Ultrasound evaluation of renal length of healthy adults in University of Port Harcourt Teaching Hospital, Nigeria

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ABSTRACT

Context: Renal length which can be determined with ultrasonography is a reliable singular renal dimension for the assessment of the kidney size both in normal and pathologic conditions. **Aim:** This study aimed at determining renal size by evaluating length in healthy adult Nigerians in the University of Port Harcourt Teaching Hospital. It also aimed to correlate the renal length with age, sex and weight of this group and determine the variation in size in both kidneys. **Materials and Methods:** This study was carried out at the Radiology Department of University of Port Harcourt Teaching Hospital. Four hundred healthy adults comprising of two hundred and eighty four females (71%) and one hundred and sixteen males (29%) who fulfilled the inclusion criteria were recruited into the study. Biodata was obtained and the length of the kidneys was measured using real time gray scale ultrasound scanning via the transabdominal route. **Data Anaysis:** Data obtained was analysed using Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc. Chicago IL, USA). **Results:** The mean renal length in males (10.6cm) was slightly higher than in females (10.5cm). The left kidney (10.8cm) was longer than the right kidney (10.4cm) in both sexes. There was a positive correlation between the mean length of both kidneys and body weight, but no correlation between the mean length of the kidneys and the age of subjects. A decline of renal length after the age of sixty years was seen. **Conclusion:** Normal values for length and variations in size of the kidneys in healthy adults in south-south Nigeria have been established.

Key words: Nigerians, renal length, renal size, ultrasonography

INTRODUCTION

Ultrasound has been described as an important imaging modality for renal tract in adults.[1] It has been reported to be simple, cheap, safe, well tolerated, easily reproducible, noninvasive,[1-3] and provided excellent visualization of the kidneys intrarenal collecting systems. It has also been shown to be able to detect gross pathology and to differentiate between cystic and solid structures.[4]

Kidney dimensions such as renal length and width, cortical thickness, and anteroposterior diameter of the renal parenchyma can be achieved using ultrasound. Ultrasonography also been shown to demonstrate abnormal kidney pathology such as the existence and composition of kidney masses, cystic structures and normal renal texture disruption, outline, alignment, and position.[5]

Andersen (1985) reported that kidney size is influenced by height, weight, body mass index, and disease conditions such as renal failure, tumors, amyloidosis, polycystic kidney disease, and multiple myeloma.[6] Similar studies reported renal length as one of the parameters assessed and has been advocated as the reliable singular renal dimension

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for the assessment of the kidney size both in normal and pathologic conditions.[7-9] Renal dimensions also have been demonstrated to be a highly imperative clinical practice in the evaluation of healthy donors.[6]

Brandt *et al*.[10] in a study titled "Ultrasound assessment of normal renal dimensions," showed that sonographic assessment of renal dimensions was found to be more accurate and reliable and that the bipolar length of both kidneys was longer in prone position than in supine position due to poor visualization of kidneys in supine position.[10]

Jones *et al*.[11] in a study of renal size using ultrasound in 45 patients showed that the determination of the renal size using the ellipsoid method which is based on the multiplication of the length, width, thickness of the kidney (in cm) by 0.5 was accurate for clinical purposes and was related to both renal mass volume and surface area. They also showed that renal mass can be obtained from renal size expressed in grams.[11]

Other comparisons have been made regarding renal sizes using other modalities. Moskowitz *et al*.[12] determined renal length and size using ultrasound and manual planimetry and established that sonographic renal size had better correlation with urographic renal lengths (r = 0.089). Lewis and Ritchie[8] also established a correlation between sonographic and urographic renal lengths by showing urographic renal length to be equal to sonographic length multiplied by 1.33.

Literatures have reported studies on renal dimensions in normal adults determined sonologically in other parts of the world,[13-15] but most existing sonological reports are still based purely on studies done among Caucasian populations.[11,12] Renal size variation has also been shown to be dependent on races and disease condition. However, it becomes imperative for a standard range of values for size of kidney in a healthy adult be established in our environment. This study therefore is aimed determining renal size by evaluating length in healthy adults in the University of Port Harcourt Teaching Hospital. It will further correlate the relationship between renal length, age, sex, and weight of this group and determine the variation in size, between the left and the right kidneys.

MATERIALS AND METHODS

This prospective study carried out in Radiology Department of University of Port Harcourt Teaching Hospital involved a total number of 400 healthy adults for over a 6 months period, August 2009–January 2010. Real-time gray-scale ultrasound examination using Prosound 3500 Aloka (ALOKA Inc. Japan, 2004) machine and a 3.5–5 MHz curvilinear probe were used for the abdominal imaging.

Adult male and female between the ages of 18 and above and had no history of renal disease were included in this study, whereas healthy adults who were not citizens of Nigeria, patients with renal hypertension or pathology were excluded from this study.

The age, sex, weight, and the blood pressure of the subject were obtained prior to the ultrasound examination. Real-time gray-scale scanning was processed using standard ultrasonographic techniques.[16] The kidneys were then measured in a perpendicular plane to obtain their length in both supine and prone positions. The longest distance between the superior and inferior renal poles (the length) was measured [Figure 1]. Data obtained were analyzed using Statistical Package for Social Sciences (SPSS) version 17.0 (SPSS Inc. Chicago IL, USA) was used to analyze the data.

RESULTS

A total of 400 adults with age ranging between 20 to 69 (with mean age of 31.6 ± 10.6 years) comprising 116 males (28%) and 284 females (72%) were studied. Sonographic length for 800 kidneys and the weight of these subjects were obtained and analyzed.

Table 1 is the biodata of the studied population showing age distributed according to sex. More than half of the study population in this study were aged between 20 and 29 years in both sexes, whereas very few subjects were 60 years and above with females constituting the highest population of the sample size. The mean age of subjects was 30.9 years for the males and 32.1 years for the females.

The chart [Figure 2] shows a steady reduction in the number of participants with increasing age in both sexes. Figure 2 also shows that most of the participants were young adults between the ages of 20 and 29 years in both sexes and that the majority of the participants were females.

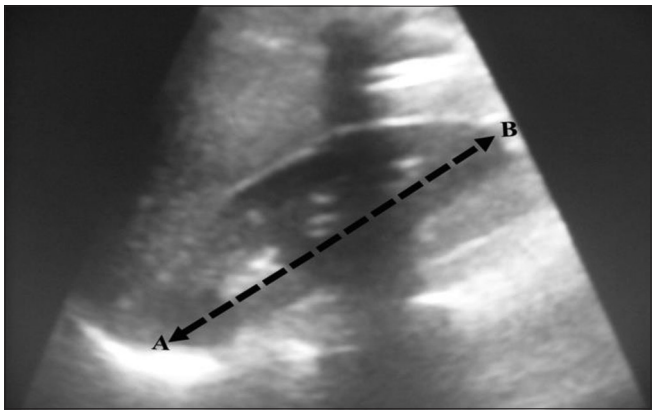

Figure 1: Longitudinal ultrasound scan of the right kidney showing measurement of its length (AB)

Tables 2 and 3 represent age group plotted against the mean renal length of male and female subjects.

The mean length of the left kidney showed a steady increase with increasing age of the subjects up to the age of 59 years after which a sharp drop was noted in male subjects. In the female subjects, the mean length of the left kidney increased initially, then decreased and increased again before finally decreasing with increasing age.

The mean length of the right kidney in male subjects showed a similar distribution as that of the left kidney in the female subjects with increasing age. The mean length of the right kidney increased with age up to the age of 49 years after which it dropped with increase in age.

Figure 3 shows a steady increase in length of the right kidney, which ended with a sharp reduction in size after the age of 59 years. The left kidney showed an initial increase in the length, which was followed by a reduction and another increase before the final drop after the age of 59 years in male subjects.

In Figure 4, the length of the left kidney in female subjects showed a steady increase, which was followed by a gradual decrease. The right kidney however displayed a similar distribution of length to that seen in left kidney in male subjects (above).

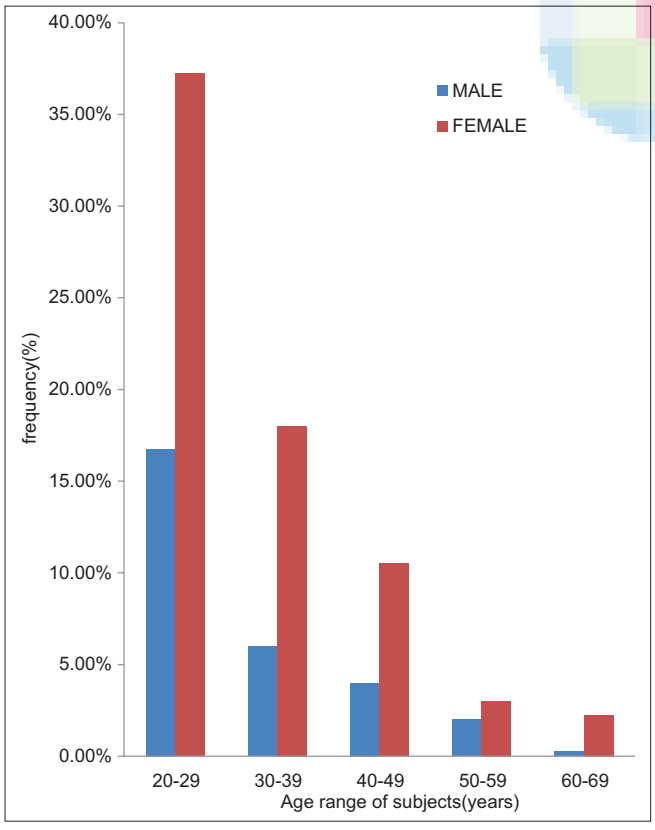

Figure 2: Bar chart showing percentage distribution of age groups (in years) among the subjects (n = 400) in both sexes

The Pearson correlation coefficients of Figures 3 and 4 between the subjects age and kidney length were r = 0.105 for the right kidney and r = 0.127 for the left kidney (P < 0.01) in males and r = 0.042 for the right kidney and r = 0.061 for the left kidney (P < 0.01) in females. These values are not statistically significant, hence no correlation was found between age and mean length of both kidneys in both sexes.

Tables 4 and 5 represent the weight of subjects plotted against the mean renal length of male and female subjects. There was a steady increase in the mean length of both kidneys with increase in the weight in both sexes. However, a pronounced disproportionate increase in length of the left kidney was noted among female subjects who weighed between 60 and 79 kg. None of the female participants weighed <40 kg, and none of the males who participated in this study weighed more than 99 kg.

Figure 5 shows a steady increase in the mean renal length with increasing body weight of male subjects. The mean

Table 1: General data of studied population showing distribution pattern of age and sex

Age (years)	Male (%)	Female (%)
20-29	16.75	37.25
30-39	6.0	18.0
40-49	4.0	10.5
50-59	2.0	3.0
60-69	0.25	2.25

n=400; 116 males and 284 females

Table 2: Renal length (mean and standard deviation) distributed according to age in male subjects

Age (years)	Mean right renal length (±SD) cm	Mean left renal length (±SD) cm
20-29	10.25±0.88	10.56±1.53
30-39	10.47±1.33	11.00±1.33
40-49	10.58±0.92	10.71±1.08
50-59	10.61±0.84	10.78±0.94
60-69	9.50±0.00	9.60±0.00

n=116. SD: Standard deviation

Table 3: Renal length (mean and standard deviation) distributed according to age in female subjects

Age (years)	Mean right renal length (±SD) cm	Mean left renal length (±SD) cm
20-29	10.10±0.70	10.45±0.79
30-39	10.49±0.82	10.76±0.78
40-49	10.22±0.78	12.76±14.29
50-59	10.66±0.60	10.75±1.16
60-69	9.30±0.70	10.39±0.85

n=284. SD: Standard deviation

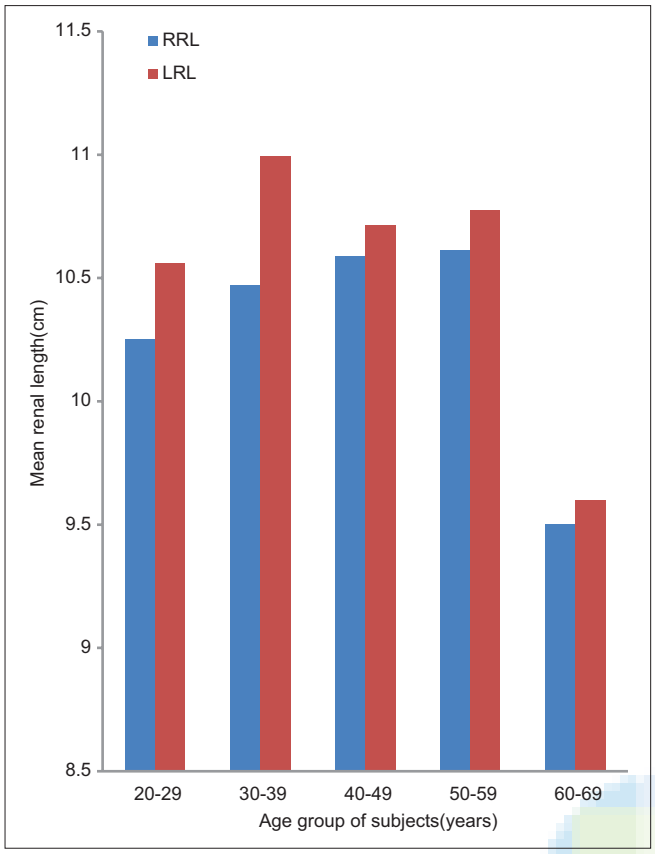

Figure 3: Bar chart showing the distribution of renal lengths (in centimeters) with increasing age (in years) in male subjects

Table 4: Renal length (mean and standard deviation) distributed according to weight in male subjects

Weight (kg)	Mean right renal length (±SD) cm	Mean left renal length (±SD) cm
20-39	09.50±0.00	09.60±0.00
40-59	10.00±0.96	10.00±0.55
60-79	0.20±0.86	10.70±0.99
80-99	11.50±0.89	11.50±1.15
100-119	0.00±0.00	0.00±0.00

n=116. SD: Standard deviation

Table 5: Renal length (mean and standard deviation) distributed according to weight in female subjects

Weight (kg)	Mean right renal length (±SD) cm	Mean left renal length (±SD) cm
20-39	00.00±0.00	00.00±0.00
40-59	09.83±0.80	10.14±0.88
60-79	10.27±0.67	11.29±7.79
80-99	10.46±0.84	10.73±0.80
100-119	10.78±0.49	10.98±0.73

n=284. SD: Standard deviation

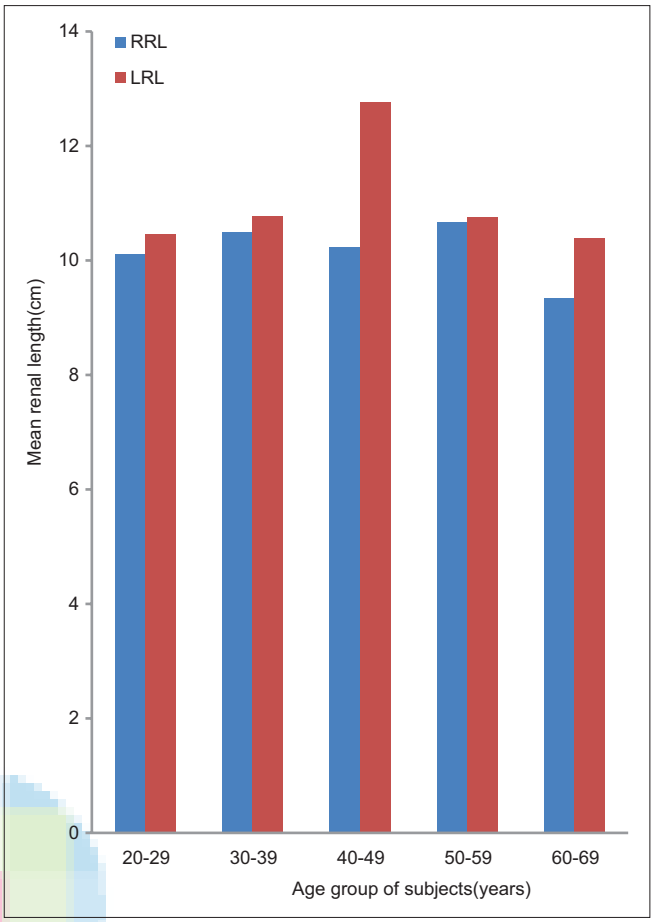

Figure 4: Bar chart showing the distribution of renal lengths (in centimeters) with increasing age (in years) in females

length of the right and left kidneys was the same in subjects weighing between 40 and 59 kg. No male participant with more than 99 kg was recorded.

Figure 6 also showed a steady increase in the mean length of both kidneys with increasing body weight of female participants. An eye-catching increase in length of the left kidney among the female subjects with body weights ranging between 60 and 79 kg. The above chart also showed that all the female participants weighed 40 kg and above.

The Pearson correlation coefficients of Figure 5 between the subjects weight and kidney length were $r = 0.495$ for the right kidney and $r = 0.422$ for the left kidney ($P < 0.01$) in males. These are statistically significant findings. Hence, the weight of male subjects correlated strongly and positively with the mean renal length. In females, the Pearson coefficient of Figure 6 between subjects weight and renal length were $r = 0.347$ for the right kidney and $r = 0.047$ for the left kidney ($P < 0.01$). These statistical findings are of mixed significance. The weight of the female subjects

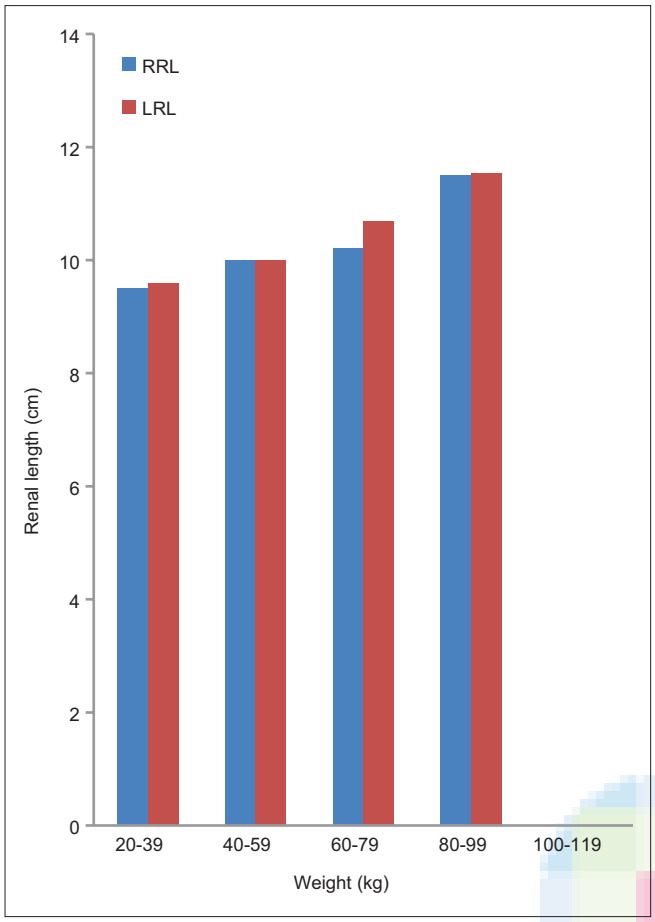

Figure 5: Bar chart showing the distribution of renal lengths (in centimeters) with increasing weight (in kilograms) in males

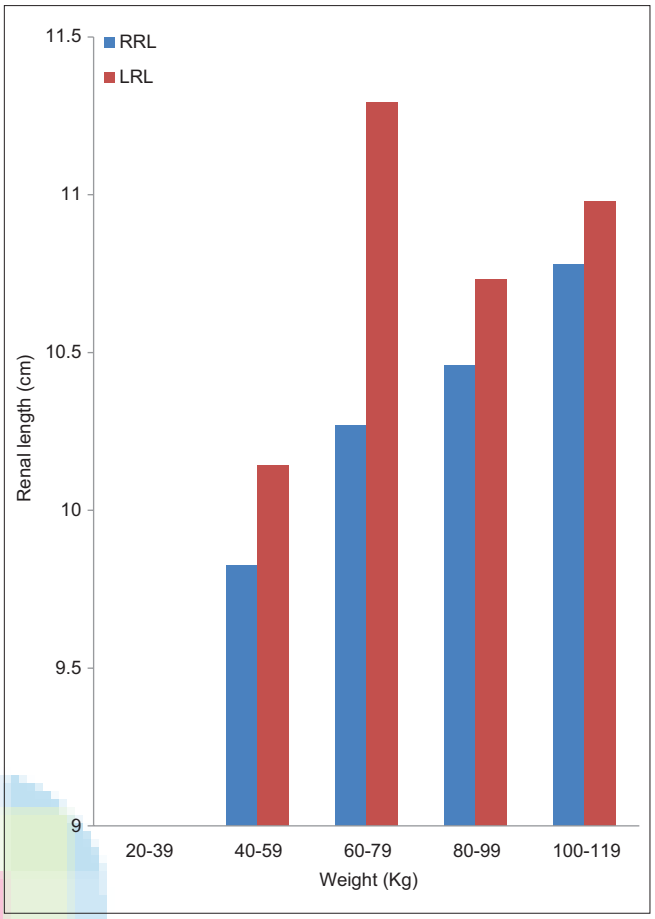

Figure 6: Bar chart showing the distribution of renal lengths (in centimeters) with increasing weight (in kilograms) in females

correlated strongly and positively with the mean length of the right kidney and weakly with the mean length of the left kidney.

DISCUSSION

Ultrasonography remains the most readily available and least expensive of the imaging modalities used in assessing the abdominal organs.[13] It is very imperative in the assessment of the kidneys sizes with or without accompanying changes in kidney architecture.[17-19] Due to its noninvasiveness and absence of radiation, it allows repeated evaluation and monitoring of disease processes in the kidneys.

Findings from this study revealed that the kidneys continue to grow in size until almost 60 years of age when it slightly declines. This observation differs from the study by Bircan *et al*.,[20] who showed that the kidneys reach their matured sizes at the third decade of life and remained without significant changes until 60 years of age. This observation was similar to the study carried out in Mexico,[13] where a decline in renal length after the age of 60 years was observed. This could possibly be as a result of the small sample size and a lower life expectancy among Nigerian population.

This study demonstrated that the mean renal lengths in males were slightly higher than those of the females and that the left kidneys were longer than the right kidneys in both sexes. This finding could be as a result of the longer growth spurt in males and ample room for the growth of the kidney on the left due to its anatomical position. This hypothesis could be further elaborated by the presence of liver on the right side which does not allow maximum metrical growth of the right kidney compared to that of the left kidney. Similar studies have reported these differences in renal length between males and females.[13,14,21]

Furthermore, the index study showed a positive correlation between body weight and the length of the kidney, which supports the assertion that body weight shows the best correlation with organ dimensions. This also concurs with Alper Safak *et al*.[17] who in their study reported that

the body weight showed the best correlation with organ dimensions (liver, kidney, and spleen). This documentation was further confirmed by studies done in Eastern Nigeria[22] and in Mexico[13] in which renal length showed a strong positive correlation with body weight.

CONCLUSION

This study revealed the mean kidney length was longer in males, and that the left kidney is slightly longer than the right kidney in both sexes, renal length was found to have a statistically significant positive correlation with the weight of subjects, a decline of renal length (especially the left kidney) after the age of 60 years and finally established a normal value for renal length in healthy adults in South-South Nigeria and documented values similar those seen elsewhere.

For further studies, an evaluation of renal length in individuals with situs inversus to ascertain the effect of the pressure from the liver on the metrical growth of the kidneys should be carried out.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Lauszus FF, Klebe JG, Rasmussen OW, Klebe TM, Dørup J, Christensen T. Renal growth during pregnancy in insulin-dependent diabetic women. A prospective study of renal volume and clinical variables. Acta Diabetol 1995;32:225-9.
2. Sanders RC. Real-time ultrasound in abdominal examinations. Radiology 1979;133(3 Pt 1):825.
3. Ried BS. Pedaitric abdominal sonography. In: Kawamura DM, Editor. Diagnostic Medical Sonography – A Guide to Clinical Practice. Philadelphia: Lippincott; 1997. p. 601-26.
4. Kumar PJ, Clark ML. Ultrasound of the kidney. Clinical Medicine: A Textbook for Medical Students and Doctors. 2nd ed. London: Bailliere Tindall; 1990. p. 237-45.
5. Julian EK. The urogenital tract. Anatomy and investigations. In: Sutton D, Editor. Textbook of Radiology and Imaging. 7th ed. China: Churchill Livingstone; 2006. p. 885-7.
6. Anderson JR. Diseases of the kidney. Muir's Textbook of Pathology. 2nd ed. London: Buttler and Tanner; 1985. p. 22.1.
7. Ojemuyiwa MI, Esho JO. Relationship between renal length and height of Nigerians. Niger Med J 1978;8:25-2.
8. Lewis E, Ritchie WG. A simple ultrasonic method for assessing renal size. J Clin Ultrasound 1980;8:417-20.
9. Spiegl G, Jeanty P, Kittel F, Struyven J. Ultrasonic measure of the normal kidney. J Belge Radiol 1982;65:513-8.
10. Brandt TD, Neiman HL, Dragowski MJ, Bulawa W, Claykamp G. Ultrasound assessment of normal renal dimensions. J Ultrasound Med 1982;1:49-52.
11. Jones TB, Riddick LR, Harpen MD, Dubuisson RL, Samuels D. Ultrasonographic determination of renal mass and renal volume. J Ultrasound Med 1983;2:151-4.
12. Moskowitz PS, Carroll BA, McCoy JM. Ultrasonic renal volumetry in children: Accuracy and simplicity of the method. Radiology 1980;134:61-4.
13. Oyuela-Carrasco J, Rodríguez-Castellanos F, Kimura E, Delgado-Hernández R, Herrera-Félix JP. Renal length measured by ultrasound in adult Mexican population. Nefrologia 2009;29:30-4.
14. Wang F, Cheok SP, Kuan BB. Renal size in healthy Malaysian adults by ultrasonography. Med J Malaysia 1989;44:45-51.
15. Barton EN, West WM, Sargeant LA, Lindo JF, Iheonunekwu NC. A sonographic study of kidney dimensions in a sample of healthy Jamaicans. West Indian Med J 2000;49:154-7.
16. Bakker J, Olree M, Kaatee R, Lange EE, Moons KG, Beutler JJ, *et al*. Renal volume measurements: Accuracy and repeatability of ultrasound compared with that of magnetic resonance imaging. Radiology 1999;211:623-8.
17. Safak A, Simsek E, Bahcebasi T. Sonographic assessment of the normal limits and percentile curves of liver, spleen, and kidney dimensions in healthy school-aged children. Ultrasound Med 2005;24:1359-64.
18. Trappe BO, von Rohden L, Kleinhans F, Handel H, Nahrendorf C, Köditz H. Renal sonography in childhood. Normal findings. Z Urol Nephrol 1985;78:641-7.
19. Eklöf O, Ringertz H. Kidney size in children. A method of assessment. Acta Radiol Diagn (Stockh) 1976;17:617-25.
20. Bircan O, Öner G, Saka O, Kavasoglu T, Akaydin M. The estimation of kidney sizes in Turkish population. J Islam Acad Sci 1993;6:197-201.
21. Karyomanggolo WT. Radiological assessment of renal length in children. Paediatr Indones 1990;30:12-30.
22. Okoye IJ, Agwu KK, Idigo FU. Normal sonographic renal length in adult southeast Nigerians. Afr J Med Med Sci 2005;34:129-31.