

Kidney Size in Healthy Adults of Terai Region, Nepal

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DOI: <https://doi.org/10.52403/ijhsr.20230117>

ABSTRACT

Background and objectives: Studies have shown that kidney size varies in different populations across the globe. And knowledge of kidney size is important for correct interpretation of imaging studies like ultrasonography in clinical practice. This study was done to assess kidney dimensions in the Terai region, Nepal.

Materials and Methods: This cross-sectional study involved healthy individuals of age 18 to 70 years. Ultrasound of abdomen was done to measure kidney dimensions which included length, width and thickness. Paired t-test was used for assessment of differences between right and left kidney dimensions. Unpaired t-test was used for assessment of differences in renal dimensions between male and female individuals.

Results: There were 98 (47.1 %) males and 110 (52.9 %) females. The mean age was 34.14 years. The mean kidney length, width and thickness were 9.8 (SD 0.9) cm, 5.25 (SD 0.9) cm, and 4.23 (SD 0.7) cm respectively. The length of right and left kidney was 9.65 (SD 0.87) cm and 9.98 (SD 0.89) cm respectively ($p = 0.001$). The width of right and left kidney was 5.18 (SD 0.79) cm, and 5.32 (SD 0.99) cm respectively ($p = 0.12$). The thickness of right and left kidney was 4.05 (SD 0.63) cm, and 4.4 (SD 0.72) cm respectively ($p = 0.001$). When compared between male and female, the mean length, width and thickness were greater in male. However, the difference in only thickness was significant ($p = 0.001$).

Conclusion: The average length, width and thickness of kidney were 9.8 cm, 5.25 cm and 4.23 cm respectively. The length of left kidney was greater than the right. Male kidney tended to be slightly larger than the female although the difference was not significant.

Key words: kidney dimension, kidney size, renal length

INTRODUCTION

Many diseases affect kidney size. [1,2] Measurement of kidney size provides valuable diagnostic information in kidney diseases. For example, contracted kidney is one of the most important findings which helps in differentiating chronic renal failure from acute renal failure. Likewise, there are

many other conditions which affect kidney size e.g. hydronephrosis, adult polycystic kidney diseases, pyelonephritis, etc. With development of imaging technologies like ultrasound, kidney size can easily be measured. Clinicians depend on radiological report for the evaluation of renal dimensions. Therefore, it is important to know normal

kidney size for correct interpretation of radiological report.

Many studies on kidney dimension have been done sonologically. Available literature suggests variable findings about kidney size in different populations. [3-5] Arooj et al suggested that the kidney size varies among different ethnicities. [5]. Real kidney size in our population may also be different from the one that quoted in standard textbook of anatomy like Gray's Anatomy. In Indian population, Muthusami et al found that the average length of the kidney is smaller than that reported in western literature. [3] So, it is imperative to study kidney size in our population too. There are few studies of this kind in Nepalese perspectives. This study was conducted for assessment of kidney dimensions by ultrasonography in healthy adults of Terai region, Nepal.

MATERIALS AND METHODS

This is a cross-sectional study conducted at Janaki Medical College, Janakpur, Nepal from April 2019 to October 2019. Two hundred and forty two apparently healthy volunteers aged 18 years and above were initially selected for the study. They were either visitors presenting with the patients, or volunteers from local community selected randomly. After taking consent from them for the study, their age, sex, height (meter), weight (kg), and blood pressure (left arm, sitting position) were recorded. Normotensive individuals were advised for laboratory investigations which included routine and microscopic urine examination, fasting or random blood glucose level, and serum creatinine measurement. Creatinine clearance was estimated using Cockcroft-Gault formula. [6] When all the laboratory parameters were found normal, ultrasonography of abdomen was done by an experienced radiologist using ultrasound machine Toshiba MEMIOMX, Power vision 6000, Tokyo, Japan, and a 3.5MHz convex transducer. Renal dimensions

measured included length, width and thickness. Renal length was measured as the longest distance between the superior and inferior poles of kidney. Renal width was measured as the maximum mediolateral distance at the level of the renal hilum. Renal thickness was measured as the maximum anteroposterior distance at the level of the renal hilum.

Individuals who were found to have any abnormal conditions or disease that could potentially affect kidney size were excluded from the study. Accordingly, individuals excluded included those with past history of any kidney disease or kidney operations, high blood pressure, high blood glucose level, abnormal urine examination findings, abnormal creatinine clearance, acquired or congenital anomalies of kidney in ultrasound of abdomen (Hydronephrosis, grossly small kidney, solitary kidney, horse-shoe kidney, malrotated kidney, polycystic kidney, etc.). Twenty nine individuals with abnormal findings and 5 individuals who dropped out before investigations were done were excluded.

Ethical approval for the study was taken from the institutional review committee of the college. Statistical analysis was done using SPSS version 21. Descriptive statistics was used for the description of the central tendencies and spread of the data. Differences of renal dimensions between the left and right kidney was analyzed using the paired t-test, and that between male and female was analyzed using the unpaired t-test. P-value less than 0.05 was considered statistically significant.

RESULT

After exclusion of 34 individuals, 208 individuals who had complete data were included for the analysis. Among them 98 (47.1 %) were males and 110 (52.9 %) females. The mean age was 34.14 (SD 12.6, range 18 - 70) years.

Overall the mean kidney length, width and thickness were 9.8 (SD 0.89) cm, 5.25 (SD 0.9) cm, and 4.23 (SD 0.7) cm respectively. Results of comparisons of length, width and thickness between right and left kidneys are shown in table 1. The length of right and left kidney was 9.65 (SD 0.87) cm, and 9.98 (SD 0.89) cm respectively, and the difference was statistically significant ($p = 0.001$). The thickness of right and left kidney was 4.05 (SD 0.63) cm, and 4.4 (SD 0.72) cm respectively, and this difference was also significant ($p = 0.001$). The width of right and left kidney was 5.18 (SD 0.79) cm, and 5.32 (SD 0.99) cm respectively, and the difference was not statistically significant ($p = 0.120$).

Table 1: Comparison between right and left kidney dimensions

| | Right kidney | Left kidney | p-value |
|---------------------|--------------|-------------|---------|
| Mean length (cm) | 9.65 | 9.98 | 0.001 |
| Range | 8 - 11.8 | 7.8 - 12.17 | |
| SD | 0.87 | 0.89 | |
| Mean width (cm) | 5.18 | 5.32 | 0.120 |
| Range | 3.5 - 7.4 | 3.38 - 7.6 | |
| SD | 0.79 | 0.99 | |
| Mean thickness (cm) | 4.05 | 4.4 | 0.001 |
| Range | 2.75 - 5.5 | 3.1 - 6.2 | |
| SD | 0.63 | 0.72 | |

Comparisons of kidney dimension between male and female revealed that the mean kidney length, width and thickness are greater in male than female (Table 2). However, the differences are not statistically significant with regard to the length and the width. Only the difference in thickness was statistically significant ($p = 0.001$).

Table 2: Comparison of renal dimensions between male and female

| | Male (n = 98) | Female (n = 110) | p-value |
|----------------------------|---------------|------------------|---------|
| Mean kidney length (cm) | 9.9 | 9.7 | 0.05 |
| SD | 1.01 | 0.77 | |
| Mean kidney width (cm) | 5.47 | 5.06 | 3.6 |
| SD | 1.03 | 0.72 | |
| Mean kidney thickness (cm) | 4.35 | 4.1 | 0.001 |
| SD | 0.77 | 0.62 | |

DISCUSSION

Knowledge of the kidney size previously relied on cadaveric studies mainly from

western world. With the development of imaging studies like ultrasound, CT scan and MRI, kidney size can be measured reliably and non-invasively in living bodies. Among these methods, ultrasound, is the least expensive, least invasive and easily available method to study renal morphology. [7] So ultrasound has been used commonly for examination of abdomen for decades and gives reliable information about anatomy and size of the kidneys. [8] Among different kidney dimensions like length, width, thickness, cortical thickness, and volume, kidney length is the most commonly measured parameter to assess the size of kidney in clinical practice.

Muthusami et al measured renal dimensions sonographically in 140 patients in Indian population. They found that the length of right and left kidneys were 9.6 (SD 0.97) cm and 9.71 (SD 0.89) cm respectively. The width of right and left kidneys were 4.5 (SD 0.7) cm and 4.54 (SD 0.63) cm respectively. The thickness of right and left kidneys were 1.99 (SD 0.3) cm and 2.09 (SD 0.29) cm respectively. [3] Another autopsy renal biometric study done in Indian population yielded comparable results with kidney length ranging between 9.1 to 9.9 cm. [9]

Saeed et al analyzed renal measurements sonographically in 225 normal subjects in Pakistani population. They reported that mean kidney lengths were 9.85 (9.74 - 9.95) cm and 10.0 (9.85 - 10.1) cm on the right and left side respectively. [10] Dominguez et al measured kidney sizes and volume by ultrasound in 105 males and 159 females of age ranging from 18 to 75 years. The left kidney was significantly larger than the right. However, the width and thickness were not significantly different between right and left side. [11] A Swiss autopsy study done by Kalucki et al demonstrated that left kidneys were on average 2 mm longer than right kidneys ($p < 0.05$). [12]

In Nepal Yadav et al studied 110 healthy population. They found that the mean renal length of right and left kidneys were 9.77 ± 0.98 cm and 9.94 ± 0.86 cm respectively, and the difference was statistically significant ($p < 0.01$). The mean renal width for the right and left kidneys were 4.08 ± 0.63 cm and 4.18 ± 0.86 cm respectively and this was also statistically significant ($p < 0.01$). [13]

The above studies have consistently reported the renal dimensions which is close to the findings of our study. These studies support the findings of the present study that the left kidney length is significantly greater than the right. The thickness of left kidney is also greater than the right. Regarding the kidney width, though it seems greater on the right side, the difference is not statistically significant. So, in general all the renal dimensions tends to be greater on the left side. There are other studies which have demonstrated no significant difference between the right and left kidney length. Murlimanju et al studied 151 adult kidneys from anatomy laboratory, of which 69 belonged to the right side and 82 to the left side. The measurements were performed by using digital Vernier caliper Kidney. The mean (SD) right and left renal length were $8.9 (\pm 0.9)$ and $9.1 (\pm 0.9)$ cm and the difference were statistically not significant ($p = 0.28$). [14] Pruijm et al also showed that there was no difference between right and left renal length. [15]

Some studies have shown that the length of healthy adult kidney is larger than that shown in our study. Jabbari et al, in Iranian population, showed that Mean (SD) kidney length was $104.96 (6.6)$ mm for the right, and $106.22 (6.16)$ mm for the left kidney ($P=0.02$). [16] According to Gray's Anatomy, the length of an adult kidney is 11 cm and width 6 cm. [4] Okoye et al have reported to have larger kidney lengths averaging $10.3 - 10.6$ cm in Nigerians. [17] In the Mexican population Oyuela et al found that the right

and left renal lengths were 104.3 ± 6.45 mm and 105.8 ± 7.56 mm respectively ($p = 0.000$). [18] Emamian et al studied 665 adult volunteers and reported that the median renal lengths were 11.2 cm on left side and 10.9 cm on the right side. [19] According to a retrospectively reviewed multi-detector CT study by Shin et al, in young Korean men, the mean right and left kidney lengths were 10.7 ± 0.76 and 10.9 ± 0.72 cm respectively. The left kidney was significantly ($p < 0.05$) longer than right kidney. [20] The larger kidney size in these studies may be a depiction of different body habitus in these population. This shows that the kidney dimensions vary among different ethnicities with different body habitus.

Regarding the impact of gender on renal dimensions, the difference seems less obvious. In one study conducted in Nepal, Koirala et al revealed that the mean renal length of male is greater than that of female. [21] Pruijm et al showed that the renal length was 11.4 ± 0.8 cm in men and 10.7 ± 0.8 cm in women [15]. Karim et al showed that male kidney length is larger than the female. [22] Muthusami et al compared renal dimensions between male and female, and found only width to be significantly different, being greater in male. There were no significant differences in length between male and female. [3] Other studies have also reported no gender related difference in renal length. [13, 17, 23]

Though average renal dimensions in the above studies tends to be greater in male than the female, the difference remains statistically insignificant. Few studies have demonstrated statistical significance. One such study by Khan et al showed that the mean size of right kidney in males and females was 10.30 ± 0.87 cm and 10.18 ± 1.22 cm respectively, and the difference was statistically significant ($p = 0.010$). The mean size of left kidney in males and females was 10.38 ± 0.98 cm and 10.23 ± 0.92 cm respectively, and the difference was

also significant ($p < 0.001$). [24] In the present study, the mean values of all the three renal dimensions were greater in male. However, only the difference in thickness was statistically significant.

Why left renal dimensions are greater than the right? Presence of liver on right side with less spatial growth of the corresponding kidney and greater blood flow to the left kidney on account of a shorter left renal artery are the plausible explanations hypothesized. [19]

This study has some limitations. The study population may not represent true community population. This is because sampling was not done randomly from the community. Some study individuals were called randomly from the community while others were healthy individuals presenting in hospital with the patients. Second limitation is that this study has not taken into account of other factors that might influence kidney size like age, height, weight, body mass index, body surface area etc.

CONCLUSION

In this study, the average renal length, width and thickness of kidney are 9.8 cm, 5.25 cm and 4.23 cm respectively. The length of left kidney length is greater than that of the right kidney. There is no significant difference in renal dimensions between male and female. Further larger scale study is needed to standardize the kidney size in our population.

Author's Contribution: Nilam Sah: data collection, analysis and preparation of manuscript; Shamsheer Shrestha and Nutan Bala Singh: guidance in framing the research work, data analysis and manuscript writing; Sunil Adhikari: radiological study of study subjects and data collection; Rakesh Kumar Pandit: selection of study subjects through clinical evaluation and interpretation of laboratory investigations and manuscript writing.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: We are thankful to the department of radiology, laboratory staff, department of medicine and surgery for their cooperation and support in investigations of study subjects and clinical evaluation. Also thanks to Dr. Jitendra Singh for help in statistical works.

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Nilam Sah, Shamsheer Shrestha, Nutan Bala Singh et.al. Kidney size in healthy adults of Terai region, Nepal. *Int J Health Sci Res.* 2023; 13(1):120-125. DOI: <https://doi.org/10.52403/ijhsr.20230117>
