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Original Research Article

Assessment of liver cranio-caudal dimensions using sonography in healthy adult Bangladeshi people

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ABSTRACT

Background: Accurate assessment of liver size is an essential component of hepatobiliary evaluation and ultrasonography remains the preferred modality for routine measurement. Population-specific normative data are necessary to improve diagnostic accuracy, yet limited evidence exists for Bangladeshi adults. This study aimed to determine the cranio-caudal length (CCL) of the liver in healthy Bangladeshi adults and examine its relationship with sex, body mass index (BMI) and body surface area (BSA).
Methods: A cross-sectional analytical study was conducted among 70 healthy adults (35 males, 35 females) at Sir Salimullah Medical College, Dhaka, Bangladesh. Anthropometric variables were recorded and liver CCL was measured via standardized ultrasonography using a 3.5 MHz convex transducer during maximal inspiration. Data were analyzed using t-tests and Pearson's correlation. A $p \leq 0.05$ was considered statistically significant.
Results: Males had significantly greater liver CCL (12.17±0.82 cm) than females (11.65±0.88 cm; p=0.014). BMI demonstrated no significant correlation with liver length in either sex, whereas BSA showed a significant positive correlation among females (r=0.35, p=0.04). No meaningful association was observed between liver length and BSA in males.
Conclusions: Liver CCL varies significantly by sex in healthy Bangladeshi adults, while BMI shows limited predictive value. BSA exhibits a modest association with liver size among females. These findings provide population-specific reference values that may enhance the clinical interpretation of hepatic ultrasonography.

Keywords: Liver size, Ultrasonography, Cranio-caudal length, Anthropometry, Body surface area

INTRODUCTION

Ultrasonography is widely recognized as the first-line modality for evaluating hepatic morphology because it is non-invasive, accessible and dependable for routine assessment. Measurement of liver size-particularly the CCL of the liver-is clinically important as deviations from normative limits may reflect conditions such as steatosis, inflammatory hepatopathies, congestion and infiltrative disorders. Standard anatomical texts acknowledge normal variability in liver dimensions across individuals, with factors such as sex, body size and constitutional differences contributing to this variation.[1,2] These differences underscore the need for population-specific reference values, as relying on generalized international

standards may lead to diagnostic inaccuracies.

A substantial body of research has examined hepatic dimensions across different regions, demonstrating measurable variation among populations. Large sonographic surveys show that liver size tends to be greater in males due to differences in body habitus, muscle mass and overall organ size.[3,4] Studies from India, Nepal, Sudan and Saudi Arabia similarly report sex-related differences, as well as moderate associations between liver dimensions and anthropometric indices such as BMI and BSA.[5,6] However, findings regarding the strength of these associations remain inconsistent: some studies identify positive correlations with BMI and BSA.[7,8] Whereas others report weak or negligible relationships.[9] Such discrepancies highlight the importance of generating local evidence, as body composition, lifestyle and nutritional patterns vary across populations.

In Bangladesh, ultrasonography is routinely used to assess hepatobiliary health, yet published normative data for adult liver dimensions remain limited. Given ethnic and anthropometric differences between Bangladeshi adults and other regional populations, establishing reference values tailored to this demographic is essential for improving diagnostic precision. This is particularly relevant in the context of rising metabolic liver disease in South Asia, where early structural changes detectable via ultrasound may precede clinical manifestations.[10]

Methodological consistency also contributes to measurement accuracy. Standardized techniques-including breath-hold imaging and fixed probe orientation-are recommended to ensure reproducibility and reduce operator variability.[11] Incorporating these standardized methods while generating population-specific data can substantially enhance interpretive reliability.

The present study addresses this gap by determining the CCL of the liver in healthy Bangladeshi adults and examining its relationship with sex and anthropometric indices. Establishing normative values for this population aims to support clinicians and radiologists in making more accurate assessments during routine sonographic evaluations.

METHODS

This cross-sectional analytical study was conducted in the Department of Anatomy, Sir Salimullah Medical College, Dhaka, Bangladesh, from January to December 2023. A total of 70 apparently healthy adults (35 males and 35 females) attending the outpatient department of radiology and imaging, Sir Salimullah Medical College, Mitford Hospital, were included through convenience sampling.

Inclusion criteria

Apparently healthy adults with normal hepatic echogenicity and echotexture were included in study.

Exclusion criteria

History of alcohol consumption, known hepatic disorders (hepatitis, cirrhosis, hepatocellular carcinoma, fatty liver, congestive cardiac failure) and history of hepatic surgery were excluded.

Data collection procedure

Each participant was briefed about the study and given written informed consent. Age was confirmed from the national identity card. Physical parameters, including height and weight, were measured using a wooden stadiometer and a digital weight machine, respectively. Sonographic measurements were obtained with a Toshiba Xario-100 digital ultrasonography machine using a 3.5 MHz convex transducer. Scanning was performed in the supine and right lateral positions with the participant holding breath at maximal inspiration. CCL measured from superior dome to inferior tip.

Procedure for measuring CCL of liver

A blue dot was drawn on the anteroinferior tip and a red dot was given on the superior most point of dome or superior surface of liver. Craniocaudal length of liver was measured by joining the blue dot and the red dot (Joish et al).[11]

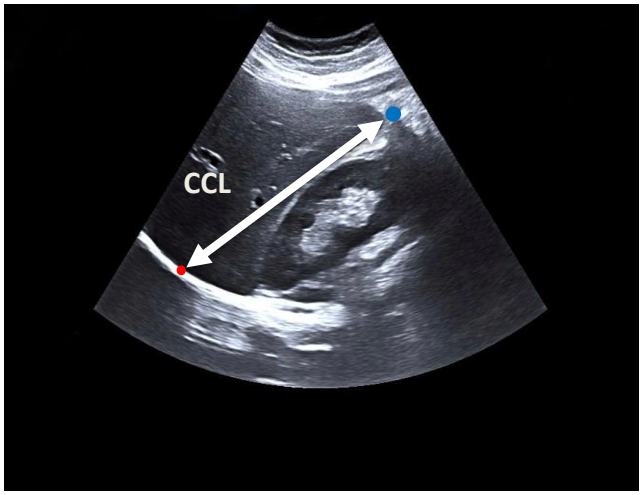

Figure 1: Digital ultrasonography of liver showing measurement of CCL of liver.

*Blue dot-represents anteroinferior tip of liver, red dot-represents superior most point of dome or superior surface of liver.

Ethical considerations

The research received ethical approval from the Institutional Ethics Committee, Sir Salimullah Medical College, Dhaka. Written informed consent was obtained from all participants, ensuring confidentiality and voluntary participation. Identifiable information was not disclosed.

Statistical analysis

Data were processed using SPSS version 27.0. Mean±SD were calculated for continuous variables. Sex differences were analyzed using the Unpaired Student's t-test. Relationships between liver dimensions and BMI/BSA were assessed using Pearson's correlation coefficient (r). A $p \leq 0.05$ was considered statistically significant.

RESULTS

The study presents sonographic measurements of liver CCL in a cohort of 70 healthy Bangladeshi adults. Key findings include a statistically significant sex-based difference in CCL, with males having a larger mean dimension than females. No significant correlation was found between CCL and BMI for either sex, while a significant positive correlation was identified between CCL and BSA in female participants.

Table 1 presents the demographic and anthropometric characteristics of the participants, stratified by sex. The male (n=35) and female (n=35) groups were comparable in mean age (35.46±9.19 vs. 32.89±10.30 years, p=0.274). However, males were significantly taller (163.43±7.52 vs. 154.46±6.34 cm) and heavier (65.83±9.62 vs. 52.89±5.98 kg), resulting in significantly higher mean BMI (24.63±3.32 vs. 22.15±2.10 kg/m²) and BSA (1.72±0.14 vs. 1.50±0.10 m²) (all p=0.000). Table 2 shows the CCL of the liver for male and female participants. The mean CCL was 12.17±0.82 cm (range: 10.52-14.11 cm) in males and 11.65±0.88 cm (range: 10.11-13.78 cm) in females.

This sex difference was statistically significant (p=0.014).

Table 1: Demographic and anthropometric characteristics of participants, (n=70).

Variables	Male (n=35), mean±SD (Range)	Female, (n=35), mean±SD (Range)	P value
Age (in years)	35.46±9.19 (18-54)	32.89±10.30 (19-52)	0.274
Height (cm)	163.43±7.52 (144-177)	154.46±6.34 (142-167)	0.000
Weight (kg)	65.83±9.62 (46-83)	52.89±5.98 (45-66)	0.000
BMI (kg/m²)	24.63±3.32 (19.05-34.72)	22.15±2.10 (18.28-26.77)	0.000
BSA (m²)	1.72±0.14 (1.4-1.9)	1.50±0.10 (1.3-1.7)	0.000

Table 2: CCL of liver in male and female, (n=70).

Parameter (cm)	Male, mean±SD (Range)	Female, mean±SD (Range)	P value
CCL	12.17±0.82, (10.52-14.11)	11.65±0.88, (10.11-13.78)	0.014

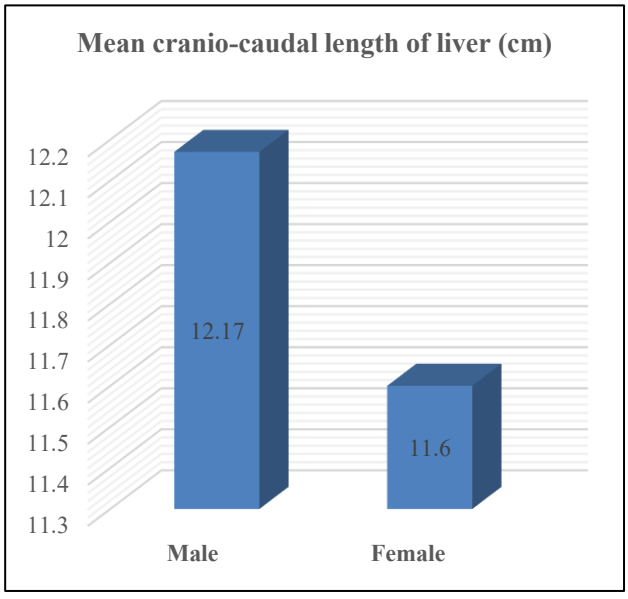

Figure 2: Mean CCL of the liver (cm) in males and females

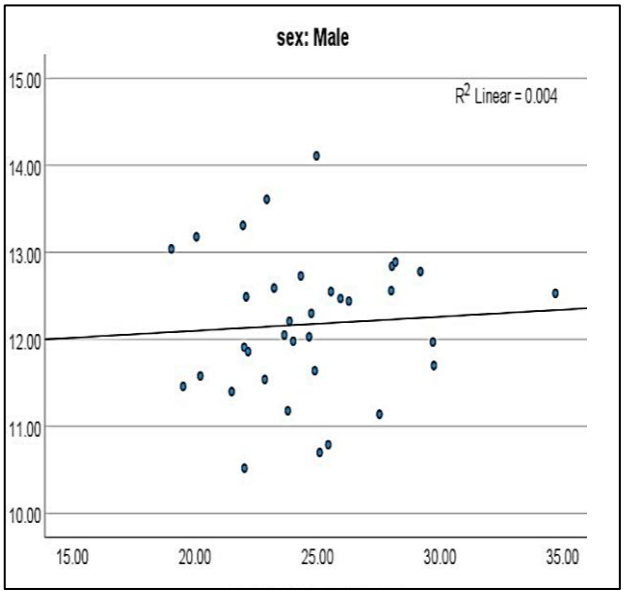

Figure 3: Non-significant positive correlation of BMI with the CCL of the liver in males.

Figure 2 illustrates the mean CCL of the liver in males and females using a bar diagram, visually demonstrating the higher mean value observed among the male participants.

Figure 3 depicts the scatter plot showing the relationship between BMI and CCL f the liver in male participants. The distribution of data points indicates a weak positive correlation that was not statistically significant.

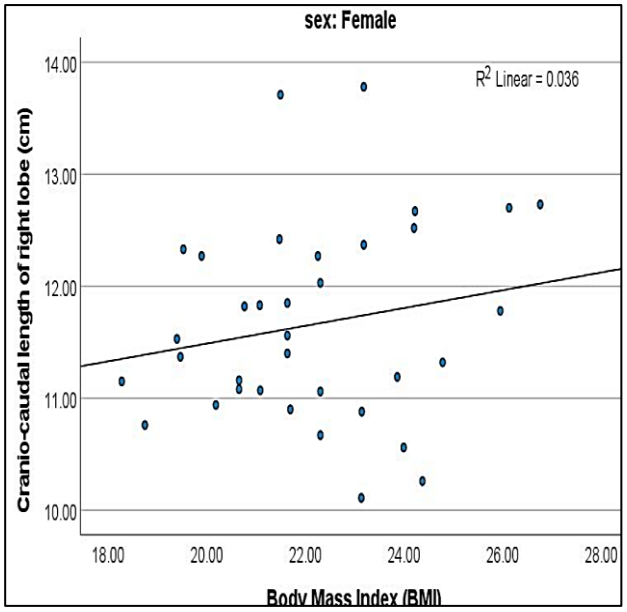

Figure 4: Non-significant positive correlation of BMI with CCL of liver (cm) in females.

Figure 4 shows the scatter plot representing the relationship between BMI and CCL of the liver in female participants. Similar to males, a positive but non-significant correlation was observed.

Table 3: Correlation of CCL, BMI and BSA.

Parameters	Male, r (p)	Female, r (p)
BMI	+0.01 (0.71)	+0.17 (0.32)
BSA	+0.07 (0.70)	+0.35 (0.04)

Table 3 shows the Pearson's correlation coefficients (r) between liver CCL and the anthropometric indices BMI and BSA. In males, CCL showed a non-significant, very weak positive correlation with both BMI (r=+0.01, p=0.71) and BSA (r=+0.07, p=0.70). In females, CCL demonstrated a non-significant weak positive correlation with BMI (r=+0.17, p=0.32) but a statistically significant moderate positive correlation with BSA (r=+0.35, p=0.04).

DISCUSSION

The present study demonstrates a clear sex-based difference in liver CCL among healthy Bangladeshi adults, with males exhibiting significantly larger measurements than females. This finding is consistent with established literature, which attributes larger visceral organ dimensions in males to differences in overall body habitus and physiological composition.[3,4] Comparable results have been reported in Indian, Nepalese, Sudanese and Saudi populations, where sex emerged as a consistent determinant of liver size.[5,6] The anthropometric discrepancies observed between males and females in this study including height, weight, BMI and BSA further reinforce these biological explanations.

The mean liver CCL observed in the present dataset aligns closely with values reported from other regional studies, though subtle variations are apparent. Nepalese and Indian adults generally show similar average dimensions, whereas some Sudanese and Saudi reports describe marginally larger spans.[12,13] Differences across populations may reflect genetic, nutritional, or environmental influences, as well as variations in measurement technique. The methodological approach used here-standardized positioning with breath-hold corresponds with established best practices for optimizing reproducibility and accuracy.[14] Such consistency enhances the reliability of the present findings and supports their use as reference values.

The weak correlation between CCL and BMI identified in this study mirrors findings from earlier research. Da Silva et al observed that BMI lacks strong predictive value for hepatic dimensions in healthy individuals, suggesting that BMI may not adequately represent visceral organ proportionality.[7] Conversely, Esmeal and Khalid reported moderate associations between liver size and BMI, indicating that the relationship remains inconsistent across populations.[8] These conflicting results emphasize that BMI, though widely used, may not accurately capture variations in lean mass or visceral tissue, both of which influence organ size.

The significant correlation between CCL and BSA among females in this study suggests that BSA may serve as a more sensitive anthropometric marker for predicting liver dimensions in certain groups. Prior research supports this interpretation. Konus et al identified BSA as a stronger predictor of internal organ size than BMI, particularly in populations with heterogeneous body compositions.[15] The sex-specific nature of this correlation in our findings may be related to differential fat distribution, metabolic differences, or hormonal influences. Future studies could explore these relationships in greater depth.

This study's findings also contribute to a broader clinical context. As non-alcoholic fatty liver disease continues to rise in South Asia, establishing population-specific normative measurements becomes increasingly important.[10] Accurate interpretation of liver size helps clinicians distinguish normal physiological variation from early manifestations of hepatomegaly. Ultrasonography plays a critical role in this early detection and its utility is enhanced when interpreted against locally validated benchmarks rather than generalized international standards. Additionally, sonographic liver measurements often serve as preliminary indicators of underlying metabolic or infectious conditions, especially in resource-limited settings where advanced imaging modalities may not be readily accessible.[16]

Overall, this study aligns well with existing global evidence while filling an important regional gap. By establishing normative liver CCL measurements for Bangladeshi adults and identifying relevant

anthropometric associations, this study provides a valuable reference that enhances diagnostic precision and supports more informed hepatobiliary assessment in everyday clinical practice.

Limitations

This study was conducted in a single tertiary medical college with a relatively small sample size, which may limit the generalizability of the findings. Sonographic measurements were operator-dependent and inter-observer variability was not assessed. Larger, multicenter studies are recommended to establish national reference standards.

CONCLUSION

This study establishes normative sonographic measurements of liver CCL among healthy Bangladeshi adults and demonstrates clear sex-related differences, with males exhibiting significantly larger dimensions. While BMI showed minimal association with liver size, BSA correlated positively among females, suggesting its greater relevance as an anthropometric predictor. These findings provide clinically valuable reference values that enhance diagnostic precision and support more accurate interpretation of hepatic morphology in Bangladeshi clinical practice.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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