ORIGINAL ARTICLE

ULTRASONOGRAPHIC NOMOGRAM OF THE KIDNEYS IN APPARENTLY HEALTHY ADULTS IN A NIGERIAN POPULATION

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ABSTRACT

BACKGROUND: Ultrasonographic assessment of the renal size is useful in diagnosis of renal pathologies. **OBJECTIVES:** To determine the renal morphometry based on age, sex and anthropometry among apparently healthy adults in Bauchi, North Eastern Nigeria. **METHODS:** A cross sectional study conducted among 533 healthy adults aged between 18-80 years in Abubakar Tafawa Balewa University Teaching Hospital, Bauchi. Real time ultrasound machine ALOKA SSD-1000, with curvilinear trans-abdominal transducer of frequency 3.5 mHz was used between December 2015 and November 2016. Kidney measurements were performed in a lateral decubitus position. The renal hilum was visualized to get the optimum longitudinal bipolar length (BPL) and transverse diameters (TD) of both kidneys in each subject were measured in the same plane. Renal parenchymal thickness was obtained from the cortex peri-renal fat interface (capsule) to the sinus pyramid apex interface at the mid portion on long section of the kidney. Subject's height and weight were measured while standing erect against a ZT WHO weighing scale. **RESULTS:** The mean ± SD of BPL ,TD, parenchyma thickness, and cortical thickness of the right kidney were 98.5 ± 8.98 mm, 39.3 ± 4.46 mm, 15.6 ± 2.25 mm and 7.1 ± 1.45 mm respectively whereas that of the Left kidney were 102.0 ± 8.14 mm, 41.4 ± 4.89 mm, 17.5 ± 2.38 mm and 8.3 ± 2.15 mm respectively. There was statistical significant difference ($P<0.05$) between kidney morphometric parameters in females and in males. **CONCLUSION:** The study has provided normal renal dimension, parenchyma thickness and cortical thickness for our population in north eastern Nigeria.

Keywords: Parenchyma thickness, cortical thickness, ultrasonography, weight, height

Introduction

The assessment of renal size is an integral part of evaluation of renal pathologies for both diagnostic and prognostic purposes. Renal size is an important parameter for clinical assessment of patients with different disease conditions like diabetes, renal artery stenosis,chronic renal failure and for assessment of kidney transplant candidates. Renal sizes facilitate differentiation between chronic and acute renal failure, and when a decision has to be made on whether to take renal biopsies or not.[1,2,3,4]

Diagnosticimaging modalities and techniques such as conventional radiography (CR), computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine (NM), renal arteriography, renal venography and ultrasonography among others have been used for renal evaluation, especially in terms of size and function, but no single method is universally accepted for renal size assessment.[2,3,5]

Ultrasonography (US) replaced standard radiography and has become the standard imaging modality in

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the investigation of renal diseases, due to its non-invasive nature and easy availability.[2] It offers excellent anatomical details, requires no special patients preparation and does not expose patients to radiation or contrast agents. Renal US is used to determine the site, shape and size of the kidneys and to detect any focal renal lesion.[3] It also helps to evaluate pertinent anatomy and pathology especially during surgery in case of intraoperative US.[4,5]

The measurement of renal parenchymal thickness provides a more accurate estimation of renal function compared to the one dimensional measurement of renal length.[6] The thickness of the renal parenchyma is related to the volume of renal mass which contain millions of nephrons in the renal parenchyma.[12] Renal parenchymal thickness appears to be a more accurate parameter than renal length for the assessment of renal function as proven by CT studies.[7]

Renal medullary pyramid thickness which is the distance between the apex and the base of the renal medulla may be reduced in some pathological conditions. Thus, clinicians canuse changes in the renal medullary pyramid and measurement of renal parenchymal thickness to grade hydronephrosis.[2,8] Grading of hydronephrosis is usually based on the degree of dilation of the pelvis and calyces and measurement of renal parenchyma. Thus, knowledge of normal range of renal parenchymaland medullary pyramid thicknesses could be important parameters in grading hydronephrosisand in the diagnosis and follow-up of renal diseases.[9,10]

Several studies have been done on kidney morphometrics in children which include renal length and volume with few studies on renal parenchymal thickness and renal medullary pyramid thickness measurements.[2] There is insufficient literature on renal parenchymal and cortical thicknesses in our adults population to the best of our knowledge as there may be racial variation in kidney dimensions.[2,11]

There is a need to establish normal values for renal lengths, renal parenchymal and cortical thicknesses for our adults population. This study was, therefore, aimed at establishing normal values for renal length, renal width, renal parenchymal thickness (RPT) and renal cortical thickness (RCT) with respect to age and anthropometric parameters among adults in a Nigerian population.

Methods

This was a cross-sectional study done from December 2015 to November 2016 at Abubakar Tafawa Balewa University Teaching Hospital Bauchi, Nigeria. Sonographic measurements of both kidneys were taken during abdominal sonographic examinations of 533 apparently healthy adults comprising of 260 males and 273 females. Participants ages ranges between 18 to 80 years. Subjects were screened by a physician/nephrologist to rule out any renopathies among participants. Any medical history known to influence renal size was also ruled out. Weight was taken using ZT WHO weighing scale with a capacity of 0-160 kg incorporated with a meter rule of 0-190 cm capacity for measurement of height. Ethical clearance was obtained from the Health Research Ethics Committee, Abubakar Tafawa Balewa University Teaching Hospital Bauchi, Nigeria, before commencing the study. The body mass index was calculated using Quetelet's formula given below:

$$BMI = \frac{\text{weight (kg)}}{\text{height}^2\ (\text{m}^2)}$$

Scanning equipment

A real time ultrasound machine ALOKA SSD-1000, (IP-1233EV, SN-57324, and Japan) with curvilinear trans-abdominal transducer of frequency 3.5 mHz equipped with electronic calipers was used for the evaluation of the kidneys.

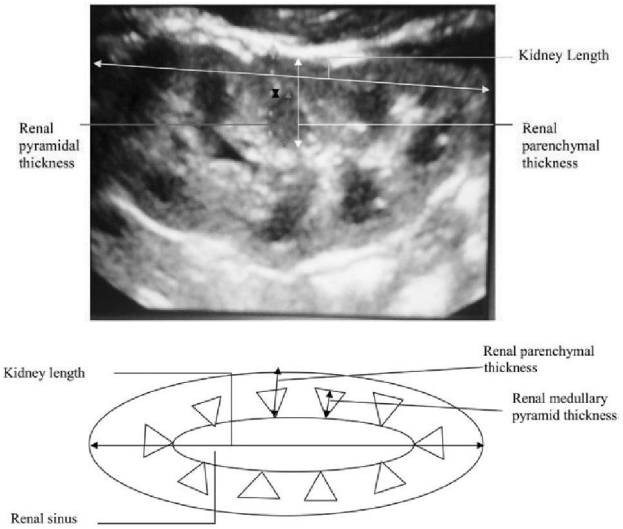
Statistical method

Descriptive statistics such as mean and standard deviation were done for both kidneys at various ages. Kolmogorov Smirnoff was used to determine the normality of data after which Pearson's Product Moment correlation and regression analysis were used to determine the relationship between renal bipolar length and renal transverse diameter with age, height, body weight, body mass index and sex.

Scanning technique

Kidney measurements were performed in a supine, prone and lateral decubitus position in accordance with the study done by Eze et al., 2016.[13] The mean of each measurement was taken and it gave us the same value. After applying a lubricating gel, the renal hilum was visualized to get the optimum longitudinal

bipolar length (BPL) and transverse diameters (TD) of both kidneys in each subject were measured.[13] Renal parenchymal thickness was obtained between the cortex peri-renal fat interface (capsule) and the sinus pyramid apex interface at the mid portion on long section of the kidney.[12] Renal medullary pyramid thickness was measured at the distance between the apex and the base of pyramid at the mid portion of the kidney on the same plane.[12] These renal parenchymal and pyramidal measurements were taken in the anterior portion of the kidneys as it is not always visualized in the posterior part.



Results

(Tab. 1, 2a, 2b and 3) shows the frequency distribution of subjects according to age group and sex, distribution of subject's anthropometric variables in relation to age, distribution of males anthropometric variables in relation to age and distribution of females anthropometric variables in relation to age respectively.

From (Tab. 1), there were two hundred and sixty males (48.78%) and two hundred and seventy three females (51.22%) were enrolled in the study given a total of five hundred and thirty three participants. The highest age group involved in the study was 35-39 years representing 141 (26.45%). The highest age group in males was 35-39 years representing 77 (14.45%) while 30-34 years in females representing 66 (12.38%). The least age group was ≤ 20 in both sexes representing 6 (1.13%) and 7 (1.31%) males and females respectively.

Age Group	Male		Female		Total	
	N	%	N	%	N	%
<=20	6	1.13	7	1.31	13	2.44
21-24	19	3.56	27	5.07	46	8.63
25-29	26	4.88	38	7.13	64	12.01
30-34	52	9.76	66	12.38	118	22.14
35-39	77	14.45	64	12.01	141	26.45
40-44	27	5.07	32	6.00	59	11.07
45-49	26	4.88	25	4.69	51	9.57
50+	27	5.07	14	2.63	41	7.69
Total	**260.00**	**48.78**	**273.00**	**51.22**	**533.00**	**100.00**

Table 1: Frequency distribution of subject according to age and sex.

(Tab. 2a) shows the mean bipolar length, transverse diameter, parenchymal thickness, and cortical thickness of the male right kidney obtained from this study were 98.5 ± 8.98 mm, 39.3 ± 4.46 mm, 15.6 ± 2.25 mm and 7.1 ± 1.45 mm respectively whereas the mean bipolar length, transverse diameter, parenchymal thickness, and cortical thickness for the male left kidneys were 102.0 ± 8.14 mm, 41.4 ± 4.89 mm, 17.5 ± 2.38 mm and 8.3 ± 2.15 mm respectively. (Tab.2b) shows distribution of the subjects (both gender) anthropometric variables in relation to age. The total mean bipolar length , transverse diameter, parenchymal thickness, and cortical thickness of the right kidney obtained from this study were 99.71 ± 10.39 mm, 39.3 ± 5.0 mm, 16.29 ± 10.00 mm and 7.19 ± 10.0 mm respectively whereas the total mean bipolar length, transverse diameter, parenchymal thickness, and cortical thickness for the left kidneys were 101.08 ± 9.0 mm, 41.85 ± 5.0 mm, 17.94 ± 7.00 mm and 7.39 ± 3.00 mm respectively.

(Tab. 3) shows the mean bipolar length,transverse diameter, parenchymal thickness, and cortical thickness of the female right kidney obtained from this study were 100.87 ± 9.9 mm, 39.47 ± 6.6 mm, 16.69 ± 3.9 mm and 7.27 ± 2.4 mm respectively whereas the mean bipolar length, transverse diameter, parenchymal thickness, andcortical thickness for the female left kidneys were 100.39 ± 6.4 mm, 42.28 ± 5.6 mm, 18.36 ± 5.6 mm and 6.53 ± 2.8 mm respectively

The mean values of the measurement revealed larger left kidney in females than in males as 100.87 ± 9.9 mm against 98.5 ± 8.93 mm, ($p<0.05$) in RBL, 16.96 ± 3.9 mm against 15.6 ± 2.25 mm in RPT, 7.27 ± 2.4 mm against 7.1 ± 1.45 mm in RCT and 39.47 ± 6.6

mm against 39.3 ± 4.46 mm. Also, the mean value of left kidney in LTD and LPT in female are larger than in males as 42.28 ± 5.6 mm against 41.4 ± 4.89 mm and 18.36 ± 5.6 mm against 18.5 ± 3.6 mm against 17.5 ± 2.38 mm ($p<0.05$). However, the mean values of left Kidney in LBL and LCT were found to be significantly larger in males than in females as 102 ± 10.14 mm against 100.39 ± 6.4 mm and 8.3 ± 2.15 mm against 6.53 ± 2.8 mm respectively ($p<0.05$).

(Tab. 4 and 5) shows the participants BMI and average anthropometrics variable, and relationship between age, weight, height, BMI and sex with anthropometrics

Age Group	RBL	RTD	RPT	RCT	LBL	LTD	LPT	LCT
	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)
<=20	83.00±0.00	33.00±0.00	13.00±0.00	5.00±0.00	101.00±0.00	51.00±0.00	20.00±0.00	11.00±0.00
21-24	83.00±0.00	33.00±0.00	13.00±0.00	5.00±0.00	101.00±0.00	51.00±0.00	20.00±0.00	11.00±0.00
25-29	103.00±0.00	42.00±0.00	16.00±0.00	8.00±0.00	115.00±0.00	43.00±0.00	17.00±0.00	10.00±0.00
30-34	97.00±6.06	39.00±1.01	14.50±1.51	7.00±1.01	111.50±6.56	45.00±2.02	16.50±1.51	9.00±3.03
35-39	100.78±7.89	39.56±6.24	16.96±2.46	7.65±1.90	96.42±5.33	36.70±2.06	17.00±0.00	7.69±1.71
40-44	94.56±4.62	39.26±3.72	14.44±1.53	6.93±1.07	93.30±1.1	41.37±3.56	20.48±1.50	7.63±0.84
45-49	113.00±0.00	42.00±0.00	18.00±0.00	7.00±0.00	104.00±0.00	38.00±0.00	13.00±0.00	6.00±0.00
50+	94.89±4.04	39.81±3.86	14.70±1.84	7.07±1.07	92.89±1.02	40.74±3.29	20.37±1.64	7.44±0.58
Total	**98.5±8.98**	**39.3±4.46**	**15.6±2.25**	**7.1±1.45**	**102±8.14**	**41.4±4.89**	**17.5±2.38**	**8.3±2.15**

Table 2a: Distribution of males anthropometrics variable in relation to age

Age Group	RBL	RTD	RPT	RCT	LBL	LTD	LPT	LCT
	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)	Mean±SD (mm)
<=20	94.00±1.65	35.54±3.43	15.85±3.05	6.92±2.02	102.31±2.95	49.69±2.95	22.15±4.28	11.54±1.94
21-24	94.20±1.05	35.54±3.46	15.89±2.88	6.80±1.98	101.46±3.80	49.33±3.80	21.78±4.33	10.93±2.79
25-29	103.00±0.39	41.28±4.84	16.66±3.17	7.63±1.80	104.25±4.13	41.59±4.13	17.78±3.83	7.47±2.61
30-34	100.36±6.02	41.31±0.29	17.56±4.99	8.12±2.44	104.24±4.40	42.78±4.40	18.61±4.99	7.92±2.30
35-39	96.60±9.07	39.63±4.74	16.10±2.32	7.06±2.09	97.50±5.01	38.84±5.01	17.70±3.33	6.41±2.66
40-44	97.31±7.85	34.39±0.28	14.25±1.11	6.39±0.19	101.07±4.38	42.24±4.38	16.90±4.04	6.56±1.19
45-49	108.94±0.00	40.90±1.17	16.39±1.89	6.27±0.96	105.57±3.81	40.25±3.81	12.88±0.33	6.16±0.92
50+	103.46±12.49	40.90±3.47	16.17±2.54	7.05±0.86	92.93±2.68	40.49±2.68	19.22±2.09	6.61±1.26
Total	**99.71±10.39**	**39.39±5.00**	**16.29±10.00**	**7.19±10.00**	**101.08±9.0**	**41.85±5.00**	**17.94±7.00**	**7.39±3.00**

R= right. L= left. PT=parenchymal thickness. CT=cortical thickness. TD=transverse diameter. BPL= bipolar length. BMI= body mass index

Table 2b: Distribution of female subject anthropometric variables in relation to age

Age Group	RBL	RTD	RPT	RCT	LBL	LTD	LPT	LCT
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
<=20	103.43±1.51	37.71±3.40	18.29±1.89	8.57±1.13	103.43±3.78	48.57±3.78	24.00±5.29	12.00±2.65
21-24	102.07±4.35	37.33±3.56	17.93±1.98	8.07±1.66	101.78±3.79	48.15±4.63	23.04±5.33	10.89±3.67
25-29	103.00±13.56	40.79±6.27	17.11±4.08	7.37±2.31	96.89±4.55	40.63±5.17	18.32±4.92	5.74±2.00
30-34	103.00±4.51	43.12±9.34	19.97±5.44	9.00±2.85	98.52±2.68	41.03±4.96	20.27±6.05	7.06±0.82
35-39	91.56±7.79	39.72±1.71	15.06±1.63	6.34±2.10	98.81±5.37	41.4±6.201	18.53±4.83	4.88±2.80
40-44	99.63±2.12	30.28±1.59	14.09±0.53	5.94±0.35	107.63±6.29	42.97±4.90	13.88±2.83	5.66±0.48
45-49	104.72±9.59	39.76±0.44	14.72±1.31	5.52±0.87	107.20±8.72	42.60±4.36	12.76±6.32	6.32±1.31
50+	120.00±0.00	43.00±0.00	19.00±0.00	7.00±0.00	93.00±0.00	40.00±0.00	17.00±0.00	5.00±0.00
Total	**100.87±9.9**	**39.47±6.6**	**16.96±3.9**	**7.27±2.4**	**100.39±6.4**	**42.28±5.6**	**18.36±5.6**	**6.53±2.8**

R= right. L= left. PT=parenchymal thickness. CT=cortical thickness. TD=transverse diameter. BPL= bipolar length. BMI= body mass index

Table 3: Distribution of females anthropometric variables in relation to age

BMI (Kg/m²)	Male	Female	Total	RBL (mm)	RTD (mm)	RPT (mm)	RCT (mm)	LBL (mm)	LTD (mm)	LPT (mm)	LCT (mm)
	n(%)	n(%)	n(%)	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
<=18.50	18(3.3)	26(4.8)	44(8.2)	102.73±6.9	33.27±3.98	14.05±2.49	7.82±0.99	98.86±2.49	36.05±3.48	14.05±2.49	7.64±1.99
18.51-24.50	138(25)	152(28.5)	29(54.1)	100.02±8.5	41.3±5.59	17.2±3.23	7.63±2.41	99.3±6.89	41±4.8	18.5±4.39	6.63±2.84
25+	104(19)	95(17.8)	199(37.3)	98.60±11.0	38±4.58	15.4±3.06	6.39±0.87	104.2±10.2	44.4±4.92	18±4.14	8.45±2.08
Total	**260(48)**	**273(51.2)**	**533(100)**	**99.71±12**	**39.39±13**	**16.29±15.00**	**7.19±13.0**	**101.1±18**	**41.85±11.00**	**17.94±27**	**7.39±13.0**

Table 4: Participants BMI and average anthropometrics variable

Subject	Age		Weight		Height		BMI		Sex	
	R-Value	P-Value	R-Value	P-Value	R-Value	P-Value	R-Value	P-Value	R-Value	P-Value
RBL	0.668	0.007	0.645	0.004	-0.205	0.006	0.555	0.015	-0.061	0.008
RTD	0.41	0.031	0.008	0.009	0.053	0.009	-0.005	0.001	0.26	0.003
LBL	-0.431	0.028	0.171	0.006	-0.571	0.013	0.353	0.003	-0.141	0.007
LTD	-0.684	0.006	-0.233	0.005	0.002	0.009	-0.143	0.007	0.793	0.019

Table 5: Relationship between age, weight, height, BMI and sex with anthropometrics variables

variables respectively.

(Tab. 4) shows that the right BL according to BMI of < 18.50, 18.51- 24.50 and >25 kg/m^2 were 102.73 ± 6.9 mm, 100.02 ± 8.5 mm and 98.60 ± 11.0 mm while that of the left BL were 98.86 ± 2.49 mm, 99.3 ± 6.89 mm and 104.2 ± 10.2 mm for BMI of< 18.50, 18.51- 24.50 and >25 kg/m^2 respectively.

(Tab. 5) shows that there is a weak positive correlation (P<0.05) between right kidney with age, anthropometric parameters and strong negative correlation with sex (P<0.05). However, the Left kidney Shows strong negative correlation (P<0.05) with age, anthropometric variables and sex (P<0.05).

(Tab. 6) shows comparison of this present study with other related study done in other countries The values are as follows; right and left renal length in Pakistan, 100.32 mm and 100 mm for male and 100.1 mm and 100.1 mm for female. Australia right and left; 110.0mm and 110.49 mm for male and 110.38 mm and 100.63 mm for females respectively. Those of Iran for right and left dimensions were 106.3 mm and 106.9 mm for male and female subjects. This present study presented 98.5 mm and 102.0 mm for male right and left respectively while that of female were 100.8 mm and 100.3 mm respectively.

Author	Population	Location	Renal	Length	(mm)	parenchyma	Thickness	(mm)
			Male	Female	All	Male	Female	All
Raza et al., 2015[14]	Pakistan	Right	100.32	100.0	100.17	9.00	13.8	11.0
		Left	100.46	100.0	100.23	15.8	14.5	13.8
Glodyn et al., 2009[23]	Austria	Right	110.2	110.38	100.85	16.3	14.5	15.4
		Left	110.49	100.63	110.13	16.5	15.0	15.8
Jabbari et al., 2016[19]	Iran	Right	106.35	104.27	104.96	17.08	16.87	16.94
		Left	106.9	105.88	106.22	18.11	18.27	18.22
Dlama et al., 2017	Nigeria	Right	98.5	100.8	100.3	15.6	16.9	16.00
(Present study)	(Bauchi)	Left	102.5	100.3	100.1	17.5	18.36	17.8

Table 6: Comparism of renal length and parenchyma thickness from different population

Discussion

Renal size was conventionally determined on urography by measuring the renal length. In addition, measurements made by computed tomography, magnetic resonance imaging or angiograms can be used interchangeably with those made by renal ultrasound.[3] Renal ultrasound has been used in the evaluation of the normal growth and development of abdominal viscera even in fetal life.[2,3,5] Ultrasonography is one of the most common imaging methods used in the routine practice for visualizing the normal anatomy and is also simple and reliable to visualize pathological changes in the abdominal organs.

The mean bipolar length and transverse diameter of the right kidney in the present study was 99.71 ± 10.39 mm and 39.39 ± 5.00 mm while that of the Left kidney was 101.08 ± 9.0 mm and 41.85 ± 5.00 mm. Similar findings were reported by other studies in northwestern Nigeria, their values were 103.0 ± 8.8 mm; 44.0 ± 7.1 mm for the right kidney and 116 ± 9.8 mm; 52.0 ± 5.26 mm for the left kidney.[3] Another study in Abuja north central Nigeria,[1] reported a mean value of 10.1 ± 0.8 cm; 4.1 ± 0.6 cm for the right kidney and 10.7 ± 60 cm; 4.7 ± 0.8 cm for the left kidney. Udoaka et al., 2013[16] found 10.02 ± 0.97 cm; 5.12 ± 0.68 cm for the right kidney and 10.31 ± 1.10 cm; 5.04 ± 0.63cm for the left kidney in southern Nigeria, Also Okoye et al., 2005,[17] reported a mean value of 10.4 cm and 10.6 cm BL for right and left kidneys respectively. The similarity in the reported values may be attributed to the adoption of similar methodology by these researchers. Measurements were done supine using transabdominal method of similar probe frequency.

However, studies conducted in other countries also reported similar findings for renal dimension for normal adult subjects for bipolar and transverse lenghts. Jeffri et al in manila,[5] Philippines reported a mean value of 103.8 mm, 53.0 mm for the left kidney and the right kidney has mean measurements of 103.2 mm, 51.5 mm, Carrasco et al., among Mexicans 104.3 ± 6.5 mm for the right kidney and 105.8 ± 7.5 mm for the left kidney.[18] Another study among Jamaicans 97 ± 7 mm for the right kidney and 100 ± 7 mm for the left kidney,[12] Jabbari et al., 2016[19] in Hamadan, Iran found right and left renal length to be 104.96 ± 6.6 mm and 106.22 ± 6.16 mm respectively. In another study in 2014 they found 106.8 ± 14 mm and 107.1 ± 10 mm renal length for right and left kidneys respectively.[20] The similarity in the reported values shows that the measurement of renal morphometrics can easily be reproducible in the hand of a qualified sonographer/sonologist with good clinical skills and working environment.

The mean parenchymal thickness (PT) and cortical thickness (CT) of the right and left kidneys were 16.29 ± 10.00 mm; 7.19 ± 10.00 mm and 17.94 ± 7.00 mm; 7.39 ± 3.00 mm respectively. This is in agreement with the work of Kolade et al., 2017 who reported PT and CT to be 15.2 ± 3.6 mm; 7.2 ± 2.7 mm and 16.8 ± 4.1 mm; 7.7 ± 2.6 mm, The mean renal morphometrics of the left kidney is larger than the right kidney with respect to age and sex. This corroborates with several studies done in Nigeria.[1,3,16,19] This may be due to the anatomical position and size of the liver on the right hypochondriac region which may exert pressure and hence may not allow proportionate growth of the right kidney than that attained by the left kidney because of the smaller size of the spleen in the left hypochondriac region. Moreover, the increased blood flow in the left renal artery may result in relatively increased in size of the kidney, due to the fact the left renal artery is shorter and less tortuous than the right renal artery.

The mean right and left renal sizes of males were compared to the mean right and left renal size of the females. The present study observed females have larger mean right and left renal sizes and their males counterparts. However, this was not statistically significant. This finding was consistent with a study in Pakistan,[21] but contrary to other studies.[1,3,17]

Also the present study noted a steady decrease in renal morphometrics with age. This may be as a result of the changes in physiologic and anatomical structure of the human body with age. It is established that by 70 years, as much as 30-50% of cortical glomeruli undergo atrophy; manifested by loss in renal mass.[3] However, renal dimensions remain essentially unchanged between the ages of 30 and 60 years, however, a significant reduction in size was observed in older age group. This is in consistent with this study which showed the renal morphometrics begins to decrease from the age group 50 and above.

The present study established a positive correlation

between Kidneys and BMI ($p<0.05$).This corroborates with other reported studies.[1,3,14,21] This is most likely due to the fact that the kidneys developmental growth is proportional to the whole body development most especially with height.

Limitations of the study

There was relatively small sample size of the participants, this was because some of the patients did not consent and data was obtained during diagnostic examination for the patients that were referred to the department for renal ultrasound scan. We hope that further studies will address the shortcomings in this study.

Conclusion

The study has provided normal renal dimension, parenchyma thickness and cortical thicknessfor our population in north eastern Nigeria. We observed similar values for other similar studies done in Nigerian. There was positive correlation between the kidneys and body mass index for all gender. This study showed that renal morphometric parameters correlate weakly with anthropometric parameters.

Recommendations

We recommend a multicenter study so that we can document normal renal dimensions for adequate comparison in the evaluation of renal diseases.

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