

# Morphometric Assessment of the Normal Dimensions of the Adult Spleen in North-west Ethiopia Region – A Radiological Study

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## ABSTRACT

**Background:** Spleen is a firm organ about the size of a clenched fist and is the largest member of lymphoid organs. Splenomegaly is enlargement of the spleen seen in a number of pathological conditions. These can be infections, haematological disorders, infiltrative states and immunological and malignant diseases. In Ethiopia, study of spleen size of the adult population was not reported previously. Therefore, the present study aims to determine the standard range of spleen size among different adult age groups in Northwest, Ethiopia.

**Methods:** A cross-sectional prospective study design was performed at the University of Gondar, hospital from October 2017 to February 2018. By obtaining informed verbal consent sonographic measurements of spleen length, width and thickness were performed on 380 subjects. **Results:** A total of 380 adults comprising 180 (47%) males and 200 (53%) females were recruited. Of the subjects, 186 (49%) and 194 (51%) were urban and rural residents, respectively. The mean splenic length, width and thickness were 9.95 cm ( $\pm 1.24$ ), 4.3 ( $\pm 0.73$ ), and 3.8 ( $\pm 0.87$ ), respectively. **Conclusion:** The present study provided the normal reference value of adult spleen size for the adults of Northwest Ethiopia, which will be useful for clinical assessment of spleen under any pathological conditions.

**Keywords:** Spleen, length, thickness, width, Sonography.

## INTRODUCTION

The spleen is a firm soft organ about the size of a clenched fist and is the largest member of lymphoid organs. It lies in the left hypochondrium part of the abdominal cavity, wedged between fundus of the stomach and the diaphragm. It lies obliquely, applied to 9th, 10th and 11th ribs behind the midaxillary line. Its long axis is along the 10th rib. Its usual dimensions are one inch thick, three inches broad, and five inches long (2.5 × 7.5 × 12.5 cm) but its size varies considerably.<sup>[1]</sup>

It has posterior and anterior ends, superior and inferior borders and diaphragmatic and visceral surfaces. The upper end lies in line with the 10th

thoracic vertebra of the spine about 4 cm from the mid line. The lower end does not project beyond the midaxillary line. The posterior border is rounded, but the anterior border is notched. The diaphragmatic surface is convexly curved to fit the concavity of the diaphragm while the visceral surface is related to the stomach, left kidney, left suprarenal gland and left colic flexure.<sup>[2]</sup>

Tail of pancreas is applied to the hilum that lies in the angle between the stomach and left kidney.<sup>[3]</sup> The spleen is entirely surrounded by peritoneum except at the hilum, where the splenic branches of the splenic artery and vein enter and leave.<sup>[4]</sup>

The spleen is anchored to stomach by means of gastro-splenic ligament and to left kidney by lienorenal ligament. It rests on the left colic flexure and the fold of peritoneum that extends from the left colic flexure to the diaphragm, the phrenic colic ligament. The ligament limits the vertical downward extension of an enlarged spleen. It rather moves downwards and medially towards the umbilicus. The spleen normally does not descend

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inferior to the costal margin. The enlarged spleen is identified by the presence of a notch in the superior border upon palpation.<sup>[5]</sup> The spleen normally contains a large quantity of blood that is expelled periodically into the circulation by the action of the smooth muscle in its capsule and trabeculae. The large size of the splenic artery or vein indicates the volume of blood that passes through the spleen's capillaries and sinuses. The thin fibrous capsule of the spleen is composed of dense<sup>[6]</sup> irregular fibro elastic connective tissue that is thickened at the splenic hilum. Internally the trabeculae (small fibrous bands), arising from the deep aspect of the capsule, carry blood vessels to and from the parenchyma or splenic pulp, the substance of the spleen.<sup>[2]</sup>

The splenic artery is the principal arterial supply of the spleen. It follows a tortuous course posterior to the omental bursa, anterior to the left kidney and along the superior border of the pancreas. Between the layers of the lienorenal ligament, the splenic artery divides into five or more branches that enter the hilum. The lack of arterial anastomosis and presence of avascular plane within the spleen enables subtotal splenectomy. Venous drainage from the spleen flows via the splenic vein, formed by several tributaries that emerge from the hilum. It is joined by the IMV (Inferior mesenteric vein) and runs posterior to the body and tail of the pancreas throughout most of its course. The splenic vein unites with the SMV (Superior mesenteric vein) posterior to the neck of the pancreas to form the hepatic portal vein. The splenic lymphatic vessels drains to the pancreaticosplenic lymph nodes then to the celiac nodes. The nerves of the spleen, derived from the celiac plexus are distributed mainly along branches of the splenic artery, and are vasomotor in function.<sup>[7,8]</sup>

The spleen is involved and therefore enlarged in a variety of clinical conditions. These can be infections, haematological disorders, infiltrative states and immunological and malignant diseases. Infections are the most common causes of splenomegaly. Among them are infectious mononucleosis, malaria, kalaazar (leishmaniosis), bacterial endocarditis, tuberculosis, brucellosis and salmonellosis.<sup>[9,10]</sup>

Gross splenomegaly can be detected both clinically and sonographically.<sup>[11]</sup> But, the clinical examination is far from accurate to detect a small increase in spleen size. It must be two to three times enlarged before it is palpable.<sup>[10]</sup> The precise measurement of spleen by palpation is not reliable, as in cases a normal sized spleen is palpable and a non-palpable spleen may not be normal sized.<sup>[12]</sup> Ultrasonography is a good modality for the detection of splenomegaly even when it is not clinically palpable.

The variation in the anthropometric features of various populations, races and regions were an

established fact.<sup>[13]</sup> In the literature, the variation of normal spleen sizes among different age groups of study subjects have been reported.<sup>[14]</sup> The standard normal range of spleen size in the population is a prerequisite for correct interpretation.<sup>[15]</sup>

Northwest Ethiopia is an endemic zone for malaria, kala-azar and other infectious diseases affecting children as well as adults causing various ranges of splenomegaly. Hence, it is utmost important to establish the normal range of spleen size in adults of Northwest Ethiopia to assess splenomegaly in all disease conditions affecting the spleen.

## MATERIALS AND METHODS

The study was conducted between October 2017 and February 2018 in the hospital of University of Gondar of Ethiopia. The cross-sectional prospective consecutive ultrasonic assessment of splenic sizes was done on 380 adult subjects (180 males and 200 females), for abdominal ultrasound examination.

### Exclusion Criteria

Clinical or laboratory evidence of infection.  
Previous history of medical disorder affecting spleen or liver.  
Upper abdominal surgery  
Oncologic disease  
Hematologic problem  
Abdominal traumatic condition  
Pregnancy

### Parameters measured

**Spleen length:** Measured in longitudinal plane at hilum the maximum distance between the dome of the spleen and the splenic tip [Figure 1]

**Spleen width:** Measured in a plane perpendicular to the length at hilum the maximum distance between the medial and lateral borders of the spleen [Figure 2]

**Spleen thickness:** The maximum AP dimension measured on the transverse section [Figure 3]



Figure 1: longitudinal scan showing measurement of spleen length.



Figure 2: longitudinal scan showing measurement of spleen width.



Figure 3: Transverse scan showing measurement of spleen thickness.

In addition to sonographic data, baseline data including age, gender, height, weight and residency were recorded for all participants.

The data were entered into a spreadsheet and analysed using the IBM SPSS Statistics, version 20. The means ( $\pm$  standard deviation), ranges, minimum, maximum, and the 95% confidence intervals for the mean (in order to include the true population mean in 95% of the cases) were all calculated. P- Value less than 0.05 is considered as statistically significant.

## RESULTS

Table 1: Anthropometric parameters of study population.

	N	%	Age	Height (cm)	Weight (kg)
All	380	100	35.4(12.2)	163.4(7.5)	57.7(9.4)
Gender					
Male	180	47	35.9(12.2)	169.3(4.9)	62.0(8.3)
Female	200	53	34.9(12.2)	158.1(5.2)	53.9(8.6)
Residency					
Urban	186	49	33.2(12.0)	163.5(7.7)	59.8(10)
Rural	194	51	37.4(12.1)	163.3(7.4)	55(8.1)

A total of 380 adults comprising 180 (47%) males and 200 (53%) females were recruited. Of the subjects, 186(49%) and 194(51%) were urban and rural residents, respectively. The age range of the study populations was between 18 and 80 years, with the mean age of 35.4 years ( $\pm$ 12.2). The difference in anthropometric parameters of study population is found to be statistically insignificant ( $p < 0.05$ ) [Table 1].

Table 2: Splenic dimensions of study population.

	Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Spleen volume in cm <sup>3</sup>
All	9.95(1.2)	4.3(0.7)	3.8(0.8)	92.0(38.4)
Gender				
Male	10.5(1.0)	4.6(0.9)	4.0(0.8)	107.7(37.4)
Female	9.4(1.12)	4.0(0.6)	3.6(0.8)	78.0(33.7)
Residency				
Urban	9.9(1.27)	4.3(0.7)	3.9(0.9)	95.8(41.0)
Rural	9.9(1.2)	4.2(0.7)	3.7(0.8)	88.4(35.6)

The mean splenic length, width, thickness and volume with ( $\pm$ SD) were 9.95 cm ( $\pm$ 1.12), 4.3 cm ( $\pm$ 0.7), 3.8 cm ( $\pm$ 0.8), and 92.0( $\pm$ 38.4) cm<sup>3</sup>, respectively. The mean splenic length, width, thickness and volume for male were 10.5 $\pm$ 1.0 cm, 4.6 $\pm$ 0.9 cm, 4.0 $\pm$ 0.8 cm and 107.7 $\pm$ 38.4 cm<sup>3</sup>, respectively. The mean splenic length, width, thickness and volume for female were 9.4 $\pm$ 1.12 cm, 4.0 $\pm$ 0.6 cm, 3.6 $\pm$ 0.8 cm and 78.0 $\pm$ 33.7 cm<sup>3</sup>, respectively [Table 2].

## DISCUSSION

The dimensions of the spleen measured with the help of the ultrasound in one hundred eighty males and two hundred female subjects. This study provides normal reference value of the spleen size for the adults of Northwest Ethiopia which will be useful in assessing the size of the spleen.

Normal spleen dimensions and size vary widely in different individuals. Some literature consider a length of 10-12 cm to be normal and acceptable in clinical practice.<sup>[12]</sup> The current clinical practice guidelines accept 11-12 cm (less than 13 cm) as normal length of the spleen.<sup>[14]</sup> In the present study spleen length varies from 7- 13.6 cm with mean spleen length of male was 10.5 $\pm$ 1.0 cm and the female mean spleen length was 9.4 $\pm$ 1.12 cm. Despite, spleen length variation, this finding not contradict the clinical guidelines set the upper limit and similar with previous literature which were done in different population.<sup>[15-18]</sup> The width of spleen in present study varies from 2.4 cm to 7.3 cm and with mean spleen width of male was 4.6 $\pm$ 0.9 cm whereas in female was 4.0 $\pm$ 0.6 cm. This finding agreed with African report and study done in Nepal and India.<sup>[5,11,19]</sup> But finding of Turkish population higher than our report.<sup>[14]</sup>

Similarly, the spleen thickness varies from 2.1cm to 6.2 cm and the mean spleen thickness of male was  $4.0 \pm 0.8$  cm whereas in female  $3.6 \pm 0.8$  cm. But, the African report of spleen thickness higher than the present finding.<sup>[10,15]</sup> The possible reasons for the dimensional variation of spleen may be genetic factors and sociodemographic factors.

An ultrasound base study done in an endemic tropical environment reported the mean splenic volume of 202.7 cm<sup>3</sup> and 153.7 cm<sup>3</sup> in male and female subjects, respectively.<sup>[10]</sup> Moreover, African population the volume of spleen was reported as 119.5 cm<sup>3</sup>.<sup>[3]</sup> Study conducted among Turkish adults indicated splenic volume for male (220.7 cm<sup>3</sup>) and for female study subjects (136.05 cm<sup>3</sup>).<sup>[19]</sup> In the present study, we found that the mean spleen volume was 92.8cm<sup>3</sup>. In male, the mean splenic volume was 107.7cm<sup>3</sup> and in female the mean splenic volume was 78.03cm<sup>3</sup>. Comparatively, the mean volume of the present study is lower than the previous literature in Africa and in western countries.<sup>[7]</sup> This may be due to racial differences as smaller spleen size in African-American collegiate athletes compared to their white American collegiate athletes and nutritional status of the population as BMI.<sup>[11]</sup>

## CONCLUSION

Normal parameters of spleen in population of North-west Ethiopia region are:

- Splenic length: 9.95 cm ( $\pm 1.12$ )
- Splenic width: 4.3 cm ( $\pm 0.7$ )
- Splenic thickness 3.8 cm ( $\pm 0.8$ )
- Splenic volume 92.0 ( $\pm 38.4$ ) cm<sup>3</sup>

### Limitation of the study

Study subjects are the only patients who came to hospital and sample selection may not have included the individuals from whole region of northwest Ethiopia and this may have limited the ability of generalizing the result with the population.

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