

## Original Research Article

# NORMAL RANGE OF VALUES OF LIVER AND SPLEEN SIZE BY ULTRASONOGRAPHY IN CHILDREN IN BELAGAVI (NORTH KARNATAKA) – A ONE YEAR HOSPITAL BASED CROSS SECTIONAL STUDY.

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## ABSTRACT

**Background:** Liver and spleen size assessment is crucial in the pediatric population to monitor growth patterns and diagnose pathological conditions. Ultrasound is a non-invasive, safe, and widely used imaging modality for this purpose. Despite the availability of normative data for adults, pediatric reference values remain limited, especially in North Karnataka. This study aims to establish normal ultrasound values for liver and spleen size in children from this region.

**Materials and Methods:** A hospital-based cross-sectional study was conducted at Jawaharlal Nehru Medical College, KLE University, Belagavi, between January 1, 2019, and December 31, 2019. A total of 312 children aged one month to 12 years who underwent abdominal ultrasonography were included. Patients with conditions affecting liver and spleen size were excluded. Measurements were obtained using a GE Voluson 8 ultrasound machine. Data analysis included descriptive statistics, t-tests, and ANOVA to compare organ sizes across age and gender groups.

**Results:** Among the 312 participants, 174 (55.77%) were male and 138 (44.23%) were female. The mean liver length was  $9.2 \pm 2.2$  cm (range: 4.5–15.0 cm), and the mean spleen length was  $6.66 \pm 1.63$  cm (range: 3.5–11.5 cm). Liver and spleen size increased significantly with age ( $p < 0.001$ ). However, no significant difference was observed between genders ( $p > 0.05$ ).

**Conclusion:** This study establishes baseline ultrasound measurements for liver and spleen size in children from North Karnataka. The findings provide a valuable reference for pediatric radiologists and clinicians, aiding in the accurate diagnosis and management of organomegaly. Further large-scale studies can help refine these normative values.

**Keywords:** Liver size, Spleen size, Ultrasonography, Pediatric reference values, North Karnataka, Organomegaly.

## INTRODUCTION

The Liver and spleen are two of the most important intra-abdominal organs screened in paediatric population for any infection or any pathology. Ultrasound is a vital imaging technique in paediatric age group for assessing a variety of clinical conditions as it is safe besides being convenient, handy and fast. It can be used everywhere from outpatient care to emergency care to inpatient care.

The normative published values also vary according to the population and the methods used for estimation.<sup>[1]</sup> It is important to measure the dimensions of abdominal organs in paediatric age group as it is vital for observing the growth patterns of abdominal organs and their diagnosis and management if needed.<sup>[2]</sup> The size of the organ is critical in the interpretation of the disease. A physical examination may not be sufficient to detect the minor changes in the size of the organs like liver and spleen.

Also interpreting the normative data is perplexing in children due to the effect of various anthropometric characteristics such as weight and height besides age, their body habitus and various known, unknown factors. There are well established normal ranges in adults, but in the paediatric age group, there is no well established data.<sup>[3]</sup> Ultrasonography is a non-invasive, recognised, safe and fast method for measuring the size of the liver and spleen.<sup>[4,5]</sup> Spleen and liver sizes are integral part of routine abdominal ultrasonography as alteration in size can be indicative of a variety of pathological conditions.<sup>[5]</sup> In addition, false positive labelling of a patient as having organomegaly can lead to further investigations, causing anxiety to the patient as well as unnecessary expenditure.<sup>[6]</sup> The ability to recognize abnormal enlargement of an organ, inevitably requires generally accepted reference values for a particular population as sizes vary with age, gender and ethnicity.

But the literature on normal range of ultrasound size of liver and spleen in paediatric population in north Karnataka is lacking. There are also no well-designed large scale studies in Karnataka to our knowledge in this regard. But a study is necessary to provide reference values for this population as well as to see how much it is par with the reference values being followed currently. This study will also help to avoid misdiagnosis of those pathological disorders affecting the liver and spleen size.

## MATERIALS AND METHODS

The current study was hospital based cross sectional study. This study was conducted in the department of Radiodiagnosis at Jawaharlal Nehru Medical College K.L.E. University, Belgaum. All children who were advised USG abdomen as an investigation by the referring consultant to the Department of Radio-Diagnosis at The KLE'S Dr. Prabhakar Kore hospital & MRC, Belagavi between 1st January 2019 to 31st December 2019 were considered as study population.

**Sample Size:** The present study is basically a cross sectional study. In the analysis comparisons are done of liver length and spleen length in different groups like age, gender etc. The sample size calculation is based on the means of males and females in the age group of 4 to 6 years, the prominent group of the study.<sup>[3]</sup>

**Sample size formula** The minimum sample size formula based on mean and standard deviation is where  $\alpha$  is linked with the level of significance and  $z\beta$  is linked with the power of the test. For 5% level of the significance  $\alpha = 1.96$  and  $z\beta = 0.84$  for 80% power of the test. is the mean of the first group (7.4) and is the mean of the second group (7.1).  $s_1$  is the standard deviation of the first group (0.99) and  $s_2$  is the standard deviation of the second group (0.90). With these values the formula gives the value of 156 in each group. Since it is a cross sectional

study single group of  $156+156 = 312$  is taken as sample size

**Sampling method:** Universal sampling was used to reach the estimated sample size.

**Inclusion Criteria:**

- All children aged between one month to 12 years, who were advised ultrasonography of abdomen by the referring consultant from 1st January 2019 to 31st December 2019.

**Exclusion criteria:**

- Patients with any infective, inflammatory, hematological, malignant, congestive or collagenous conditions that can affect the size of the liver and the spleen.
- Non consenting patients.

**Ethical considerations:** Institutional human ethics committee approval was obtained. After explaining the procedure, objectives and all the details, only the willing participants were included in the study after getting informed consent from the parent/guardian. Their data was kept confidential.

**Methodology:** A detailed clinical history was taken using a proforma to exclude the presence of any infective, inflammatory, hematological, malignant, congestive or collagenous conditions that can affect the size of the liver and the spleen. Study was done using a USG machine G.E. VOLUSON 8.

"Liver measurements were performed in a supine position. The longitudinal axis was measured after clear visualization of the liver in the midclavicular plane. The uppermost edge under the dome of the diaphragm was taken as the upper margin, and the lowermost edge as the lower margin. Spleen measurements were performed in a lateral decubitus position. The longitudinal measurement of the spleen was taken between the most supero-medial and the most infero-lateral margins".

(i) Equipment: USG MACHINE G.E. VOLUSON 8

**Statistical Methods:** Descriptive analysis: Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency and proportion for categorical variables. Data was also represented using appropriate diagrams like bar diagram and pie diagram.

**Categorical outcome:** The association between explanatory variables and categorical outcomes was assessed by cross tabulation and comparison of percentages. Odds ratio along with 95% CI is presented. Chi square test was used to test statistical significance.

For normally distributed Quantitative parameters the mean values were compared between study groups using Independent sample t-test (2 groups).

The association between categorical explanatory variables and quantitative outcome was assessed by comparing the mean values. The mean differences along with their 95% CI were presented. ANOVA was used to assess statistical significance. P value < 0.05 was considered statistically significant. IBM SPSS version 22 was used for statistical analysis.

## RESULTS

**Table 1: Descriptive analysis of age groups in the study population (N=312)**

Age Groups	Frequency	Percentages
1 month - <3 months	25	8.01%
3 months - <6 months	28	8.97%
6 months - <12 months	26	8.33%
1 year - <2 years	45	14.42%
2 years - <4 years	56	17.95%
4 years - <6 years	36	11.54%
6 year - <8 years	35	11.22%
8 years - <10 years	34	10.90%
10 years - <12 years	27	8.65%

Among the study population, 25(8.01%) participants were aged between 1 to <3 months, 28 (8.97%) were aged between 3 to <6 months, 26 (8.33%) were aged between 6 to <12 months, 45 (14.42%) were aged between 1 to <2 years, 56 (17.95%) were aged between 2 to <4 years , 36 (11.54%) were aged

between 4 to <6 years , 35 (11.22%) were aged between 6 to <8 years , 34 (10.9%) were aged between 8 to <10 years , 27 (8.65%) were aged between 10 to <12 years. Among the study population, 174 (55.77%) were male and remaining 138 (44.23%) participants were female.

**Table 2: Descriptive analysis of liver- length, spleen-length in study population (N=312)**

Parameter	Mean $\pm$ SD	Median	Minimum	Maximum	95% C.I	
					Lower	Upper
Liver- Length	9.2 $\pm$ 2.2	8.9	4.5	15.0	9.0	9.4
Spleen-Length	6.66 $\pm$ 1.63	6.5	3.5	11.5	6.5	6.9

The mean Liver- Length was 9.2  $\pm$  2.2 in the study population, minimum level was 4.5 and maximum level was 15 in the study population (95% CI 9 to 9.4). The mean Spleen-Length was 6.66  $\pm$  1.63 in the

study population, minimum level was 3.5 and maximum level was 11.5 in the study population (95% CI 6.5 to 6.9).

**Table 3: Comparison of mean of liver - length and spleen - length between gender (N=312)**

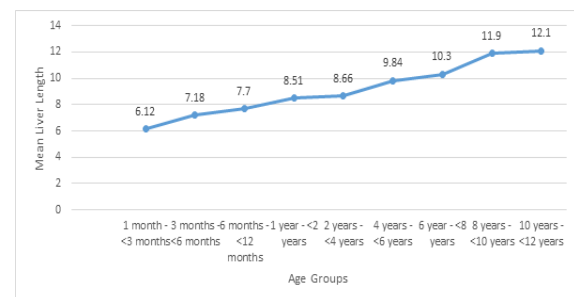
Parameter	Gender (Mean $\pm$ SD)		P value
	Male (N=174)	Female (N=138)	
Liver- Length	9.17 $\pm$ 2.24	9.23 $\pm$ 2.15	0.815
Spleen-Length	6.7 $\pm$ 1.72	6.62 $\pm$ 1.52	0.696

There was no statistically significant difference in mean Liver- Length (P value 0.815) and mean Spleen- Length (P value 0.696) between Gender.

**Table 4: Comparison of mean liver- length across the age groups (N=312)**

Age Groups	Liver- Length Mean $\pm$ SD	Mean difference	95% CI		P value
			Lower	Upper	
1 month - <3 months	6.12 $\pm$ 1.12				
3 months - <6 months	7.18 $\pm$ 0.9	-1.06	-1.77	-0.36	0.003
6 months - <12 months	7.7 $\pm$ 1.07	-1.58	-2.30	-0.86	<0.001
1 year - <2 years	8.51 $\pm$ 1.12	-2.39	-3.03	-1.75	<0.001
2 years - <4 years	8.66 $\pm$ 1.05	-2.54	-3.16	-1.92	<0.001
4 years - <6 years	9.84 $\pm$ 2.22	-3.72	-4.39	-3.05	<0.001
6 year - <8 years	10.3 $\pm$ 1.07	-4.17	-3.03	-1.75	<0.001
8 years - <10 years	11.9 $\pm$ 1.04	-5.87	-3.16	-1.92	<0.001
10 years - <12 years	12.1 $\pm$ 1.32	-6.02	-4.39	-3.05	<0.001

The Mean Liver- Length for 1 month - <3 months participants was 6.12  $\pm$  1.12, Taking as base line, the mean difference of Liver- Length (1.06) in 3 months - <6 months participants was statistically significant (P value <0.05) and the mean difference of Liver - Length in 6 months - <12 months (1.58) , 1 year - <2 years (2.39) , 2 years - <4 years (2.54) , 4 years - <6 years (3.72) , 6 year - <8 years (4.17) , 8 years - <10 years (5.87) , 10 years - <12 years (6.02) was also statistically significant (P value <0.05).



**Figure 1: Line chart for comparison of mean of liver - length across the age groups (N=312)**

The Mean Spleen- Length for 1 month - <3 months participants was  $4.88 \pm 1.15$ , Taking as base line, the mean difference of Spleen- Length (0.5) in 3 months - <6 months participants was statistically not significant (P value 0.142) and the mean difference

of Spleen - Length in 6 months - <12 months (1.20) , 1 year - <2 years (1.45) , 2 years - <4 years (1.18) , 4 years - <6 years (2.13) , 6 year - <8 years (2.65) , 8 years - <10 years (3.50) , 10 years - <12 years (3.43) was statistically significant (P value <0.05).

**Table 5: Comparison of mean of liver- length and Spleen length between gender at different age groups.**

Gender	Frequency	Parameter	
		Liver- Length (N=312)	Spleen-Length (N=312)
Age Group (1 month – <3 months)			
Male	14	6.24 ± 1.22	4.89 ± 1.36
Female	11	5.96 ± 1.01	4.85 ± 0.9
P value		0.548	0.936
Age Group (3 months – <6 months)			
Male	18	7.29 ± 0.89	5.32 ± 0.48
Female	10	6.98 ± 0.94	5.49 ± 0.56
P value		0.386	0.395
Age Group (6 months – <12 months)			
Male	17	7.61 ± 1	6.22 ± 1.17
Female	9	7.88 ± 1.22	5.82 ± 0.97
P value		0.556	0.394
Age Group (1 year – <2 years)			
Male	28	8.44 ± 1.05	6.48 ± 1.5
Female	17	8.62 ± 1.26	6.06 ± 1.14
P value		0.611	0.329
Age Group (2 years – <4 years)			
Male	29	8.51 ± 0.92	5.92 ± 1.53
Female	27	8.82 ± 1.16	6.2 ± 0.9
P value		0.280	0.413
Age Group (4 years – <6 years)			
Male	16	10.09 ± 2.5	7.28 ± 1.66
Female	20	9.65 ± 2.02	6.8 ± 1.24
P value		0.560	0.326
Age Group (6 years – <8 years)			
Male	19	10.52 ± 0.82	7.67 ± 0.94
Female	16	10.02 ± 1.29	7.36 ± 1.6
P value		0.176	0.479
Age Group (8 years – <10 years)			
Male	21	12.15 ± 1.36	8.52 ± 1.01
Female	13	11.49 ± 1.35	8.13 ± 1.35
P value		0.177	0.340
Age Group (10 years – <12 years)			
Male	12	12.32 ± 1.22	8.41 ± 1.62
Female	15	12 ± 1.42	8.23 ± 1.36
P value		0.546	0.763

There was no statistically significant difference in mean Liver- Length and mean Spleen- Length for participants of all type of Age Groups between Gender.

## DISCUSSION

Any abnormality in the size of the liver or spleen may denote a pathological disease. But its assessment is challenging, with change in the size of the organs with age. The normative published values also vary according to the population and the methods used for estimation.

This cross sectional study was conducted with the objective of estimating the normal values for liver and spleen size in children and to correlate it with age and sex of children. A total of 312 subjects were included in the final analysis aged between one month to 12 years. Similar to our study, Dhingra B et al,<sup>[3]</sup> did their study on 597 healthy Indian children and measured the length of the spleen and liver sonographically. Their study population included children between the age of one month to 12 years similar to our study. Calle-Toro JS et al<sup>[1]</sup> did a

systematic review on Liver, Spleen, and Kidney Size in Children as measured by ultrasound. Their study population included children from birth to 18 years. Rousan LA et al,<sup>[7]</sup> did their study on 315 children to establish normal reference values for liver and spleen size in children similar to our study.

There was an even distribution of study subjects across the age groups in our study. 25.3% of the children were aged between one month to one year. 17.95% were aged between two to four years while 14.42% were aged between one to two years. In the study by Dhingra B et al,<sup>[3]</sup> 17.9% of study subjects were aged between one month to one year. 22% of study subjects were aged between two to four years while 12.9% were aged between one to two years. Their median age was 48 months with a range of one to 156 months. The study subjects in their study were slightly older compared to our study as 50% of study subjects were aged 4 years and above in their study



compared to only 42.3% in our study. There was also an equal distribution of study subjects, age group wise in the study by Rosenberg HK et al.<sup>[4]</sup> In their study, out of the 230 subjects, 58 were aged less than one year, 36 subjects were aged between one to four years while 136 were aged between four to twenty years.

The mean Liver length was  $9.2 \pm 2.2$  cm. The maximum length was 15 cm. The mean length of the liver was  $9.59 \pm 1.98$  cm in the study by Dhingra B et al.<sup>[3]</sup> It was similar to our study. They measured the liver length with the child in supine position along the MCL. They used Philips Envisor® Color Doppler system with a multi-frequency 3.5 to 5 MHz probe in their study. USG MACHINE G.E. VOLUSON 8 was used in our study. In our study also, the longitudinal axis in mid-clavicular plane was used. We also placed the subjects in supine position for measurement.

Özdikici M et al,<sup>[8]</sup> in their study observed the Midclavicular Line Longitudinal Diameter (MCLLD) in their study similar to our study. They also measured in the supine position with a 3.5 MHz convex transducer.

The mean liver length was  $6.12 \pm 1.12$  cm in 1 month to <3 months age group in our study. There was a statistically significant difference between mean liver length at baseline compared to mean liver length at various age groups. There was a statistically significant increase in mean length of the liver with age. Dhingra B et al,<sup>[3]</sup> in their study also observed that there was a statistically significant increase in length of the liver with increase in age similar to our study ( $P < 0.05$ ). Calle-Toro JS et al,<sup>[1]</sup> in their systematic review also concluded that liver size increases constantly with growth of the child. Özdikici M et al,<sup>[8]</sup> in their study also observed that there was no significant difference between the sexes with regards to length at various age groups. Dhingra B et al,<sup>[3]</sup> in their study also observed there was no significant difference between the sexes with regards to mean length of liver across various age groups.

The mean Spleen length was  $6.66 \pm 1.63$  cm. The maximum length was 11.5 cm. The mean length of the spleen was  $6.99 \pm 1.36$  cm in the study by Dhingra B et al.<sup>[3]</sup> It was similar to our study. In our study, lateral decubitus position was used for measuring the spleen length longitudinally. In the study by Dhingra B et al,<sup>[3]</sup> the longitudinal coronal view was used. In the systematic review by Calle-Toro JS et al,<sup>[1]</sup> the length of the spleen was measured in all studies in the sagittal plane longitudinally and ranged from 5.2 cm in younger patients, to a maximum of 12.5 cm in older patients.

The Mean spleen length was  $4.88 \pm 1.15$  cm in 1 month to <3 months age group in our study. There was a statistically significant difference between mean spleen length at baseline compared to spleen length at various age groups except at 3 months to <6 months. There was a statistically significant increase in mean length of the spleen with age ( $p < 0.001$ ) except at 3 months to <6 months age compared to baseline. Dhingra B et al,<sup>[3]</sup> in their study also

observed that there was a statistically significant increase in length of the spleen with increase in age similar to our study. Calle-Toro JS et al,<sup>[1]</sup> in their systematic review also concluded that spleen size increases constantly with growth of the child. Özdikici M et al,<sup>[8]</sup> and Dhingra B et al,<sup>[3]</sup> in their study also observed there was no significant difference between the sexes with regards to mean length of spleen across various age groups and seen by other studies.<sup>[9,10]</sup>

Clinical methods of liver and spleen size can be very variable and inaccurate. USG provides a reliable and easy alternative method for estimating the size of the liver and spleen. In addition to size or length, there are several palpatory characteristics of the liver and spleen like the edges, nodularity, consistency etc. contributing to the bedside assessment of organomegaly.<sup>[11,12]</sup>

**Limitations:** Our study was only a single center hospital based study. The sampling was done conveniently. Only the children referred by the treating consultant were included. The generalizability of our study results may not be valid. But our study is one of the kind in creating a database for normal values of liver and spleen from this part of the country. One limitation of USG is the inter observer variability, which was overcome by the same investigator performing all the procedures in our study. But new problems include enhanced visualization of various anatomic layers in the current scenario resulting from more advanced technology, leading to erroneous placement of measurement markers compared to previous studies.

## CONCLUSION

The size of the organ is critical in the interpretation of the disease. A physical examination may not be sufficient to detect the minor changes in the size of the organs like liver and spleen. The mean Liver length was  $9.2 \pm 2.2$  cm. The maximum length was 15 cm. There was a statistically significant difference between mean liver length at baseline compared to mean liver length at various age groups. Sex is not a determining factor for organ dimensions in the pediatric age group. There was no statistically significant difference between male and female children with regards to mean length of the liver ( $p$  value = 0.815) and also across various age groups.

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