



Sonographic Measurement of the Spleen in the healthy adult Nigerian Population in Enugu State, Nigeria

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Abstract

Context: measurement of the spleen with ultrasound in order to obtain normal lengths (nomogram) is possible because ultrasound is devoid of ionizing radiation, it is real time, readily available, cheap easily reproducible and has high specificity and high sensitivity values.

Aim: Sonographic measurement of the spleen was carried out in 500 healthy adult Nigerians in Enugu State in order to determine the nomogram for the spleen and to correlate the measurements with the sex, age, height, weight and body mass index, so as to find out whether there is a significant difference in the size of this organ as compared to other races in the reviewed literature.

Materials and Methods: Measurement of the spleen was carried out in 500 healthy adult Nigerians comprising 195 males (39%) and 305 females (61%). The individuals were not less than twenty (20) years as at the time of data collection. The data was analyzed using SPSS statistical package version 20.0. The mean, median, variance, standard deviation of the spleen sizes were evaluated and correlated with the age, sex, weight, height and body mass index of the subjects.

Results: the mean splenic length for males was 104.1 ± 14.5 mm and 103.3 ± 13.4 mm for females with P values of 0.515. The mean splenic width was 62.9 ± 12.8 mm for males and 60.3 ± 10.6 for females with P values of 0.013 which is significant showing that males have longer splenic width than females. There was a significant relationship between age and spleen width in both sexes with P values of 0.001. There is also a significant correlation of the spleen dimension with body mass index in both sexes with P values < 0.05 . Furthermore, the result shows that there was a correlation of the splenic length and width with age. There was also positive correlation of the splenic length with Body Mass Index P values 0.014, height P values 0.000 but not with subject's weight P values 0.311.

Conclusion: There is significant correlation of the spleen width with height, weight but not with body mass index. Males have greater splenic width than females. There is also a significant correlation of the splenic length and width with age.

Keywords: Adults, dimensions, sonography, spleen

Introduction

Normal sizes of the spleen, liver and kidneys have been found to vary significantly depending on the age, sex, height, and weight of individuals.¹ The measurement of these organs is important because

there could be changes in the sizes of the liver, spleen and kidneys in some disease conditions like; malaria, typhoid fever, diabetes mellitus, liver cirrhosis, amyloidosis, immune deficiency states and haemoglobinopathies.²

Ultrasound is an important method in the evaluation of some organs such as the spleen due to the fact that it provides real-time images, it does not require anesthesia, it gives accurate measurement and it is devoid of ionizing radiation.³ Lamb et al in their measurement of spleen with ultrasound observed that ultrasound is reliable and is a good indicator of

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splenic size. Previous studies that were carried out with ultrasound by measurement of the spleen in vivo and comparing with the measurement of the spleen in-vitro have shown good correlation with each other showing that ultrasound gives accurate measurement.^{4,5}

The spleen functions as part of the immune system and contributes to the production and storage of blood cells as part of the circulatory system, for instance the spleen removes the old red blood cells from the blood (via red pulp) and produces white blood cells which in turn produces antibodies (via white pulp). The majority of the function of the spleen is taken over by the liver after splenectomy, Splenectomy greatly increases the risk of septicaemia and of pneumococcal infection as well as malaria⁶.

Enlargement of the spleen is usually done by palpation especially when it is enlarged but when there is mild enlargement or decrease in size of the organ, making decisions whether they are enlarged or not becomes difficult. This is buttressed by Jurgen et al⁷ who stated in their sonographic measurement of the normal liver, spleen and pancreas that measurement of the liver, pancreas and spleen based on percussion and palpation are inaccurate and unreliable because it cannot determine exactly to what extent the organs have changed in their sizes, furthermore, Okoye et al in their sonographic measurement of the spleen in 250 healthy adult Nigerian population stated that clinical evaluation of the spleen and liver sizes is difficult and unreliable due to the fact that the spleen and liver are concealed in their anatomic locations under the ribs, and considerable enlargement need to occur before they can be clinically palpated. Arkes et al also noted that a palpable spleen does not necessarily mean that it is enlarged. This view was supported by Gerspacher et al who compared ultrasonography and splenic palpation for evaluation of size changes and concluded that abdominal palpation was a poor method for estimation of splenomegaly and hepatomegaly. Based on this, the use of an imaging modality like ultrasound becomes useful. It is therefore necessary to have a set of standard normal sonographic measurement values showing upper and lower limits of the spleen. This will detect when this organ is normal. The enlargement of the spleen most times

will help in making diagnosis of a disease entity like Hepato-splenomegaly seen in HIV and AIDS, leukaemias and others⁸.

The morphology of visceral organs like the spleen varies from person to person. It has been noticed that during maturation process for instance from infancy to adolescence that growth of visceral organs show high correlations with gains in height, weight and body surface area⁹. This statement is buttressed by Deland et al¹⁰ in their study of the spleen, liver and kidneys in 440 adult autopsy specimen, where they showed that there is variation in the sizes of these organs in terms of sex and age of the individual. They reported that the spleen size in females was smaller than in males for all age groups. Also Konus et al¹¹ in their study with 307 children were able to show that there is a good correlation between organ size and body weight. Dinkel et al¹² also showed a good correlation between spleen size and the body weight in childhood. Christophe et al¹³ in their sonographic measurement of the liver, spleen and kidney measurements in healthy term and preterm newborns were able to show that as the gestational age increases, the spleen dimensions also increases. It has been noted that the spleen reduces in size as old age sets in. Neidirean et al¹⁴ in their sonographic study on adults found that this organ decreases in size with ageing.

Materials and method

This study was on sonographic measurement of the spleen in the healthy adult Nigerian population. The examination was done with a mobile ultrasound scanner (model IPC-1530(U) SN mo 7292 made in Japan by Aloka co. Ltd) with 3.5MHZ trans-abdominal curvilinear transducer. The spleen width was measured in the coronal plane at the hilum (S1). As well as the longest longitudinal distance from the dome of the diaphragm to the tip of the spleen (S2). The objective of the study was to determine the nomogram for the spleen, to correlate the measurement with the sex, age, height, weight and body mass index, in the adult Nigerian population, and also to find out whether there is a significant difference in the size of this organ as compared to other races in the reviewed literature.

A sample size of five hundred (500) was used for the study and the individuals were not less than twenty (20) years as at the time of data collection. A

questionnaire was used for inclusion and exclusion criteria. Consent was obtained from the individuals before the study and strict confidentiality was maintained.

Ultrasonography was chosen because it is devoid of radiation, non-invasive, real-time and gives accurate measurements. Approval for the study was sought and obtained from the Research and Ethics Committee of University of Nigeria Teaching Hospital.

Measurement of the spleen was done in right posterior oblique position for the spleen. The height of individuals were measured with a meter rule in centimeters, the weight in kilograms using weighing scale. The body mass index was calculated using weight (W)/height² (H²). Individuals filled a short questionnaire which was used for inclusion/exclusion.

The exclusion criteria were as follows

1. Non- Nigerians.
2. History of fever or illness at the time of presentation.
3. Age less than 20 years.
4. SS genotype.
5. History of surgery on any of these organs (liver, spleen, and kidney).
6. Pregnancy.
7. Obesity (BMI > 30kg/m²)

Method of Data Analysis

The data was analyzed using Statistical package for Social Sciences (SPSS) version 20.0. The mean, median, variance, standard deviation of the spleen size were evaluated and correlated with the age, sex, weight, height and body mass index of the subjects. The results obtained were presented in tables, charts and figures.

The data collected was sorted, coded and imputed into SPSS version 15.0 statistical package. Frequency tables and charts were generated for relevant variables. Descriptive statistics such as mean, median, range, variance and standard deviation were used to summarize quantitative variables (age, height, weight, BMI, and organ dimensions) while categorical variable like sex was summarized by proportions. The t-test was used to test for significant difference in organ dimension between dichotomous variable. While One-way Analysis of Variance was used to test for significant

difference in organ dimension for more than two categorical variables. Scatter diagrams were presented for better illustration of correlations. Pearson's moment correlation coefficients were reported to show relationship of organ dimension with age, BMI, height and weight. All analysis was done at the 5% level of significance, with p-value < 0.05 considered statistically significant.

Results

Table 1: Biodata of study participants

Characteristics	Frequency	Percentages
Sex		
Male	195	39.0
Female	305	61.0
Age (years)		
20-25	89	17.8
25-34	182	38.4
35-44	85	17.0
45-54	61	12.2
55-64	22	4.40
65-74	27	5.40
75+	34	6.80
BMI (kg/m²)		
Underweight (<18.5)	13	2.6
Normal weight(18.5-24.9)	289	57.8
Overweight (25.0-29.9)	178	35.6
Obese (<30)	20	4.0
Total	500	100.0

Discussion

The result of the study showed that males have greater splenic width than females. When correlated with age, height, weight and body mass index of the subjects, the study further revealed that there is a significant correlation of the splenic length and width with age, even though the splenic length and width tend to reduce with age in the 75 years old and above. However, there is a significant correlation of splenic length with body mass index, (p = 0.014), height (p = 0.000) but there is no correlation with the weight. The mean splenic length for males was 104.1 ± 14.5mm with a range of (77.0-130.0mm), while females had a mean splenic length of 103.3 ± 13.4mm with a range of (54.0-127.0mm) (P = 0.515). It shows that males have greater splenic length than females but the differences in length are not significant. The mean splenic width was

Table 2: Organ dimension according to sex

ORGAN	SEX	Number	Mean ± (SD) (mm)	Minimal- Maximum (mm)	Median (mm)	Range (mm)	Variance (mm)
Spleen Length	Male	195	104.1± 14.5	77.0-130.0	104.1	53.0	209.5
	Female	305	103.3±13.4	54.0-127.0	102.0	73.0	180.2
	Total	500	103.6±13.8	54.0-130.0	103.0	76.0	191.4
			t= 0.651	p-value=0.515	df= 498		
Spleen Width	Male	195	62.9±12.8	34.0-89.0	61.0	55.0	164.8
	Female	305	60.3± 10.6	39.0-90.0	59.0	51.0	112.3
	Total	500	61.4±11.5	34.0-90.0	60.0	56.0	134.2
			t=2.488	p-value=0.013*	df= 498		

Table 3: Spleen length according to age and sex

Spleen length	Age group (years)	Sex	Number	Mean ±S.D (mm)	Minimum- Maximum (mm)	Median (mm)	Range (mm)
20- 25		M	32	110.2±18.5	78.0-130.0	109.5	52.0
		F	57	103.7±11.7	75.0-126.0	103.0	51.0
		Total	89	106.0±14.9	75.0-130.0	104.0	55.0
25-34		M	54	105.3±12.8	76.0-130.0	103.0	54.0
		F	128	98.7±9.1	77.0-118.0	98.5	41.0
		Total	182	103.4±12.2	76.0-130.0	102.0	54.0
35-44		M	22	101.3±9.2	86.0-120.0	102.5	34.0
		F	63	99.1±15.2	81.0-124.0	90.5	43.0
		Total	85	100.8±11.0	81.0-124.0	101.0	43.0
45-54		M	34	109.7±19.0	74.0-137.0	112.0	63.0
		F	27	106.3±14.6	80.0-126.0	112.0	63.0
		Total	61	107.8±16.6	74.0-137.0	112.0	63.0
55-64		M	8	114.9±7.1	106.0-120.0	120.0	14.0
		F	14	88.9±16.8	54.0-109.0	91.0	55.0
		Total	22	98.3±18.8	54.0-120.0	92.0	66.0
65-74		M	11	105.7±7.3	91.0-110.0	109.0	19.0
		F	16	94.4±10.9	84.0-113.0	91.0	29.0
		Total	27	99.0±10.9	84.0-113.0	92.0	29.0
75 and above		M	34	105.0±15.6	84.0-127.0	101.5	43.0
		F	-	-	-	-	-
		Total	34	105.0±15.6	84.0-127.0	101.5	43.0

F – value = 3.138, df = 499, p-value = 0.005

There is a statistically significant relationship between age and spleen length.

62.9 12.8mm, range of 34.0-89.0mm for males and 60.3 10.6mm for females with P value of 0.013 which is statistically significant. The splenorenal index was stratified by age of subjects and it was found that there is a statistically significant relationship between age and splenorenal index with P values <0.0001 as well as body mass index with P values 0.017. The splenorenal index was obtained by getting a ratio between the length of the spleen and that of the left kidney length. From the statistical data chart, it was observed that the range

of splenorenal index irrespective of age was 0.54-1.67. It is suggested from the study that the normal values for the splenorenal index was 0.54-1.67 for both adult males and females. This value was similar to the findings of Loftus and Metreweli1 in their study of upper limit of normal for spleen dimension in the pediatric population. They suggested an upper limit ratio of (1.25) as the splenorenal index for children. They did not state the lower limit.

There is significant correlation of the spleen width

Table 4: Spleen width according to age and sex

Spleen width	Age group (years)	Sex	Number	Mean \pm S.D (mm)	Minimum-Maximum (mm)	Median (mm)	Range (mm)
	20 - 25	M	32	66.7 \pm 14.9	43.0-89.0	72.0	46.0
		F	57	64.4 \pm 10.80	50.0-96.0	62.0	46.0
		Total	89	65.2 \pm 12.4	43.0-96.0	63.0	53.0
	25-34	M	54	65.6 \pm 11.7	43.0-88.0	62.0	45.0
		F	128	57.9 \pm 9.9	39.0-83.0	57.0	44.0
		Total	182	60.2 \pm 11.6	39.0-88.0	59.0	49.0
	35-44	M	22	63.3 \pm 14.2	34.0-79.0	71.0	45.0
		F	63	62.3 \pm 9.8	49.0-87.0	60.0	44.0
		Total	85	62.6 \pm 11.0	34.0-87.0	60.0	49.0
	45-54	M	34	60.6 \pm 12.4	39.0-78.0	58.5	38.0
		F	27	58.3 \pm 12.1	36.0-78.0	56.5	42.0
		Total	61	59.3 \pm 12.2	36.0-78.0	57.0	42.0
	55-64	M	8	56.3 \pm 7.9	46.0-70.0	65.0	26.0
		F	14	54.5 \pm 10.7	45.0-68.0	48.0	23.0
		Total	22	55.6 \pm 8.8	45.0-70.0	54.5	27.0
	65-74	M	11	70.0 \pm 0.83	69.0-71.0	70.0	2.0
		F	16	60.1 \pm 11.3	44.0-70.0	65.0	26.0
		Total	27	64.1 \pm 9.9	69.0-71.0	69.0	27.0
	75 and above	M	34	59.3 \pm 11.9	41.0-76.0	56.0	35.0
		F	-	-	-	-	-
		Total	34	59.3 \pm 11.9	41.0-76.0	56.0	35.0

F – value = 3.907, df = 499, p-value = 0.001

There is a statistically significant relationship between age and spleen width.

Table 5: Spleen dimension by body mass index

Spleen	BMI	Number	Mean \pm SP	Minimum-maximum	f-value	p-value	df
Length	Under weight (< 18.5 kg/m ²)	13	99.6 \pm 10.8	54.0-110.0	5.994	0.011*	499
	Normal weight (18.5-24.9 kg/m ²)	289	101.2 \pm 13.1	76.0-129.0			
	Over weight (25.0-29.9 kg/m ²)	178	103.6 \pm 14.9	78.0-132.0			
	Obese (> 30 kg/m ²)	20	105.2 \pm 13.6	80.0-139.0			
	Total	500	103.6 \pm 13.8	54.0-139.0			
Width	Under weight (< 18.5 kg/m ²)	13	60.6 \pm 8.19	39.0-66.0	4.365	0.020*	499
	Normal weight (18.5-24.9 kg/m ²)	289	62.8 \pm 11.9	42.0-76.0			
	Over weight (25.0-29.9 kg/m ²)	178	64.4 \pm 11.1	44.0-87.0			
	Obese (> 30 kg/m ²)	20	66.7 \pm 6.1	45.0-89.0			
	Total	500	63.4 \pm 12.9	39.0-89.0			

*There is a statistically significant relationship with p-value < 0.05.

Table 6: Correlation analysis of organ dimension with age, BMI, height and weight of subjects

		Age	Body mass index	height	weight
Subject's spleen length	Pearson correlation	0.254	0.110	0.241	0.045
	Sig (2tailed)	0.005	0.014*	0.000*	0.311
Subject's spleen width	Pearson correlation	0.179	0.038	0.275	0.130
	Sig (2tailed)	0.006	0.390	0.000*	0.004*

with height (p value 0.000) and weight (p value 0.004), but not with body mass index.

These findings are similar to those of Okoye et al¹⁵ in their sonographic measurement of the spleen in 250 healthy adult Nigerian population, where they stated that there was poor correlation between spleen dimension and age, but that splenic weight increased with body weight. In the same vein, the mean splenic length for both males and females were less than 120mm which fell within a normal limit of the length of the spleen as was defined by Obajimi et al¹⁶ in their study on abdominal ultrasonography in HIV/AIDS patients in the South-Western Nigeria. From this study, the normal range for the splenic length and width was 77.0-130.0mm and 34.0-89.0mm for males and 54.0-127.0mm and 39.0-90.0mm for females respectively.

Conclusion

This study concludes that there is significant correlation of the spleen width with height (p values 0.000) and weight (p values 0.004), but not with body mass index. Males have greater splenic width than females. There is also a significant correlation of the splenic length and width with age, even though the splenic length and width tend to reduce with age in the 75 years old and above. However, there is a statistical significant correlation of splenic length with body mass index, (p values 0.014) and height (p values 0.000). Males have greater splenic length than females but the differences in length are not significant.

References

- Loftus WK, Metrewili C. Normal Spleen, Kidney and Liver Sizes in Chinese Population. *Journal of Ultrasound Medicine*. 1997; 16: 345 - 347
- Andrey LS, David MD, Mark AK. Sonographic Evaluation of the Spleen Size in Tall Healthy Athletes. *American Journal of Radiology*. 2005; 184:45-49.
- Sureyya K., Soyupak A., Nejat N. Sonographic Measurement of the Liver, Spleen and Kidney Dimensions in the Healthy Terms and Pre-term Newborns. *European Journal of Radiology*, 2002; 43: 73-78.
- Rodrigues A, Rodrique C, Germano M, Rasera I, Carri E. Sonographic Assessment of Normal Spleen Volume. *Journal of Clinical Anatomy*, 1995; 8: 252 - 259
- Koga T. Correlation between Sectional Area of the Spleen by Ultrasonic Tomography and Actual Volume of the Removed Spleen. *Journal of Clinical Ultrasound*, 1979; 7:11-20.
- Roddie M.N, Keith W. *Textbook of Pathology*, 13th Edition, ELBS Publishers 1996; 641.
- Jurgan E, Muler MD, Joachin F. Sonographic Measurement of the Normal Liver, Spleen, pancreas and Portal Vein, *Radiology* 2000; 149:537-540.
- Hacer Y, Mechmet S, Erol H. Sonographic Measurement of the Liver, Spleen and Kidney in Healthy Term Newborns. *American Journal of Radiology* 2003; 180: 35 – 40.
- Dinkel E, Milde S. Sonographic Biometry of the Liver and Spleen Size in Childhood. *Pediatr Radiol* 1983; 13: 206 – 11.
- Deland FH. Normal Spleen. *Liver and Kidney Sizes*. *Radiology*, 2000; 157: 275 – 279.
- Konus O. Normal Liver, Spleen and Kidney Dimensions in Neonates, Infants and Children: Evaluation with Sonograph. *American journal Roentgenol* 1998; 171: 1693 – 1698.
- Dinkel E, Ertel M, Districh M. Kidney Size in Childhood: Growth Charts for Kidney Length and Volume. *Pediatric Radiology* 2000; 25: 32 – 37.
- Christophe C, Cantraine F, Bogaert C. Ultrasound: A Method for Kidney Size Monitoring in Children. *European Journal of Pediatrics* 1986; 145: 532 – 538.
- Niederan C, Sonneberg A, Muller JE, Erdienbredit JF, Scholten T, Fritsch WP. Sonographic Measurement of Normal Liver, Spleen, Pcreas and Portal Vein. *Radiology* 1983; 149: 537 – 540.
- Okoye I.J, Agwu K.K, Ochie K. Sonographic Splenic Sizes in adult Nigerian Population, *West African Journal of Radiology*, April 2005; Vol. 12 No. 1.
- Obajimi M, Atalabi O. Abdominal ultrasonography in HIV/AIDS patients in the south-western Nigeria, *BMC Medical Imaging*.2008; 8:5.