

SHORT COMMUNICATION

## Sonographic Determination of Normal Spleen Weight among Adults at Barishal District in Bangladesh

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### ABSTRACT

The study was conducted to determine normal spleen dimensions and anthropometric evaluation by ultrasonography from females and males at Barisal district in Bangladesh. A cross sectional data was collected from the 200 subjects in our population. These measurements were taken using an ultrasonography. The mean values of the age, height, weight and body mass index (BMI) of subjects, spleen width (SW), spleen length (SL), spleen thickness (ST) and spleen volume calculated with ellipsoid formula; length x width x thickness x 0.524 were taken. These measurements were found to be 41.37±16.92 years, 157.48±3.71 cm, 55.36±2.11 kg, 20.1±1.01 kg/m<sup>2</sup>, 3.63±0.75 cm, 7.60±1.0 cm, 6.05±1.19 cm and 78.92±34.78 cm<sup>3</sup> in females respectively. Additionally, in males' same dimensions were 42.85±17.93 years, 165.1±4.57 cm, 61.26±3.34 kg, 21.1±1.02 kg/m<sup>2</sup>, 4.01±0.34 cm, 8.66±0.74 cm, 7.67±0.35 cm and 92.17 ±36.35 cm<sup>3</sup>, respectively. The observations presented in this report have defined anatomic parameters about spleen size that need to be taken into consideration for reference data to determine population discrepancies and helpful for radiologists and clinicians.

**Key words:** Adult, Bangladesh, Spleen volume

### Introduction

The spleen is the largest lymphoid organ with a parenchymal structure in the reticuloendothelial system and it is situated in the left hypochondrium (Danila, 2010; Lamp et al., 2002; Ehimwenma & Tagbo, 2011). It is covered by the ribs. The shape of the spleen is tetrahedral or wedges (Nayak et al., 2011). Moreover, the spleen size shows variations according to people, depending on the individual's height, age and sex (Danila, 2010; Hosey et al., 2006). Splenomegaly is an indicator of varieties of inflammatory, infectious, infiltrative, metabolic, neoplastic, hematopoietic diseases and the other diseases like portal hypertension, glycogen storage disorder, leukemia, lymphoma, melanoma, celiac disease (De Odorico et al., 1999; Mustapha et al., 2010; Asghar et

al., 2011a). Furthermore, splenic enlargement may be result of especially viral illnesses and is a crucial criterion in diagnosing primary myeloproliferative diseases (Picardi et al., 2002; Spielmann et al., 2005). However, evaluation of splenic size by palpation can cause unreliable and wrong conclusions because spleen is not palpable until it is enlarged 2 to 3 times its size (De Odorico et al., 1999; Hosey et al., 2006). The knowledge of spleen size, shape or external features might be of importance to surgeons and radiologists (Nayak et al., 2011). Ultrasonography is commonly used to diagnose splenomegaly and to determine the spleen size and it is safe, quick and reliable method for the calculation of splenic dimensions (Mustapha et al., 2010). Therefore, the purpose of this study was to establish guidelines for normal splenic

sizes in our healthy adults by using sonographic method and to compare our findings to other populations 'data. Splenomegaly is an important clinical finding and well-known manifestation of several diseases that may involve in liver disease, portal hypertension, splenic vein thrombosis, lymphoma, other primary and metastatic neoplastic processes, hematologic entities, infectious and immunologic conditions. The prevalence of splenomegaly due to different kinds of liver diseases like viral hepatitis, liver cirrhosis and related disease are very common in our country. The various factors known to prevail in Bangladesh related to the high incidence of splenomegaly are inadequate health awareness, environmental pollution, poor sanitation, contaminated food and drinks, drug and alcohol abuse, various superstitions about liver and spleen diseases, treatment by traditional healers, and limited screening and health care facilities. Some diseases like chronic malaria, chronic kalazar, tropical spruce, chronic myeloid leukemia, storage disease, typhoid fever affect the spleen which is frequent in the country.

## Methodology

The study was conducted among the adult population at different area in Barisal district. The purposive sample is done for this study. The data was collected from the different diagnostic center in Barisal city. A total of 200 adult subjects (84 males and 116 females, ages 20 to 80 years) were enrolled in the research who met the case definition and oral statement were obtained from these subjects. The patients selected for the study were evaluated with ultrasonography (USG) for abdominal and/or pelvic problems unrelated to the spleen, mostly because of urinary tract infection or abdominal pain. They had no history of disease related to the liver or spleen and no gastrointestinal, hematologic, oncologic or traumatic conditions. Anthropometric data, including sex, age, height and weight was recorded from each subject and body mass index was calculated according to the formula:  $BMI = \text{weight in kg} / \text{height in m}^2$ . All

examinations were performed by sonologist in abdominal ultrasonography using a commercially available high-resolution real time SONOSCAPE S50 made by China.



**Figure 1. Splenic length, thickness and width measurement methods used in this study**

Moreover, images were obtained with the subject lying in the supine or slightly right lateral decubitus position and through an oblique intercostal approach following suspended deep inspiration. Splenic weight was calculated with the following standard ellipsoid formula as;  $0.524 \times \text{width} \times \text{length} \times \text{thickness}$ . Splenic weight measurement methods were shown in Figure 1.

The data were divided into two groups: female and male. The SPSS program was used for statistical analysis of the measurement results. From these measurements, Means, standard deviations (SD), and minimum and maximum values were calculated.

## Results

The following tables presented the data obtained from 200 subjects who were examined using ultrasonography. The spleen length, width, thickness and volume were measured. Patient's without noninfectious age, weight, height and body mass index (BMI) were also measured. Anthropometric measurement including sex, age, height and weight and Body Mass Index (BMI) shown in Table 1. Male body height, weight is higher than female.

**Table 1. Anthropometric measurement including sex, age, height and weight and Body Mass Index (BMI)**

Parameters	Females (N=116)		Males (N=84)	
	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range
Age (years)	41.37 $\pm$ 16.92	20–80	42.85 $\pm$ 17.93	21–80
Height(cm)	157.48 $\pm$ 3.71	137–160	165.1 $\pm$ 4.57	142–175
Weight(kg)	55.36 $\pm$ 2.11	43–65	61.26 $\pm$ 3.34	48–72
Body Mass Index (MI)(kg/m <sup>2</sup> )	20.1 $\pm$ 1.01	16–24	21.1 $\pm$ 1.02	18–26

**Table 2. Measurement of spleen characteristic with the mean, standard deviation and the range.**

Parameters	Females (N=116)		Males (N=84)	
	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range
Splenic Width (cm)	3.63 $\pm$ 0.75	2.4–4.61	4.01 $\pm$ 0.34	3.74 – 4.51
Splenic Length (cm)	7.60 $\pm$ 1.0	6.56–8.85	8.66 $\pm$ 0.74	7.69 – 9.39
Splenic Thickness (cm)	6.05 $\pm$ 1.19	3.93–7.39	7.67 $\pm$ 0.35	7.33 – 8.11
Splenic volume (cm <sup>3</sup> )	78.92 $\pm$ 34.78	30 – 177	92.17 $\pm$ 36.35	34 – 180

## Discussion

The spleen which filters the unwanted elements from blood by phagocytosis, is located in the abdomen, below the diaphragm and connected to the stomach. Moreover, it is an important lymphoid organ and plays a crucial role in the immune responses (Mobius & Kraal, 2005;

Chaware et al., 2012). Splenic size can be used as an indicator of disease activity in a variety of disorders of the reticuloendothelial system and many disorders alter splenic size including infective, infestation, infiltrative, immunologic and malignant conditions. However, the physical examination is unreliable to evaluate the

splenic enlargement (Ehimwenma & Tagbo, 2011; Spielmann et al., 2005). Moreover, it has been reported that the presence of the colon, stomach and lung near the spleen makes the examination difficult. But the intercostal approach permits a good examination (Danila, 2010). Ultrasonography (USG) is usually used for the diagnosis of the splenomegaly. Additionally, US measurement of splenic size is standard application and it provides an objective way of noninvasive examination of the spleen. It is especially useful because of lack of radiation exposure (Ehimwenma & Tagbo, 2011; Hosey et al., 2006; Mustapha et al., 2010). Thus, it is safe, quick and accurate method for measurement of splenic dimensions (Picardi et al., 2002; Megremis et al., 2004; Mittal & Chowdhary, 2010). Moreover, the spleen size is exposed to many variations at different periods of life, in different individuals, and in the same individual under different conditions. It can vary from individual, depending on the individual's height, age and sex (Danila, 2010; Hosey et al., 2006).

The information of anomalous size, shape or external features of the spleen could be of important for surgeons and radiologists (Nayak et al., 2011). Moreover, splenomegaly is a crucial clinical sign. Because it might be the only manifestation of a serious underlying disease such as lymphoma and other hematologic diseases (De Odorico et al., 1999; Loftus et al., 1999). Furthermore, it was reported that spleen length was related to age, height, weight and body surface area (Megremis et al.). During the growth duration from infancy to adolescence, development of visceral organs like spleen demonstrated correlation with increases in height, weight and body surface area. Additionally, it was estimated that splenic length measured by ultrasonography provided an objective and safe method to evaluate spleen size (Hosey et al., 2006; Megremis et al., 2004). In this study Table 1, There were 84 males and 116 females; their age ranged between 20 and 80 years. For the female the mean age was 41.37 years ( $\pm 16.92$  SD), mean height was 157.48 cm ( $\pm 3.71$  SD), mean weight was 55.36 kg ( $\pm 2.11$  SD), and mean body mass index was 20.1 ( $\pm 1.01$  SD) and the male the mean age was 42.85 years ( $\pm 17.93$  SD) mean height was 165 cm ( $\pm 4.57$  SD), mean weight 61.26 kg ( $\pm 3.34$  SD), and mean BMI was 21.1 ( $\pm 1.02$  SD). Splenic volume varies from man to man. Organ size is usually associated with subject height and weight (De La et al., 2001). We found that males have higher Splenic volume than females because of their higher height, weight, and BMI. Okoye et al., Spielman et al. 2005, found strong correlation between subject height and SL. As there were correlations between SS and both subject height and weight, we would expect a larger average SV in men on the basis of their larger body size.

In this study, we measured the splenic length, width, thickness and weight (calculated with formula in adults and compared our results to other populations. The mean values of splenic length and width were  $9.91 \pm 1.12$  cm and  $4.74 \pm 1.01$  cm in females and  $11.29 \pm 2.13$  cm and  $5.54 \pm 1.11$  cm in males in U.S.A. respectively whereas, same values were  $10.1 \pm 2.02$  cm,  $4.0 \pm 1.03$  cm in females and  $11.1 \pm 2.1$  cm,  $4.4 \pm 1.01$  cm in males in Nigerians respectively (Ehimwenma & Tagbo, 2011; Hosey et al.,

2006). However, corresponding values were as  $8.9 \pm 1.22$  cm and  $4.9 \pm 1.01$  cm in Africans (Mustapha et al.). Moreover, same values were found to be  $9.34 \pm 2.03$  cm and  $3.45 \pm 1.02$  cm in females  $9.40 \pm 2.01$  cm and  $3.45 \pm 1.01$  cm in males in Rajasthan population respectively (Mittal & Chowdhary). These dimensions were  $10.34 \pm 2.02$  cm and  $5.61 \pm 1.02$  in females and  $10.91 \pm 1.01$  cm and  $9.74 \pm 2.11$  cm in males in North Indians and  $7.68 \pm 1.11$  cm and  $8.5 \pm 2.01$  cm in Thai adults, respectively (Asghar et al., 2011b; Srisajjakul et al., 2012). However, the mean and standard deviation splenic length was found as between  $8.48 \pm 2.11$  cm in Chinese population (Loftus et al.). When we analyze our data including splenic length (SL) and splenic width (SW) were found to be  $7.60 \pm 1.0$  cm (Mean  $\pm$  SD) with the range of 6.56–8.85 and  $3.63 \pm 0.75$  cm (Mean  $\pm$  SD) with the range of 2.4–4.61 in females respectively and in males as  $8.66 \pm 0.74$  cm (Mean  $\pm$  SD) with the range of 7.69 – 9.39 and  $4.01 \pm 0.34$  cm (Mean  $\pm$  SD) with the range of 3.74 – 4.51, respectively. We found that splenic length and width is lower than other population of above studies. But mean and standard deviation values of splenic thickness were reported between  $3.33 \pm 1.01$  cm and  $6 \pm 1.21$  cm in Thai population, Indians, Africans, Americans and Nigerians (Mustapha et al., 2010; Asghar et al., 2011b; Srisajjakul et al., 2012; Tonelli et al., 2013). In this study this value was  $7.67 \pm 0.35$  cm in males with the range of 7.33 – 8.11, and  $6.05 \pm 1.19$  cm in females with the range of 3.93–7.39. According to this data our result is slightly higher than other population in above studies.

Splenic weight is calculated using with standard ellipsoid formula ( $0.524 \times \text{width} \times \text{length} \times \text{thickness}$ ). This formula is often used for predicting the volume of many irregularly shaped organs (Asghar et al., 2011b; Yetter et al., 2003; Sonmez et al., 2007). In literature findings, it was seen that ellipsoid formula was used. It was found to be  $92.17 \pm 34.78$  cm<sup>3</sup> (Mean  $\pm$  SD) in males and  $78.92 \pm 36.35$  cm<sup>3</sup> (Mean  $\pm$  SD) in females. In a studying consisting of Nigerians, in males mean and standard deviation value of splenic volume was  $202.7 \pm 108.4$  cm<sup>3</sup> and in females  $153.79 \pm 96.08$  cm<sup>3</sup> respectively (Ehimwenma & Tagbo, 2011). Moreover, the same value was  $119.5 \pm 78.12$  cm<sup>3</sup> in African population (Mustapha et al., 2010). Asgar et al. (2011a) determined that the splenic volume was 288.36 and  $217.44 \pm 108.12$  cm<sup>3</sup> in males and females, respectively. Furthermore, the mean volume of the spleen was  $132 \pm 88.14$  and  $113 \pm 72.11$  cm<sup>3</sup>, respectively in males and females of Japan whereas; same dimensions were  $134.2 \pm 82.03$  and  $115.6 \pm 68.34$  cm<sup>3</sup> in males and females, respectively in Thai adults (Srisajjakul et al.; Kaneko et al., 2008). However, same value was  $344 \pm 171.02$  cm<sup>3</sup> in USA (Tonelli et al., 2013). Due to these data, we found differences in the mean values of splenic volume of Nigerians, Africans, Japanese population, Thai population and USA population. Our splenic volume having lower than other population.

## Conclusion

In conclusion, we think that the precise knowledge of the spleen morphology with USG may be essential for safe and accurate diagnose of many disorders such as

infections, splenomegaly, malignant conditions and viral illnesses for surgeons and radiologist. Therefore, the observations presented in this study have defined anatomic parameters that need to be taken into consideration for evaluate splenic problems and guidelines for determine the reference values. As a result, we believe that the data obtained in this study can provide crucial information for surgeons and radiologists about spleen and they can be used as reference values for evaluating pathologic changes in the spleen region.

## References

- Asghar A, Agrawal D, Yunus SM, Sharma PK, Zaidi SH, Sinha (2011a) A Standard Splenic Volume Estimation in North Indian Adult Population: Using 3D Reconstruction of Abdominal CT Scan Images. *Anatomy Research International*, 2011: doi:10.1155/2011/707325.
- Asghar A, Naaz S, Agrawal D, Sharma, PK (2011b.) Morphometric study of spleen in North Indian adult population: CT Scan image-based study. *Journal of Clinical Diagnostic Research*, 5(5): 974-7.
- Danila M (2010) The ultrasound examination of the spleen. *Medical Ultrasound*, 12(3): 253-4.
- De La Grandmaison GL, Clariand I, Durigon M (2001) Organ weigh in 684 adult autopsies: new tables for a Caucasoid population. *Forensic Science International*, 119: 149-154.
- De Odorico I, Spaulding KA, Pretorius DH, Lev-Toaff AS, Bailey TB, Nelson, TR (1999) Normal splenic volumes estimated using three-dimensional ultrasonography. *Journal of Ultrasound in Medicine*, 18(3):231-6.
- Ehimwenma O, Tagbo MT (2011) Determination of normal dimension of the spleen by ultrasound in an endemic tropical environment. *Nigerian Medical Journal*, 52(3):198-203.
- Hosey RG, Mattacola CG, Kriss V, Armsey T, Quarles JD, Jagger J (2006) Ultrasound assessment of spleen size in collegiate athletes. *British Journal of Sports Medicine*, 40(3): 251-4.
- Kaneko J, Sugawara Y, Matsui Y, Makuuchi M (2008) Spleen size of live donors for liver transplantation. *Surgical and Radiologic Anatomy*, 30(6): 515-8.
- Loftus WK, Chow LT, Metreweli C (1999) Sonographic measurement of splenic length: correlation with measurement at autopsy. *Journal of Clinical Ultrasound*, 27(2): 71-4.
- Mebius RE, Kraal G (2005) Structure and function of the spleen. *Nature Reviews Immunology*, 5(8): 606-16.
- Megremis SD, Vlachonikolis IG, Tsilimigaki AM (2004) Spleen length in childhood with US: normal values based on age, sex, and somatometric parameters. *Radiology*, 231(1): 129-34.
- Mittal R, Chowdhary DS (2010) A pilot study of the normal measurements of the liver and spleen by ultrasonography in the Rajasthani population. *Journal of Clinical Diagnostic Research*, 4(4): 2733-6.
- Mustapha Z, Tahir A, Tukur M, Bukar M, Lee WK (2010) Sonographic determination of normal spleen size in an adult African population. *European Journal of Radiology*, 75(1): e133-5.
- Nayak BS, Somayaji SN, Soumya KV (2011) A study on the variations of size, shape and external features of the spleen in South Indian population. *International Journal of Morphology*, 29(3): 675-7.
- Okoye IJ, Agwu KK, Ochie K (2005) Sonographic splenic sizes in normal adult Nigerian population. *West African Journal of Radiology*, 12: 37-43.
- Picardi M, Martinelli V, Ciancia R, Soscia E, Morante R, Sodano A, Fortunato G, Rotoli B (2002) Measurement of spleen volume by ultrasound scanning in patients with thrombocytosis: a prospective study. *Blood*, 99(11): 4228-30.
- Spielman AL, DeLong DM, Kliewer MA (2005) Sonographic evaluation of spleen size in tall healthy athletes. *AJR Am J Roentgenol*, 184: 45-49.
- Srisajjakul S, Prapaisilp P, Laorratkul N (2012) Normal splenic volume assessment on CT in 426 adults. *Siriraj Medical Journal*, 64(2): 43-6.
- Tonelli AR, Yadav R, Gupta A, Arrossi AV, Heresi GA Dweik RA (2013) Spleen size in idiopathic and heritable pulmonary arterial hypertension. *Respiration*, 85(5): 391-9.
- Yetter EM, Acosta KB, Olson MC, Blundell K (2003) estimating splenic volume: sonographic measurements correlated with helical CT determination. *AJR Am J Roentgenol*, 181(6): 1615-20.