

Sonographic Assessment of Kidney Length in Jordanian Children: Results from a Tertiary Hospital in The North of the Kingdom

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Abstract

Objective: To provide a reliable and practical reference for normal standard kidney length values in Jordanian children using ultrasound according to age, height, and weight, and to assess the comparability of our standards to those from previous studies.

Materials and Methods: The kidneys of 331 children (156 males, 175 females) ages between newborns and 14 years of age, who had diseases unrelated to the urinary tract were prospectively examined by ultrasound. All the examined kidneys were normal in size, shape, and position. The length of the kidneys were correlated with the age, weight, and height of the patients, and was compared to previous studies published in the literature.

Results: There was no significant statistical difference between the length of the right kidney and the left kidney, and no difference between boys and girls ($P > 0.05$). There was good correlation between the length of the kidneys and the somatic parameters of the patients. Also, there was agreement between the kidney length in our study to those from previous international studies.

Conclusions: A reliable and practical reference for normal standard kidney length values in Jordanian children is provided, which is in concordance with previously published data.

Keywords: Sonographic Assessment, Kidney Length, Jordan.

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Introduction

Assessment of kidney length is a common practice in pediatric radiology for both

diagnostic and prognostic purposes. Several urinary tract and systemic diseases are associated with alteration in kidney size such as: urinary tract infections, obstructive

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uropathies, renal parenchymal diseases, vesico-ureteric reflux, presence of solid or cystic masses, oncology diseases, and congenital agenesis or nephrectomy resulting in compensatory hypertrophy⁽¹⁻³⁾. Therefore, it is of great importance to establish normal kidney growth charts to determine whether the kidney length is within normal limits for a specific age group, particularly that kidney size changes with age and growth of the child⁽⁴⁾.

There are several reference growth charts of the kidney size by ultrasound available in the literature for the pediatric population in western countries^(5,6). Most of these studies have assessed kidney growth in comparison to changes in age, height, weight, and body surface area. The kidney size is widely measured by the length⁽¹⁾, or by the renal parenchymal volume⁽²⁾. Since there are no kidney size reference values available for Jordanian children, the available data from other countries provided in the literature are widely used in Jordanian health institutions. Therefore, the aim of this study was to provide a reliable and practical reference for normal standard kidney length values in Jordanian children using ultrasound according to age, height, and weight, and to assess the comparability of our standards to those from previous studies which proved to show no significant difference.

Methods

The subjects in the study were inpatients and outpatients within a large general hospital serving a population of more than 1.2 million in the north part of the Kingdom. The patients were referred to the radiology department to obtain an ultrasound for symptoms or reasons unrelated to the urinary tract. Exclusion

criteria included: urinary tract infection, vesico-ureteric reflux, hydronephrosis, any congenital anomalies of the urinary tract, renal parenchymal masses or cysts, oncology patients, and trauma patients. The height and weight of each patient were recorded at the time of the examination to the nearest 0.1 cm and 0.1 kg, respectively, and only the patients whose growth parameters were within normal limits according to the growth charts were included in the study.

A total of 331 pediatric patients (175 females and 156 males) aged from newborns to 14 years who met the inclusion criteria during the study period were prospectively examined using a real time ultrasound machine (ALT, HDI 5000, USA) with 5-8 MHz or 4-7 MHz sector transducers equipped with electronic calipers. The maximum bipolar length of the right and left kidneys were measured in a sagittal view. The patient was positioned in a supine position or in a contralateral decubitus position, with the probe oriented subcostally or posteriorly for the supine and lateral decubitus positions, respectively. The measurements were recorded to the nearest 0.1 cm. The studies were performed by three radiologists with 5-10 years of experience in ultrasound.

The study was approved by the Institutional Review Board at Jordan University of Science and Technology.

Statistical analysis:

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS version 15). The age of the patients was categorized into 10 categories. Data were described using means and standard deviations. The difference in the length between the right and left kidneys was tested

using paired t-test. Independent t test was used to compare the mean kidney length between boys and girls. One way ANOVA was used to compare the mean kidney lengths for children according to age, weight, and height categories. The results were considered significant at a p-value of less than 0.05.

Kidney length from our data was compared to previous published data of children from America, Australia, and Hong Kong. For the purpose of comparability, our data was rearranged into the same age subgroups that were reported in the published studies.

Results

A total of 331 children (175 (53%) females and 156 (47%) males) were included in this study. On average, the left kidney was slightly but statistically insignificantly longer than the right kidney with an average difference of about 0.07cm. Therefore, the average length of the right and left kidneys was taken and analyzed. There was no significant statistical difference between the kidney length between boys and girls in all age groups (P >0.05). Accordingly, the kidney length was reported for all children according to age (table 1), weight (figure 1), and height (figure 2).

Table 1. The length of the kidney in correlation with age

Age Months (m) Years (y)	No. of patients	Minimum (cm)	Maximum (cm)	Mean (cm)	SD	95% Confidence Interval
0-3 m	33	3.1	5.6	4.6	0.5	(4.4, 4.8)
3-6 m	25	4.6	6.2	5.4	0.4	(5.2, 5.6)
6-12 m	43	4.2	6.7	5.9	0.6	(5.8, 6.1)
1-2 y	23	5.4	8.0	6.6	0.6	(6.3, 6.8)
2-4 y	35	5.4	8.4	6.8	0.6	(6.6, 7.1)
4-6 y	38	5.9	9.0	7.6	0.7	(7.4, 7.9)
6-8 y	41	6.0	9.2	7.9	0.7	(7.6, 8.1)
8-10 y	39	6.9	10.2	8.5	0.8	(8.2, 8.7)
10-12 y	30	7.6	10.8	8.9	0.9	(8.6, 9.2)
12-14 y	24	7.0	11.5	9.4	1.1	(9.0, 9.9)

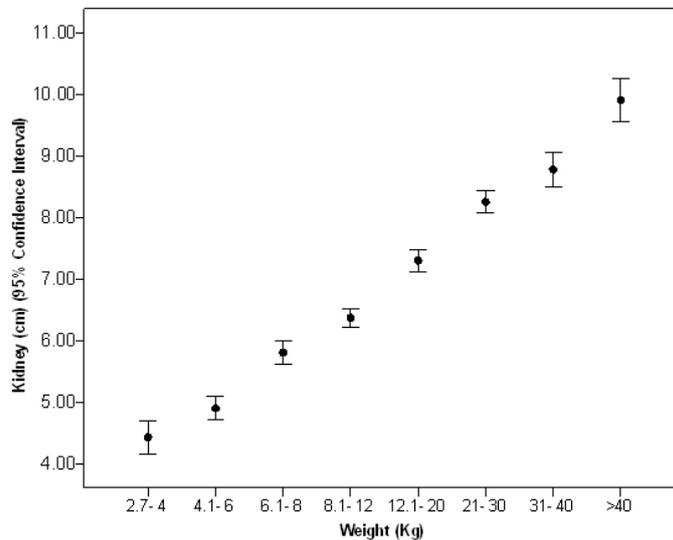


Figure 1: Graph shows kidney length versus weight

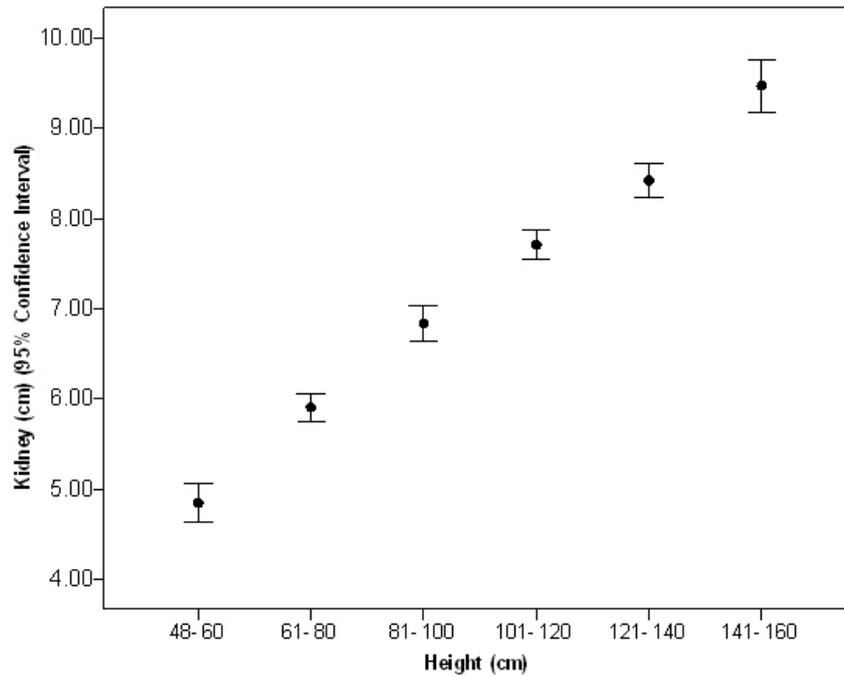


Figure 2: Figure 2: Graph shows kidney length versus height

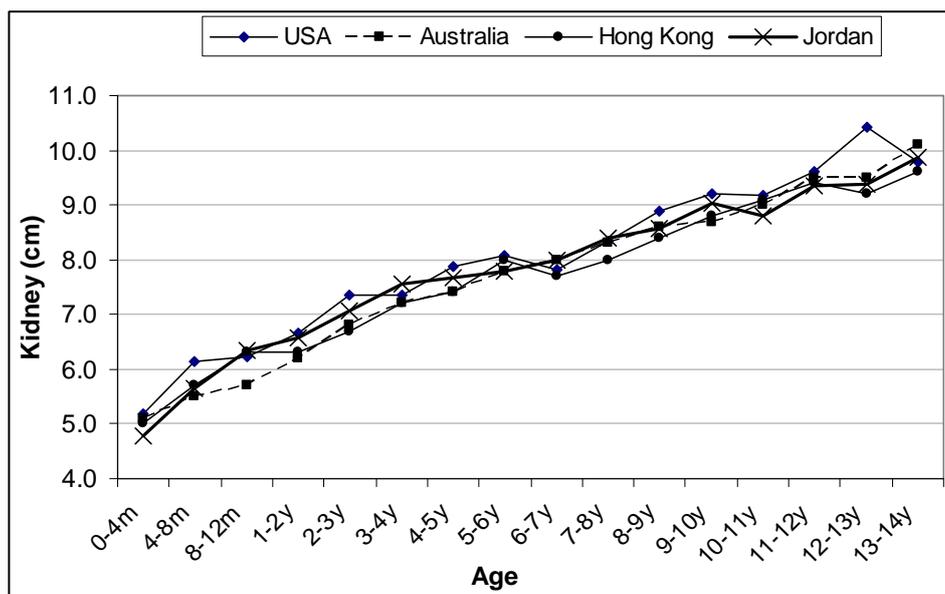


Figure 3: Graph showing mean kidney length in children from Jordan, Hong Kong, Australia, and United States

The length of the kidney was correlated with age, height and weight for all age groups. There was a steady linear increase in the

length of the kidney from 4.6 cm in the 0-3 months age group to 9.4 cm in the 12-14 year age group.

Figure 3 shows the comparison between our data and data reported in Loftus et al. (4) study in which they compared data from America, Australia, and Hong Kong. Our data showed close agreement.

Discussion

Ultrasound is the modality of choice to assess kidney length and morphology. It lacks ionizing radiation, can be performed bedside and in real time, is well tolerated by the patient and parents, and the measurements are reproducible (7,8).

Previous studies were not consistent in establishing a solid view in regard to which kidney was longer or whether there was no difference between their lengths. A number of studies showed a significant difference of length between the left and right kidneys, and most of the studies showed that the left was longer than the right (9-12). The right kidney was found to be longer than the left in few cases (3,13). And no significant difference was found in others (14,16). In our study, there was a slight difference in length between the left and right kidney, the left kidney being longer with a difference of 0.07cm. This difference was considered to be small and not of any clinical significance and may be attributed to changes in the position of the patient during the examination which is thought to influence the filling of the renal collecting system and consequently altering the size of the kidney, or probably related to the change in the degree of respiration affecting the accuracy of the obtained measurement (8).

Although there are known differences in the body composition and rate of body growth among females and males (6,17), there was no significant difference in the kidney length among boys and girls in all age groups in our study. This finding correlates well with

previous published data (1,4,11,14,16).

In children; the growth of organs is dependant on the growth of the child's body, and thus, the organ growth can be correlated with somatic parameters, such as: height, weight, and body surface area in addition to age (5). Most of the previous studies had shown that the best correlation was made with height (6,15), others found the best correlation to be with the weight (11). We compared the kidney length with age, height, and weight, and found that the kidney length correlated well with all variables, and therefore, could be used interchangeably. But since it might be difficult to obtain the height and weight of the child at the time of examination; we considered correlation with age to be more practical (18).

Chen et al and Ece et al. (9,19) suggested that different ethnic backgrounds and nutritional status may affect the growth of the kidneys in children. But a study conducted by Loftus et al (4) showed there was no difference in the kidney length between children from different ethnic backgrounds. They compared the kidney length of children from Hong Kong, Australia, and America in correlation with age. In a study by Otiv et al. (6), the authors found the length of the kidneys of Indian children to be smaller than that of American children in respect to age. However, they suggest that the difference could have been less if the length was correlated with body height. We used the data available from Loftus et al (4) to compare the kidney length versus age in our children with that of their data. We found there was no significant difference in kidney length between the Jordanian children and the Hong Kong, Australian, and American children studied in relation to age. Although a difference may be present if the data was compared in relation to other somatic parameters, which warrants

further investigations.

The limitation to this study is attributed to the fact that three radiologists of different levels of experience (5-10 years) performed the sonographic measurements contributing to inter-observer bias. In addition to the small sample size from only the north part of the Kingdom that might not be entirely representative of the whole pediatric population in Jordan.

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قياسات حجم الكلى عند الأطفال الأردنيين باستخدام جهاز التصوير التلفزيوني: نتائج من مستشفى تحويلي في شمال المملكة

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الملخص

الهدف: تهدف الدراسة إلى توفير قيم مرجعية عملية ذات مصداقية لقياسات أطوال الكلى عند الأطفال الأردنيين، ومقارنة هذه القياسات بما تم نشره علمياً.

الطريقة: لقد تم فحص ما مجموعه 331 طفلاً (156 ذكراً و175 إناثاً) بجهاز التصوير بالأموح فوق الصوتية كانوا يعانون من أمراض غير متعلقة بالجهاز البولي. وكانت جميع الكلى تبدو سليمة من ناحية المظهر والموقع. كانت أعمار أفراد العينة تتراوح بين مواليد جدد و14 عاماً. تم قياس ارتباط أحجام الكلى بعمر وطول ووزن كل فرد من أفراد العينة وأيضاً مقارنة القياسات مع الدراسات السابقة.

النتائج: أشارت النتائج إلى عدم وجود أي اختلاف ملحوظ بين حجم الكلية اليمين و الكلية اليسار، ولا يوجد أي اختلاف في حجم الكلى بين الجنسين ($P>0.05$). وكان الارتباط بين أحجام الكلى مع كل من العمر والوزن والطول جيدة. كما أن النتائج عن الأطفال الأردنيين كانت متفقة مع ما هو منشور علمياً.

الاستنتاجات: لقد تم توفير قاعدة بيانات لأحجام الكلى القياسية للأطفال الأردنيين و كانت بدورها متفقة مع البيانات المنشورة علمياً.

الكلمات الدالة: قياسات حجم الكلى، الأطفال، جهاز التصوير التلفزيوني، الأردن.