



**ORIGINAL RESEARCH PAPER**

**Radiology**

**NORMAL SIZE AND VALUES IN ADULT POPULATION IN THE WESTERN REGION OF SAUDI ARABIA: KIDNEYS**

**KEY WORDS:** Kidneys, normal range, renal dimensions, CT scan.

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**ABSTRACT**

The kidneys are of the most vital organs in the human body. They receive about 25% of cardiac output and continuously filter the blood of wastes and toxic compounds. They are essential for maintaining electrolytes in equilibrium and keeping fluid levels. The size of kidneys plays an important role in the clinical evaluation of those with disease processes. Different pathologies can interfere with kidney sizes such as hereditary polycystic kidney disease, vascular diseases such as diabetes and hypertension, infectious diseases, and urinary tract obstruction. Therefore, it is of utmost importance to have a range of normal kidney sizes in healthy individuals in a given population for diagnostic and prognostic measures. This study aims to assess the normal range values of kidney size in the population of Jeddah, western area, Saudi Arabia.

**METHOD:**

This retrospective study targeted Saudi Arabian adults with normal kidney size who were seeking medical advice at King Abdulaziz University Hospital for other health reasons from August to October of 2016. This study was approved by the King Abdulaziz University ethical committee. A total of 2,000 files were reviewed of patients at KAUH during this period, and of those files, only 459 patients matched the inclusion criteria of the study. Any patient with previous renal operation or known to have DM, HTN, chronic renal medical disease or abnormal renal function tests has been excluded. The data was collected using a data collection sheet that included the patient's profile number, age, gender, and kidney measurements in axial, sagittal and coronal views on CT scan.

**INTRODUCTION:**

In vertebrates, Kidneys are the two bean-shaped organs, located in the retroperitoneal space. The structural and functional unit of Kidneys is Nephron [1]. Human adult kidney is made up of 1 million nephrons. The process associated with the kidneys are: filtration, reabsorption, secretion, and excretion, resulting in the formation of urine. The kidneys thus filter the blood, removes the waste materials, and regulates the body's fluid balance, and maintains the correct levels of electrolytes [2].

The kidneys are naturally un-equal in sizes, the right kidney is slightly bigger than the left kidney. The pathological changes in the sizes of the kidneys may occur due to reflux nephropathy, infections, renal artery stenosis, and glomerulonephritis [3]. The normal functioning of the kidney is diagnosed using blood tests, urine tests, blood pressure measurements, scans, X-rays and CT scans. The Urinary tract infections affect the size of the kidney and also kidney functioning. Tuberculosis, Malaria, Dawn's syndrome, drug abuse may lead to the abnormality in the kidneys. Nephrotoxicity occurs due to the excessive use or adverse reactions of Acetaminophen. Diabetes majorly affects the size and function of the kidneys [4].

Many studies had reported that the normal kidney size for the average adult population is 11 cm ± 1 cm. There are limited researches done on the variation of the normal kidney size in relation to the body habitus as well as the race [5]. Only a few

studies showed variations found in the renal size of different genders and races related to different body habitus.

There were very few studies that reported the dimensions and volumes of the kidneys, however, few studies reported the normal size of kidneys in the average adult population of Saudi Arabia to be around 10.17 cm ± 0.89. To overcome the limited studies carried out to measure the normal size of kidneys in the adult population of the western region of Saudi Arabia. This was done using the computed tomography technique.

**METHODOLOGY:**

This is a retrospective study conducted in patients with varied health conditions that were seeking medical advice at King Abdulaziz University Hospital, Jeddah. The study got approval from the ethical committee of King Abdulaziz University.

The files of the patients were reviewed at the King Abdulaziz University Hospital, Jeddah. About 459 patients matched the inclusion and exclusion criteria of the study. Any patient with a previous renal operation or known to have DM, HTN, chronic renal medical disease or abnormal renal function tests has been excluded. The collection of the data was done using the Data collection sheet with demographic characters like Patient's profile number, Patient's age, and Patient's gender and also the size of the Kidney (axial, coronal and sagittal view).

**RESULT:**

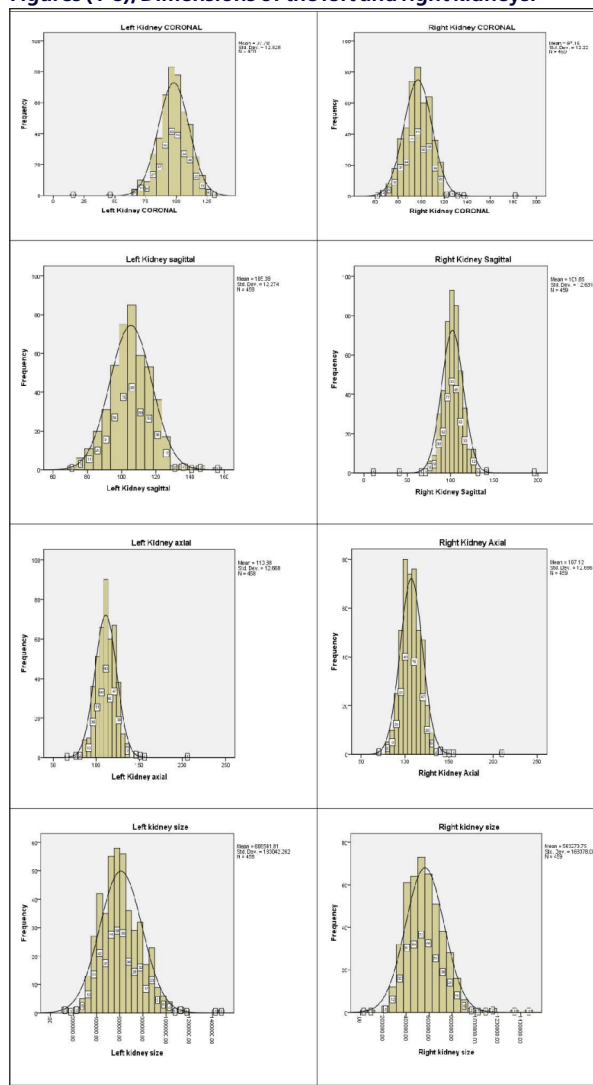
The male and female left & right Kidney dimensions were reported from the three axes (Coronal, Sagittal & Axial) using the computed tomographic technique. The mean score values of the kidneys in the Coronal, Sagittal and Axial views were (R: 97.19, L: 97.78), (R: 101.85, L: 105.38) and (R: 107.12, L: 110.88) respectively for the Right and left kidneys. The mean volume of the Right kidney is 563.3 (cm<sup>3</sup>) and Left Kidney is 608.5 (cm<sup>3</sup>). The left kidney coronal has negative Skewness and leptokurtic, the right kidney coronal has positive Skewness and leptokurtic. The left kidney sagittal view is symmetrical and platykurtic and right kidney sagittal has symmetrical distribution and leptokurtic. The left and right kidney axial has positive Skewness and leptokurtic. The volume of the left and right kidney has symmetrical distribution and platykurtic.

**Table. No: 1, Dimensions of the Left and Right kidneys.**

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
Right Kidney CORONAL	459	62	180	97.19	12.220	0.584	4.155
Left Kidney CORONAL	458	16	132	97.78	12.525	-0.795-	3.886
Right Kidney SAGITTAL	459	11	198	101.85	12.631	0.024	13.286

Left Kidney SAGITTAL	458	71	158	105.38	12.274	0.187	0.831
Right Kidney AXIAL	459	70	210	107.12	12.686	1.405	9.355
Left Kidney AXIAL	458	66	208	110.88	12.668	1.020	7.732
Right kidney Size	459	61776	1474200	563273.7563.3 (cm3)	168378	0.934	2.898
Left kidney Size	458	104291.20	1462032.00	608541.81608.5 (cm3)	183042.26	0.663	1.470
Valid N (list wise)	458						

Figures (1-8), Dimensions of the left and right kidneys.



**DISCUSSION:**

The Saudi adult patients >15 years of age attending King Abdulaziz University Hospital were studied to obtain their standard values of kidney sizes measured by using the computed tomographic techniques. These results can be used as a standard reference for future studies in the western region of Saudi Arabia. Kidneys are a part of the renal system, kidneys are bean-shaped organs that filter the blood and remove the waste materials from the body as urine. Kidneys are made up of 3 main regions: renal cortex, renal medulla, renal pelvis [6]. Each kidney is made up of nearly 1 million nephrons. The nephron takes in blood, metabolizes the nutrients and pass out the waste materials from the filtered blood. The nephron is made up of Renal corpuscle (Glomerulus, Bowman’s capsule) and the renal tubule (Proximal convoluted tubule, Loop of Henle, Distal convoluted tubule). Kidneys are located in the upper abdominal area in the retroperitoneal space against the back muscles on both the left and right side of the body [7]. The kidneys are exclusively vascular supplied with a number of blood capillaries. The renal capsule is covered by a shock absorbing layer called the renal fat pad.

The Kidneys are the significant organs that purify the blood and remove the waste materials. They also play a major role to maintain

homeostasis in the body and also maintain and regulates the blood pressure in the body. The kidneys also maintain the electrolytic levels, acid base and fluid content in the body. A number of studies had been reported that concluded that the size of the kidneys changes during disease or a disorder in the body. The clinical information available on the size and function of the normal adult is available in large numbers to help the physicians, surgeons and the radiologists during the diagnosis.

The upper abdominal pain in the back should never be neglected and exclusive examination should be done to check the size of the kidneys to determine its normal working and functioning. The creatinine and the BUN test need to be done to accurately check the functioning of the kidneys. Other diagnostic tests include X-rays, CT scans, nuclear scans, Ultrasound and MRI [8].

Computed tomography (CT scan or the CAT scan) is a non-invasive diagnostic imaging procedure to give us the axial, coronal and sagittal axis of the kidneys. CT scan can not only determine the size of the kidneys but also detect several diseases and disorders related to the kidneys [9]. The present study also utilizes the Computed tomography to determine the size of the kidneys in the adult population of the western region of Saudi Arabia by giving a three-dimensional view of the kidney [10].

In a study carried out in Saudi Arabia, it was reported that the renal length was 10.17 cm ± 0.89 on the left side and 9.91 cm ± 0.85 on the right side. It was also reported that the mean left and right kidney length in males was found to be significantly longer than in females with p < 0.05 for both genders. The study also reported that in Saudi Arabia, the kidney length was significantly shorter in the younger age group when compared to the elder age people with p = 0.001 and 0.000 for right and left sides respectively.

This present study does not obey the studies of Bircan et al., and Ablett et al., on Turkish population, and the study of Buchholz et al. on Pakistani population where all of them mentioned that “there was no significant difference between the right and left kidney length”. LF Hammad et al. reported that the mean volume of the Right kidney is 142.48 (cm3) and left kidney is 138.99 (cm3) in a study in Riyadh using ultrasound. MA Makusidi et al. reported the volume of the left and right kidney to be around 98.6 ± 41.9 (cm3) and 105 ± 46.2 (cm3) respectively.

There was no significant relationship between the age and the size of the kidneys in the studies performed on the Turkish population, Pakistani population, and European populations. A strong correlation between the length of the kidney and the advancing Chronic Kidney Disease was reported in a study carried out in Nigeria [13]. N.M Elsayed et al. reported that every race has its own renal measurements in a study carried out in the kingdom of Saudi Arabia.

Similar kind of studies was carried out in other parts of the world like Brazil, Mexico, Europe, and India [14, 15]. The renal dimensions reported varied from one population to another. These dimensions are important and set as the standard values for the use of the radiologists that helps them with the diagnosis. The renal dimensions (length and size of the kidneys) are been influenced by a number of factors affecting it: The varied races, different provinces and also difference in the gender, it also depends on the number of participants of the study.

**CONCLUSION:**

The kidney size in the adult population in the western region of Saudi Arabia is found to be comparable to the kidneys size in the rest of the world. This study may serve as a standard reference for the renal dimensions of the target population. Further studies

need to be conducted in different regions of Saudi Arabia in different health care centers to broaden up the standard renal dimensions of the adult Saudi population and also provide the factors affecting the size of the kidneys in this race.

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