11*),* 4228-4230.

Safak A.A., Simsek E. and Ahcebasi T. (2005). Sonographic assessment of the normal limits a Percentile curves of liver, spleen and kidney dimensions in healthy school-aged children.*J. Ultras. Med.* **24**, 1359- 1364.

Sarac K., Kutlu R., Yakinci C., Durmaz Y., Baysal T., Ozgen U. (2000). Sonographic evaluation of Liver and spleen size in school-aged children. *Turk. J. Med. Sc.,* **30**, 187- 190.

Singh A., Ansari H., Das J.K., Naresh C. (2011) Ultrasonographic measurements of splenic length in
Relation with height in Bihuri adult population. A prospective study. *J. Anat.Soc.India* **60***(2)*, 188-189.

Tarawneh E. S., Hadidy A. M., Haroun A.A., Mahefza W.S., Samara O.A., Arafeh F. M., Alsharif A.
A. (2009). Ultrasound measurement of liver span in Jordanian adults. A preliminary Experience. *Jordanian Med. J.* **43**(3), 197-204.

Udoaka A.I., Enyi C. And Agi C.E. (2013). Sonological evaluation of the liver, spleen and the kidneys in an adult Southern Nigerian population. *Asian J. Med.Sci.***5** *(2)*, 33-36.

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