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NORMAL RENAL DIMENSIONS IN A SPECIFIC POPULATION

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ABSTRACT

Introduction: Renal dimensions (RD) are important for the diagnostic and the prognostic of nephropathies.

Materials and Methods: We selected 904 Brazilians subjects with normal excretory urographies, showing dense nephrogram at the 5th minute of the exam, serum creatinine <1.3mg/dl, and absence of any disease that could modify RD. Length, width, and area of both kidneys were correlated with gender, age, height, and body weight. Five hundred and eighty one subjects were men (64.3%) and 323 were women (35.7%). Age ranged from 21 to 87 years old, body weight from 40 to 106kg (69.9±9.5 for men and 62.4±9.7 for women), and height from 1.37 to 1.94m (1.68±0.07 for men and 1.57±0.07 for women).

Results: There was an association (one-way Anova test) between length, width, and area, for each kidney and for both, with height ($p<0.001$), body weight ($p<0.001$), and gender ($p<0.001$). After adjustment for height (covariance analysis), both gender and body weight did not show influence on RD. Renal length and area reduced with aging ($p<0.001$), from the 7th decade compared to the others. Excluding these patients, height was the only variable to show association with RD, justifying data stratification by this variable.

Conclusions: Renal length in this population showed that the normal patterns defined by other studies are inadequate for our population. Adjusting the data by height, gender, and body weight did not influence RD; however, the left kidney was bigger than the right kidney. Also, the influence of height was more pronounced below 1.66m.

Key words: kidney; biometry; urography; ultrasonography
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INTRODUCTION

Background knowledge of normal renal dimensions (RD) may help in the diagnosis of kidney diseases. Renal dimensional variations occur in nephropathies due to hypertrophic process and/or atrophy (1). Thus, it is imperative to establish the pattern of normal renal dimensions.

It has been postulated from necropsy studies that variations in RD and renal weight are related to gender, with weight being higher in males. It is also known that the left kidney is larger than the right one, independent of gender (2). Data from necropsies are not universally accepted, since a wide variation in dimensions is observed, and this variability has been confirmed by studies utilizing intravenous pyelographies (IVP) (2,3). Studies in this field have also tried to establish a correlation between RD and age, since it was shown that a reduction of up to 40% in renal weight occurs over the years (4-6).

The Brazilian population has immigrants from many different countries, resulting in a highly mixed population. The normal pattern of renal dimensions should be established for this population considering its characteristics. Although of high relevance, this issue has not been well explored in subjects with normal renal function. Thus, the aim of this study was to evaluate the renal dimensions in a Brazilian population, and to verify possible correlations with gender, body weight, age, and height.

MATERIALS AND METHODS

We analyzed 904 normal intravenous pyelographies, 581 from men and 323 from women. The exams were performed at the Radiological Division of Gaffrée Guinle and Andaraí Hospitals in Rio de Janeiro, Brazil, from January 1985 to December 1996. The following criteria for patient inclusion were used: 1)- Serum creatinine of less than 1.0mg/dl; 2)- Normal arterial blood pressure measurements; 3)- No acute or chronic disease that could lead to renal impairment; 4)- No personal or family history of renal disease. Body weight, height, and a urine sample were also evaluated. Length (L), width (W), and area of both kidneys were measured. The major distance between the renal poles (superior and inferior) was taken as the length (KL). The major distance between the lateral and medial borders perpendicular to the length was taken as the width (KW). Renal area (RA) was estimated through the formula used for an ellipse, $RA = \pi \times KL \times KW/4$, where π is a constant (3.1416).

Patients were stratified by height and age and separated in 10 years ranges, starting from the third decade.

STATISTICAL ANALYSIS

Results are expressed as mean ± standard deviation (X ± SD). Comparison of kidney length by weight and height of subjects was done by analysis of variance and multiple comparisons with the Tamhane test. Renal dimensions of left and right kidneys were compared with the paired t test. The differences were considered statistically significant when $p<0.01$.

Table 1 *- General data of the studied population (n=904; 581 males and 323 females).*

Age (years)	49 ± 16.4	
Patients' Height (m)	Males	1.68 ± 0.07
	Females	1.57 ± 0.07
Body Weight (kg)	Males	69.9 ± 9.5
	Females	62.4 ± 9.7

RESULTS

General data for the study population is shown in Table-1. Age ranged from 21 to 87 years, height from 1.37 to 1.94m, and body weight (BW) from 40 to 106kg.

When RD was analyzed with respect to BW, it was shown that KL correlated to those levels (Table-2). Similarly, when the data was grouped according to height, this variable showed a significant association with KL (Table-3), ($p<0.001$).

Table-4 presents an analysis of height with respect to BW, showing that individuals with higher mean height had higher BW.

Table-5 shows a reduction of RA for individuals in the 7th decade life when compared to the 3rd and 4th decades ($p<0.001$). For this reason, we analyzed only subjects under 71 years of age.

RD data for the 645 individuals under 71 years of age, adjusted for height, is shown in Table-6. There was no significant difference among KL,

Table 2 *- Renal dimensions (mean ± standard deviation) distributed according to body weight (n=904).*

Body Weight (kg)		**Length (cm)**	
		Right*	**Left***
<60;	n=216	11.6 ± 0.7	12.2 ± 0.7
60-69;	n=331	11.9 ± 0.7	12.5 ± 0.7
70-79;	n=236	12.1 ± 0.7	12.7 ± 0.7
>80;	n=121	12.5 ± 0.8	13.2 ± 0.8

**p<0.001 according to analysis of variance*

Table 3 - Renal dimensions (mean ± standard deviation) distributed according to patients' height (n=904).

Patient's Height (m)	Length (cm)	
	Right*	Left*
<1.55; n=194	11.4 ± 0.6	11.9 ± 0.6
1.56-1.65; n=290	11.7 ± 0.6	12.3 ± 0.6
1.66-1.75; n=332	12.3 ± 0.7	12.9 ± 0.7
1.76-1.85; n=88	12.6 ± 0.5	13.2 ± 0.5

**p<0.001 according to analysis of variance*

KW, and RA for men or women, suggesting that gender is not a determinant factor for RD.

Table-7 shows RD values of 645 subjects with less than 71 years, stratified by height, and the location of the kidney (left and right). The data is reported as medians followed by percentiles 5 and 95. Comparison of the results of KL for both kidneys among distinct height ranges showed that the 2 lowest height levels differed from one another and also from the others (p<0.001); there was no significant difference between the third and fourth height levels. When related to KW, the left kidney showed a significant difference only compared to the 2 lower height levels (p<0.001), and the right kidney showed a significant difference between the third and fourth height levels, and between these and the other levels (p<0.005). When different height ranges were compared in terms of right kidney RA, we found that they differ significantly from one another (p<0.001), whereas left kidney RA was significantly different only between the 2 lowest height levels (p<0.001).

***Table 4** - Relationship between patients' height and weight (n=904).*

Weight (kg)*	Height (m)*
<60, n=216	1.57 (0.06)
60-69; n=332	1.62 (0.07)
70-79; n=237	1.68 (0.06)
>80; n=119	1.73 (0.08)

**p <0.001*

DISCUSSION

Normal RD is an additional tool to study renal function. Ultrasound is the technique of choice to evaluate these dimensions, although its measures are smaller than those obtained by IVP (7), probably due to geometric magnification, and because the osmotic diuresis distension effect caused by the contrast medium do not occur. Measurements from radiograms have intrinsic distortion caused by many factors: a)- The distance between the film and the organ (influenced by the adipose tissue thickness); b)- The angle of X-ray penetration. We chose IVP based on the following features: 1)- It evaluates the function of both kidneys, permitting the exclusion of patients with any unilateral deficiency, as well as patients with compensatory hypertrophy and congenital defects not detected by ultrasound; 2)- Permits evaluating renal shadows, with lesser influence when compared to ultrasound; 3)- It has a good linear correlation with the renal dimensions obtained by ultrasound (8).

In the present study, we analyzed renal size in terms of length and width, which are simple, reproducible, reliable, and objective measurements. Data obtained by measurements of right and left kidneys agreed with data from other studies, showing that the left kidney is larger than the right (5,9,10). The anthropometric profile of the sample showed a significant difference between genders (Table-1) for BW and height, and we believe that this data is typical of the Brazilian population. The relation between BW and height in this population showed that individuals with higher BW also have higher heights. The present data show that the Brazilian population has a mean height between that of Asian (11) and European (2) population. One study in Pakistan (12) also highlights the necessity of investigating renal dimensions for each population, strengthening that European and American populations' data cannot be used as universal patterns.

Comparing RD between genders, data not shown, we observed that KL, KW and RA were significantly higher in males, with the left kidney being larger than the right, similar to the data reported in other studies (2,11). When investigating the association between gender and RD, we found that height

Table 5 *- Renal dimensions (mean ± standard deviation) distributed by age (grouped by decade of life), n=904.*

Decade	Kidney Length (cm)		Kidney Width (cm)		Kidney Area (cm²)	
	RK*	LK*	RK*	LK*	RK*	LK*
3rd; (n=160)	12.2 ± 0.7	12.8 ± 0.8	5.6 ± 0.4	6.0 ± 0.4	54.0 ± 6.1	60.5 ± 6.6
4th; (n=189)	12.0 ± 0.8	12.7 ± 0.8	5.7 ± 0.4	6.1 ± 0.5	53.6 ± 6.8	60.5 ± 7.6
5th; (n=135)	11.9 ± 0.8	12.5 ± 0.8	5.6 ± 0.5	6.0 ± 0.4	52.7 ± 6.7	59.4 ± 6.7
6th; (n=161)	12.0 ± 0.7	12.6 ± 0.7	5.6 ± 0.5	6.0 ± 0.4	53.0 ± 6.3	59.9 ± 6.0
7th; (n=259)	11.7 ± 0.7	12.3 ± 0.8	5.3 ± 0.5	5.9 ± 0.4	51.0 ± 6.6	57.5 ± 6.7

**p<0.001 according to analysis of variance; LK=left kidney; RK=right kidney*

was the only difference detected between genders. Comparing the effect of gender on RD after adjusting it for height, we observed that the difference did not persist, supporting the idea that gender is not an independent determinant of RD and therefore suggesting that special tables based on gender are not necessary.

The association between RD and BW showed a highly significant direct relation in the higher BW ranges. There was an association between BW and height, indicating the need for an adjusted analysis, which showed no relation between RD and BW; this finding led us not to use RD values corrected for body surface, as recommended by others (2), because it could underestimate values in obese patients.

Renal area is not usually employed as a renal dimension parameter. However, in the present study, area was shown to be a sensitive measure for variations in renal dimensions. When analyzing the distinct height ranges, RA was shown to be highly sensitive, especially in the 2 higher ranges. We suggest therefore that RA is a good parameter for detecting variations in renal mass, and thus may be used.

It is known that aging leads to a progressive reduction of renal size (5,13). From the 5th decade on, KL decreases approximately 0.5cm per decade, especially due to a reduction of about 1% per year in blood flow after the third decade (6,13). In the present study, we observed a consistent reduction in RD in individuals from the 7th decade when compared with the other age ranges; others showed similar findings (14). In order not to underestimate RD, all individuals with up to 70 years were excluded from the adjusted analysis to prevent a reduction of normal limits.

After the exclusion of older patients, the study showed that height was the only variable correlated with RD, justifying the use of this parameter in reference tables for renal dimensions. Another study finds

Table 6 *- Relationship between gender and renal dimensions (mean) in individuals under 70 years of age, adjusted by height (n=645).*

Renal Dimensions		Gender	
		Male (n=376)	Female (n=269)
Right Kidney Length	(cm)	12.03	12.01
Right Kidney Width	(cm)	5.64	05.62
Left Kidney Length	(cm)	12.67	12.59
Left Kidney Width	(cm)	06.07	05.99
Right Kidney Area	(cm²)	53.40	53.16
Left Kidney Area	(cm²)	60.52	59.36

Table 7 – Renal dimensions percentiles distributed by patients' height.

Renal Dimensions	Height	n	Percentiles 5%	50%	95%
Right Kidney Length	<1.55	155	10.50	11.40	12.32
	1.56-1.65	188	11.00	11.90	13.00
	1.66-1.75	239	11.39	12.40	13.41
	1.76-1.85	63	11.56	12.50	13.48
Right Kidney Width	<1.55	155	4.68	5.50	6.42
	1.56-1.65	188	4.90	5.60	6.30
	1.66-1.75	239	5.00	5.70	6.41
	1.76-1.85	63	5.42	6.00	6.48
Left Kidney Length	<1.55	155	11.16	12.00	13.10
	1.56-1.65	188	11.64	12.50	13.56
	1.66-1.75	239	12.00	13.00	14.00
	1.76-1.85	63	12.32	13.10	14.00
Left Kidney Width	<1.55	155	5.00	5.80	6.50
	1.56-1.65	188	5.40	5.90	6.62
	1.66-1.75	239	5.60	6.10	6.71
	1.76-1.85	63	5.66	6.30	6.88
Right Kidney Area	<1.55	155	40.78	49.19	58.45
	1.56-1.65	188	43.78	51.40	60.88
	1.66-1.75	239	47.42	55.41	66.36
	1.76-1.85	63	51.09	58.38	66.21
Left Kidney Area	<1.55	155	45.97	55.06	64.42
	1.56-1.65	188	51.62	57.39	68.19
	1.66-1.75	239	54.79	62.20	73.14
	1.76-1.85	63	55.38	65.34	74.44

similar data analyzing renal dimensions by ultrasound (15).

The present data show that the absolute values obtained for the dimensions of both kidneys were below those found in European studies (2). The present KL values for our population show that the normal pattern defined by other studies from other countries is not adequate for our population. Data adjusted by height showed that gender and BW did not influence RD, but height showed a direct correlation with KL. Additionally, we observed that a more pronounced influence of height occurred in the ranges below 1.66m.

REFERENCES

1. Elkin M: Kidney Size. In: Elkin M (ed.), Radiology of the Urinary System. Boston, Little, Brown and Company. 1980; pp. 1014-1032.
2. Moëll H: Size of normal kidneys. Acta Radiol. 1956; 46:640-5.

3. Braasch WF, Merricks JW: Clinical and radiological data associated with congenital and acquired single kidney. Surg Gynec and Obst. 1938; 67:281-3.
4. Korenchevsky V: Natural relative hypoplasia of organs and process of aging. F Path Balt. 1942; 54:13-24.
5. Simon AL: Normal renal size: An absolute criterion. Am J Roentgenol. 1964; 92:270-2.
6. Wald H: Weight of normal adult human kidney and its variability. Arch Path. 1937; 23:493-500.
7. Mellins HZ: Radiologia del Tracto Urinario. In: Walsh PC, Gittes RF, Perlmutter AD & Stamey TA (eds.), Campell Urologia. Buenos Aires, Tradução de Editorial Médica Panamericana AS. 1988; pp. 333-539.
8. Moskowitz PS, Carroll BA, McCoy JM: Ultrasonic renal volumetry in children. Radiology. 1980; 134:61-4.
9. Odita JC: Roentgenologic estimation of kidney in adult Nigerians. Trop Geogr Med. 1982; 34:177-81.
10. Sampaio FJ, Mandarin-de-Lacerda CA: Morphometry of the kidney. Applied study in urology and imaging. J Urol.[Paris] 1989; 95:77-80.
11. Wang F: Renal size in healthy Malaysian adults by ultrasonography. Med J Malaysia. 1989; 1:45-51.
12. Buchholz NP, Abbas F, Biyabani SR, Afzal M, Javed Q, Rizvi I, et al.: Ultrassonographic renal size in individuals without known renal disease. J Pak Med Assoc. 2000; 50:12-6.
13. McLachlan M, Wasserman P: Changes in sizes and distensibility of the aging kidney. British J of Radiology. 1981; 54:488-91.
14. Miletic D, Fuckar Z, Sustic A, Mozetic V, Stimac D, Zauhar G: Sonographic measurement of absolute and relative renal length in adults. J Clin Ultrasound. 1998; 26:185-9.
15. Emamian SA, Nielsen MB, Pedersen JF, Ytte L: Kidney dimensions at sonography: correlation with age, sex, and habitus in 665 adults volunteers. Am J Roentgenol. 1993; 160:83-6.

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