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Parameters Affecting the Kidney Size in Individuals without Known Renal Pathology: an Ultrasonographic Study

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ABSTRACT

Background: *Renal size can be affected by various causal elements such as age, sex, and demographic characteristics. It is crucial for medical professionals to consider these factors when making clinical decisions. The purpose of this investigation was to establish normograms for renal measurements and explore their association with the anthropometric variables in the natives of Northern India.*

Methods: *A total of 105 individuals with presumed healthy kidneys were enrolled in the present study. Kidney length, width and parenchymal thickness were measured, and data were analysed to identify potential differences related to age, gender and side. Correlation analysis was conducted to examine the relationship between kidney measurements and body biometrics, including body height, body weight, body mass index (BMI) and body surface area (BSA).*

Results: *Mean values for kidney length, width and parenchymal thickness in the 209 kidneys analysed were as follows: right kidney – length 10.65 ± 1.34 cm, width 4.5 ± 0.42 cm and parenchymal thickness 0.91 ± 0.16 cm; left kidney – length 10.7 ± 1.69 cm, width 4.78 ± 1.26 cm and parenchymal thickness 0.76 ± 0.40 cm. Thickness showed significant differences between the right and left kidneys. No significant differences in renal parameters were found between males and females. Analysis based on age groups revealed an increase in renal length and thickness with advancing age, while width decreased in the middle age group (31-40 years) and then increased. Weak positive correlations were observed between kidney parameters and body height, body weight, BSA, and BMI.*

Conclusion: *Renal parameters can vary among different populations depending on age, demographic characteristics, and ethnicity. Therefore, relying on commonly cited values for renal sonographic*

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interpretation or clinical decision-making may not be appropriate. Interpreting renal measurements should be based on reference data specific to the studied population.

Keywords: sonography, parameters, pathology, dimensions, renogram.

INTRODUCTION

The size of the kidney plays a significant role in medical practice and can indicate the transition from normal to abnormal conditions in individuals. Traditional anatomical textbooks state that the adult kidney measures 12 cm (length), 6 cm (width), and 3 cm (depth) (1). However, research has demonstrated that renal dimensions are not constant and can vary depending on factors such as age, sex, body biometrics, pregnancy, and coexisting pathological conditions. Changes in kidney size can indicate the loss or gain of renal tissue and, consequently, reflect the functional status of the kidney (2, 3). Monitoring unilateral renal pathology (4) or distinguishing between upper and lower urinary tract infections (5) relies on an accurate assessment of kidney size. Understanding the normal range of renal dimensions is essential for identifying variations that may arise due to different health conditions. Ultrasound is a safe and straightforward method to evaluate renal size across all age groups, enabling the assessment of renal changes associated with various morbidities. However, establishing normal kidney dimensions specific to different age groups is necessary to detect deviations from the norm (6). Renal disorders, diabetes mellitus, and hypertension are common comorbidities that can influence renal size (4, 5). Ultrasonography is a rapid and non-invasive diagnostic tool widely used to assess renal morphology, making it the primary choice for screening and follow-up of patients and healthy individuals (7). The existing literature predominantly provides information from European or other ethnic populations, making it challenging to extrapolate these findings universally, as renal size can differ among ethnic groups and correlate with morphometric parameters such as body height, weight, body surface area (BSA) and body mass index (BMI). Therefore, it is crucial to establish the normal values of kidney parameters specific to the population under study. In the present background, the prime objective of this current investigation was to determine the renal size in the northern Indian population without known renal disease using renal ultrasonography. The additional objective was to evaluate the role of age, sex, side, body height, body weight, and BMI on renal size. ❑

MATERIALS AND METHODS

In this study conducted at the Department of Radio Diagnosis, a prospective cross-sectional design was employed, and a total of 209 normal renograms from 105 patients aged between 18 and 55 years were included. The institutional ethics committee approved the project, and all participants consented in writing before the commencement of the investigation. This investigation primarily concentrated on consecutive patients who visited the Department of Radiodiagnosis for an ultrasound without any renal indications. Specific inclusion criteria were applied, which included having normal serum creatinine levels within the last six months, normotensive blood pressure during the ultrasound examination, and the absence of acute or chronic kidney diseases. Patients with a history of renal pathology, prior abdominal surgery related to renal pathology, pregnancy, chronic diabetes or hypertension were excluded.

Ultrasound examinations of both kidneys were conducted by the same sonologist using a Toshiba Powervision 6000 ultrasound device and a convex transducer (3.5 MHz). Prior to examination, the bladder was emptied to prevent hydration-associated changes in renal parameters. Renal measurements, including renal length (L), renal width (W) and parenchymal thickness (PT), were recorded. The body height (Ht) and body weight (Wt) of the patients were recorded, and BSA and BMI were deducted using standard formulas. To minimize inter-observer variation, all ultrasound scans were performed by an experienced radiologist.

Statistical analysis involved the use of descriptive statistics to summarize the data. Paired Student t-tests were employed to differentiate left and right renal parameters, while unpaired t-tests

were used to evaluate gender differences. Pearson correlation coefficient (r) was utilized to determine the associations between renal lengths and anthropometric variables. Additionally, a one-way analysis of variance (ANOVA) was performed to compare renal dimensions among different age groups. ❑

RESULTS

A total of 209 renal ultrasound scans from 105 patients (59 males and 46 females) were analysed. The participants were aged between 18 and 55 years. The mean length of the right kidney was 10.65 ± 1.34 cm (ranging from 9.7 cm to 11.6 cm), while that of the left kidney was 10.7 ± 1.69 cm (ranging from 9.5 cm to 11.9 cm). The mean renal width was 4.5 ± 0.42 cm (ranging from 3.8 cm to 6.6 cm) on the right side and 4.78 ± 1.26 cm (ranging from 0.4 cm to 10 cm) on the left side. The mean parenchymal thickness was 0.91 ± 0.16 cm (ranging from 0.7 cm to 1.3 cm) on the right side and 0.76 ± 0.40 cm (ranging from 0.1 cm to 1.6 cm) on the left side (Figure 1). The detailed renal dimensions are summarized in Table 1. Parenchymal thickness showed a significant difference between right and left kidneys ($p < 0.05$). When analysing the data by gender, none of the renal parameters showed any sexual dimorphism.

	Right side length	Right side breadth	Right side thickness	Left length	Left breadth	Left thickness
Mean	10.65	4.8	0.915	10.7	4.78878	0.768421
Median	10.65	4	0.9	10.7	4.6	0.9
Max	11.6	6.6	1.3	11.9	10	1.6
Min	9.7	3.8	0.7	9.5	0.4	0.1
Range	1.9	2.8	0.6	2.4	9.6	1.5
Standard deviation (SD)	1.343503	1.56205	0.163111	1.697056	1.260455	0.404218
18-30 mean	9.93	5.73	1.15	9.7	5.3	1.05
18-30 SD	1.46	1.39	0.27	0.89	0.99	0.27
31-40 mean	9.94	4.91	1.14	10.1	4.84	1.2
31-40 SD	0.67	1.45	0.43	0.68	1.5	0.52
41-50 mean	10.14	5.85	1.24	9.93	5.57	1.16
41-50 SD	0.89	1.38	0.24	1.02	1.25	0.18
>51	Only one person					

TABLE 1. Values of different renal dimensions according to their side and age group

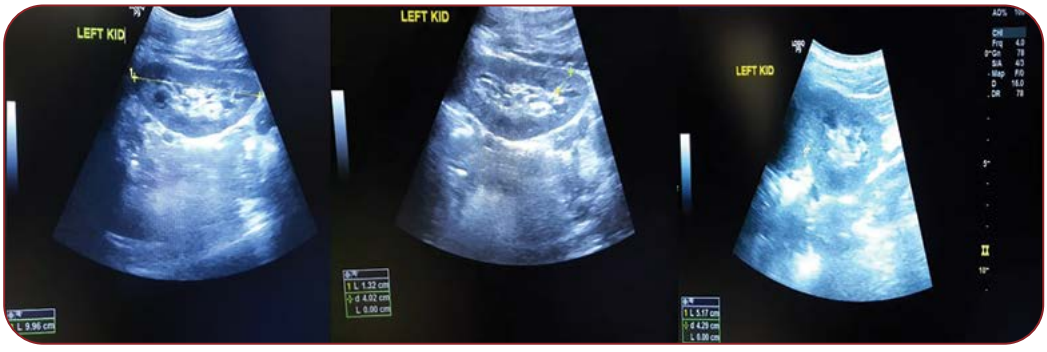

FIGURE 1. Measurement techniques and parameters employed during the use of a normal Reno gram, utilizing a 3.5 MHz convex transducer from Toshiba Powervision 6000 in Tokyo, Japan

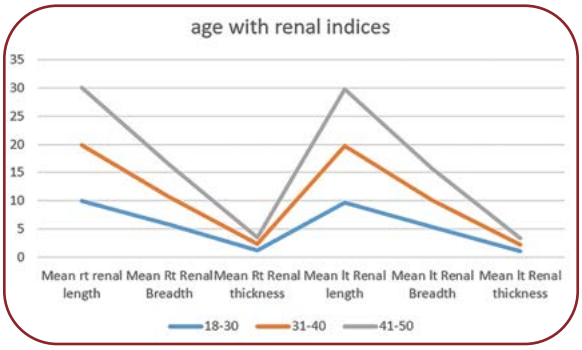

FIGURE 2. Analysis based on different age groups showing a gradual augmentation in renal length and thickness with advancing age, except for a decrease in the width of the kidney within the middle age group (31-40) before subsequently increasing

In terms of age groups, there was a gradual increase in renal length and thickness with advancing age, while renal width decreased in the middle age group (31-40) and then increased (Figure 2). The present study revealed weak positive associations between kidney parameters and different factors. Specifically, there were weak positive correlations observed between kidney parameters and body weight (right kidney: r = 0.16, left kidney: r = 0.18), height (right kidney: r = 0.19, left kidney: r = 0.21), BSA (right kidney: r = 0.25, left kidney: r = 0.23) and BMI (right kidney: r = 0.17, left kidney: r = 0.19). ❑

DISCUSSION

The dimensions of the kidneys play a significant role in assessing their functional status, but available published data on renal dimensions mainly focus on the pediatric age group (8-11) or are obtained from the investigations conducted on Caucasian populations, which might not be relevant to the Indian population (12). In our study, we used ultrasonography to examine renal dimensions and correlate them with age, sex, and other morphometric parameters such as body weight, body height, BMI and BSA.

The renal lengths observed in our investigation were close to the values reported in previous studies conducted on populations from Mexico (13), Pakistan (14), and Malaysia (15). However, they were smaller compared to studies conducted on Japanese (16) and Iranian populations (17). We did not find any significant differences in renal parameters between males and females, consistent with the findings of Muthusami *et al* (12). However, some studies have reported sex differences in renal dimensions (17-19). We did find a significant difference in parenchymal thickness between the sexes.

When examining the data based on different age groups, we noted a gradual rise in renal length and thickness as age increased. However, there was a distinct pattern for renal width, which initially decreased in the middle age group (31-40 years) before showing an increase. These findings align with previous studies conducted by Muthusami *et al* (12), who observed a consistent renal length across all adult age groups but a significant decrease in bilateral renal length after the age of 60. Other research has also indicated a gradual decline in renal length with age, with a more rapid decrease occurring after the age of seventy (13, 17).

In a study conducted by Buchholz *et al* (14), a group of individuals aged between 13 and 80 years was examined. The results indicated that there was no significant distinction in kidney length between the right and left sides. However, differences were observed in terms of width, cortical thickness, and overall size, with the right kidney being smaller compared to the left kidney. Furthermore, the study revealed that female kidneys were significantly smaller than male kidneys. Regarding the impact of age, all renal dimensions experienced an increase until the third decade, followed by a stable phase during middle age, and eventually a decline beyond the sixth decade.

These findings have important implications for clinical decision-making, and our study suggests that correcting renal sizes for age in adults up to the age of forty may not be necessary. However, future studies should investigate whether these age-related differences in renal dimensions are influenced by population ethnicity or are merely statistical variations.

Anthropometric parameters are known to potentially affect renal dimensions, so we statistically correlated the measured parameters with individual body weight, height, BSA and BMI. We found weak positive correlations between all renal dimensions and body weight, body height, BSA and BMI. Similar weak correlations between renal dimensions and body parameters were reported by Oyuela-Carrasco *et al* (13). However, it is crucial to observe that while these trends may hold true within specific populations or ethnicities, they may not be extrapolated to different populations with comparable anthropometric indices. Gavela *et al* (20) also demonstrated correlations between renal length and weight, height, and BSA in the pediatric age group. ❑

CONCLUSION

Factors such as age, sex, and anthropometric parameters like body surface area and body mass index have an impact on the normal measurement values of the kidney. Deviations from these values can provide important clinical insights and confirmations in diagnosing specific diseases. In our population, the renal sizes differ from the commonly accepted normal values found in the literature. Therefore, it is crucial to

rely on population-specific nomograms for interpreting renal sizes and not solely rely on data from other populations. ❑

Conflicts of interest: none declared.

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Ethical approval: Institutional ethical approval was obtained for the study protocol vide letter no: Trg/2012/9364-68 (G.G.S. Medical College and Hospital, Faridkot, India) and written informed consent was taken from all participants.

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