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Original Research Article

STUDY OF CORRELATION OF LIVER SIZE WITH HEIGHT IN NORTH-EAST KARNATAKA CHILDREN BY ULTRASONOGRAPHY

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ABSTRACT

Background: Liver vary widely according to age. Many diseases can affect their size ranging from infective processes to malignant disorders. Palpation and percussion are standard bedside techniques to document but are far from accurate to detect small increases in size.Variations in the anthropometric features of various populations, races and regions are an established fact.

Ultrasonography is widely used in medicine.It is possible to perform both diagnosis and therapeutic procedures. Sonography is effective for imaging soft tissues of body. Ultrasound is an extremely important imaging method in evaluation of liver in children due to the fact that it is easy to use, non invasive, safe, quick and accurate. In present study, aim is to evaluate correlation of liver size with the parameters such as age, sex and height in children.

Objective: To know whether there is any correlation between the normal liver size with parameters such as age, sex and height in children.

Materials and Methods: Present study is cross-sectional in nature and conducted in Government Medical College and District Hospital, Bidar. Sample size of 260 cases was taken between the age group of 1 to 17 years, infancy to middle adolescence period living in North-east part of Karnataka.

Results: The mean liver length is greater in males in all age groups and it increases in older children in the age group of 10-13yrs and 14-17 yrs among both males and females. Liver length highly correlated with each age and height in both male and female children.

Conclusion: The methods of measurement and analysis used in this study is standardized and easy to apply. Findings are handy and reliable and is suitable particularly for radiology and pediatric departments. The results of this study can be used as a practical and comprehensive guide to indicate the normal liver length range for every child, according to his/ her age.

KEY WORDS: Liver length, Ultrasonography , Age, Sex, Height.

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INTRODUCTION

Liver is a vital organ of our body. It is reddish brown organ with four lobes of unequal size and shape. It is the largest internal organ and gland in the human body. It is located in the right upper quadrant of the abdominal cavity , resting just below the diaphragm. The liver lies to the right of the stomach and overlies the gallbladder.

Hepatomegaly is the enlarged liver. An enlarged liver may not always be palpable if it is slightly enlarged and a palpable liver is not always englarged. Hepatomegaly are caused by septicaemia, malaria, kala-azar, CCF, cirrhosis, sarcoidosis, leukemias, lymphoma, Gaucher's disease, metastasis, secondaries, arsenic and phosphorus poisoning. Hepatomegaly is of great concern.

Liver size vary widely according to age. Many diseases can affect their size ranging from infective processes to malignant disorders. Palpation and percussion are standard bedside techniques to document but are far from accurate to detect small increases in size [1]. Variations in the anthropometric features of various populations, races and regions are an established fact.

Ultrasound is an extremely important imaging method in evaluation of liver in children due to the fact that it is easy to use, non invasive, safe, quick and accurate. In present study, aim is to evaluate correlation of liver with the parameters such as age, sex, height in both male and female children [1].

There is no comprehensive anthropometric study on normal measurements of liver size by ultrasonography in North East Karnataka region (Bidar District) therefore, it is thought pertinent to undertake present study to evaluate the normal measurement of liver. Hence in the present study an attempt is made to study how liver size varies with age in children of both sexes and correlate this finding with various anthropometric parameters of the body.

MATERIALS AND METHODS

The present study is cross-sectional in nature and conducted in Government Medical College and District Hospital, Bidar.

Sample size of 260 cases was taken between the age group of 1 to 17 years, infancy to middle adolescence period living in North-east part of Karnataka. This age group was selected since there is increase in longitudinal dimensions of organs rapidly during first year of life and puberty along with body growth.

These children came to hospital as outpatients for either a follow up examination or a routine check up . The follow up examination concerned previously treated conditions such as mild upper respiratory tract or urinary tract infections, while the check up concerned routine cases with atypical recurrent abdominal pain.

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

Informed and verbal consent was obtained from the accompanying guardians/parents of all children, and verbal assent taken from all children older than 5 year. Baseline data including the age, sex and height were recorded for all the children in a structured proforma. The age was recorded to the nearest completed month. A wall mounted stadiometer (1 mm markings) were used to measure the height (cm), as per standard methodology [2].

In each child, the mid clavicular line was defined and as well as sonographic measurements were done with reference to midclavicular line[2]. Deeper structures such as liver and kidney are imaged at a lower frequency1–6 MHz with lower axial and lateral resolution but greater penetration.

Ultrasonographic evaluation: All the children underwent an ultrasonographic assessment of the liver size by using a Philips HDI 4000 200-240V -5A,50/60HZ system. The liver length was measured with the child in supine position and the section level along the midclavicular

line was determined by simultaneous demonstration of the right kidney as per standard methodology[3]. 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.

All measured liver had a normal position shape and texture. Three sequential measurements were obtained and calculated mean, thus assured minimum intraoperator variation and greater accuracy and reliability of measurements. Observations obtained in respect with all the variables was tabulated and shown by using Bar diagram, Pie chart and Scatter plots. The findings was then statistically analysed and "p" value determined. Statistical significance is mentioned below each table.

The results were then discussed with other comparable studies done by various workers inside and outside India . After discussing the results, final conclusions were mentioned of the present study.

OBSERVATIONS AND RESULTS

The present cross-sectional study is done among 260 cases, where in 149 are female children and 111 are male children. The below pie chart shows that 57.3% are female children and 42.7% are male children.

Chart 1: Represents the percentage distribution of female and male children.

Female Statistics: n = 149

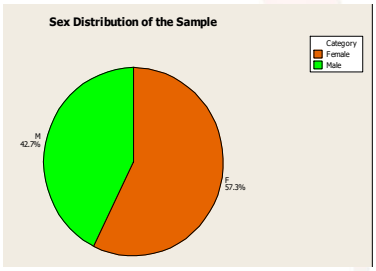


Table 1: Mean, SD, and median for different parameters among female children.

Parameter	Mean	SD	Median
Age (yrs)	10.7	4.3	11
Height (cm)	128.3	26.5	134
Liver length (cm)	11.2	1.5	11.2

In females, mean age= 10.7, mean height =10.7, mean liver length =11.2, SD = 1.5, median = 11.2

Male Statistics: n = 111

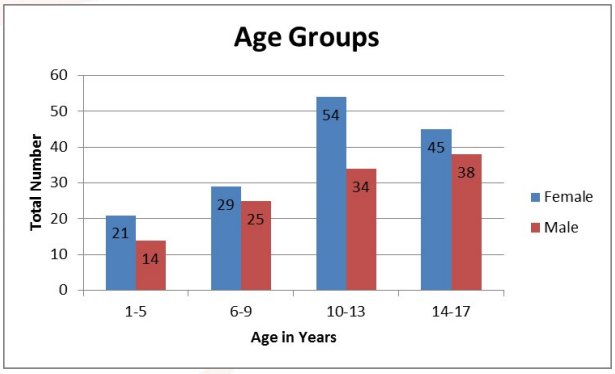
Table 2: Mean, SD, and median for different parameters among male children.

Parameter	Mean	SD	Median
Age (yrs)	10.9	4.4	12
Height (cm)	132.2	28.5	140.2
Liver length	11.5	1.5	11.4

In males, mean age= 10.9, mean height = 132.2, mean liver length = 11.5, SD = 1.5, median= 11.4

The following observations and results show that mean height is greater in male children. This may be due to difference in body composition and habitus of males and females. There is no significant difference in results of mean liver length between the female and male children.

Chart 2: Represents the age distribution into 4 groups and the number of male and female children in different age groups.



The sample size of 260 cases were divided into 4 age groups : 1-5 yrs (pre-school age), 6-9 yrs (school age), 10-13 yrs(early adolescence age) and 14-17 yrs(middle adolescence)respectively. In each age group, number of female and male children was calculated. The observations as represented in the above Bar diagram are:

In 1-5 yrs, Female children = 21,
male children = 14
In 6-9 yrs, Female children = 29,
male children = 25
In 10-13 yrs, Female children = 54,
male children = 34
In 14-17 yrs, Female children = 45,
male children = 38

In all the age groups, the number of female children is greater compared to male children and the number of female children in 10-13 yrs (early adolescence) is greater than in any other age groups. This may be due to the poor general conditions of females particularly in the early adolescence period for which they visit the hospital.

Table 3: Mean spleen length and liver length among male and female children in different age groups.

Age Group (yrs)	Female		Male	
	Height (cm)	Liver length (cm)	Height (cm)	Liver length (cm)
1-5	79.2 ± 19.83	9.57 ± 0.9	79 ± 20.16	9.8 ± 0.98
6-9	118.32 ± 15.75	10.96 ± 1.43	117.78 ± 19.85	11.2 ± 1.66
10-13	136.24 ± 9.55	11.38 ± 1.27	138.03 ± 8.52	11.7 ± 1.3
14-17	148.38 ± 14.63	12.2 ± 1.45	156.11 ± 10.97	12.2 ± 1.16

Anova test was applied for determining if Liver length varies significantly across above age groups:

The test shows that Liver length between the 4 age groups that is defined in the Table 3 were highly significant. The significance level used for the test was 0.05.

Spleen - (Analysis of variance, F = 25.8; df = 3, 256; P < 0.001)

Liver - (Analysis of variance, F = 32.6; df = 3, 256; P < 0.001)

The mean liver length was greater in males in all age groups and it is increased in older children in 10-13 and 14-17 yrs among both male and female. General body growth is rapid during 1-2 yrs and puberty. In the intervening period of mid childhood, the somatic growth velocity is relatively slowed down and this is more in males.

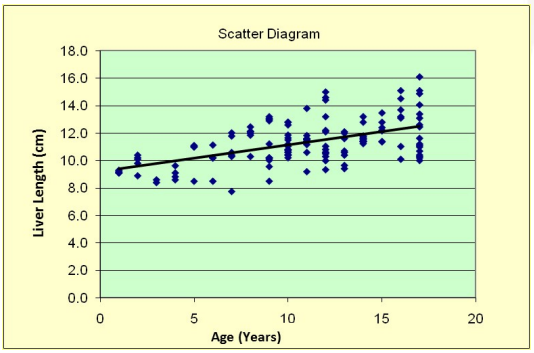
Liver length highly correlated with each age and height. The correlation was calculated for each of the variables differently for both sexes (Male and Female) and the scatter plots for the same can be seen below. The correlation observed was all similar in magnitude and highly significant (P < 0.0001). The pattern of the relationship between variables is explored using simple linear regression analysis.

Co-relation and simple regression analysis

In Female children:

1. Liver length to Age

Fig. 1: Scatter plot of liver size (length) against age shows simple linear correlation in female children.

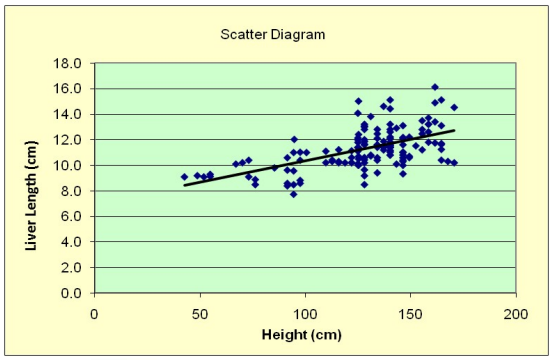


Liver size (length) in relation to age and height are represented as scatter plots.

The observation shows that liver length increases with age. r = 0.55, p < 0.0001

2. Liver length to Height

Fig. 2: Scatter plot of liver size (length) against height shows simple linear correlation in female children

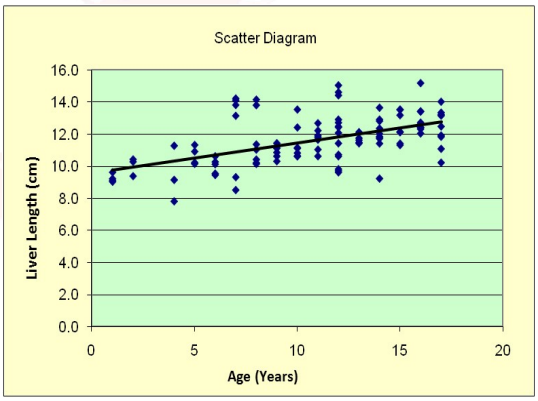


In Male children:

Liver size (length) in relation to age and height are represented as scatter plots.

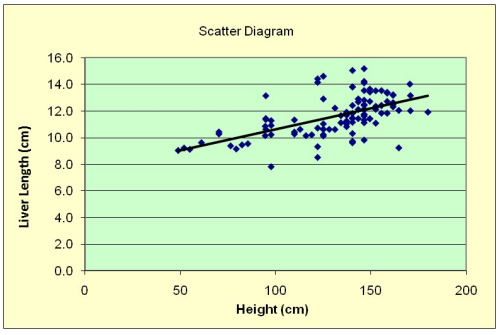
1. Liver length to age

Fig. 3: Scatter plot of liver size (length) against age shows simple linear correlation in male children.



2. Liver length to height

Fig. 4: Scatter plot of liver size (length) against height shows simple linear correlation in male children.



The observation shows that liver length increases with height as age increases. r = 0.54, p = 0.0001

DISCUSSION

The observations of the present study are compared here along with the available literature from past. Many studies have been done in past throughout the world on the same or related topic by other workers.

With the observations of other studies, findings of present study are compared. Present study was done among 260 children in Bidar Institute of Medical Sciences and Hospital, Bidar within the period of October 2011 to November 2013.

There have been quite a few previous reports giving the standard sizes of liver by ultrasound in children, but none has been done in North-east Karnataka population Our results are comparable to earlier studies [1,4,5].

In the study done by Konus [4], 307 pediatric subjects were involved. The subjects were 5 days to 16 years old children. At least two dimensions were obtained for liver. Relationships of the dimensions of these organs with sex, age, and height were investigated. No statistically significant differences were found between the two sexes in any age group. In the present study, the mean liver length between the 4 age groups is highly significant. The significance level used for the test was 0.05. Male children had larger mean liver length in all age groups.

Konus [4] found that longitudinal dimensions of liver length correlated with age in both male and female children. Similarly, in the present study, liver length highly correlated with age in females and males.

Konus [4] found that among the body parameters, height correlated best with the longitudinal dimension of each organ in male and female Turkish children. Similarly, in the present study, height showed best significant correlation with liver length in both male and female North-east Karnataka children.

In the study done by Safak [5], 712 school-aged children in the age group from 7 to 15 years were screened in Turkey. Safak found longitudinal dimension of the liver showed weakest correlations with age and height in both male and female children ($p < 0.001$).In the present study, age and height showed significant correlation with liver length in both male and female children ($p< 0.0001$).

In females, For, liver length, $p< 0.25$. In males, For, liver length, $p<0.09$

In the study done by Bhavana Dhingra[1], in 597 healthy children between the ages of 1 month to 12 years, the mean (SD) liver length was 9.59 (1.98) cm (males, 9.63 cm; females, 9.54cm).

In present study, among 260 cases, 149 were female children and 111 were male children. In females, mean liver length is 11.2, SD = 1.5 and median is 11.2. In males, mean liver length is 11.5, SD = 1.5 and median is 11.

Table 4: Comparison of mean liver length.

Authors	Mean liver length (cm)	
	Male	female
Bhavana Dhingra (1 month to 12 yrs)	9.63	9.54
Present study (1 to 17 yrs)	11.5	11.2

In the study done by Bhavana Dhingra [1] in North Indian children, males had larger mean liver length compared to female children. Similarly, in the present study, the mean liver length was larger in males compared to female children but the values are higher in North-east Karnataka children when compared to North Indian children. Bhavana Dhingara [1] showed that the mean liver length increased with age and significantly correlated with age, height in both male and female children in North Indian children. Similarly, the mean liver length increased with age and significantly correlated with age and height in both male and female children in North-east Karnataka children.

There are also some limitations of our study. The ultrasonography was not performed by single radiologist. The number of subjects in the age group 1-5 months and the number of males in the age-group 1-5 months was less. Although, many previous studies have published normative data using similar small numbers [10], the small sample size in certain groups may affect the generalisability of the values to these age-groups. Nutritional anemia and malnutrition may be associated with organomegaly and were not specifically excluded (except severe malnutrition and clinically obvious anemia). However, by presenting the largest paediatric series, we provide a more accurate assessment of liver size

in children, especially those in North-east Karnataka.

In addition to size, there are several palpatory characteristics of the liver (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.

When compared the mean liver length according to age group, the present study findings roughly seemed to agree with authors above. The age groups used in their study were not identical to those in the present study, but we can make an approximate comparison. This reveals that their results were also not very different from the present study.

The bedside assessment of liver enlargement will not obviate diagnostic imaging when such information is vital to further therapeutic management of the patient. Our results provide a standard set of normal range of liver size according to age and sex of the children, as determined by ultrasonography. We found height to be a significant correlate of the liver and spleen size across all ages, in both the males and females. 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.

CONCLUSION

In the present cross-sectional study an attempt has been made to determine the normal range of length of liver and to correlate this with the age, sex, height. Comparison is also done with other studies done in India and in other countries and noted whether there is any relation of our study with other regions. Liver length highly correlated with age and height. The correlation observed was all similar in magnitude and highly significant ($P < 0.0001$). The pattern of the relationship between variables is explored using simple linear regression analysis.

Most statistically significant correlation with liver length was observed with height in both male and female children. The mean liver length increased with age. Establishing normal parameters is mandatory for defining the pathologic changes in size of the liver in routine sonographic examinations of children. The methods of measurement and analysis we used in this study are standardized and easy to apply.

Findings are handy and reliable and are suitable particularly for radiology and paediatric departments. The results of this study can be used as a practical and comprehensive guide to indicate the normal liver length range for every child, according to his/ her age and body habitus and to analyze whether there is actual hepatopmegaly.

Conflicts of Interests: **None**

REFERENCES

[1]. Bhavana Dhingra, Suvasini Sharma, Devendra Mishra, Reema Kumari, Ravindra Mohan pandey, Shailendra Aggarwal. Normal values of liver and spleen size by Ultrasonography in Indian children. Indian pediatrics 2009; 03:1-6.

[2]. Swash M.Hutchison's clinical methods. 20th edition.London:WB Saunders company Ltd: 1995.

[3]. Dittrich M, Milde S, Dinkel E, Baumann W, Weitsel D. Sonographic biometry of liver and spleen size in childhood. Pediatr Radiol 1983;13:206-211.

[4]. Konus OL, Ozdemir A, Akkaya A, Erbaus G, Celik H, Isik S. Normal liver, spleenAnd kidney dimensions in neonates, infants and children: evaluation with sonography. AJR Am J Roentgenol 1998;171:1693–1698.

[5]. Alp Alper Safak, Enver Simsek, Talat Bahcebasi. Sonographic assessment of the normal limits and percentile curves of liver, spleen and kidney dimensions in healthy school aged children. J. ultrasound med 2005;24:1359-64.

[6]. https://www.Stanford.edu/A History of the Liver, Spleen and Gallbladder.

[7]. Petzoldt R, Lutz H, Ehler R, Neidhardt B. Determination of splenic size by ultrasonic Scanning. Med Klin.1976; 26.71 (48): 2113-6

[8]. Niederau C, Sonnenberg A, Muller JE, Erckenbrecht JF, Scholten T, Fritsch WP.Sonographic measurement of the normal liver, spleen, pancreas and Portalvein. Radiology, 1983;149:537-540.

[9]. Markisz JA, Treves ST, Davis RT. Normalhepatic and splenic size in children: Scintigraphic determination. Pediatr Radiol, 1987;17:273-276.

[10]. Rosenberg H K. Markowitz R I. Kolberg. H. park C. Hubbard A. Bellah RD. Normal splenic size in infants and children : sonographic measurements. AJR, 1991;157:119-121.

[11]. Chen CM, Wang JJ. Clinical and sonographic assessment of liver size in normal Chinese neonates. Acta Paediatr 1993; 82:345-347.

[12]. Singh V, Haldar N, Nain CK, Singh K, Liver span: a comparative appraisal of Various methods. Trop Gastroenterol 1998;19:98-99.

[13]. Kaya Sarac ,Ramazan Kutlu ,Cengiz Yakinci ,Yasar Durmaz,Tamer Bayasal ,Ünsal Özgen : Sonographic Evaluation of Liver and Spleen Size in School-Age Children , December 25, 1998

[14].Capaccioli L, Stecco A, Vanzi E, Brizzi E, Ultrasonographic study on the growth and dimensions of healthy children and adults organs. Ital J Anat Embryol2000; 105: 1-50.

[15]. Megremis SD, Vlachoni Kolis LG, Tsilimigaki AM. Spleen length in childhood with US : Normal values based on age, sex and somatometric parameters. Radiology 2004;23: 129-34.

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