https://doi.org/10.33472/AFJBS.6.13.2024.1643-1649

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

CLINICAL AND ULTRASONOGRAPHIC ASSESSMENT AND ANALYSIS OF LIVER SPAN IN NORMAL CHILDREN

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Article Info

Volume 6, Issue 13, July 2024

Received: 02 June 2024

Accepted: 30 June 2024

Published: 24 July 2024

doi: 10.33472/AFJBS.6.13.2024.1643-1649

ABSTRACT:

Introduction: The clinical assessment of liver size remains a cornerstone in physical examination, particularly in the pediatric and adolescent population. The primary objective of this study is to assess the normal liver span in children across various age groups through clinical methods. The secondary objective is to correlate the liver span measurements obtained clinically with those obtained through ultrasonography.

Material and Methods: This study employed a prospective cross-sectional design and was conducted in the outpatient department (OPD) of a tertiary care hospital. The inclusion criteria for the study encompassed newborns attending the well-baby clinic at the OPD, children presenting with minor problems such as upper respiratory infections (URI), children visiting the immunization clinic, and siblings accompanying pediatric patients to the OPD. Exclusion criteria were applied to children with fever of any cause, those with any systemic illness including cardiovascular, respiratory, neurological, or abdominal problems, and children with significant illness in the recent past. Imaging exclusion criteria included the presence of parenchymal mass lesions and cysts.

Results; The mean liver span in boys ranges from 5.6 cm at birth to 9.75 cm at 12 years. The mean liver span in girls ranges from 5.8 cm at birth to 10.0 cm at 12 years. The correlation between clinical and ultrasound liver span measurements has a Pearson's correlation coefficient of 0.91, indicating a strong positive correlation.

Conclusion Clinical liver span measurement is useful and reliable, ultrasonography provides a more precise and consistent assessment, especially in pediatric patients.

Keywords: Ultrasound, Liver, Liver span, Portal vein diameter

1. INTRODUCTION

The clinical assessment of liver size remains a cornerstone in physical examination, particularly in the pediatric and adolescent population.[1] Understanding the normal values of liver size across different ages is crucial for accurate clinical evaluation. This initial assessment is often the first step in identifying hepatomegaly or other abnormalities in liver size, despite the existence of more precise methods such as ultrasonography.[2] Liver span, a key parameter in this assessment, correlates with various factors including age, sex, height, weight, and body surface area. Additionally, it is likely influenced by ethnic background, adding another layer of complexity to establishing normal reference values. The most reliable method for measuring liver span in clinical practice involves percussion and palpation along the mid-clavicular line, determining both the lower and upper margins of the liver.[3]

Ultrasonography has emerged as a highly accurate and reliable method for evaluating liver size. It is particularly favored in pediatric care due to its non-invasive nature and lack of radiation exposure, making it a safer alternative for repeated assessments.[4] This imaging modality allows detailed visualization of the liver and other visceral organs, providing comprehensive information that surpasses the capabilities of physical examination alone. While the palpation-percussion method for estimating liver span is both cost-effective and straightforward to perform, its accuracy and precision have been subjects of debate. The technique's reliability is often questioned due to its subjective nature and the potential for inter-examiner variability. Consequently, there is a notable gap in research comparing the efficacy of traditional clinical methods against the gold standard of ultrasonography in children.[5]

In clinical practice, the radiographical evaluation of liver size, particularly through ultrasonography, is recognized as a more dependable index than palpation just below the costal margin.[4,5] This method provides a consistent and objective measurement of liver dimensions, which is critical for the early detection and management of hepatomegaly and other liver-related conditions. The primary objective of this study is to assess the normal liver span in children across various age groups through clinical methods. The secondary objective is to correlate the liver span measurements obtained clinically with those obtained through ultrasonography.

2. MATERIAL AND METHODS

This study employed a prospective cross-sectional design and was conducted in the outpatient department (OPD) of a tertiary care hospital. The inclusion criteria for the study encompassed newborns attending the well-baby clinic at the OPD, children presenting with minor problems such as upper respiratory infections (URI), children visiting the immunization clinic, and siblings accompanying pediatric patients to the OPD. Exclusion criteria were applied to children with fever of any cause, those with any systemic illness including cardiovascular, respiratory, neurological, or abdominal problems, and children with significant illness in the recent past. Imaging exclusion criteria included the presence of parenchymal mass lesions and cysts.

The liver span in the mid-clavicular line was determined using a standardized technique. During the examination, children were placed in a supine position and instructed to breathe quietly. The pleximeter finger was positioned perpendicular to the mid-clavicular line. Percussion began at the right second intercostal space in the mid-clavicular line, where typical lung field resonance was heard. The percussion then moved gradually downward, one rib space

at a time, until a change in tone indicated the presence of the liver dome behind the air-filled lung. The upper border of the liver was identified by slightly harder percussion, while the lower border was determined by soft percussion starting from the right lower abdominal quadrant and moving upwards towards the liver.

Due to the inability of young children to sustain full inspiration required for accurate palpation, both upper and lower liver borders were percussed. Palpation of the lower liver edge was also attempted during quiet breathing for each child. A mark was made using a skin marker pen on the skin at the point corresponding to the middle of the pleximeter finger. The distance between the pen marks was then measured in centimeters. Liver span estimation was independently performed by two observers, and the total span was measured to the nearest half centimeter using a non-stretchable tape.
Following the physical examination, an independent sonographic estimation of the liver span was conducted at the same locus with the child in a supine position. Each child's liver span was measured three times, and the mean value was recorded as the absolute length. Informed consent was obtained from the parents of all children participating in the study.

3. RESULTS

The study had overall 500 participants with each age group consisted of 100 participants. The gender distribution across all age groups was fairly balanced, with slight variations in each age bracket. Overall, the total sample included an equal distribution of 50% males and 50% females.

Figure 1: Distribution of gender among the study participants (N=500)

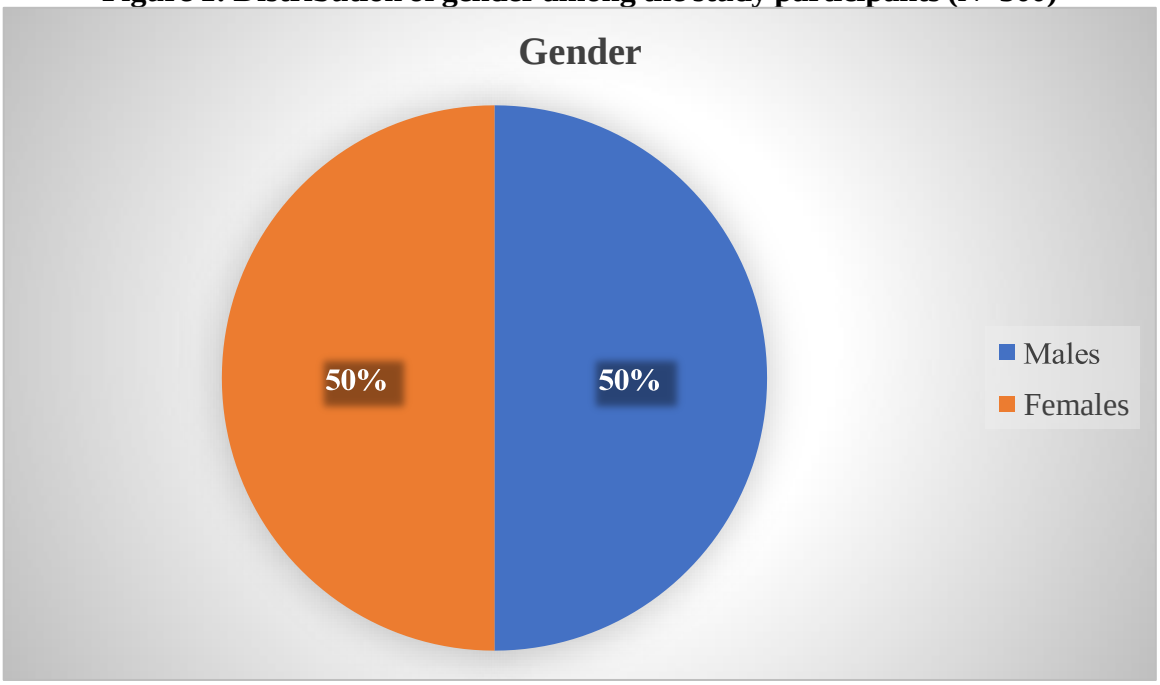

Table 1: Age and Gender Distribution of Participants (N=500)

Age Group	Number of Participants	Males=250 n (%)	Females=250 n (%)
0-1 years	100	50 (50)	50 (50)
1-3 years	100	52 (52)	48 (48)

3-6 years	100	51 (51)	49 (49)
6-9 years	100	49 (49)	51 (51)
9-12 years	100	48 (48)	52 (52)

Table 1 shows five hundred patients, the mean clinical liver span, age-wise and sex-wise.

Table 2: Clinical Liver Span (Male) (n=250)

Age Group	Mean Liver Span (cm)	Standard Deviation (cm)
0-1 years	5.6	0.389
1-3 years	6.4	0.713
3-6 years	7.1	0.703
6-9 years	8.3	0.564
9-12 years	9.75	0.560

The mean liver span in boys ranges from 5.6 cm at birth to 9.75 cm at 12 years (Table 2). The mean liver span in girls ranges from 5.8 cm at birth to 10.0 cm at 12 years (Table 3). The data shows that the liver span increases with age in both boys and girls. Up to one year, the liver span is slightly higher in girls. From two years onwards, the liver span is higher in boys.

Table 3: Clinical Liver Span (Female) (n=250)

Age Group	Mean Liver Span (cm)	Standard Deviation (cm)
0-1 years	5.8	0.339
1-3 years	6.6	0.77
3-6 years	8.2	0.383
6-9 years	8.9	0.539
9-12 years	10.0	0.597

The data indicates that ultrasound measurements of liver span show a good correlation with clinical measurements, with slight variations (Table 3 and Table 4).

Table 4: Ultrasound Liver Span (Male) (n=250)

Age Group	Mean Liver Span (cm)	Standard Deviation (cm)
0-1 years	5.6	0.389
1-3 years	6.4	0.713
3-6 years	6.9	0.742
6-9 years	8.1	0.773
9-12 years	8.8	0.594

Table 5: Ultrasound Liver Span (Female) (n=250)

Age Group	Mean Liver Span (cm)	Standard Deviation (cm)
0-1 years	5.8	0.339
1-3 years	6.6	0.77
3-6 years	7.3	0.742
6-9 years	7.9	0.773
9-12 years	8.6	0.430

The correlation between clinical and ultrasound liver span measurements has a Pearson's correlation coefficient of 0.91, indicating a strong positive correlation.

4. DISCUSSION

Liver size provides critical information for diagnosing and managing gastrointestinal and hematological diseases. Clinical liver span findings are especially important in emergency settings, such as in the management of shock, where hepatomegaly can be an early sign of impending cardiac failure. Establishing the expected liver size is crucial for identifying significant enlargement. Clinical assessment by percussion remains a simple and practical method for this purpose. As Sheila Sherlock noted, "Percussion is a valuable method of determining liver size," and is important in monitoring patient progress.[6]

However, clinical liver span measurement by percussion is prone to inter-observer variation and may differ from ultrasound measurements. In children, accurate palpation is challenging because they cannot sustain the deep breaths needed for precise examination. This study compares clinical and ultrasound measurements of liver span, analyzing their correlation and the influence of anthropometric parameters such as age, sex, height, and weight.

In our study, the mean clinical liver span measurements for various age groups are as follows: 5.6 cm for newborns, 5.8 cm for infants, 6.1 cm at 1 year, 6.8 cm at 2 years, 7.4 cm at 3 years, 7.7 cm at 4 years, 7.8 cm at 5 years, 8.3 cm at 6 years, 8.6 cm at 7 years, 9.1 cm at 8 years, 9.2 cm at 9 years, and 9.3 cm at 10-12 years. These values are closely aligned with norms compiled by Naveh and Berant, which indicate a liver span ranging from 5.6 -5.9 cm for newborns to 9 cm from 6 years onwards. The small differences of 0.1 cm to 0.7 cm between our observations and those of Naveh and Berant highlight the consistency of our findings with established norms.

Nelson's standards state that liver span ranges from 4.5 to 5 cm at one week of age to approximately 7-8 cm in boys and 6-6.5 cm in girls by 12 years of age. Our study shows measurable liver spans by percussion ranging from 3.5 cm to 10.5 cm, increasing curvilinearly with age, consistent with the pattern observed by Lawson et al[7]. This correlation indicates that liver growth closely resembles body weight and height growth.

Statistical analysis using the Intraclass correlation test showed a coefficient of 0.89 (p=0.00) between the measurements of two observers, indicating good agreement and reliability of

clinical liver span measurements. This finding aligns with Lawson et al[7]., who found no statistical difference between measurements by two examiners in infants and children. In contrast, Joshi et al[8]. reported poor inter-observer reliability for detecting hepatomegaly in adults using palpation and percussion, a discrepancy likely due to differences in patient age and body composition.

Diagnostic imaging techniques, particularly ultrasonography, are superior to clinical examination for determining liver size. Sonographic measurement is non-invasive, cost-effective, portable, and free from radiation exposure, making it ideal for routine use in pediatric patients. Wolfgang Patzak et al[9]. demonstrated that ultrasound is an accurate and reliable method for liver size assessment. However, there remains a lack of standardized procedures and accepted norms for liver size across various age groups in ultrasonography.

Our study found a strong correlation between clinical and ultrasound liver span measurements (r=0.91). This was consistent across all age groups, with ultrasound measurements showing a difference of up to 1.1 cm compared to clinical measurements, generally being higher. This finding is supported by studies such as those by Skrainka et al[10]., who found direct percussion to be as accurate as ultrasound, and by Chen CM et al[11]., who demonstrated good correlation between clinical and ultrasound liver span measurements in Chinese neonates.
The liver span increases with age, with significant correlation observed between liver span and age by ultrasound (r=0.90, p=0.00). In our study, girls had a slightly larger liver span than boys up to one year of age, after which boys had a larger liver span up to 12 years of age. This difference, though not statistically significant (p=0.44), aligns with existing literature indicating larger gastrointestinal organs in males. Liver span also showed strong independent correlations with height and weight (r=0.89 and 0.86, respectively). Similar findings were reported by Castell et al[12]., who found liver span to be best predicted using a combination of height and weight. Our multivariate regression analysis confirmed that age, height, and weight all influence liver span, with age being the most significant factor.

5. CONCLUSION

In conclusion, while clinical liver span measurement is useful and reliable, ultrasonography provides a more precise and consistent assessment, especially in pediatric patients. Both methods should be used complementarily for accurate diagnosis and management of liver-related conditions.

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