

ORIGINAL ARTICLE

SONOGRAPHIC MEASUREMENT OF THE SPLENIC LENGTH IN ADULTS AND ITS CORRELATION WITH DIFFERENT PARAMETERS

Dambar Sah,^{1*} MD. Kalim Akhtar,¹ Akhilesh Kumar Jha,¹ Shashi Shekhar Prasad Shah,¹ Rajan Kumar Mahato,¹ Vandana Mourya,¹ Chandan Chaurasiya,¹ Rakesh Kumar Jha,¹ Trayush Adhikari,¹ Amit Kumar Thakur¹

¹ Department of Radiology, National Medical College and Teaching Hospital, Birgunj, Parsa, Nepal

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***Correspondence to:**

Dambar Sah, Department of Radiology, National Medical College and Teaching Hospital, Birgunj, Parsa, Nepal.

Phone: +977-9848056716

Email: dambarsah4@gmail.com

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ABSTRACT

Introduction: Splenic length is an important parameter for many splenic pathologies. Ultrasonography has been an efficient tool for the measurement of different splenic parameters including the splenic length. The objective of this prospective study was to determine the splenic length in healthy adults without any hematological, oncologic or traumatic condition and to correlate it with age, sex, height, weight, body surface area of the body.

Methods: A total of 360 healthy subjects were included in this study conducted for a period of 6 months. Informed written consent and ethical approval were taken. A detailed clinical history of all the patients were taken. Basic investigations, clinical and ultrasonography examination were performed. Then the data collected was analyzed by MS Excel and SPSS 25 program.

Results: The study included 360 participants (180 male & 180 female) with mean age of the 40.39 ±11.51 years. The mean splenic length was found to be 9.11±1.16 cm. There was significant correlation of splenic length with age, weight, height and body surface area. The splenic length was higher in male compared to female in each age group.

Conclusions: The study aimed to establish the normal range of spleen length and to examine its correlation with body height, weight, and surface area in male and female subjects. The researchers found that spleen length decreases with age in both sexes. Additionally, spleen length increases with body height, weight, and body surface area. Female spleen length is less than male spleen length for corresponding ages.

Keywords: Body Surface Area, Height, Sonography, Splenic Length, Weight

INTRODUCTION

The spleen is the largest lymphoid organ situated in the left hypochondrium and covered by the inferior thoracic rib cage.¹ It extends from the 9th-11th ribs on the left side with its long axis running parallel to the 10th rib.^{2,3}

Splenomegaly is the enlargement of the spleen, which can occur in various clinical disorders, including infections, metabolism or storage disorders, and hematological abnormalities. It is a common problem worldwide and is not a diagnosis in itself but an indicator of underlying pathologic processes.⁴

Splenomegaly is a sign of disease that can originate in the spleen or other organs, making it important to measure spleen size for diagnosis and treatment. However, clinical evaluation of spleen size can be difficult and unreliable due to the spleen's location under the ribs, and prior to imaging techniques, it was challenging to measure. Ultrasound and other imaging modalities have improved

the ability to measure spleen size.⁵

Various modes of investigation, including plane radiograph, sonography, computed tomography (CT), magnetic resonance image (MRI), and radionuclide scan, can be used to identify an enlarged spleen. However, sonography and CT are the most reliable imaging modalities for intra-abdominal organs.⁶

Ultrasound has been proven to be a cost-effective and reliable means of directly visualizing and assessing abdominal organs, including the spleen.⁷ This makes it an excellent option for imaging in developing countries like Nepal.⁸

There is a lack of studies on the normal range of spleen size in Nepalese adults, and existing measurements are based on data from Western studies. However, it is well-established that there are variations in anthropometric

features across different populations, races, and regions. The diverse climate and socio-economic status of Nepalese people make this population unique. Therefore, a comprehensive anthropometric study of spleen size based on a normal Nepalese population is necessary to provide more reliable values and confidently detect early splenic pathology.⁸

This study aims to develop guidelines for the normal range of spleen size in individuals of different ages using a straightforward and repeatable sonographic approach. Additionally, the study seeks to investigate the relationship between spleen length and factors such as age, height, weight, and body surface area of the subjects. By establishing these norms, healthcare providers will be better equipped to identify minimal changes in spleen size and predict early onset of splenic pathology in Nepalese adults.⁹

MATERIALS AND METHODS

Cross sectional study was conducted on 360 adults (180 men and 180 women) aged between 21 to 60 years living in the Terai belt of central Nepal who presented to Radiology Department, NMCTH, Birgunj. This study was first approved by the Institutional Review Committee of NMCTH, Birgunj, and written informed consent was taken from the patients. The patients were being evaluated sonographically for abdominal or pelvic problems unrelated to the spleen, and cases of pregnancy and splenomegaly were excluded. All the measured spleens had a normal position, shape, and texture, and the subjects had no history of disease related to the liver or spleen, gastrointestinal, hematologic, oncologic, or traumatic conditions. The weight, height, of patient was taken. Then body surface area of the subjects was calculated using the Mosteller formula.¹⁰

A high-resolution ultrasound scanner (CANON XARIO 200 and CANON APLIO 300) equipped with a curvilinear 3.5-5 MHz transducer was utilized for the scanning procedure. The spleen was then measured using sonography, while the patient was in a right lateral position with the left side elevated and taking a deep breath, to reduce interference from the lung. The margin between the spleen and the lung served as the boundary for transverse and longitudinal diameter measurement, as the upper portion of the spleen was partially obscured by air in the lung.⁹ The splenic length was determined by measuring the distance between the most superomedial and the most inferolateral points of the spleen, passing through the hilum, on a longitudinal coronal image (figure 1). To ensure minimal intraoperative variation, each measurement was repeated at least three times and the mean was calculated for reproducibility assessment.¹¹

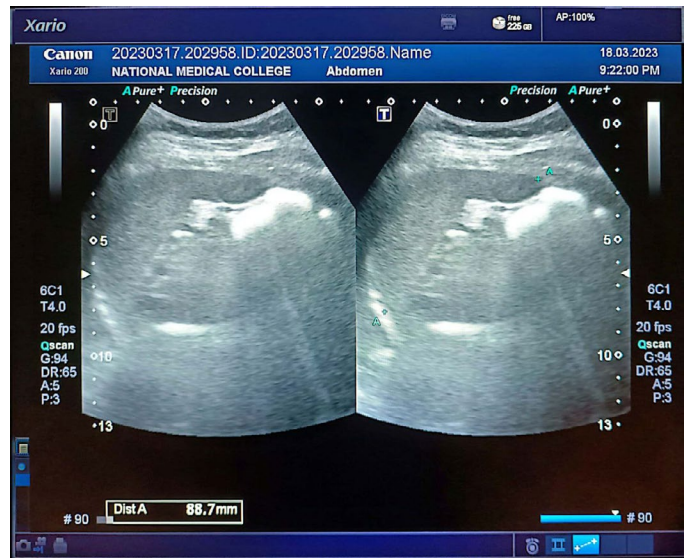


Fig. 1: Ultrasonographic Measurement of splenic length.

Statistical analysis

The data obtained from the samples were recorded in a Microsoft Excel spreadsheet and subsequently entered into a computer-based program called IBM SPSS version 25 for statistical analysis. The t-test was used for data analysis. Pearson's correlation coefficient (r) was employed to determine the degree of correlation between splenic length and various factors such as age, weight, height, and body surface area. The results were presented in terms of mean values with 95% confidence intervals (CI) and as mean values with standard deviations (SD). A p-value less than 0.05 was considered statistically significant.

RESULTS

In this study, 360 individuals from different areas of the Western region of Nepal who presented to the Radiology Department, NMCTH, Birgunj, were included to measure the splenic length using ultrasound. The study group consisted of 180 males and 180 females. The measurements were taken with respect to age, height, weight, and body surface area.

Table 1: Descriptive statistics including mean and range of studied variables

Variables	Mean±S.D.	Range
Age (Years)	40.39 ±11.51	21-60
Weight (Kg)	59.49±10.72	35-90
Height (cm)	156.91±8.28	135-180
Body surface area (m ²)	1.60±0.168	1.17-2.08
Splenic Length (cm)	9.11±1.16	6.00-12.70

Mean age of the people was 40.39±11.5 year, mean weight was 59.49±10.72 kg, mean height was 156.91±8.28 cm, mean body surface area was 1.60±0.168 m² and at last

mean splenic length was 9.11 ± 1.16 cm. (Table 1)

Table 2: Comparison of splenic length in different age groups.

Age Group	Total	Male	Female	Mean (cm) \pm S.D.	Range (cm)	Correlation
21-30 years	90	45	45	9.24 ± 1.19	6.60-11.90	R=-0.14 P=0.005
31-40 years	90	45	45	9.22 ± 1.25	6.70-12.70	
41-50 years	90	45	45	9.15 ± 1.08	6.50-12.30	
51-60 years	90	45	45	9.02 ± 1.25	6.00-12.10	

Table 2 shows that mean splenic length decreases with increase in age from 21 years to 60 years. There is negative correlation between splenic length and age of subject. (R=-0.14)

Table 3: Comparison of splenic length in different height groups

Height Group	Total	Male	Female	Mean (mm) \pm S.D.	Range (mm)	Correlation
131-140 cm	7	0	7	8.31 ± 1.52	6.60-11.40	R=0.257 P=0.000
141-150 cm	93	16	77	8.98 ± 1.11	6.50-12.70	
151-160 cm	158	81	77	9.10 ± 1.19	6.00-12.30	
161-170 cm	78	66	12	9.57 ± 1.15	7.60-12.10	
171-180 cm	18	16	2	9.47 ± 1.17	7.30-11.00	

Table 3 shows that mean splenic length increases with height showing positive correlation.

Table 4: Comparison of splenic length in different weight groups

Weight Group	N	Male	Female	Mean (mm) \pm S.D.	Range (mm)	Correlation
31-40 kg	10	3	7	7.55 ± 0.72	6.50-9.00	R=0.245 P=0.000
41-50kg	80	20	60	8.97 ± 1.31	6.50-12.70	
51-60 kg	124	47	47	9.17 ± 1.13	6.70-12.30	
61-70 kg	93	62	31	9.26 ± 1.14	6.00-12.10	
71-80 kg	40	38	2	9.42 ± 1.02	7.50-11.20	
81-90 kg	13	10	3	9.92 ± 1.05	8.20-11.30	

Table 4 shows that splenic length increases with weight which is statistically significant.

Table 5: Comparison of splenic length in patients of different body surface area groups

Body surface area group	N	Male	Female	Mean \pm S.D.	Range	Correlation
1.10-1.29 m ²	9	2	7	7.98 ± 1.49	6.50-11.40	R=0.271 P=0.000
1.30-1.49 m ²	90	21	69	8.91 ± 1.27	6.50-12.70	
1.50-1.69 m ²	155	66	89	9.13 ± 1.09	6.00-12.30	
1.70-1.89 m ²	90	78	12	9.42 ± 1.12	7.20-12.10	
1.90-2.09 m ²	16	13	3	10.06 ± 0.99	8.20-11.30	

Table 5 shows that the splenic length increases with increase in body surface area which shows statistically significant correlation.

Table 6: Correlation between splenic length and different parameters

Parameters	Male	Female	Total
Age	R=-0.148 P=0.48	R=-0.153 P=0.040	R=-0.14 P=0.005
Height	R=0.160 P=0.031	R=0.150 P=0.044	R=0.257 P=0.000
Weight	R=0.178 P=0.017	R=0.198 P=0.008	R=0.245 P=0.000
Body Surface Area	R=0.196 P=0.008	R=0.184 P=0.013	R=0.271 P=0.000

Table 6 shows that there is positive statistically significant correlation between splenic length and height, weight and body surface area.

Table 7a: Length of spleen among male subjects

Age group	Mean \pm S.D.	Range
21-30 years	9.28 ± 1.13	7.50-11.80
31-40 years	9.48 ± 1.31	6.70-12.70
41-50 years	9.33 ± 0.97	7.50-11.40
51-60 years	8.90 ± 0.80	7.20-10.90

Table 7b: Length of spleen among female subjects

Age group	Mean \pm S.D.	Range
21-30 years	9.17 ± 1.22	6.60-11.90
31-40 years	9.03 ± 1.20	6.90-12.00
41-50 years	9.04 ± 1.20	6.50-12.30
51-60 years	8.63 ± 1.25	6.00-11.90

It was observed in table 7a and 7b that mean splenic length of age group 21 - 30 years was 9.28 ± 1.13 cm for males and 9.17 ± 1.22 for females. The splenic length of age 31 - 40 years was 9.48 ± 1.31 for males and 9.03 ± 1.20

for females. The splenic length for age 41- 50 years was 9.33 ± 0.97 for males and 9.04 ± 1.20 for females. Similarly, the splenic length for age 51-60 years was 8.90 ± 0.80 for males and 8.63 ± 1.25 for females. This table shows that the splenic length for females is less than the males for each of the age group.

DISCUSSION

Ultrasonography is a common radiologic examination used to assess splenic anatomy and pathology. US gives the easy, reliable and reproducible result as compared to other investigation. The splenic size may give information about the diagnosis and course of the gastrointestinal and hematologic disease. The majority of earlier studies have examined splenic length and its relationship with other variables. Only limited research has assessed the splenic length and its relation with variables such as age, weight, height and body surface area together.

We calculated the splenic length and its correlation with several parameters to establish some preliminary statistics on our population. We conducted a hospital based prospective cross-sectional study which included 360 participants (180 male & 180 female) with mean age of the participants 40.39 ± 11.51 years. The mean splenic length was found to be 9.11 ± 1.16 cm. Our study found significant correlation between splenic length and age, height, weight and body surface area ($p < 0.05$).

Kaneko et al. conducted a study to evaluate splenic size in patients with sarcoidosis and thrombocytosis. They found that splenomegaly was present in 57% of patients but clinically palpable in only 8%. This highlights the importance of using imaging to accurately measure splenic size and monitor it over time. The findings may also have implications for developing guidelines for athletes with these conditions to return to play.¹²

The present study found that splenic length decreases with age, with a slow rate of decrease up to the age of 50 years, after which it decreases rapidly. These findings are consistent with those of Loftus and Metreweli, who observed a rapid growth in splenic length up to age 20, followed by a mild decrease up to age 50, and then a rapid fall after age 50.¹³

This study also demonstrated that the splenic length of males were greater than those in females in each age group of this study. Other similar studies conducted in different countries like Turkey, Saudi, Nigeria, India and Sudan supported the findings of this study.^{14, 15, 16, 17, 18} It is suggested that this difference may be due to the general development of organs in males or differences in weight, height, body surface area, and genetic factors between males and females.

The present study found that the splenic length of males was 0.2-0.4 cm longer than that of females, which is slightly different from the findings of Loftus and Metreweli who observed a 0.5 cm difference in splenic length between males and females.¹³ The difference in findings may be attributed to differences in height, weight, surface area, and genetic factors between males and females.

In the present study, it was observed that the majority of subjects had a splenic length of less than 11 cm. This finding is similar to that of Frank et al.¹⁹

Konus et al. proposed that the splenic length correlated best with the body height. This was similar to the findings of the present study. Likewise in another study it was revealed that the splenic length was below 12.80 cm in 95% subjects.²⁰ However, the splenic length was found below 8.7 cm with mean and SD, 5.5 ± 1.4 in study conducted by Niederau C et al.²¹ Racial differences in splenic length could result in inaccurate interpretation of the splenic size as noted by Lotus et al. The observation by Loftus et al, suggested that a population specific splenic normogram would provide more accurate standards.¹³

Spielmann et al. also proposed that the body height was correlated with the length and width of the spleen in males and females.²² This was similar to the findings of the present study.

Megremis et al. revealed that the body height, weight, and surface area have a significant positive correlation with the splenic length.¹¹ Their findings were similar to the findings of the present study.

Finally, it seems that to establish the local references values, more population-based studies with a larger sample size are needed to establish the normal values of the Nepalese population.

CONCLUSION

The study aimed to establish the normal range of spleen length and to examine its correlation with body height, weight, and body surface area in male and female subjects. The researchers measured the spleen length via ultrasound in 180 male and 180 female subjects and found that spleen length decreases with age in both sexes. Additionally, spleen length increases with body height, weight, and body surface area. Female spleen length is less than male spleen length for corresponding ages. Finally, in most subjects, spleen length is less than 11 cm.

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