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SONOGRAPHIC ASSESSMENT OF RENAL LENGTH IN APPARENTLY HEALTHY STUDENTS OF COLLEGE OF HEALTH SCIENCES, BAYERO UNIVERSITY, KANO

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ABSTRACT
In persons with normal renal function, renal length has been found to be the most important marker for assessing renal function. Ultrasound is readily available, non-invasive and provides a direct and easy method of determining renal length. The aim of this study is to determine the range of normal renal measurements among the students of College of Health Sciences, BUK. Renal lengths of apparently healthy volunteered students were measured using Mindray DP-7700 digital ultrasound scanner with a 3.5MHz curvilinear transducer. Maximum bipolar length for each kidney was measured with participants in supine position. Differences between renal length with age and gender was assessed while its relationship with BMI were assessed statistically for right and left kidneys. A total of 201 consenting participants were recruited into the study. Average mean bipolar length among the student's was established to be 9.28±0.94cm and 9.42±1.02cm for the right and left kidneys respectively. Mean renal length in males was found to be 9.51 ± 1.11cm for the left and 9.47 ± 0.93cm for the right which are slightly higher than those of the females 9.29 ± 0.87cm for the left and 9.07 ± 0.91cm for the right. The left kidneys were longer than the right kidneys. The mean renal length did not correlate with age and BMI. Nomogram of renal dimension among students of BUK were established. This will form basis for renal diagnosis especially for health Institutions like the BUK health services.
KEY WORDS: Normal students, Renal length, Ultrasonography.

INTRODUCTION

Ultrasound imaging (USG) also known as ultrasound scanning or sonography is a simple, readily accessible and non-invasive method that remains the most commonly used imaging procedure to assess abdominal viscera and their dimensions (Zira *et al.,* 2018). It offers exceptional anatomical details requiring no special patient preparation, and does not expose the patients to ionizing radiation. A number of imaging modalities such as conventional radiographs, intravenous urography (IVU), computed tomography (CT) and magnetic resonance imaging (MRI) have been used to assess renal size. The primary modality of choice are the MRI and CT, because they can acquire three-dimensional data and, therefore, do not rely on geometric postulation to estimate organ volume (Cheong *et al.,* 2007). Similarly, the use of Computed Tomography as a routine non-invasive method to estimate renal size is limited because of the unavoidable use of ionizing radiation and possible nephrotoxic effect of contrast media in contrast series of image acquisition. Conversely, MRI has the advantage of acquiring true tomographic data without restrictions of using ionizing radiation and the potential nephrotoxic burden (Cheong *et al*., 2007). Nonetheless, both of them (CT and MRI) are both expensive and not readily available as compared to USG.

In comparison with IVU for renal assessment, ultrasound is more accurate and is not affected by x-ray geometric magnification or possible increase in size by osmotic diuresis of contrast media (Myint *et al.*, 2016). Assessment of renal size plays a significant role in decision making especially in cases of renal biopsy, renal transplant or even avoiding immunosuppressive therapy (Ablett *et al.,* 1995). Renal size estimation can be achieved measuring renal length, renal volume, cortical thickness or volume (Emamian *et al.,*1995). Renal length and width are important clinical factors in the assessment of patients having numerous renal diseases (Yadav *et al.*, 2017; Oluseyi & Helen, 2017; Zira *et a.l,* 2017). The use of USG for this purpose has been reported with a high reliability (Carrasco *et al.,* 2009; Zira *et al.,* 2017).

The literature documents adult kidney dimensions (both sexes) as 12 cm long, 6 cm wide and 3 cm deep (Buchholz, 2000). Further review of the literature shows that renal size varies with age, gender, body mass index, pregnancy and co-morbid conditions (Buchholz, 2000). Renal dimensions depend on different factors, which include body build up, body mass index and gender (Zira *et al*., 2017). However, race has particular connotations, which directly determines all the previous variables (Buchholz, 2000). Change in renal size is a suggestive evidence of pathologic process, whose explanation requires specific parameters for the population to study. It is therefore necessary to have standard parameters in our population group. The aim of this study therefore is to determine the normal renal length in across apparently healthy students of college of health sciences, Aminu Kano Teaching Hospital (AKTH).

MATERIALS AND METHODS

The study was conducted in the Department of Medical Radiography, Bayero University, Kano (BUK), Nigeria from August to November, 2018. Participants were apparently healthy volunteer students of the College of Health Sciences, BUK who are situated in Aminu Kano teaching Hospital Campus. A cross sectional design was adopted and convenience sampling method was used to recruit participants. Volunteers with known history of renal pathology or surgery were excluded. Possible limitation was that participants were from a similar age category and may essentially be sharing the same life style as against the true heterogenous population of our society. Furthermore, variations in observers' skill and interpretation attributable to USG may also be a factor (Maaji *et al*., 2015).

A total of two hundred and one (201) students that satisfied the inclusion criteria were recruited into the study. Sonographic images of both Kidneys were obtained with participant in supine position and in arrested inspiration in accordance with the study of Zira *et al.,* (2017) and Eze *et al.,* (2016). To ensure maximum bipolar length measurement, renal length was measured only when renal hilum is visualized in the longitudinal plane. Scanning, image plane acquisition and measurement were conducted using a Mindray (DP-7700) digital ultrasound scanner with a 3.5MHz curvilinear transducer. Weight and height measurement were done using a calibrated stadiometer with model no: MPH07SP1W. Body Mass Index (BMI) was calculated using Quetelets formula given below:

$$BMI = \frac{Weight\ (kg)}{Height^2\ (m^2)}$$ (Salkind 2012)

Ethical clearance was obtained from the Health Research Ethics Committee of the College of Health Sciences, BUK. Data was processed and presented as mean and standard deviation following Kolmogorov Smirnoff test for normality. Pearson correlation test was used to check for significance between the renal length with age and BMI of participants. An independent t-test was used to check for gender differences in the kidneys. A p-value less than 0.05 was set as level of statistical significance

RESULTS

A total of 201 participants comprising of 116(57.7%) males and 85(42.3%) females with age range of 19-38 years were recruited into the study (table 1).

Table 1: Frequency distribution of participants.

Gender	Mean age ± SD (years)	Frequency	Percentage%
Male	23±3	116	57.7
Female	22±2	85	42.3
Total		201	100

Participants were grouped in age groups on a 5 years class interval and also based on gender. Age group of 20-24 years had the highest frequency of 134(66.6%), the least were those in age group of 35-40 years with a frequency of only 3(1.5%) participants table 2 .

Table 2: Frequency distribution of participants according to age and gender.

Age group	Frequency	Male	female	Percentage
15-19	12	6	6	6.0
20-24	134	71	63	66.6
25-29	46	31	15	22.9
30-34	6	6	-	3
35-40	3	2	1	1.5
Total	**201**	**116**	**85**	**100**

Mean bipolar length for the study was established to be 9.28±0.94cm and 9.42±1.02cm for the right and left kidneys respectively. Mean bipolar lengths based on gender were also estimated and presented in (table 3). To be 9.47±0.93cm and 9.51±1.11cm for the right and left kidneys in males respectively and 9.07±0.91cm and 9.29±0.87cm for the right and left kidneys in females respectively. The distribution of mean bipolar renal lengths based on gender and according to age categories is presented in table 3.

Table 3: Mean (SD) Renal Length Distribution according to Age Groups.

Age group (years)	Male		Female	
	Right RL(cm)	Left RL(cm)	Right RL(cm)	Left RL(cm)
15-20	10.82 ± 1.46	10.5 ± 1.17	9.74 ± 0.77	9.68 ± 0.63
20-24	9.83 ± 0.98	9.47 ± 1.11	9.06 ± 0.88	9.28 ± 0.90
24-29	9.38 ± 0.76	9.39 ± 0.91	8.81 ± 0.93	9.17 ± 0.80
30-34	9.57 ± 0.62	9.38 ± 1.25	-	-
35-40	9.18 ± 1.10	10.18 ± 0.88	10.6	9.21
Average	9.47 ± 0.93	9.51 ± 1.11	9.07 ± 0.91	9.29 ± 0.87

KEY: RL= Renal Length; SD: Standard Deviation.

Mean bipolar lengths were further estimated based on participants BMI and categorized into three namely: BMI of <18.5Kg/m^2, BMI of (18.6 - 24.5) Kg/m^2 and BMI of >24.5Kg/m^2as seen in table 4.

Table 4: Distribution of Mean Renal Lengths based on Participants BMI.

BMI (Kg/$m^{2)}$	Frequency	Right RL (cm)	Left RL (cm)
<18.5	39	9.09 ± 0.86	9.36 ± 0.92
18.6-24.5	143	9.40 ± 1.60	9.42 ± 0.95
>25.5	19	9.81 ± 1.29	9.54 ± 0.33
Total	**201**	**9.28**± 1.25	**9.42**± 0.73

KEY: RL= Renal Length

The relationship between estimated renal length with age and BMI was also explored using pearson's correlation. Surprisingly, no statistically significant relationship was established between the right and left renal lengths with both age or BMI (p>0.05) (table 5).

Table 5: Statistical Relationship Renal Length with their Age and BMI.

		RRL	LRL
Age	p-value	0.74	0.88
	r-value	-0.024	0.01
BMI	p-value	0.78	0.14
	r-value	0.02	0.11

KEY: RRL: Right Renal Length; LRL: Left Renal Length. p-value< 0.05

Statistical differences between renal length among gender was also assessed. Statistically significant difference was established between the male and female right renal length (p<0.05), while no statistical difference was established between the male and female left renal length (p>0.05) as seen in table 6.

Table 6: Mean renal length according to gender

	Male	F**emale**	**p-value**	**T**	**df**
Right kidney	9.47 ± 0.93	9.07 ± 0.91	0.009	2.67	199
Left kidney	9.51 ± 1.11	9.29 ± 0.87	0.127	1.53	199

$p<0.05$

DISCUSSION

Renal size has been reported as a good marker of renal function and renal length is one factor that assesses the state of renal function (Srivastava *et al.*, 2016). Renal assessment using USG remains a modality of choice due of its availability, non-use of ionizing radiation, non-invasiveness and its's accessibility makes it a stand-alone independent modality by most clinicians and clients (Maaji, *et al.,* 2015). The literature states that normal renal length varies from 9-12cm across different populations (Purohit *et al*., 2017). The estimated mean renal length in the present study was found to be 9.28±0.94cm and 9.42±1.02cm for the right and left kidneys respectively. This is similar with most studies conducted across Nigeria and even across the world. A study conducted in a North-eastern Nigerian population by Zira *et al.,* in 2017 reported a mean renal length of 99.71 ±10.39mm and 101.08±9.0mm for the right and left kidneys respectively. In North-central Nigeria, Kolade *et al.,* in 2017 reported a renal length of 10.1±0.8cm and 10.7±6.0cm for the right and left kidneys respectively. Accordingly, in a North-western Nigerian population, Maaji *et al.,* in 2015 reported 103mm±8.8mm and 116±9.8mm renal lengths for the right and left kidneys respectively. Furthermore, a number of similar studies conducted in Southern Nigeria agrees with our findings. For instance, in South-eastern Nigerian population, Okeye *et al.,* in 2005 and Udoaka *et al.,* in 2013 conducted similar independent studies and reported mean renal lengths of (10.4cm and 10.6cm) and (10.02cm and 10.31cm) for the right and left kidneys respectively. Similarly, in the present study and all the studies sighted above, the left kidney was larger across all the studies despite both geographical and even racial differences. Similar reported ranges of renal length from different populations across the world also showed agreement with these findings. Emanian *et al*., in 1993 in Denmark reported a mean right and left renal length of 106.8mm and 107.1mm respectively. Carrasco *et al*., in 2009 in a Mexican population reported a mean renal length of 104.3mm and 105.8mm for the right and left kidneys respectively. Jeffri and Adbulla in 2010 in Phillipines reported 103.2mm and 103.8mm for the right and left kidneys respectively. In a Jamaican population, Tuma *et al*., in 2010 reported a mean renal length of 97mm and 100mm for the right and left kidneys respectively. Similarly, Jabbari *et al.,* in 2016 also reported a mean renal length of 104mm and 106mm for the right and left kidneys respectively. Saeed *et al.,* in 2012 in Pakistan reported mean renal length dimension of 9.74cm and 9.95cm for the right and left kidneys respectively. In Indian population, Srivastava *et al*., 2016 and Purohit *et al.,* in 2017 reported mean right and left renal lengths of (9.53±0.84cm and 9.92±0.97cm) and (9.44±1.18cm and 9.74±0.12cm) respectively. These similarities across studies in different regions (both locally and international) could be directly related to the methodology employed by the researchers. A standard protocol template of imaging the kidneys in supine position was employed across all the studies, thus limiting the potential of variability attributable to USG. However, despite the values across all sighted studies falling within the range of established by Purohit *et al*., in 2017, the marginal variation may be related to several factors. Renal morphology has been reported to be influenced by several factors such as age, ethnicity, gender, weight and height (Srivastava *et al*., 2016). Environmental, genetic and nutritional factors can also affect renal length (Oluseyi & Helen, 2017). Thus, it is easy to relate the marginal variation of reported values to this factor which are dependent on geographical and racial attributes.

The present study estimated the mean right and left renal lengths in males to be 9.47±0.93cm and 9.51±1.11cm and females to be 9.07±0.91cm and 9.29±0.87cm respectively. This shows males have slightly longer renal length than their female counterparts. This is consistent with similar works across different geographical locations and tribes. For example Buchholz *et al*., in 2000 and Carrasco *et al.,* in 2009 reported similar findings among Karachi and Mexican populations respectively. However, it is in contrast with the findings of El-reshaid & Abdul-fattah in 2014 were they stated there is no difference in renal length between males and females in Kuwait population.

A possible explanation to this is that gender differences in renal length can be accounted for by the disparity in body size, as height and weight are independent predictors of renal length (Saeed *et al.,* 2012). Since slight disparities exist across different regions, body habitus may be a factor.

Furthermore, in the present study, the left kidneys were found to be longer than the right kidneys in both sexes. This is in accordance with the works of Okeke *et al*., in 2016 in Port-harcout, Nigeria, Elsayed, in 2012 in Saudi Arabia and Saeed *et al.,* in 2012 in Pakistan. Reason for this might possibly be due to the presence of liver on the right side being the second largest organ in the body and indenting its weight heavily on the right kidney thereby limiting its potential for normal unrestricted growth (Zira *et al.,* 2017). Furthermore, the shorter renal artery in the left, may allow more nutrient to the left kidney than right artery (Bergman 2018).

Similarly, the present study could not establish any statistically significant difference in the left kidneys among gender. However, statistically significant difference exists in the right kidneys among gender. Reason for this is not yet established by the researcher as at the time of preparing this work. Furthermore, correlation between renal length with age was not established in the present study. Similar studies have reported conflicting findings on this fact. For example, in 2016, Srivastava *et al.*, carried a similar study among Indian population and reported no correlation between renal length with age. However, in 2017, Yadav *et al.*, in Nepal reported that there is an increase in renal length with age. In 2012, Saeed *et al* in Pakistan reported a finding conflicting with the present study. They reported that a strong relationship exists between renal length and age. An explanation to this relationship could be as a result of the distribution of the participants in the present study. A significant proportion of about 66% comes from a single age category (20-24) years. The skewed distribution may obviously affect the relationship of renal length with age in the present study since they fall in the lower age category.

Similarly, renal length did not show a significant correlation with BMI. This is contrary to the findings of El-reshaid and Abdul-fattah in 2014 among Kuwaiti population, Carrasco *et al.,* in 2009 among Mexican population and Yadav *et al.*, in 2017 among Indian population where they all reported a significant positive correlation between renal length and BMI. Again, the higher proportion of participants of about 71% falling within a particular BMI category could account for the finding in the present study.

CONCLUSION

Mean renal length for the right and left kidneys was found to be 9.28cm and 9.42cm respectively. Left kidneys were consistently larger than the right kidneys among both sexes. Males had slightly longer renal length than their female counterparts among each symmetrical side. Age, gender and BMI of participants were taken into consideration. No statistically significant difference exists in the left kidney among gender, however, differences was established in the right kidney among gender. No correlation was established between renal Length with age & BMI perhaps due to the nature participants distribution falling into a particular age category. Nonetheless, a nomogram has been drawn for reference especially by the Bayero University Health Services.

RECOMMENDATION

We recommend a study with larger sample size and incorporate post-graduate students so as to have even distribution of participants especially across age groups. This is further confirm whether age and gender have specific relationship with renal length.

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Conflict of Interest

We hereby declare there was no conflict of interest in the entirety of this work.

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