

# Association of Sonographic Measurements of Kidneys and Spleen with Body Height in University Age Saudi Population

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## Abstract

A person's body weight, height, and age influence the size of their abdominal organs. Ultrasound imaging is a noninvasive, radiation-free, fast, low-cost method of evaluating the urinary system and measuring different abdominal organs. The purpose of this study was to correlate body measurements with renal and splenic measurements. A total of 94 university students from both genders were studied by the radiology department at the University of Hail between September 2017 and December 2019. An ultrasonographic scan was performed on all subjects to measure the kidney and spleen length. The respondents were recorded by age, sex, weight, and height. The left kidney is particularly affected by body height and renal length. It was not found that gender and renal length are significantly correlated. Our study revealed no significant relationship between BMI and renal length. A correlation exists between splenomegaly and renal length. Several previous studies have found a strong correlation between body height and renal length. In addition, there was a positive correlation between splenic size and height, as well as between mildly enlarged spleens and top normal left kidney sizes. Neither gender nor BMI had a remarkable correlation with renal length in our study. More studies regarding this area are recommended and will be valuable.

**Keywords:** Spleen, Renal dimensions, Height, BMI, Ultra-sonography

## INTRODUCTION

Radiological modalities that may be used to measure the dimensions and volume of the abdominal organs include Computed Tomography (CT), Magnetic resonance imaging (MRI), and Ultrasonography (US) [1]. The high cost of CT and MRI examination and the high dose of ionizing radiation in CT have made these modalities not so appealing in the studies of normal values referencing. However medical ultrasound is a simple and reliable imaging modality for the assessment and measurement of abdominal organs. It is affordable, widely available, and free of ionizing radiation. Also, ultrasound measurements of distance are reportedly sufficiently accurate for use in clinical practice [1].

Among several body growth parameters, kidney size is considered an important parameter used in the clinical evaluation of renal growth and abnormalities. Kidney length could be influenced by the overall body parameters of an individual, including age, height, weight, body mass index (BMI), and body surface area (BSA) [2-4]. Many diseases can affect kidney size, varying from infection to malignant disorders. Therefore, having a reliable reference for kidney length is valuable for clinical assessment [5]. The spleen is the size of a fist, measuring up to 12 cm long, 7 cm wide, and

3-4 cm thick. Its long axis is in the line of the tenth rib and its lower pole does not usually extend beyond the midaxillary line [6]. Spleen size and shape are both highly variable, with a gradual age-related decrease in volume. A splenic length of below 12 cm is generally considered normal, although this is subject to variation in shape and the plane of measurement used [7].

However, anthropometry varies with races and regions of the world. The size of various abdominal organs varies with age,

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height, and weight. Splenic size varies with age, nutrition, and hydration. It is relatively large in children, reaching adult size by fifteen years [5].

Renal size depends on different factors, which include side, age, and gender. However, race has particular connotations, which directly determine all the previous variables. The change in renal size can be very suggestive evidence of disease, whose interpretation requires specific parameters for the population to study. It is therefore necessary to have benchmark parameters in each population group [7].

Sadisu *et al.*, found a positive correlation between renal volume and age, height, and body mass index in the adult Nigerian population [8]. Rafat Saeed *et al.*, stated that the assessment of kidney volume is time-consuming and impractical and kidney length correlates better with body parameters and that height had the most significant correlation with kidney length and there was a consistent difference in kidney length by gender in Saudi children ≤14 years old [9].

Yared Tekle *et al.*, stated that a positive correlation is found between the spleen parameters and BMI of both genders in the Ethiopian population which has both clinical and forensic importance [10]. A few studies have been carried out on the normal dimensions of the kidney and spleen in Saudi Arabia.

### MATERIALS AND METHODS

This was an observational cross-sectional type study which has been conducted in the Radiology Department, University of Hail during the period from September 2019 until December 2019. This study was carried out to assess and establish reference values of the splenic and renal ranges of dimensions in the normal young adult Saudi population and to find out their correlation with weight, height, and BMI.

The study samples included in this study were 94 normal students from both genders at Hail university. Volunteer’s height in centimeters (cm) and converted to meters in the formula and weight in kg were measured, BMI of all subjects has been generated by using the following formula:

$$BMI = \text{Weight (kg)} / \text{height (m)}^2 \tag{1}$$

Then, all subjects underwent a sonographic scan, and measurements for spleen and kidney dimensions were performed in an ultrasonographic laboratory by a Logiq e ultrasound machine, and a (3-5MHz) transducer was used. Standard protocols of abdominal ultrasound and measurements for splenic length and both kidneys’ lengths were applied.

The data were collected using a data collection sheet that included all the variables needed for the study. Statistical Package for the Social Sciences (SPSS17) program was used for analysis. Frequency, percentage, cross-tabulation, and

chi-square tests were used. Informed consent was taken from all the subjects who participated in the study.

### RESULTS AND DISCUSSION

The statistical analysis results of the study are in **Tables 1-4**. The analysis includes frequency, percentage, cross-tabulation, and the statistical test, Chi-square, to test the correlations between the variables.

**Table 1. Correlation between height and renal length**

Height	Right Kidney Length (R.K.L)		Left Kidney Length (L.K.L)		Total
	7-10	10.1-13	7-10	10.1-13	
1.57-1.66	8	3	7	4	11
	11.9%	11.1%	14.9%	8.5%	11.7%
1.67-1.76	32	15	19	28	47
	47.8%	55.6%	40.4%	59.6%	50.0%
1.77-1.86	26	8	21	13	34
	38.8%	29.6%	44.7%	27.7%	36.2%
1.87-1.97	1	1	0	2	2
	1.5%	3.7%	.0%	4.3%	2.1%
<b>Total</b>	67	27	47	47	94

**Table 2. Correlation between gender and renal length**

Gender	Left Kidney Length (L.K.L)		Right Kidney Length (R.K.L)		Total
	7-10	10.1-13	7-10	10.1-13	
Female	19	17	21	15	36
	52.8%	47.2%	58.3%	41.7%	38.3%
Male	28	30	46	12	58
	48.3%	51.7%	79.3%	20.7%	61.7%
<b>Total</b>	47	47	67	27	94

**Table 3. Correlation between height and splenic length**

Height	Spleen.Length			Total
	6-8.5	8.6-11	11.1-13.5	
1.57-1.66	3	7	1	11
	6.4%	16.3%	25.0%	11.7%
1.67-1.76	24	22	1	47
	51.1%	51.2%	25.0%	50.0%
1.77-1.86	19	13	2	34
	40.4%	30.2%	50.0%	36.2%
1.87-1.97	1	1	0	2
	2.1%	2.3%	.0%	2.1%
<b>Total</b>	47	43	4	94
	100.0%	100.0%	100.0%	100.0%

**Table 4.** Correlation between renal length and splenic length

Spleen.Length	Right Kidney Length (R.K.L)		Left Kidney Length (L.K.L)		Total
	7-10	10.1-13	7-10	10.1-13	
	6-8.5	28	19	25	
8.6-11	35	8	20	23	43
11.1-13.5	4	0	2	2	4
Total	67	27	47	47	94

Most cases with a low to medium range of body height showed a small range of normal renal length (7-10cm) whereas cases with a body height of more than 1.87m showed a high range of normal left kidney length (10.1-13cm) 2 (4.3%) cases. One of the same two cases showed a high range of normal right kidney length but the other case showed a 7-10cm length. This may suggest a relationship between body height and renal length, especially with the left kidney which agrees with Rafat Saeed *et al.* [9]. Our sonographic measurements of the kidney and spleen are correlated with previous studies [10-20].

The most of the male and female cases, 46 (79.3%) and 21 (58.3%) consistently demonstrated a 7-10cm range for right kidney length which is considered small to medium renal length. In general, No remarkable correlation between gender and renal length, this disagrees with Rafat Saeed *et al.* who listed a consistent difference in kidney length by gender [9].

The result showed disagreement with Sadiu Mohammed Maaji *et al.* who found a positive correlation between renal volume and body mass index in the adult Nigerian population, with no significant relationship between BMI and renal length revealed by our study [8].

When comparing renal length to splenic length, a marginal large Spleen. The length was shown in 4 cases with R.K.L between 7-10cm, these cases demonstrated 2 cases with 7-10cm and the other 2 cases between 10.1-13 cm. L.K.L which may suggest a correlation between mildly enlarged spleen and marginally large left kidney length. This may be either normal or linked to renal or splenic disorders. This may be consistent with Yared Tekle1 *et al.*, results which stated that a positive correlation is found between splenic parameters and BMI of both genders in the Ethiopian population [10].

Also, our study has a significant correlation found between splenic length, body height and a correlation between enlarged spleen, and normal left kidney length, this agrees with the study done by Amna Yousaf, *et al.* which concluded that the minimum and maximum values of the Splenic/Kidney ratio were 0.94 and 1.3 respectively [20]. Splenomegaly should be suspected in those subjects whose ratio of the spleen to the left kidney exceeds 1.3 without

kidney disorders. And showed disagreement with the same study of Amna Yousaf, *et al.* which said Boys had a greater Splenic/Kidney ratio as compared to girls [20].

## CONCLUSION

We recognized a relationship between body height and renal length, especially with the left kidney. A positive correlation was found between splenic length, and body height, as well as a correlation between mildly enlarged spleen and marginally high normal left kidney length, has been shown.

## Recommendation

No remarkable correlation between gender and renal length. No significant relationship between BMI and renal length was revealed. More studies regarding this area are recommended and will be valuable.

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