

# Normal Spleen Size in Relation To Weight of Adult Population in the Northwest Ethiopia Region: A Radiological Study.

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## Abstract

**Background:** Ultrasonography is the first imaging method to assess splenomegaly. So far, established normal limits of spleen dimensions remain scanty in the Ethiopian population, and the ultrasound data from the previous studies demonstrated that racial differences could affect the splenic volume; this necessitates the establishment of normative data of spleen dimensions for different areas. **Subjects and 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 of the subjects were measured using standard anthropometric technique. Age and sex were also recorded. By Pearson's product moment correlation coefficients, the relation of spleen dimensions to weight was evaluated. **Results:** In males, there is a statistically significant positive correlation between subject weight and spleen length ( $r=0.244$ ,  $P<0.001$ ), and volume ( $r=0.164$ ,  $P<0.05$ ); however, there is no statistically significant correlation with spleen width ( $r=0.034$ ,  $P>0.05$ ) and spleen thickness ( $r=0.136$ ,  $P>0.05$ ). In females there is a statistically significant positive correlation between the weight of female subject and spleen length ( $r=0.274$ ,  $P<0.001$ ), width ( $r=0.239$ ,  $P<0.01$ ), thickness ( $r=0.244$ ,  $P<0.01$ ), and volume ( $r=0.335$ ,  $P<0.0001$ ). **Conclusion:** The positive correlation is found between the spleen parameters and weight of both the genders in Ethiopian population which has both clinical and forensic importance.

**Keywords:** Spleen dimensions, Weight, Ultra-sonography.

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## Introduction

The spleen is the largest organ in the reticulo endothelial system. Spleen size is important in the evaluation of gastrointestinal and haematological diseases for both radiologists and clinicians.<sup>[1]</sup> The normal spleen weighs 150-200 g, and is  $10.9 \pm 1.4$  cm long,  $4.0 \pm 0.45$  cm deep, and  $6.8 \pm 0.71$  cm in diameter. It is located in the left hypogastric quadrant of the abdomen beneath the 9th to the 11th intercostal spaces. It is a crescent shaped structure, with a convex outer margin, and indented inner margin.<sup>[2]</sup> Splenomegaly is a well-known manifestation of several diseases that may involve the liver, immune system, and hematopoietic system. The reliability of clinical palpation is imprecise; the normal spleen is usually not palpable, whereas a non-palpable spleen is not always normal sized.<sup>[3]</sup> The spleen volume can be measured by various techniques such as radiography, scintigraphy, CT, MRI, and ultrasonography. Ultrasonography is the first imaging method to assess splenomegaly. It is a non-invasive, commonly available, and an affordable imaging method

without the risk of ionizing radiation.<sup>[4]</sup>

Current knowledge of spleen size is based on different populations or derived from autopsy studies.<sup>[5-8]</sup> So far, established normal limits of spleen dimensions remain scanty in the Ethiopian population, and the ultrasound data from the previous studies demonstrated that racial differences could affect the splenic volume; this necessitates the establishment of normative data of spleen dimensions for different areas.

The aim of this prospective screening survey was to establish reference values of splenic dimensions and volume in a population of adult healthy Ethiopians, and to determine the relationship of splenic volume with weight. This study was conducted as a first step in an attempt to improve the study design prior to performance of a full scale investigation of splenic volumes in this population.

## Subjects and Methods

The study was performed at the Radiology and Anatomy Departments, University of Gondar Referral Hospital,

Northwest Ethiopia. 380 adult subjects (180 males and 200 females) were included in this study, and written informed consent was taken for each case. Ethical approval was obtained from the Academic Research Council of the University.

**Exclusion criteria**

- a) History of any previous or current conditions that might involve the size of the spleen.
- b) Clinical or laboratory evidence of infection (subjects who had fever either at the time of the examination or within at least 4 weeks prior to the examination)
- c) Hematopoietic diseases
- d) Genetic diseases (thalassemia and sickle cell anaemia)
- e) Lymphadenopathy
- f) Liver diseases (cirrhosis or portal hypertension)
- g) Renal failure
- h) History of splenic trauma
- i) Non-traumatic benign splenic lesions (infarctions, lobulations, cysts, accessory spleen, and haemangioma)
- j) Malignant lesions
- k) Pregnancy.

Following radiological parameters were measured

Spleen length: Measured in longitudinal plane at hilum the maximum distance between the dome of the spleen and the splenic tip.<sup>[5]</sup>

Spleen width: Measured in a plane perpendicular to the length at hilum the maximum distance between the medial and lateral borders of the spleen.<sup>[5]</sup>

Spleen thickness: The maximum AP dimension measured on the transverse section.<sup>[5]</sup>

Volume of the spleen: length × width × depth × 0.524<sup>[8]</sup> (The formula is frequently used for estimation of the volume of many irregularly shaped organs.)

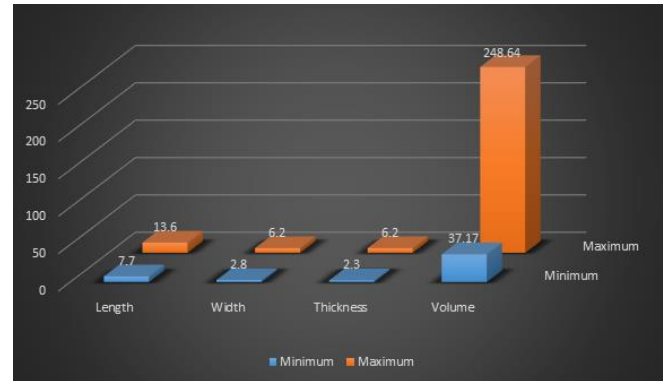
The patients selected for the present study were examined using a Sonoscape SSI 8000 ultrasound machine (Soonchunhyang University Medical center, China) for abdominal and/or pelvic problems not related to the spleen.

In addition to sonographic data, baseline data including age, gender and weight were recorded for all participants. Weight was measured with the help of weighing machine using standard anthropometric method.<sup>[7]</sup>

The collected data were checked for completeness, accuracy and clarity before analysis. The data were entered into a spreadsheet and analysed using the IBM SPSS Statistics, version 20. The means (± 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. The coronal measurements of the spleen and the volume were compared with the height of the various subjects. Differences of continuous variables between two independent groups were assessed with the 2-tailed t-test. The relationship between splenic dimensions and height was assessed with the Pearson’s correlation coefficient (r).

**Results**

The splenic parameters (mean± standard deviation) is shown in [Figure 1]. A statistically significant difference between males and females was observed in weight (p<0.0001). The mean weight in males and females is found to be 62.0 (±8.3) and 53.9 (±8.6) respectively.



**Figure 1: Radiographic range of dimensions of spleen.**

**Table 1: Pearson’s correlation (r) of spleen dimension with weight of all study population.**

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Weight In kg	Pearson Correlation	0.409	0.274	0.27	0.373
	Sig. (2-tailed)	0	0	0	0
	N	380	380	380	380

**Table 2: Pearson’s correlation (r) of spleen dimension with weight of male study population.**

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Weight In kg	Pearson Correlation	0.244	0.034	0.136	0.162
	Sig. (2-tailed)	0.001	0.646	0.069	0.029
	N	180	180	180	180

**Table 3: Pearson’s correlation (r) of spleen dimension with weight of female study population.**

		Spleen length in cm	Spleen width in cm	Spleen thickness in cm	Volume of spleen (cm3)
Weight In kg	Pearson Correlation	0.274	0.239	0.244	0.335
	Sig. (2-tailed)	0	0.001	0.001	0
	N	200	200	200	200

A moderate positive significant correlation (P<0.0001) was found between the splenic length, width, volume and body weight (r: >0.3) [Table 1].

In males, there was a statistically significant positive correlation between subject weight and spleen length (r=0.244, P<0.001), and volume (r=0.164, P<0.05);

however, there was no statistically significant correlation with spleen width ( $r=0.034$ ,  $P>0.05$ ) and spleen thickness ( $r=0.136$ ,  $P>0.05$ ) [Table 2].

In contrast to this in females there was a statistically significant positive correlation between the weight of female subject and spleen length ( $r=0.274$ ,  $P<0.001$ ), width ( $r=0.239$ ,  $P<0.01$ ), thickness ( $r=0.244$ ,  $P<0.01$ ), and volume ( $r=0.335$ ,  $P<0.0001$ ) [Table 3].

## Discussion

The wide range of normal spleen size values reported in the literature of different races makes the establishment of normal ranges more difficult. Taking the upper limits readings into consideration, our values were still higher than the data from Indians for example, implicating that ethnicity could be attributed in part to the wide ranges of normative data registered by different populations.<sup>[11,12]</sup>

A recent study performed on Saudi Arabian adults to estimate splenic volume using 3-dimensional abdominal CT scan images, yielded slightly higher measurements than the values recorded in this study.<sup>[13]</sup> In the latter study, the same ellipsoid formula was used to calculate the spleen volume, the lower values of sonography measurements in the study were most probably due to overlapping ribs or bowel gas. Spleen length at the hilum is considered the most reproducible linear measurement of spleen size.<sup>[14]</sup> Splenomegaly is considered as moderate if the biggest dimension is 11-20 cm, and severe if the biggest dimension is greater than 20 cm.<sup>[15]</sup> However, caution is required in defining splenomegaly in different populations.

Moderate positive relationships between splenic dimensions and weight, BSA were observed; this was similar to the data from spleen sonography and autopsy.<sup>[11,12]</sup>

Different studies showed unmistakable trend for splenic dimensions to increase in parallel with the increase in the body parameters. The body weight and height might show variations in different ethnic origins. In addition, variations in the body fat distribution might also be caused by variations of physical activity, diet, and ethnicity. So the variations of body parameters could be attributed to different splenic measurements in different areas. Previous studies showed that the longitudinal measurements of the spleen were best correlated only with body height.<sup>[16,17]</sup> On the other hand, studies of African adults and Turkish males found positive correlation between spleen parameters and body weight.<sup>[11,12]</sup> From a physiological perspective, our findings would make more sense; as patients with a bigger body habitus will have a larger blood volume requiring larger spleens for filtration.

We believe that the results of this study can be used as a practical and comprehensive guide to indicate the normal spleen length range for the population of Northwest Ethiopia, according to his/ her body habitus and weight.

## Limitation of the study

The main limitation was the small sample size, which certainly has affected the generalizability of our estimates.

A larger study sample is required in order to improve the accuracy of our measurements. Therefore, further studies are needed with larger study populations and more ethnic backgrounds to explore wider environmental and genetic influences that might determine the splenic parameters.

## Conclusion

Pearson's correlation finding indicated a moderate positive significant correlation ( $P<0.0001$ ) between the splenic length, width, volume and body height of all the subjects ( $r>0.3$ ).

No statistically significant correlation with splenic dimensions in males ( $r=0.107$ ,  $0.039$ ,  $0.060$ , and  $0.091$  for spleen length, width, thickness, and volume, respectively) was found.

Height of female study subjects had a statistically significant positive correlation with spleen length ( $r=0.203$ ,  $P<0.01$ ), width ( $r=0.175$ ,  $P<0.05$ ), thickness ( $r=0.292$ ,  $P<0.001$ ), and volume ( $r=0.261$ ,  $P<0.001$ ).

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