




## Research Article

## Computed Tomographic Assessment of Normal Splenic Length in Relation to Anthropometric Parameters: An Observational Cross-Sectional Study in Iraq

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## Abstract

**Background:** Clinical examination by palpation is often inaccurate. Consequently, imaging techniques have become vital for the accurate assessment of splenic size. **Objectives:** To evaluate the range of normal splenic length in the Iraqi population and correlate it with some anthropometric indices. **Methods:** The splenic lengths were measured by CT scan in 110 adults. Statistical analysis was performed according to age and sex and the correlation of splenic length with anthropometric indices like body weight, height, body mass index (BMI), and body surface area (BSA). **Results:** The mean length of the spleen was  $9.7 \pm 1.9$  cm for both genders:  $10 \pm 2$  for males and  $9 \pm 1.4$  for females. The mean splenic lengths in the Iraqi population were similar to those of the Sudanese and Turkish populations, less than those of the Jordanian and Iranian populations, and slightly more than those of the Indian and Nigerian populations. The mean splenic length is greater in males than in females. There was a modest positive correlation between splenic length and height and body surface area, but not weight or body mass index. **Conclusion:** Standard splenic length ranges in Iraqi adults using CT scan imaging can be easily used in clinical practice to calculate the splenic length depending on some anthropometric indices like height and BSA.

**Keywords:** Anthropometric features, CT Abdomen, Iraqi people, Splenic length.

التقييم المقطعي المحوسب لطول الطحال الطبيعي فيما يتعلق بالمعلومات الأنثروبومترية: دراسة مقطعية رصدية في العراق

## الخلاصة

**الخلفية:** الفحص السريري عن طريق الجسم غالباً ما يكون غير دقيق. وبالتالي، أصبحت تقنيات التصوير حيوية للتقييم الدقيق لحجم الطحال. **الأهداف:** تقييم مدى طول الطحال الطبيعي في السكان العراقيين وربطه ببعض المؤشرات الأنثروبومترية. **الطريقة:** تم قياس أطوال الطحال عن طريق التصوير المقطعي المحوسب في 110 بالغين. تم إجراء التحليل الإحصائي وفقاً للعمر والجنس وارتباط طول الطحال بالمؤشرات الأنثروبومترية مثل وزن الجسم والطول ومؤشر كتلة الجسم (BMI) ومساحة سطح الجسم (BSA). **النتائج:** كان متوسط طول الطحال  $9.7 \pm 1.9$  سم لكلا الجنسين:  $10 \pm 2$  للذكور و  $9 \pm 1.4$  للإناث. كان متوسط أطوال الطحال في السكان العراقيين مشابهاً لمتوسط أطوال السكان السودانيين والأتراك، وأقل من السكان الأردنيين والإيرانيين، وأكثر بقليل من السكان الهنود والنيجيريين. متوسط طول الطحال أكبر في الذكور منه في الإناث. كان هناك ارتباط إيجابي متواضع بين طول الطحال والطول ومساحة سطح الجسم، ولكن ليس الوزن أو مؤشر كتلة الجسم. **الخلاصة:** يمكن استخدام نطاقات طول الطحال القياسية لدى البالغين العراقيين باستخدام التصوير المقطعي المحوسب بسهولة في الممارسة السريرية لحساب طول الطحال اعتماداً على بعض المؤشرات الأنثروبومترية مثل الطول ومساحة سطح الجسم.

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## INTRODUCTION

The spleen is the largest lymphatic organ in the body and the only one that is involved in blood filtration, rendering it a vital organ in the defense against many infections. It is also a crucial site for the destruction of old red blood cells [1]. Splenic size is greatly variable among individuals, and it is affected by a variety of conditions, where splenic enlargement is associated with infectious diseases (like malaria, tuberculosis, subacute bacterial endocarditis, and others), connective tissue disorders (like systemic lupus erythematosus and rheumatoid arthritis), neoplastic disorders (like leukemia and lymphomas), hemolytic anemias and hemoglobinopathy, and liver disorders (like cirrhosis). On the other hand, splenic atrophy is another problematic issue that can occur in conditions like sickle cell anemia resulting from frequent vasoocclusive events and infarctions [2–4]. Assessment of splenic size is a vital step in diagnosing, treating, and following up on patients with these conditions. Clinical examination by palpation and percussion is the ordinary bedside method for splenic size estimation, but it may lack accuracy in the recognition of small-size spleens [5]. Splenic size is assessed by measuring its three dimensions (length, width, and depth) and volume. Of these, splenic length is the simplest, reproducible, and convenient means to mean, with only a small degree of intra- and inter-observer variabilities [6]. The present data on splenic dimensions is based on different populations or derived from cadaveric studies [7]. To date, the recognized normal limits of splenic dimensions remain short in the Iraqi population. Therefore, this study aimed to establish reference values of splenic lengths in healthy adult Iraqis and to determine their relationships with age, gender, weight, height, body mass index (BMI), and body surface area (BSA).

## METHODS

The study is an observational cross-sectional design conducted in the Department of Human Anatomy at Al-Mustansiriyah University, College of Medicine, and the Radiological Department at Al-Yarmok Teaching Hospital, Baghdad. It was authorized by the ethical committee of Al-Mustansiriyah Medical College according to the ethical principles of the Helsinki Declaration, with verbal and informed consent taken from the participants. The study includes 110 adult individuals aged 17 to 80 who had undergone a CT examination of the abdomen for various indications during February 2023–June 2023). Exclusion criteria: all participants had undergone clinical examination and were subjected to a short questionnaire to exclude any current or previous conditions that may alter splenic size. These include clinical evidence of infection (individuals who had fever at the time of the survey or within at least one month prior), hematopoietic diseases and genetic diseases that might affect the spleen (for

instance, spherocytosis and thalassemia), lymphadenopathy, hepatic diseases (like liver cirrhosis), renal failure, trauma to the spleen, non-traumatic lesions (like cysts, hemangioma, and accessory infarctions), splenic tumors, and pregnancy. Each participant's age, gender, height, weight, body mass index, and body surface area were documented at the time of the examination. Height and weight were recorded to near tenth, body mass index was estimated using the formula "BMI = Weight in kg/(Height in meter)<sup>2</sup>, and body surface area was estimated using the Mosteller formula "BSA =0.016667 \* H0.5 \* W0.5, where H represents height in meters and W represents weight in kg" [8,9]. All subjects were examined by the "Siemens SOMATOM Definition AS CT Scanner", and 2D CT scan grayscale pictures were taken by a qualified CT technician in the coronal plane that passed throughout the splenic hilum [Figure 1]. These pictures were assessed by a specialized radiologist. The splenic lengths were recorded to the nearest tenth of a centimeter (0.1 cm).



**Figure 1:** Abdominal CT scan reformatted coronal view, showing longitudinal splenic length measurement.

## Statistical analysis

Statistical analyses were executed using SPSS "Statistical Package for the Social Sciences" version 26 and Microsoft Office Excel 2021. Continuous data were exhibited as mean±SD. Inter- and intra-group comparisons were performed using a t-test. The correlations between two data points were revealed by Pearson's correlation coefficient (r). Bivariate regression and the "coefficient of determination" R<sup>2</sup> were established and were used to calculate any relationship between different variables and also for deriving regression equations. A probability value of P<0.05 was considered statistically significant [10]. The regression equations are as follows:

$$SL \text{ (cm)} = (0.05 * H) + 1.3, \text{ and } SL \text{ (cm)} = (2 * BSA) + 6.$$

**RESULTS**

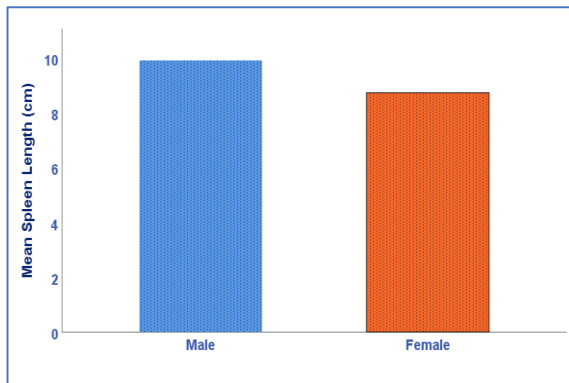
The total number of participants in the study was 110; their descriptive data are summarized in Table 1. The percentile contribution of males and females was 67% and 33%, respectively. The cases were stratified into five age groups: < 30 years ( $n=23$ ), 30-40 years ( $n=36$ ), 41-50 years ( $n=15$ ), 51-60 years ( $n=16$ ) and > 60 years ( $n=20$ ).

**Table 1:** Descriptive Statistics of the cases

Variables	Count	Minimum	Maximum	Mean	SD	
Age	All	110	18	79	43.06	16.60
	M	74	18	79	41.69	16.80
	F	36	20	69	45.89	16.05
Height	All	110	154	190	169.03	9.77
	M	74	160	190	173.81	7.67
	F	36	154	175	159.19	5.17
Weight	All	110	50	115	78.26	14.04
	M	74	56	115	80.95	13.80
	F	36	50	97	72.75	13.04
BMI	All	110	18.08	37.89	27.39	4.32
	M	74	18.08	35.43	26.76	3.94
	F	36	19.53	37.89	28.67	4.83
BSA	All	110	1.47	2.46	1.91	0.21
	M	74	1.64	2.46	1.97	0.19
	F	36	1.47	2.08	1.79	0.18
SL	All	110	6.00	15.00	9.69	1.86
	M	74	7.00	15.00	10.02	1.99
	F	36	6.00	13.50	9.02	1.36

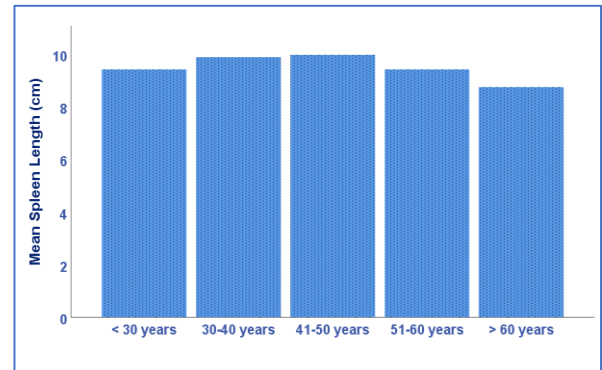
SL = Splenic Length (cm)

The normal splenic length in both genders ranges from 6–15 cm, with a mean of  $9.7\pm 1.9$  cm. In males, the splenic length ranges from 7–15 cm with a mean of  $10\pm 2$  cm, and in females, it ranges from 6–13.5 cm with a mean of  $9\pm 1.4$ . To investigate the effect of gender on splenic lengths, an independent t-test was performed. It exposed a significant difference in splenic lengths between males and females, where the mean splenic length is greater in males than in females ( $p=0.001$ ) (Figure 2).



**Figure 2:** Simple bar chart showing mean splenic lengths in male vs. female.

The analysis of variance and covariance (ANOVA) test fails to confirm any significant difference in splenic lengths between different age groups ( $p=0.2$ ) (Figure 3).

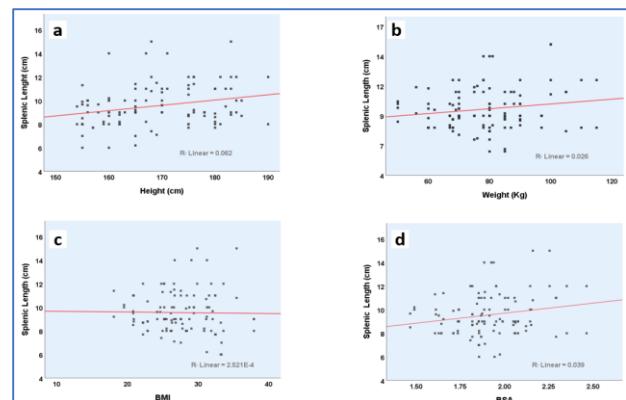


**Figure 3:** Simple bar chart showing mean splenic lengths in different age groups

A Pearson correlation test was performed to investigate the effect of an individual’s anthropometric parameters on splenic lengths. The test concluded that there was a statistically significant positive correlation between splenic length and height ( $r= 0.249, p=0.009$ ), and splenic length and BSA ( $r=0.198, p=0.038$ ), with no correlation between splenic length and body weight ( $r=0.16, p=0.094$ ) or splenic length and BMI ( $r= - 0.016, p=0.869$ ) (Table 2, Figure 4).

**Table 2:** Pearson correlation – Splenic length vs. various anthropometric parameters

	Descriptive data	
	Mean	Std. Deviation
SL (cm)	9.55	1.76
Height (cm)	169	9.77
Weight (kg)	78.26	14.04
BMI (kg/m <sup>2</sup> )	27.4	4.32
BSA (M <sup>2</sup> )	1.9	0.20
<i>Correlation analysis</i>		
Group	Pearson correlation	<i>p</i> -value
SL-Height	0.249	0.009
SL-Weight	0.16	0.094
SL-BMI	- 0.016	0.869
SL-BSA	0.198	0.038



**Figure 4:** Scatter correlations and linear regressions: splenic length versus anthropometric parameters (in both genders). a: splenic length vs height, b: splenic length vs weight, c: splenic length vs BMI, d: splenic length vs BSA.

## DISCUSSION

Knowing the normal splenic size is very valuable in the assessment, management, and follow-up of patients with various diseases [3]. The mean splenic lengths in the present study were  $10\pm 2$  cm for males,  $9\pm 1.4$  cm for females, and  $9.7\pm 1.9$  cm for all genders. These findings were quite similar to those reported from Sudan [11] and Turkey [12]. Slightly larger than those reported from India [13] and Nigeria [14]. Smaller than those reported from the north of Iraq [15], Jordan [16], and Iran [17] (Table 3).

**Table 3:** Comparisons of splenic lengths described among different countries

Country	Year	No.	Technique	SL $\pm$ SD	Reference
Iraq	Present study	110	CT scan	9.7 $\pm$ 1.9	-
Sudan	2018	108	Ultrasound	9.7 $\pm$ 1.1	[12]
Turkey	2015	150	Ultrasound	9.8 $\pm$ 1.3	[13]
India	2016	146	Ultrasound	8.9 $\pm$ 1.6	[14]
Nigeria	2010	375	Ultrasound	8.9 $\pm$ 1.3	[15]
Iraq (North)	2023	300	Ultrasound	10.7 $\pm$ 1.3	[16]
Jordan	2015	205	Ultrasound	10.7 $\pm$ 1.4	[17]
Iran	2016	693	Autopsy	11.3 $\pm$ 3.1	[18]

Splenomegaly is regarded as moderate when splenic length measures between 11 and 20 cm and severe when it exceeds 20 cm [18]. However, we have documented a splenic length of 15 cm as the upper normal limit in Iraqis. Consequently, care is needed when describing splenomegaly in the Iraqi population. Regarding gender, the present study reported that the mean splenic lengths in males were significantly larger than those of females. As there is a modest positive correlation between splenic length and body height, a larger average of splenic length was anticipated in males on the basis of their greater anthropometric indices reported in this study. This was in accordance with the most previously reported articles [15,19-23]. Still, some articles have no such differences between males and females [24–26]. A likely decline in splenic length due to aging recorded in previous studies was not apparent in the present study [16,27-29]. Though the study results were in accordance with the findings recorded in some African and Indian research [14], the study reveals a moderately positive correlation between splenic length, body height, and BSA. These findings were similar to those recorded in some African, Iranian, and Turkish research [14,17,27]. On the other hand, the study failed to confirm any correlation between splenic length and body weight, or BMI; these findings were in accordance with findings reported in some Indian and African studies [28,29].

## Conclusion

The study supports the knowledge of the standard splenic length range in a study population of Iraqi adult individuals through the use of CT scan imaging and draws linear regression equations and graphs that can be easily used in clinical practice to calculate the splenic length depending on body indices like height and body surface area. Likewise, it recommended setting higher cut-off values for defining splenomegaly in Iraqis.

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## Conflicts of interest

There are no conflicts of interest.

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The authors did not receive any source of fund.

## Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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