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## Sonographical evaluation of normal liver, spleen, and kidney dimensions in neonates, infants, and children upto 5 years of age at tertiary care teaching hospital in Gujarat

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### Abstract

**Objective:** The objective of this study was to determine the normal range of dimensions for the liver, spleen, and kidney in healthy neonates, infants, and children upto 5 years in Gujarat.

**Subjects and Methods:** This cross-sectional, prospective study involved 663 Paediatric participants (307 girls and 383 boys) with normal physical or sonographic findings who were examined because of problems unrelated to the measured organs. The participants were 1 day to 5 years old. All measured organs were sonographically normal. At least two dimensions were obtained for each liver, spleen, and kidney. Relationships of the dimensions of these organs with sex and age were investigated. Suggested limits of normal dimensions were defined.

**Results:** A 663 paediatric participants of which 369 (55.65%) were male and 294 (44.34%) were female participants with male to female ratio of (1.25:1). Maximum number of participants were neonates. Average size of liver, spleen and kidney found was 58.33 mm, 44.44mm, 36 x 18 mm (R), 40 x 21 mm (L) respectively.

**Conclusion:** Determination of pathologic changes in size of the liver, spleen, and kidney necessitates knowing the normal range of dimensions for these organs in healthy neonates, infants, and young children. The study provides the normal values of liver, spleen and kidney size by ultrasonography in healthy Indian children.

**Keywords:** Children, liver, measurements, spleen, kidney, ultrasonography

### Introduction

Sonography is one of the most common imaging modalities used in clinical practice. This is routinely used for evaluation of visceral organs in children because it is safe, quick and reliable for measuring the dimensions of visceral organs dimensions. This examination is real time, tridimensional, and independent of organ function. A large number of pathologic entities can affect size of the visceral organs, and the clinical examination might not be accurate to detect small increases in size. Liver and spleen size vary widely according to age. However, the normal limit of size of visceral organs according to age and body habitus has not been specified in the standard textbooks of radiology. Hence, the adult reference values are used most of the time that might lead to under detection of organomegaly in children. There are few studies to define the normal limits of organ dimensions in healthy children. However, available data are limited for the liver, spleen and kidney which causes difficulty in defining hepatomegaly, and splenomegaly on sonography. These data are even scarce among children of eastern world. Therefore, this study was conducted with the primary objective to determine the normal size of liver, spleen and kidney in healthy children and to determine the relationship of each organ with sex, height and body weight. This study would also be helpful to establish our own standards. Thus, the study is believed to provide additional data to the literature on this subject <sup>[1]</sup>.

### Materials and methods

A cross-sectional-prospective study was conducted among the indoor and outdoor patients of Paediatric department at Medical College Baroda and SSG Hospital, Vadodara. The study was carried out over a period of 6 months from 1ST January 2019- 30 TH June 2019.

**Study Setting:** The study was carried out in the indoor and outdoor patients of paediatric department at Medical College Baroda and SSG Hospital, Vadodara.

**Study Population:** All the patients of paediatric department at Medical College Baroda and SSG Hospital, Vadodara.

**Study Duration:** 6 months

**Study Design:** Prospective, Cross-sectional Study

**Sampling and Sample Size:** It was a time-bound study carried out over a period of 6 months, wherein data of 663 patients were collected.

**Inclusion Criteria**

- All children upto age of 5 who visited SSG hospital having no clinically or sonographically pathologic findings related to the studied organs.

**Exclusion Criteria**

Any child under evaluation for/follow-up case of a condition which could affect the size of the spleen, liver or kidney e.g. viral hepatitis, malaria, haemolytic anaemia, enteric fever, congestive heart failure and malnutrition was not included in the study.

**Ethical Issues:** less than minimal risk.

**Study Permission:** Approval of Institutional Ethics Committee for Human Research (IECHR) was taken before initiation of the study.

**Informed Consent Process:** Informed, written consent was obtained from the accompanying caregivers/parents of all children.

**Data Collection Procedures**

Study was conducted over 6 months and children fulfilling the inclusion criteria were enrolled. It was ensured by detailed structured parental history, examination and medical record review (if available) that these children did not have any pre-existing suspected inflammatory, metabolic, traumatic, collagen or hematopoietic diseases and malignancies, that could affect liver and spleen, kidney size. Baseline data including the age, sex, height/ length and weight were recorded for all the children in a structured Performa. The age was recorded to the nearest completed month.

**Ultrasonographic evaluation**

All the children underwent an ultrasonographic assessment of the liver, spleen and kidney size on the same day by a single radiologist (RK). All ultrasonographic scans were done on Philips Affiniti 50G Machine with a linear 10 MHz transducer by an experienced sonographer. The measurement of spleen length was the optically maximal distance at the

hilum on the longitudinal coronal view (between the most supero-medial and the most infero-lateral points) as the spleen length at the hilum is considered the most reproducible linear measurement. The liver length was measured with the child in supine position and the section level along the MCL was determined by simultaneous demonstration of the right kidney as per standard methodology. The upper and lower points of the measurement of the liver span were marked and then measured from the sonographic image. The measurements were made during quiet breathing in younger children and during breath-holding in older children. Neither preparation nor sedation was used. Longitudinal and transverse dimensions of both kidneys were obtained in the coronal plane passing through the renal hilum with subjects in the supine or slightly right or left lateral decubitus position.

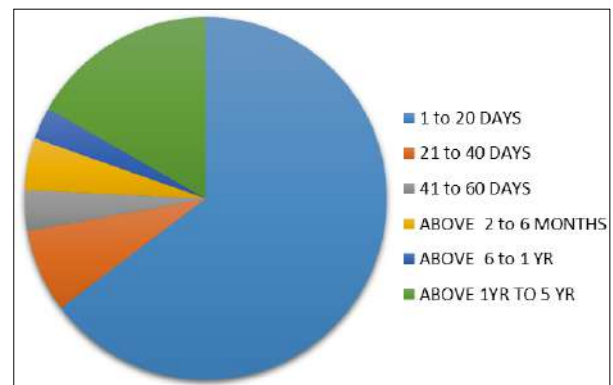
**Confidentiality Issues and Data Safety:** Confidentiality and data safety of the patients enrolled in the study is maintained.

**Statistical analysis:** The data was entered in Microsoft Excel Spreadsheet and analysed using suitable statistical tests (such as mean ± SD, percentage).

**Results**

**Demographic profile of patients according to their age and gender distribution**

A Total of 663 children between the age-group 1 day to 5 years visiting the in-patient department were evaluated during the study of which 369 (55.65%) were male and 294 (44.34%) were female participants with male to female ratio of (1.25:1). Maximum number of participants (429, (64.70%)) belonged to age group of 1 to 20 days followed by age group of 1 to 5 years (111, (16.74%)).



**Fig 1:** Age wise distribution of patients

Mean size of various age groups was depicted in tab.1 and fig.2.

Obtained data shows that Mean size of liver, spleen, kidney seen to increase in linear progression as age group advances.

**Table 1:** Age group wise size of liver, spleen and kidney

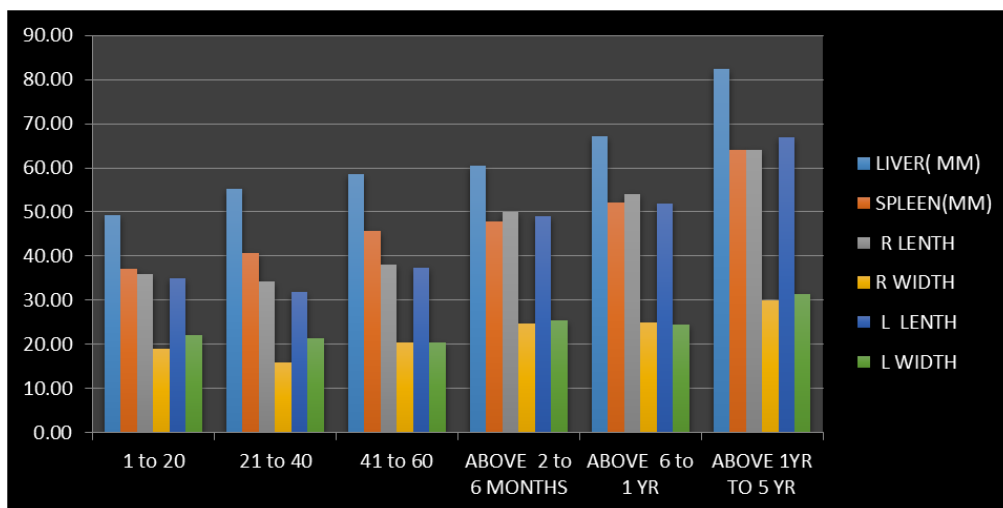
Age Group	Liver (MM)	Spleen (MM)	RK Lenth (MM)	RK Width (MM)	LK Lenth (MM)	LK Width (MM)
1 to 20 days	49.25	37.06	35.93	19.04	34.94	22.00
21 to 40 days	55.27	40.61	34.25	16.00	32.00	21.40
41 to 60 days	58.54	45.83	38.00	20.50	37.33	20.33
Above 2 to 6 Months	60.42	47.90	50.00	24.67	49.00	25.50

Above 6 to 1 YR	67.26	52.11	54.00	25.00	52.00	24.50
Above 1YR TO 5 YR	82.37	64.02	64.00	30.00	67.00	31.50

Age Group	Gender	Liver (MM)	Spleen (MM)	R Length	R Width	L Length	L Width
1to 20 Days	F	49.33	36.85	38.19	18.58	37.78	18.67
	M	49.49	37.77	38.19	18.87	38.16	18.94
21 To 40 Days	F	54.86	38.29	40.00	18.64	39.93	19.21
	M	55.43	41.54	41.83	20.49	42.26	20.60
41 To60 Days	F	51.71	37.00	37.14	19.29	37.43	18.29
	M	61.35	48.59	45.29	20.18	45.41	21.65
Above 2 To 6 Months	F	61.45	48.09	45.73	23.73	42.82	23.09
	M	59.85	47.80	48.40	22.00	47.10	23.85
Above 6 Months To 1 Yrs	F	67.25	51.00	47.63	24.13	46.38	23.25
	M	73.91	56.00	54.18	25.27	56.18	26.73
Above 1 Yr To 5 Yrs	F	78.84	59.29	56.84	26.81	56.78	28.31
	M	86.23	69.19	63.91	28.26	64.87	29.36

**Table 2:** Gender wise size of liver, spleen and kidney

Gender	Liver( MM)	Spleen(MM)	R Length	R Width	L Length	L Width
Male	58.55	45.21	35.40	19.13	40.60	23.55
Female	58.11	43.69	38.44	18.80	40.08	20.40



**Fig 2:** Age group wise size of liver, spleen and kidney

**Discussion**

Sonography is a simple and reliable way to visualize and to measure abdominal visceral organs without the risk of ionizing radiation. Organ volumes or ratios obtained by using various organ dimensions and body surface areas are already used in correlation with body parameters to describe the normal dimensions and to measure the degree of pathological deviation from normal. However, those techniques are time-consuming and impractical in daily use. On the other hand, either one or more of the longitudinal, anteroposterior, and transverse dimensions of these organs are measured as part of routine abdominal sonographic scanning.

Our study provides a standard set of normal range of liver, spleen and kidney size according to age and sex of the children, as determined by ultrasonography. Among 663 participants majority were neonate. Among the more recent ones, Dhingra *et al.* [2], Warnakulasuriya *et al.* [3], Thapa *et al.* [1]. Have provided ultrasonographic data of liver, kidney, spleen on 559, 332 and 272 children, respectively which is smaller than our study population of 663 children, however Safak *et al.* [4] have provided data on 720 children which is higher than our sample size. In a study carried out by Ugwu *et al.* [5] total 237 children with sickle cell anaemia were

included which is different than our study as we have excluded children with any pathology. A otiv *et al.* [6] included 1000 children from 1 month to 12 yrs in his study and measured renal size which is comparable to our study findings. A single radiologist performing the ultrasonography removed the inter-observer bias. However, by presenting the largest paediatric series so far, we provide a more accurate assessment of liver, spleen and kidney sizes in children, especially those in India. In addition to size, there are several palpatory characteristics of the liver and spleen (tenderness, liver edge, nodularity and consistency of the surface, etc.) that contribute significantly to the overall bedside assessment of the organomegaly. Thus, clinical liver span remains a simple practical measurement of liver size, also providing additional supplemental information, and the most applicable in developing countries. The bedside assessment of liver and splenic enlargement will not obviate diagnostic imaging when such information is vital to further therapeutic management of the patient. We believe that the results of this study can be used as a practical and comprehensive guide to indicate the normal liver and spleen length range for every child, according to his/ her age and body habitus.

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**Competing interests:** None stated.

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