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The Observational Study of Sonographic Measurement of Splenic Dimensions and Correlation with Body Mass Index.

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Abstract

Background: The volume, size, and weight of abdominal organs bear potential significance. For instance, infectious, hematologic, or metabolic conditions may result in an increase in the size of the spleen. The aim of this study is to assess and document the splenic sizes in asymptomatic adults in a Northwest Ethiopia and to correlate with Body mass index (BMI). **Methods:** A cross-sectional prospective study design was performed at the University of Gondar, hospital. The sonographic measurements of spleen length, width, thickness and volume were performed on 380 subjects. In addition, weight and height of the subjects were measured using standard anthropometric technique. Body mass index was calculated. By Pearson's product moment correlation coefficients, the relation of spleen dimensions to BMI was evaluated. **Results:** The body mass index had also statistically significant positive correlation with spleen dimension at $p < 0.05$ ($r=0.195$, 0.176, for splenic length and width) and volume in females ($r=0.236$, $P<0.001$). In males body mass index of the subjects also had a statistically significant correlation with spleen length ($r=0.218$, $p<0.01$); nonetheless, there was no statistically significant correlation with width, thickness, and volume ($r=0.024$, 0.116 and 0.136, respectively).**Conclusion:** The positive correlation is found between the spleen parameters and BMI of both the genders in Ethiopian population which has both clinical and forensic importance.

Keywords: Spleen dimensions, BMI, Ultra-sonography.

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Introduction

The volume, size, and weight of abdominal organs bear potential significance. A multitude of medical conditions are associated with changes in volume and size of these organs. For instance, infectious, hematologic, or metabolic conditions may result in an increase in the size of the spleen.[1,2] Kidney dimensions may change in correlation with the severity of the renal pathology involved. Pancreatic atrophy is associated with changes in exocrine functions.[2,3]Also, deviations from the normal ranges of the weight of an organ may indicate the presence of certain pathological changes. Thus, organ weight may play a role in the determination of the cause of death under different pathological conditions, as well as assisting in defining the association between trauma and disease.[4-6]

Normal anatomic ranges should first be described in order to define pathological conditions. Data from studies examining normal ranges allow a relative comparison of the weight and size of organs. Also, they may help define the degree of atrophy or hypertrophy of a particular organ inflicted by certain diseases.[7] The pancreas, spleen, and kidneys continue to grow until approximately 25 years of age.[8,9]

Thus, only individuals older than 25 years of age were included in this study.

Several studies have sought to develop standards for splenic size, utilizing a variety of imaging techniques such as computed tomography, scintigraphy, magnetic resonance imaging, and sonography.[7–10] Volumetric measurements are most accurately obtained on computed tomography or magnetic resonance imaging. Nevertheless routine computed tomography for the diagnosis and serial follow-up of patients for suspected splenic enlargement is difficult to justify in view of the radiation exposure (especially in a paediatric or adolescent population) and the expense in our environment. The use of magnetic resonance imaging is similarly hampered by expense and limited availability in many areas of the world, particularly in developing countries.[4]

Ultrasonography affords a useful non-invasive role in evaluating the spleen and used for best advantage, it can demonstrate the existence and composition of splenic masses, disruption of splenic texture or outline, progressive changes in masses and the size of the spleen.[6]

The aims of this study are to assess and document the splenic sizes in asymptomatic adults in a Northwest Ethiopia and thereby serve as a baseline for comparison in cases of splenomegaly using transabdominal sonography. This study will also serve as a guide in management and follow up of such cases. The finding will be compared to what is obtained elsewhere, bearing in mind the peculiarity of our environment.

Subjects and Methods

This study comprised of prospective consecutive ultrasonic assessment of splenic sizes in 380 adult subjects (180 males and 200 females) who came to the Department of Radiology of the University of Gondar Hospital. The period of the study was between October 2017 and February, 2018.

Informed consent was obtained from the patients before being used for the study. The reason for the study, possible effects, and stages of examination was explained to the subjects as a group or individually.

The body weight measurements were conducted using the same scale (between 0 and 300 kg, with a sensitivity of 100 g). Height was defined as the distance between the top of the head and heel in centimetres. Anthropometric data includes the body weight, height and BMI.

BMI was calculated using the formula:

BMI = W/H2, where W = weight in kilograms (kg) and H = height in metres (m).

The patients selected for the present study were examined using a Sonoscape SSI 8000 ultrasound machine (Soonchunhyang University Medical center, China) for abdominal and/or pelvic problems not related to the spleen, mostly due to abdominal pain and urinary tract infection. The study subjects had no history of disease related to the spleen and hematologic, oncologic or traumatic conditions.

For the purpose of ultrasound examination of the spleen, first the subjects were placed in supine position and coupling gel was placed on the abdominal wall in the left hypochondriac region to allow optimal transmission of energy between the patient and the probe. Then, the study participants were asked to lie in the right lateral position with the left side elevated. In order to minimize masking by the lung, the splenic measurements were taken during deep inspiration. Splenic length was measured in the longitudinal section maximum distance between the domes of the spleen and the splenic tip. The splenic width defined as the maximum distance between the medial and lateral borders of the spleen was measured in a plane perpendicular to the length through the hilum. Transverse scans were obtained with the transducer rotated through 90° splenic thickness defined as the maximum AP dimension was measured on the transverse section.

To maintain reproducibility, each measurement was repeated at least 3 times and most repeated value was recorded according to the guidelines of the American Institute of Ultrasound in Medicine and as described by lamp and collaborators.

The volume of the spleen was calculated manually from the formula for a prolate ellipsoid formula (length × width × depth × 0.524). The formula is frequently used for estimation of the volume of many irregularly shaped organs.

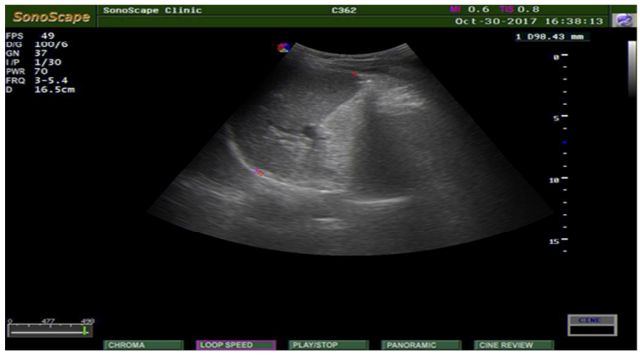

Figure 1: Longitudinal scan showing measurement of spleen length.

Results

A total of 380 adults comprising 180 (47%) males and 200 (53%) females were recruited. The mean height was 163.4 cm (±7.5), the mean weight of the subjects was 57.7 kg (±9.4) and the mean BMI of the subjects was 21.5(±2.9) [Figure 1,2].

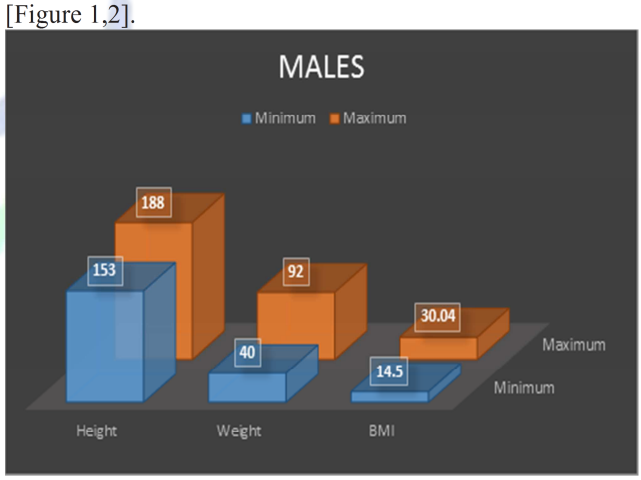

Figure 2: Anthropometric parameters in males.

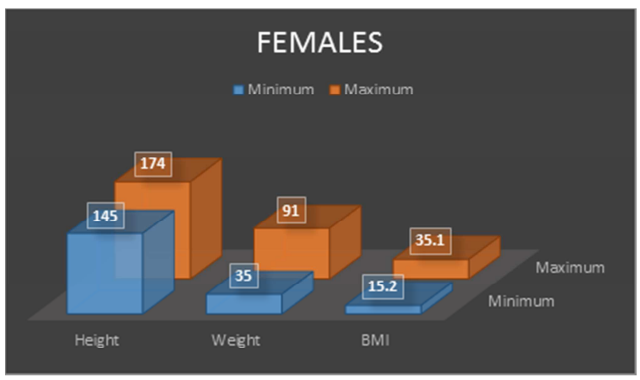

Figure 3: Anthropometric parameters in females.

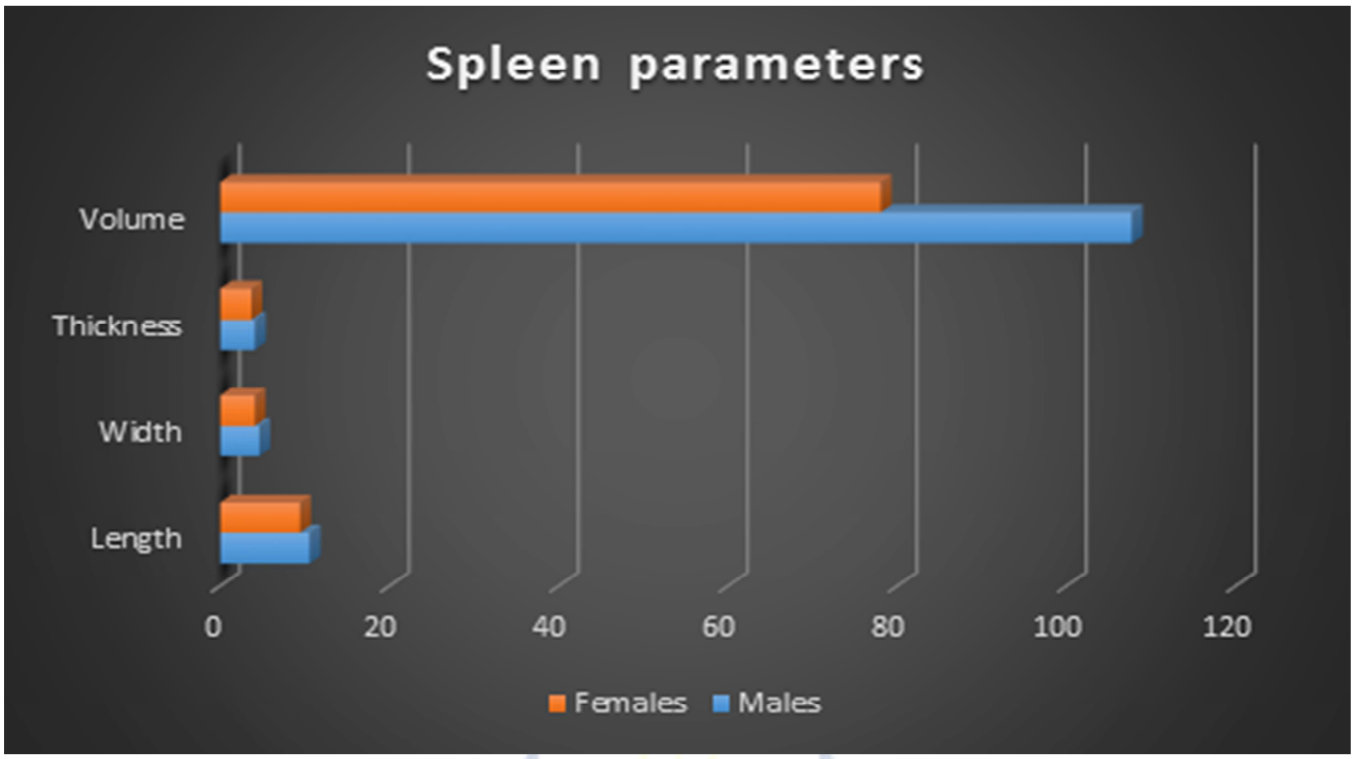

Figure 4: Comparison of parameters of spleen in both genders.

Different linear dimensions and volume of the spleen among males and females in the Northwest Ethiopian population were shown in the above table (Figure 4). Two – tailed t-test analysis indicated a statistically significant difference ($p<0.0001$) between mean splenic dimensions (length, width, thickness, and volume) of male and female subjects. In all measurements, the mean spleen dimensions of male were greater than female.

Table 1: Correlation of spleen dimensions with Body mass index in all subjects.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen(cm3)
Body mass index (Kg/m2)	Pearson Correlation	0.183	0.106	0.118	0.176
	Sig. (2-tailed)	0	0.039	0.022	0.001
	N	380	380	380	380

Table 2: Correlation of spleen dimensions with Body mass index in females.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen(cm3)
Body mass index (Kg/m2)	Pearson Correlation	0.195	0.176	0.122	0.236
	Sig. (2-tailed)	0.006	0.013	0.084	0.001
	N	200	200	200	200

Table 3: Correlation of spleen dimensions with Body mass index in males.

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen(cm3)
Body mass index (Kg/m2)	Pearson Correlation	0.218	0.024	0.116	0.136
	Sig. (2-tailed)	0.003	0.745	0.12	0.069
	N	180	180	180	180

A moderate positive significant correlation ($P<0.0001$) was found between the splenic length, width, volume and body mass index [Table 1].Interestingly, the body mass index had also statistically significant positive correlation with spleen dimension at $p<0.05$ ($r=0.195$, 0.176, for splenic length and width) and volume in females ($r=0.236$, $P<0.001$) [Table 2]. In males body mass index of the subjects also had a statistically significant correlation with spleen length ($r=0.218$, $p<0.01$); nonetheless, there was no statistically significant correlation with width, thickness, and volume ($r=0.024$, 0.116 and 0.136, respectively) [Table 3].

Discussion

Many conditions are known to influence the volume, weight, and size of organs. Some diseases enlarge organs while some may diminish their volume, weight, and size.[11]Even normal organs seem to show great variation. Meanwhile, the volume, weight, and size of organ reference tables are only valid over a limited period of time and may vary among different populations.

Ultrasound measurement of splenic length is standard practice, and it provides a very useful means of non-invasive examination of the spleen. Kluhs et al.[12] in a study to investigate splenic weight determined sonographically and the weight of the spleen measured at autopsy or after splenectomy found that a significant correlation existed.

This study has shown the following mean dimensions of splenic sizes, for the males; the mean splenic length, width, depth, and volume were 11.1 cm (±0.9 SD), 4.4 cm (±0.5 SD), 7.8 cm (±0.6 SD), and 202.7 cm3 (±49.4 SD), respectively, and for the females the corresponding values of splenic length, width, depth and volume were 10.1 cm (±0.7 SD), 4.0 cm (±0.4 SD), 7.1 cm (±0.5 SD) and 153.7 cm3 (±33.2 SD), respectively. The height and weight of the subjects, for both male and female, respectively, increased linearly with the splenic dimensions. This was noted more prominently with the height of subjects. This was not different from other studies in different continents, where the peculiar endemicity in our environment does not exist. Loftus et al.[13] in their study of a Chinese population suggested an upper limit of normal length of 12 cm. Some textbooks of ultrasound and other studies suggested an average splenic length of 12 cm, average width of 5 cm, and average depth (antero-posterior dimension) of 7 cm.

Malaria, tuberculosis, and other water borne parasitic infections are a major public health concern in Nigeria. According to recent estimates, half of the Nigerian population has at least one episode of malaria annually, and majority of outpatient visits can be attributed to malaria. This is similar to exposure to tuberculosis and water borne parasitic infection. This by extrapolation may have exposed the subjects to immunological memory. The spleen is a reticuloendothelial organ involved in defence against infection and infestation and thus it is expected that the spleen may be slightly comparatively larger in exposed subjects than to what is obtained in non-exposed subjects.[8,11]

Different study found that the mean spleen volume and weight of 114 male individuals were 201.3 mL and 209 g, respectively. With regards to the values for splenic volume and weight, our study found that spleen volume and weight are positively correlated with body height, weight and BMI. Henderson et al.[14] found in 11 normal subjects a mean spleen volume of 209 ml. Hoefs et al.[15]used a CT scan and found a normal spleen volume of 201 mL in normal patients. Prassopoulos et al.[16] reported a mean spleen volume of 215 mL for 140 patients. Geraghty et al.[17]found the mean spleen volume of 209 cm3 in 149 individuals. Ehimwenma and Tagbo,[18]reported that the average spleen volume was 202 cm3 in 91 male individuals (mean age of 32 years).

Land,[19] reported an average spleen weight of 163 g in 440 autopsies (in the 35 - 59 age range) and spleen weight increased with increasing body weight, height, and surface area. Garby et al.[20]reported an average spleen weight of 167 g for males. Organ weight was found to be positively correlated with BMI and body height. Grandmaison,[21] did not find a correlation between the weight and age and BM, but instead body weight and height. Shekzadi et al.[22] reported found no correlation between spleen weight with body height. Ehimwenma and Tagbo et al.[18] reported that there was no statistically significant correlation between age of subjects and spleen length, weight, or volume. We found no correlation between spleen volume, weight, and size with age in this study. We found a significant correlation between spleen size and subject height, weight and BMI.

Conclusion

- A moderate positive significant correlation (P<0.0001) was found between the splenic length, width, volume and body mass index.
- The body mass index had also statistically significant positive correlation with spleen dimension at p <0.05 (r=0.195, 0.176, for splenic length and width) and volume in females (r=0.236, P<0.001).
- In males body mass index of the subjects also had a statistically significant correlation with spleen length (r=0.218, p<0.01); nonetheless, there was no statistically significant correlation with width, thickness, and volume (r=0.024, 0.116 and 0.136, respectively).

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