**ORIGINAL ARTICLE**

# Normative Data of Hepato-Splenic Sizes in Pakistani Pediatric Population Using Ultrasonography

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**ABSTRACT**

**Background:** Hepatosplenic sizes of children vary with age .There are many diseases which affect the sizes of the liver and spleen ranging from acute liver disease to other hepatosplenic disorders . Ultrasound is a quick and reliable method .Unfortunately there is lack of sufficient data in our population therefore my study would be beneficial in determining various disease processes.

**Objective:** To establish normative data of Hepato-Splenic sizes in Pakistani pediatric population using ultrasonography.

**Methods:** The study was conducted at the Ziauddin University Hospital, a tertiary care teaching facility in Karachi. The cross sectional prospective hospital based study was conducted with 150 patients aged 1 month to 14 years. Ultrasonographic evaluation for the assessment of liver, spleen and portal vein size was performed. These were correlated with the age, sex, height/length and weight of the children.

**Results:** Normal liver and spleen length and its ranges with portal vein diameter were obtained. The liver, spleen length and portal vein significantly correlated highly with the height/length (r=0.7,0.7,0.6 )respectively and weight of the subjects (r=0.7,0.7,0.4 respectively).

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**Conclusion:** The study provides the normal values of liver and spleen size by ultrasonography in healthy Pakistani pediatric population.

**Keywords**: *Hepatosplenic Size, Ultrasound, Liver Transplant, Chronic Liver Disease.*

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## INTRODUCTION

The variations in the anthropometric features of various populations, races and regions are an established and proved fact in west.[1] Ultrasonography is a non-invasive, established, safe, fast and reliable method for measurement of liver and spleen sizes.[2] Liver and spleen size changes according to age of the children. Many diseases can affect their size, ranging from inflammatory processes to malignant diseases. Palpation and percussion are the bedside techniques to document liver and spleen size, but are far from accurate to detect small increase in sizes.

Imaging children with liver diseases plays a major role in diagnosis and treatment. Follow up after long-term medical therapy is essential. Nowadays liver transplantation also depends on imaging assessment.[3,4] Major goal for pre transplantation imaging is to detect abnormalities that would lead to successful transplantation or standard surgical approach.[5]

Chronic liver disease may be caused commonly by persistent viral infections, metabolic diseases, drugs, autoimmune hepatitis, or unknown factors.[6] The National Program for Prevention & Control of Hepatitis has been implemented in Pakistan since August 2007.According to this program the prevalence of Hepatitis B & C in children of Pakistan is 3-4% and 5-6% respectively.[7]

The obesity and insulin resistance in children has also been increasing dramatically in pediatric population. Nonalcoholic fatty liver disease is also getting prevalent in children.[8,9]

The spleen is palpable in 15%–17% of healthy neonates[10,11] and 10% of healthy children; There are numerous causes for splenomegaly from enteric fever, malaria, sickle cell disease etc. Spleen size varies widely according to age also many diseases can affect their size, including infections and malignancy. [4,26]

The study has been conducted to document the normal sizes of spleen and liver in orthogonal dimensions in pediatric population which may be beneficial in the assessment of various disease processes. Presently, little data is available in imaging of children. The baseline data collected will help in determining the variations from international data.

## METHODOLOGY

This descriptive study was conducted in the Radiology Department at a private tertiary care teaching hospital. A total of 180 asymptomatic children between the age-group 1 month to 14 years were approached randomly out of which only 150 children were evaluated from January to June 2014. Non probability purposive sampling technique was used. Children suffering from any of a condition which could change the size of spleen or liver like viral hepatitis, malaria, hemolytic anemia, enteric fever, congestive heart failure, malnutrition were excluded from the study. Some children with urinary tract infection were included in this study as this condition do not change the sizes of liver and spleen. Consent was taken from the parents. A detailed parental history was taken for any pre existing disease relevant to heptosplenic sizes. There were 30 parental refusals for participation due to lack of time or awareness.

Baseline data including the age, sex, height/length and weight were recorded for all

the children in a structured performa. The ages were recorded to the nearest completed month.

The high-resolution real-time ultrasound machine Xario$^{TM}$ 200 Toshiba [Tokyo, Japan] with 3.5-MHz convex transducers. Patients had neither undergone preparation nor sedation during ultrasound examination. All measured organs had a normal position, shape and echo texture. The measurement of spleen length was the 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.[12,13,14] The splenic width was taken at the point of splenic hilum. The liver length was measured with the child in supine position and the section level along the Mid-Clavicular Line (MCL) was determined by simultaneous demonstration of the right kidney as per standard methodology.[15] For liver anteroposterior dimensions and longitudinal dimensions were obtained in the midsagittal planes each for the right and left lobes. Midsagittal plane means that the plane passes through the xiphoid process. In both planes, the tip of liver was defined as the uppermost edge under the dome of the diaphragm, whereas the lower margin was defined as the lower most edge of the lobe.[16]

The mean portal vein diameter was also calculated and the portal vein diameter was cross tabulated with the age of the patient. Measurement of the portal vein diameter was taken in quiet respiration at the hilum of the liver just before bifurcation into right and left main portal branches. Supervision was made during the data collection by the PG to assure the data quality.

Data obtained from the measurements were classified into 8 age groups. Relationships of all dimensions with sex, age, height, weight and body mass index were statistically analyzed. Data was analyzed on SPSS version 19.0. All categorical variables were presented as percentage and frequency, and all numerical variables as mean and standard deviation. Appropriate test of significance was applied.

## RESULTS

The mean age of the subjects obtained in our study is 6.5 +/- 3.8.out of which 84 (56%) were male and 66 (46%) female. All the children were stratified into eight subgroups (Figure 1).

**Table 1. Age and Sex Distribution of the Study Population**

| Age Group | Male n (%) | Female n (%) | Total n (%) |
|---|---|---|---|
| 1 to 12 months | 9 (6.3) | 8 (5.6) | 17 (11.9) |
| 1 to < 2 year | 5 (3.6) | 6 (4.2) | 11 (7.7) |
| 2 to < 4 year | 8 (7) | 16 (13.9) | 24 (20.9) |
| 4 to < 6 year | 17 (14.8) | 14 (12.2) | 31 (27) |
| 6 to < 8 year | 11 (9.6) | 9 (7.8) | 20 (17.4) |
| 8 to < 10year | 12 (10.4) | 4 (3.5) | 16 (13.9) |
| 10 to <12 year | 16 (13.9) | 8 (7) | 24 (20.9) |
| 12 to 14 year | 6 (4) | 1 (0.7) | 7 (4.7) |
| **Total (%)** | **84 (56)** | **66 (44)** | **150 (100)** |

**Table 2. Descriptive Statistics of Organ Measurements (cm)**

| Organ Measurements | Male Mean (SD) | Female Mean (SD) | P-Value |
|---|---|---|---|
| Liver length | 11.5 (2.6) | 10.2 (1.9) | 0.001 |
| Spleen length | 7.5 (1.6) | 7.1 (1.5) | 0.02 |
| Spleen width | 3.5 (0.8) | 3.0 (0.8) | 0.001 |
| RT lobe AP | 9.3 (1.9) | 8.8 (2.0) | 0.11 |
| LT lobe AP | 4.7 (1.4) | 4.4 (0.9) | 0.21 |
| Portal Vein Size | 0.6 (0.2) | 0.5 (0.1) | 0.09 |

**Table 3. Organ Measurements according to age Groups**

| Age Group | Liver Length Mean (SD) | Spleen Length Mean (SD) |
|---|---|---|

| | | |
|---|---|---|
| **1 to 12 months (n)**<br>• Male (9)<br>• Female (8) | 7.9(1.7)<br>6.8 (2.0) | 4.9 (1.5)<br>4.7 (2.3) |
| **1 to < 2 year (n)**<br>• Male (5)<br>• Female (6) | 9.6 (1.5)<br>9.4 (1.7) | 6.4 (1.6)<br>6.2 (1.6) |
| **2 to < 4 year (n)**<br>• Male (8)<br>• Female (16) | 10.6 (0.9)<br>9.2 (0.9) | 7.1 (0.7)<br>7.3 (0.9) |
| **4 to < 6 year (n)**<br>• Male (17)<br>• Female (14) | 10.6 (1.0)<br>9.5 (1.0) | 7.0 (0.5)<br>7.0(0.9) |
| **6 to < 8 year (n)**<br>• Male (11)<br>• Female (9) | 11.4 (0.9)<br>11.0 (0.6) | 8.3 (1.0)<br>8.1 (0.6) |
| **8 to < 10year (n)**<br>• Male (12)<br>• Female (4) | 12.1 (1.0)<br>12.4 (0.3) | 8.6 (1.8)<br>8.7 (0.4) |
| **10 to <12 year (n)**<br>• Male (16)<br>• Female (8) | 13.3 (3.4)<br>11.8 (0.4) | 8.6 (0.6)<br>8.6 (0.5) |
| **12 to 14 year (n)**<br>• Male (6)<br>• Female (10 | 13.2 (0.4)<br>11.5 (0.0) | 9.1 (0.1)<br>9.3 (0.0) |
| **P- Value** | **0.000** | **0.000** |

**Table 4. Measurements according to Hieght weight**

| Parameter | Liver Length mean (SD) | Spleen Length mean (SD) | Portal Vein Size mean (SD) |
|---|---|---|---|
| **Height (cm)** | | | |
| 50-80 | 9.12 (1.1) | 5.74 (1.1) | 0.41 (0.1) |
| 81-100 | 10.16 (0.6) | 6.55 (0.75) | 0.46 (01) |
| 101-120 | 10.42 (1.2) | 7.17 (0.79) | 0.55 (0.1) |
| 121-140 | 12.88 (2.5) | 8.38 (1.1) | 0.63 (0.1) |
| >140 | 12.81 (0.9) | 8.59 (1.0) | 0.63 (0.2) |
| **Weight (kg)** | | | |
| ≤ 10 | 8.01 (1.8) | 5.11 (1.5) | 0.35 (0.1) |
| 10.1-20 | 10.51 (0.9) | 7.31 (0.8) | 0.53 (0.1) |
| 20.1-30 | 12.33 (2.4) | 8.10 (1.05) | 0.63 (0.1) |
| 30.1-40 | 12.55 (0.7) | 8.72 (0.2) | 0.77 (0.1) |

The Ethnic background of the children suggested 41.3% pathan, 19.3 % sindhi, 14.7 % Punjabi, 12 % urdu speaking, 6.7 % balochi and 6 % others.

The statistical results of the liver, spleen and portal vein size estimation by sonographic measurement of the longitudinal and antero-posterior dimensions are tabulated to the effective variables such as gender, height, weight and age in Tables 1,2 and 3 . No significant difference was found between the results of females and males of all the age groups as depicted in Table 4,

Liver length correlate significantly with height (r=0.769 ) and weight (r=0.738),Spleen length correlate significantly with height (r=0.781 ) and weight (r=0.736),Portal vein size correlate significantly with height (r=0.635) and weight (r=0.454)

**Figure 1. Anteroposterior measurements of Right and Left Lobe of Liver.**


Multiple regression analysis with liver length as dependent variable showed that both height (β coefficient 0.441, SE 0.01, P= 0.000) and age (β

coefficient 0.205, SE 0.06, P= 0.04) had significant independent positive association with liver length, no significant association could be seen with weight (β coefficient 0.17, SE 0.03, P= 0.142)

**Figure 2. Portal vien diameter and longitudnal dimension of the Liver from upper most to the lower most edge**.


**Figure 3. Length and width of the spleen.**


Multiple regression analysis with Spleen length as dependent variable showed that both height (β coefficient 0.669, SE 0.007, P= 0.000) and weight (β coefficient 0.241, SE 0.02, P= 0.043) had significant independent positive association with Spleen length, no significant and negative association could be seen with age (β coefficient -0.123, SE 0.041, P= 0.21)

Multiple regression analysis with Portal Vein Size as dependent variable showed that both height (β coefficient 0.964, SE 0.001, P= 0.000) and age (β coefficient 0.308, SE 0.005, P= 0.008) had significant positive association with portal vein size while, weight (β coefficient -0.659, SE 0.002, P=0.000) had significant but negative association.

## DISCUSSION

By reviewing the literature the clinical estimation of liver size in children has been done in 1970 by Deligeorgis et al[14] who examined liver size clinically and roentgenographically in 365 healthy infants and children. This study emphasized the value of examining both the upper and lower borders of liver, but due to the radiation hazards was not acknowledged. In 1982, Wiseman et al[16] examined 100 neonates with percussion of the upper border and palpation of the lower border. The liver span was reported 5.65 cm with 95% confidential interval. No correlation was found between weigh, height, sex and the liver size. In 1983, Detrich[15] reported that the evaluation of liver size by percussion and palpation method was unreliable. He performed sonography as a non invasive and more accurate method for liver and spleen size measurements with demonstration of anatomy of the liver in 794 children. He reported a correlation between liver size and the child's height as a reference parameter. Safak, et al[17] studied 712, 7-15 year old children and provided data according to bodyweight groups. Konus, et al[18] studied liver and spleen sizes for 307 children and provided the data in height-range and age-group categories. The results of the current study are comparable to these. They considered the height was the best index to correlate with longitudinal dimension of liver. They believed this was due to different techniques. In our study we tried to acquire the same technique.

The current study showed a significant correlation between liver (M.C.L & A-P), spleen (length and width) and portal vein dimensions with body parameters (Table 4). Among which, the body height is correlated best to the size of the liver. In the study the length of the entire liver was measured but right and left lobe dimensions

were also measured separately in anteroposterior manner.

De Land[19] stated that the spleen showed variation according to sex and age. He reported that spleen in females was smaller than males in all age groups. But Niederau et al.[20] in their sonographic study, which was carried out on adults, found that spleen size decreased with increasing age

All the nutrient rich blood from the GIT flows into the portal vein which determines the anatomical division of the hepatic lobes.[21,22] The length of the portal vein is of surgical importance which is often cut down to link with other vessels in interventional procedures like liver transplantation, trans hepatic portal vein embolization and pancreatectomy.[23] Literature review has shown that the most primitive diameter of portal vein was established as 6.3 ± 2.3mm in west.[24] Gray scale assessment of portal vein diameter is corner stone in the initial evaluation. Knowing the normal portal venous dimension in a specified population is crucial nowadays.

Hawaz in his study showed mean portal vein diameter of 7.9 +/- 2mm with an increase in diameter with increase in age of the subject. He also revealed 21.5% increase in portal vein diameter with the phases of inspiration.[25]

## CONCLUSION

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. There were some limitations in our study as described above due to awareness and reluctance of parents we had small sample size , so another study with large sample size will be required which may also improve our estimates in daily practice in clinical radiology.

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