

ULTRASONOGRAPHIC MEASUREMENT OF RENAL DIMENSIONS: IT'S CORRELATION WITH BODY SURFACE AREA IN ADULTS

Jayanta Kumar Sarkar ¹, Turlika Sinha ^{*2}, Abhishek Das ³, Bijon Chandra Dutta ⁴.

^{1,2} Associate professor of Anatomy, Silchar Medical College, P.O.: Ghungoor, Silchar, Cachar, Assam, India.

³ Assistant professor of Radiology, Silchar Medical College, Silchar, Cachar, Assam, India.

⁴ Professor & Head of Anatomy, Silchar Medical College, P.O.: Ghungoor, Silchar, Cachar, Assam, India.

ABSTRACT

Introduction: Ultrasound is the first imaging modality used to assess the kidneys and renal tract due to its easy accessibility, lack of radiation and low cost. The size of kidney is considered an important indicator for various clinical signs. Ultra-sonographic measurement of renal dimensions such as length, breadth and thickness are important parameters in diagnosis and management of kidney diseases as there is a close proximity between renal size and its function.

Aim: The aim of the present study was to ascertain the renal dimensions in adult by ultrasonography and to correlate with somatic parameters like age, sex, height and body surface area.

Methods: This study was carried out on 118 patients (51 male & 67 female) taking measurements of 236 kidneys having no radiologic evidence of renal diseases. Renal dimensions of right were compared with the left. The volume of the kidney was correlated with age, sex, height and body surface area.

Results: The present study revealed that the volume of left kidney was more than the right in both male and female. The size of kidney in male was larger than female. The volume of kidney showed linear relationship with the body surface area both in male and female. However, volume of kidneys decreased from sixty years of age.

Conclusion: Measurements of renal dimensions can be obtained quickly and easily with ultrasonography having advantage of not exposing the patients to ionizing radiation. This allowed us to find differences in relation to age, sex, weight and height. There is a gender difference in adult kidney sizes. The renal length is correlated best with height and body surface area.

KEY WORDS: Ultrasonography, Kidney, Body Surface Area, Nomogram.

Address for Correspondence: Dr. Turlika Sinha, Associate professor of Anatomy, Silchar Medical College, P.O.: Ghungoor, Silchar-14, Cachar, Assam, PIN: 788014, India. Mobile No: (+91)9435043209
E-Mail: dr.turlikasinha@rediffmail.com

Access this Article online	Journal Information
Quick Response code  DOI: 10.16965/ijar.2018.338	International Journal of Anatomy and Research ICV for 2016 90.30 ISSN (E) 2321-4287 ISSN (P) 2321-8967 https://www.ijmhr.org/ijar.htm DOI-Prefix: https://dx.doi.org/10.16965/ijar 
	Article Information
	Received: 29 Jul 2018 Peer Review: 29 Jul 2018 Revised: None
	Accepted: 06 Sep 2018 Published (O): 10 Oct 2018 Published (P): 10 Oct 2018

INTRODUCTION

Ultrasound is the first imaging modality used to assess the kidneys and renal tract due to its easy accessibility, lack of radiation and low cost [1]. The size of kidney is considered an important

indicator for various clinical signs as it gets affected by congenital anomalies, neoplasm, diabetes mellitus and hypertension. The deviation of renal parameters from established normal values is an important criterion in

diagnosing kidney disease [2]. Ultrasonography is a valuable non-invasive technique to assess renal size and to investigate patients who are suspected of having kidney diseases. It is often the only method required for renal imaging and has the advantage of showing other abdominal, pelvic and retroperitoneal pathology [3]. Ultra-sonographic measurement of renal dimensions such as length, breadth and thickness are important parameter in diagnosis and management of kidney diseases as there is a close relationship between renal size and its function [4]. Renal length as measured by ultrasonography is a simple, practical and reproducible measurement and widely accepted to monitor renal size [5]. The size of the kidney and its dimensions are influenced by age, gender, height and weight of the individuals. It is also well known that the right kidney is smaller in size than the left kidney independent of gender. While data on normal ranges for renal dimensions are available from Western literature, little data are available from the Indian subcontinent. A renal size of 9 cm, widely accepted as the cut-off to indicate irreversible renal disease in most populations, is a size often seen in normal and healthy Indian adults [6]. In common practice, measurements of renal dimensions are compared with the measurements that are predicted by standard nomograms. Since our currently used renal nomogram in India is based on the western database, it may lead to false positive and false negative diagnosis of kidney condition. A normal functioning kidney usually have renal volume specific to particular gender and ethnicity. The ultra-sonographic measurement of renal dimensions is very important to determine the health of the individuals and also to detect any abnormalities present in the kidneys [4].

Therefore, the current research is conducted as a first step to formulate a nomogram to provide a better accuracy of measurements of renal dimensions in terms of making a proper medical diagnosis and also during monitoring the disease progress for the adult population in North-East India.

AIM: The aim of the present study was to ascertain the renal dimensions in normal adult by ultrasonography. Our main objective was to

correlate dimensions of kidneys with somatic parameters like age, sex, height and body surface area.

METHODS

This study was carried out on 236 kidneys of 118 patients in the Department of Anatomy and Radiology of Silchar Medical College & Hospital after approval by Institutional Ethical committee. Informed consent was taken from all participants. The cases (51 male & 67 female) were selected on the basis of having no radiologic evidence of renal diseases. Patients with known history of kidney diseases including renal stone or with prior abdominal surgery for renal causes were excluded from the present study. The cases were categorized into five age groups (Table-1).

Fig. 1: Ultrasonographic image of kidney showing measurements of length and breadth.

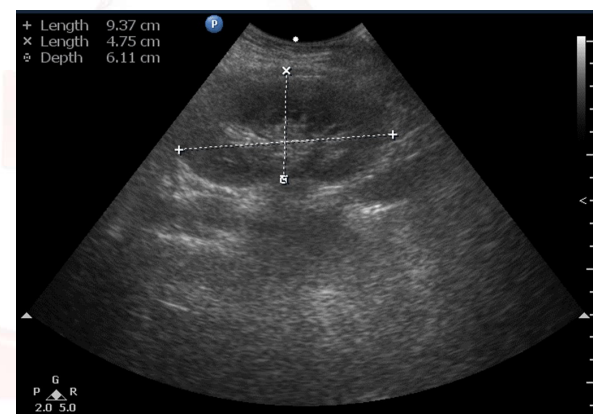
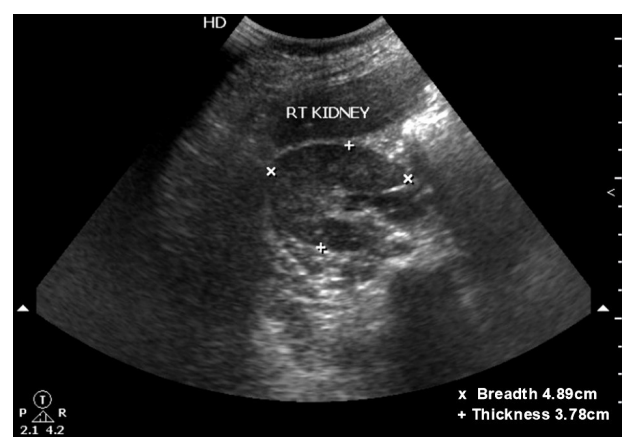


Fig. 2: Ultrasonographic image of right kidney showing measurements of breadth and thickness.



The length of kidney was measured by distance from upper pole to lower pole, breadth by transverse measurement at the level of hilum and thickness by anteroposterior measurement at the midway between upper and lower pole of kidney (fig 1 & 2). Renal dimensions, length,

breadth and thickness of both the kidneys were measured in centimeters. Mean with standard deviations of length, breadth and thickness were calculated. The volume of the kidney was calculated by using the formula:

$$\text{Volume} = 0.523 \times \text{Length} \times \text{Breadth} \times \text{Thickness cm}^3$$

The patients' height and weight were measured before the ultrasound examination. Height was measured without footwear, using a stadiometer. Body surface area (BSA) was calculated by

$$\text{using the formula } BSA = \sqrt{\frac{\text{Weight X Height}}{36}} \text{ where}$$

weight is in kilograms and height is in meters. Renal dimensions of right were compared with the left. The volume of the kidney was correlated with age, sex, height and body surface area (BSA) and presented in table and figure after the data being analysed statistically with SPSS version 21.

Table 1: Distribution of mean of age, sex, and length, breadth & thickness of both kidneys. N=118, M=51, F=67

Age group	Sex	cases	Age years	Right Kidney cm			Left Kidney cm			Right kidney volume	Left kidney volume
				L	B	T	L	B	T		
18-30	M	17	25.06	10.08	5.06	3.42	10.31	5.06	3.39	91.23	92.49
	F	27	22.92	9.92	4.68	3.23	10.01	4.69	3.26	78.43	80.04
31-40	M	14	35.86	10.16	4.93	3.61	10.25	5	3.65	94.56	97.83
	F	12	36.58	10.17	4.69	3.29	10.15	5.03	3.18	82.07	84.91
41-50	M	6	46.83	10.42	4.92	3.6	10.65	5.2	3.4	96.52	98.47
	F	15	45.33	10.02	4.71	3.41	10.45	4.9	3.3	84.16	88.37
51-60	M	7	57.14	10.37	5.14	3.33	10.63	5.3	3.26	92.82	96.06
	F	6	56.83	9.9	4.8	3.32	10.06	4.98	3.32	82.51	86.98
61-70	M	7	65	9.77	4.84	3.19	10.11	4.91	3.3	80.5	85.67
	F	7	64.33	9.47	4.59	3.21	9.86	4.67	3.31	72.97	79.71

RESULTS

The age group wise mean of kidney dimensions (length, breadth & thickness) of both male and female are shown in table-1 and chart-1. It was observed that the kidney dimensions, length, breadth, thickness and volume of kidneys decreased from 6th decade onwards in the present study. 'Height group' wise distribution of mean of weight, height, body surface area and volume of both kidneys were shown in table 2. When length of kidney correlated with height of individuals in unpaired t test, the two-tailed P value < 0.0001, considered extremely significant. t = 55.83 and t = 51.53 for right and left kidney with 132 degrees of freedom in female. t = 53.32 for right kidney and t= 45.55 for left kidney with 100 degrees of freedom in male. In Tukey-Kramer multiple comparisons test p value <0.001, when height of the individuals compared with length, breadth and thickness of both the kidneys in all the age groups both in male and female.

Mean length, breadth, thickness and volume of 236 kidneys of 118 (M=51, F=67) cases without any detectable kidney diseases are shown in table-3. The present study revealed mean of right kidney length 10.15cm ± 0.51, breadth 4.98

± 0.32 and thickness 3.46 ± 0.36 and left kidney length 10.35±0.69, breadth 5.07±0.42, thickness 3.45±0.31 in male (table 3). The volume of right kidney was 91.47cm³ and left kidney 94.68cm³ respectively. The mean of right kidney length 9.94cm ± 0.53, breadth 4.69 ± 0.34 and thickness 3.29 ± 0.28 and mean of left kidney length 10.12±0.59, breadth 4.83±0.40, thickness 3.27±0.25 in female. The volumes of right kidney were 80.21cm³ and left kidney 83.59cm³ respectively (table 3). It was observed that volume of left kidney was more than right kidney both in male as well as in female. The size of kidney in male was larger than female.

When right kidney compared with left in male, the two-tailed P values in unpaired t test are 0.09, 0.90 and 0.20 for length, breadth and thickness respectively with 100 degree of freedom, difference between right and left kidney considered not significant. When right kidney compared with left in female, the two-tailed P values in unpaired t test are 0.06, 0.03 and 0.39 for length, breadth and thickness respectively with 132 degree of freedom, difference between right and left kidney considered not quite significant. The volume of kidney showed linear relationship with the body surface area both in male (chart 3) and female (chart 4). However

volume of kidneys decreased from sixty years of age. The volume of right kidney when correlated with left in male, Pearson's correlation coefficient (r) = 0.98, 95% confidence interval: 0.74 to 0.99 and the two-tailed P value 0.003,

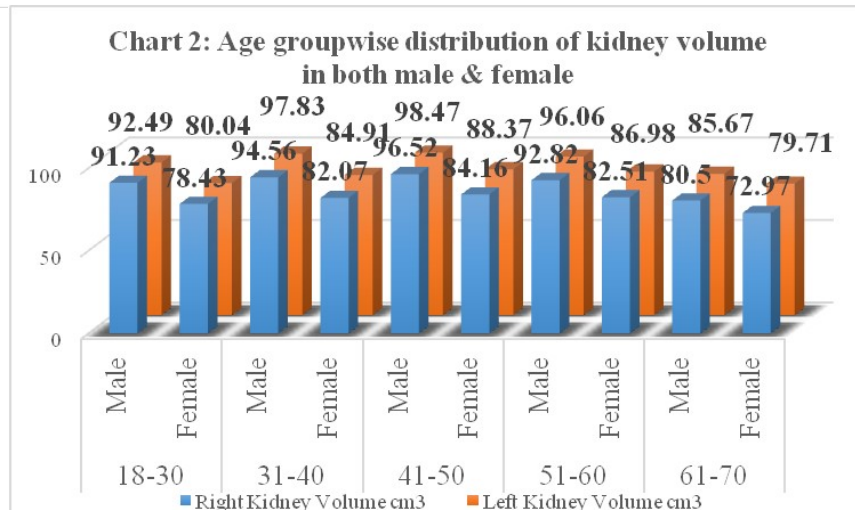
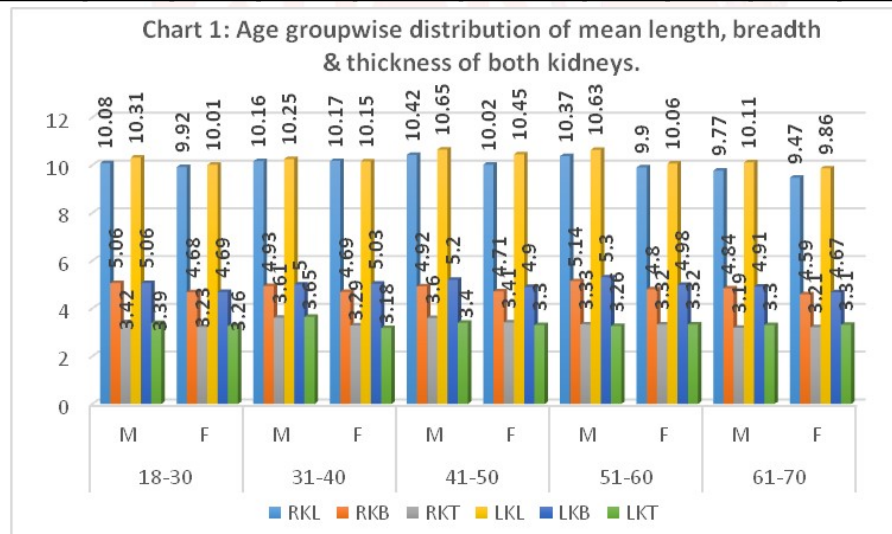
considered very significant. When female right kidney volume correlated with left, Pearson's correlation coefficient (r) = 0.90, 95% confidence interval: 0.098 to 0.99 and the two-tailed P value 0.036, considered significant (table 2).

Table 2: Height group wise distribution of mean of weight, height, body surface area and volume of both kidneys. N=118, M=51, F=67

Height group	1.31-1.40		1.41-1.50		1.51-1.60		1.61-1.70		1.71-1.80		1.81-1.90	
Sex	M	F	M	F	M	F	M	F	M	F	M	F
Weight	-	45	54.55	46.66	58.5	49.87	59.2	54.65	62.15	59.75	68.75	-
Height meter	-	1.35	1.47	1.48	1.55	1.55	1.66	1.64	1.73	1.73	1.85	-
BSA	-	1.29	1.49	1.38	1.58	1.46	1.65	1.57	1.72	1.63	1.87	-
RK volume	-	65.9	77.5	72.7	83.8	82.1	90.6	85.9	98	92.2	108.2	-
LK volume	-	70	80.7	78.2	86.9	85.1	97.6	88.8	104.8	97.9	114.6	-

Table 3: Mean of Length, Breadth, Thickness and volumes of Kidney n=118, M=51, F=67.

Kidney Dimensions		Male					Female				
		Min	Max	Mean	Std. Dev	Volume	Min	Max	Mean	Std. Dev	Volume
Right	Length	9.2	11.4	10.15	0.51	91.47	9	11.2	9.94	0.53	80.21
	Breadth	4.3	5.7	4.98	0.32		3.9	5.4	4.69	0.34	
	Thickness	3	4.3	3.46	0.36		2.5	3.8	3.29	0.28	
Left	Length	8.4	12.4	10.35	0.69	94.68	8.5	12	10.12	0.59	83.59
	Breadth	4	5.7	5.07	0.42		3.9	5.5	4.83	0.4	
	Thickness	2.8	4.4	3.45	0.31		2.6	3.9	3.27	0.25	

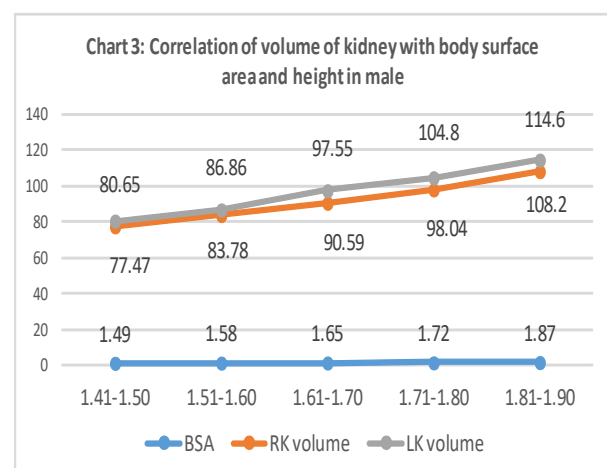


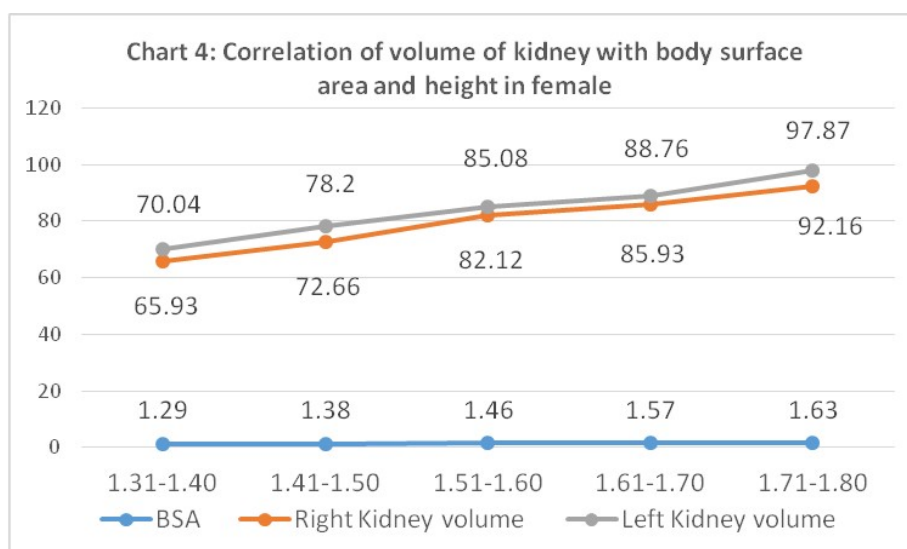
DISCUSSION

Gebrehiwot M et al [7] found that the left kidney was longer than the right and the mean kidney length was greater in men than in women. Okoye I J et al [8] and El-Reshaid W [9] reported the mean renal length of males were slightly higher than those of females. Kolade-Yunusa [10] observed the renal dimensions among the subjects were higher on the left side than the right. Discrepancy between right and left renal length of up to 1.5 cm was considered to be within normal limits by Butler P [1]. Present study also revealed similar findings having left kidney length more than right kidney both in male and female. Renal length in our study was quite similar to those obtained by Sahni D [11] in north India. However, Barton EN et al [12] reported no difference in width between right or left kidneys in the group as a whole or within either gender. Muthusami P et al [6] in his study showed no significant right-left difference in length or width with a significant decline in bilateral renal length after the age of sixty years. Glodny B et al [13] found that the kidney length increased significantly and breadth slightly upto 5th decade of life and the size decreased in both gender thereafter. There was linear correlation between height and length & width of kidney. The present study also showed significant correlation between length of kidney and body height. Prasad and Kumar [14] confirmed that the age was a factor influencing the length of the kidney and the mean renal length of both kidneys found to increase with advancing age upto 60 years. The present study also showed decrease in renal length and size from sixty years of age.

Egberongbe et al [15] showed that the renal volume was higher in the left than the right kidney in both sexes and volume of kidneys decreased with age. The volume of kidney decreased after 60 years of age in the present study. According to Emamian et al [16], renal size decreased with age, almost entirely because of parenchymal reduction. Renal volume correlated best with total body area and the length correlated best with body height. Males had larger kidney sizes than females, age however was only associated with a decrease

in renal length after age of 70 by Saeed Z [17]. The right kidney usually is smaller than the left by Gheissari A [18]. Karim et al [19] reported that the left kidney size was found to be larger as compared to the right and the size increased with age till the 5th decade of life. The male renal size was found to be greater than the female renal size with the same age group. Fernandes M M R et al [20] showed a reduction of renal size for individuals in the 7th decade life compared to the 3rd and 4th decades. Murlimanju B V [21] reported that the volume of right kidney was significantly smaller than that of the left. Raza et al [22] observed that left kidney was significantly larger than right in length, width, parenchymal thickness and volumes. Left kidney was significantly larger than right and larger renal sizes were seen bilaterally in males compared to females. The present study also revealed similar findings that the left kidney size was larger than right. Kidney volume was found to be significantly greater in males than females amongst the study population and the correlation of renal volume with age & body weight of an individual was found to be significant by Talhar et al [23]. According to Rathore et al [24], the volume of both the right and the left kidneys was higher among males compared with females. However, there was no statistically significant difference between volumes of the right and left kidneys in either sex. The volume of left kidney was more than the right in both male & female in the present study and the volume of kidneys showed linear relationship with the body surface area and height (chart 3 & chart 4).





CONCLUSION

Measurements of renal dimensions can be obtained quickly and easily with ultrasonography. This allowed us to find differences in renal dimensions on the basis of age, sex, weight and height. Ultrasonography has advantages in measuring renal dimensions as the patients are not exposed to ionizing radiation. There is a gender difference in adult kidney sizes. The renal length is correlated best with body height and body surface area. Variations in measurements of renal dimensions have gained much research attention as they are believed to possess significant clinical importance. The present study signifies the potential of ultrasound as a useful tool for diagnostic and follow-up purposes of kidney and its associated diseases. By extending the present research and including data from other parts of the country, we can formulate age, sex and height specific nomogram for kidney dimensions for adequate comparison in evaluation of kidney.

ABBREVIATIONS

L-length, B-breadth, T-thickness, M-Male, F-Female, BSA-Body surface area, RK-right kidney, LK-left kidney, RKL-right kidney length, RKB-left kidney breadth, RKT-right kidney thickness, LKL-left kidney length, LKB-left kidney breadth, LKT-left kidney thickness.

Conflicts of Interests: None

REFERENCES

- [1]. Butler P, Mitchell A W M, Ellis H: The renal tract, retroperitoneum and pelvis: Applied Radiological Anatomy for Medical Students. 2007:47-63
- [2]. Ashwini N S, Divya C, Venkateshu K V: Morphometric analysis of human adult kidneys: a cadaveric study. *Int J Anat Res.* 2017; 5(2.3): 3900-04.
- [3]. Walker B R: Kidney and urinary tract disease: in Davidson's Principles and Practice of Medicine. 22nd edition. 2014; 464-523
- [4]. Arooj A, Lam J, Wui Y J, Supriyanto E: Comparison of renal size among different ethnicities: *International Journal of Biology and Biomedical Engineering.* 2011; 5(4): 221-228.
- [5]. Kanitkar M: Kidney size- what is normal?: *Indian pediatrics.* 2012; 49:523
- [6]. Muthusami P, Ananthakrishnan R, Santosh P: Need for a nomogram of renal sizes in the Indian population- findings from a single centre sonographic study: *Indian J Med Res.* 2014; 139: 686-693
- [7]. Gebrehiwot M, Atnafu: Determination of normal renal dimensions of adult Ethiopian patients as seen by excretory urography: *Ethiop Med J.* 1998; 36(1):27-35.
- [8]. Okoye I J, Agwu K K, Idigbo F U: Normal sonographic renal length in adult southeast Nigerians: *Afr J Med Med Sci.* 2005; 34(2):129-31.
- [9]. El-Reshaid W, Abdul-Fattah H: Sonographic assessment of renal size: *Med Princ Pract.* 2014; 23:432-436
- [10]. Kolade-Yunusa, Oluseyi H, Helen MM: Ultrasonographic measurement of renal size among normal adults in Abuja, North-central, Nigeria: *Int Inv J Med Med Sci.* 2017; 4(1):6-11. <http://internationalinvtjournals.org/journals/IJMMMS>
- [11]. Sahni D, Jit I, Sodhi L. Weight and measurements of kidneys in northwest Indian adults. *Am J Hum Biol.* 2001; 13: 726-32
- [12]. Barton E N, West W M, Sargeant L A, Lindo J F, Iheonunekwu N C: A sonographic study of kidney dimensions in a sample of healthy Jamaicans: *West Indian Med J.* 2000; 49(2):154-7.

- [13]. Glodny B, Unterholzner V, Taferner B, Hofmann K J, Rehder P, Strasak A, Petersen J: Normal kidney size and its influencing factors - a 64-slice MDCT study of 1.040 asymptomatic patients: BMC Urol. 2009; 9: 19. doi: 10.1186/1471-2490-9-19 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2813848/>
- [14]. Prasad V A, Kumar U S: Morphometric study of kidney in normal human subjects by using ultrasonography: IOSR Journal of Dental and Medical Sciences. 2018; 17(2): 21-27 www.iosrjournals.org DOI: 10.9790/0853-1702122127
- [15]. Egberongbe A A, Adetiloye V A, Adeyinka A O, Afolabi O T, Akintomide A O, Ayoola O O: Evaluation of renal volume by ultrasonography in patients with essential hypertension in Ile-Ife, south western Nigeria: Libyan J Med 2010, 5: 4848 - DOI: 10.3402/ljm.v5i0.4848
- [16]. Emamian S A, Nielsen M B, Pedersen J F, Ytte L: Kidney Dimensions at Sonography: Correlation with age, sex, and habitus in 665 adult volunteers. AJR. 1993;160:83-86
- [17]. Saeed Z, Mirza W, Sayani R, Sheikh A, Yazdani I, Hussain S A: Sonographic measurement of renal dimensions in adults and its correlates: International Journal of Collaborative Research on Internal Medicine & Public Health: Vol. 2012; 4(9): 1626-1641
- [18]. Gheissari A: The place of ultrasound in renal medicine: Saudi J Kidney Dis Transpl. 2006; 17:540-548. <http://www.sjkdt.org/text.asp?2006/17/4/540/32493>
- [19]. Karim S H, Mohammed N A, Aghaways IHA, Muhammed B A: Comparative ultrasonographic measurement of renal size and its correlation with age, gender, and body mass index in normal subjects in Sulaimani region: European Scientific Journal. 2015; 11(12): 236-250
- [20]. Fernandes M M R et al: Normal renal dimensions in a specific population: International Braz J Urol. 2002; 28(6): 510-515.
- [21]. Murlimanju B V et al: Morphometric parameters of the human adult kidney: An anatomical study. Int. J. Morphol. 2014; 32(2):656-659.
- [22]. Raza M, Hameed A, Khan MI: Ultra-sonographic assessment of renal size and its correlation with body mass index in adults without known renal disease: J Ayub Med Col. 2011; 23(3): 64-68. <http://www.ayubmed.edu.pk/JAMC/23-3/Mujahid.pdf>
- [23]. Talhar S S, Waghmare J E, Paul L, Kale S, Shende M R: Computed tomographic estimation of relationship between renal volume and body weight of an individual: J Clin Diagn Res. 2017 Jun; 11(6):4-8. doi: 10.7860/JCDR/2017/25275.10010 <https://www.ncbi.nlm.nih.gov/pubmed/28764140>
- [24]. Rathore RS, Mehta N, Pillai BS, Sam MP, Upendran B, Krishnamoorthy H. Variations in renal morphometry: A hospital-based Indian study. Indian J Urol 2016; 32:61-4

How to cite this article:

Jayanta Kumar Sarkar, Turlika Sinha, Abhishek Das, Bijon Chandra Dutta. ULTRASONOGRAPHIC MEASUREMENT OF RENAL DIMENSIONS: IT'S CORRELATION WITH BODY SURFACE AREA IN ADULTS. Int J Anat Res 2018;6(4.1):5765-5771. DOI: 10.16965/ijar.2018.338