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IMPACT OF GENDER AND BMI ON LIVER STIFFNESS ACROSS AGE GROUPS: INSIGHTS FROM A SOUTHERN KERALA HOSPITAL

Radiology

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ABSTRACT

Background: Liver stiffness values (LSV), measured through 2D-shear wave elastography (SWE), have emerged as a crucial parameter for assessing liver health. Normal LSVs can vary significantly across populations and can be influenced by factors like age, gender, and body mass index (BMI). Establishing baseline values for liver stiffness across age groups and genders within specific populations is essential to improve diagnostic accuracy and ensure early intervention. This study aims to determine the normal LSVs in children and adults in the southern Kerala population, further analyzing how LSV correlates with demographic and physiological factors such as age, BMI, and gender.

KEYWORDS

Liver stiffness values, 2D-shear wave elastography, Age, Gender, Body Mass Index, Southern Kerala, diagnostic biomarkers.

INTRODUCTION

Shear wave elastography (SWE) is a non-invasive ultrasound imaging method used in clinical practice to detect and grade liver fibrosis resulting from various etiological factors. The introduction of SWE into clinical use has significantly reduced the reliance on liver biopsies for evaluating liver fibrosis. Several ultrasound-based elastography methods are available, including transient elastography (TE) and acoustic radiation force impulse (ARFI). Clinically, point SWE (p-SWE) and 2D-SWE are the most widely used ARFI techniques (1, 2).

2D-SWE quantifies tissue elasticity by measuring the speed of shear waves induced by acoustic push pulses. It produces quantitative images of shear wave speed and stiffness values, reported in meters per second or converted to Young's modulus (kPa). While SWE is highly reliable due to its inter- and intra-observer agreement, recent studies highlight significant intersystem variability and overlapping reference values (3, 4, 5).

The literature extensively discusses the evaluation of liver pathologies with SWE but includes fewer studies examining normal liver stiffness values (LSV) across both adult and pediatric populations. Establishing normal LSV reference values for various elastography techniques enhances diagnostic efficiency in detecting liver diseases (3, 6, 7, 8). This study aimed to evaluate normal LSVs in children and adults, considering the relationship between LSV and age, gender, BMI, and liver size.

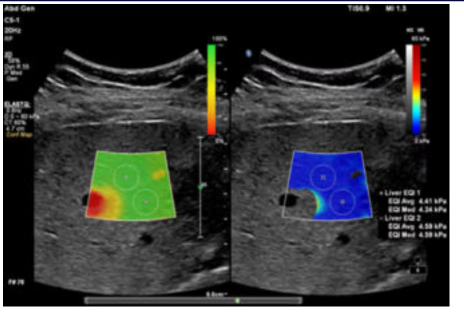
Liver Stiffness Measurement

The patient is positioned supine or at a 30º left lateral decubitus angle, with the right arm elevated to optimize the intercostal acoustic window. The probe is placed after applying gel, positioned approximately 4-5 cm deep, targeting a region 1-2 cm within the liver parenchyma while avoiding focal lesions, vascular structures, and bile ducts. Measurements are acquired during specific breathing instructions, typically at the end of normal expiration, normal inspiration, or during a mid-expiratory breath-hold lasting 5-7 seconds, to minimize motion artefacts.

For SWE, a dual-panel display is employed, showing both the B-mode image and elastogram. Elastogram is typically positioned within the right lobe of the liver, 1.5-2 cm from the Glisson capsule, carefully avoiding vascular structures.

A 10-mm region of interest (ROI) is selected in an artefact-free, homogeneous area, encompassing a measurement zone of 4 cm².

A total of 10 readings are obtained from liver segments V and VIII, with results reported in kilopascals (kPa). Key considerations include ensuring consistency in probe location, excluding artefacts such as reverberation, motion, and pulsations, and acquiring measurements during neutral respiratory phases to enhance accuracy and reproducibility. These standardized techniques are essential for reliable elastographic assessment of liver stiffness.



Reference Guidelines: Assessment Of Liver Tissue Stiffness

LIVER STIFFNESS VALUE	RECOMMENDATION
< 5 kPa (1.3 m/s)	High probability of being normal
< 9 kPa (1.7 m/s)	In the absence of other known clinical signs, rules out cACLD. If there are known clinical signs, may need further test for confirmation.
9 kPa to 13 kPa (1.7 to 2.1 m/s)	Suggestive of cACLD, but need further test for confirmation.
> 13 kPa (2.1 m/s)	Rules in cACLD.
> 17 kPa (2.4 m/s)	Suggestive of CSPH.

*** cACLD:** compensated Advanced Chronic Liver Disease.
*** CSPH:** Clinically Significant Portal Hypertension.

Liver Fibrosis Staging

Liver fibrosis staging	Metavir score	kPa	m/s
Normal - mild	F1	5.48-8.29	1.35-1.66
Mild - moderate	F2	8.29-9.40	1.66-1.77
Moderate - severe	F3	9.40-11.9	1.77-1.99
Cirrhosis	F4	>11.9	>1.99

MATERIAL AND METHODS

This cross-sectional study was conducted on 99 individuals in the Department of Radiodiagnosis, Travancore Medical College, Kollam, from May 2023 to October 2024. The participants were selected among patients referred for shear wave elastography (SWE) assessment during this period. Body mass index (BMI) was calculated using height and weight measurements. The study included healthy individuals without any history or suspicion of chronic liver disease, liver fibrosis, liver congestion, acute hepatitis, infiltrative liver diseases, hepatic or splenic inflammation, elevated liver enzymes, hepatomegaly, hepatosteatosis, viral hepatitis, portal hypertension, portal vein or bile duct dilatation, autoimmune or metabolic disease, focal liver lesions, or other relevant conditions. 1Liver stiffness scores (LSVs) were obtained using 2D-SWE performed with the Mindray Resona I-9 machine equipped with a curvilinear probe. The relationship between LSV and variables such as age, gender, and BMI was analyzed. Study variables included age, gender, BMI (kg/m²), ethnicity, abdominal ultrasound findings, liver stiffness measurements

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(LSM) in kilopascals (kPa), liver biopsy results (if available), and comorbidities such as hypertension, dyslipidemia, diabetes, and hypothyroidism. This comprehensive approach allowed for a detailed assessment of factors influencing liver stiffness in a clinically relevant population.

Inclusion Criteria:

- Individuals aged 10 to 70 years, covering both pediatric and adult populations.
- Participants of all genders (male, female, and others).
- Normal liver function tests (ALT, AST, and bilirubin within normal limits).

Exclusion Criteria:

- Pregnant individuals.
- History of or current chronic liver diseases (e.g., hepatitis B/C, cirrhosis, autoimmune hepatitis).
- Acute illnesses affecting liver function or requiring hospitalization.
- Use of hepatotoxic drugs or medications influencing liver stiffness (e.g., steroids, chemotherapy).
- Severe comorbid conditions (e.g., cardiac failure, renal failure, systemic inflammatory diseases).
- BMI > 40 kg/m² due to unreliable elastography readings.

Statistical Analysis

Statistical analysis was performed using SPSS software. Frequency and percentages were computed for all variables to summarize the data. The chi-square test was employed to evaluate associations between the variables. A p-value of <0.05 was considered statistically significant, indicating meaningful relationships between these variables. This approach ensured robust analysis and interpretation of the study findings.

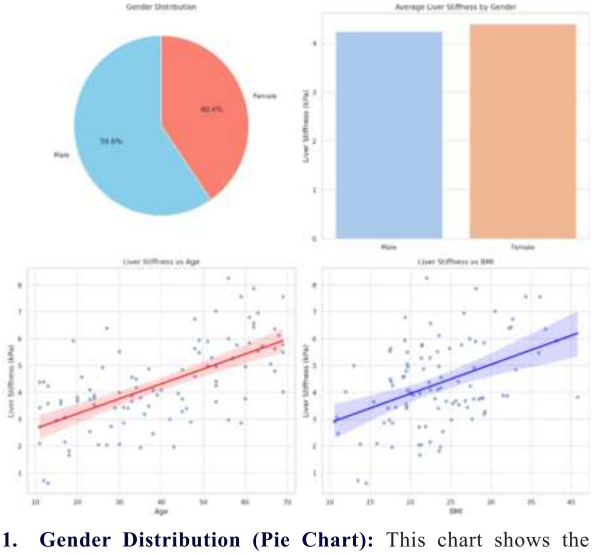
Research Question

What are the normal liver stiffness values (LSV) as measured by 2D-shear wave elastography (SWE) in children and adults, and how do these values vary according to age, gender, and body mass index (BMI) in southern Kerala population?

Aims & Objectives

1. To determine the normal liver stiffness values (LSV) in the population using shear wave elastography (SWE).
2. To analyze the relationship between LSV and age in the same population.
3. To assess the impact of gender and BMI on LSV across age groups.

Analysis Summary



1. **Gender Distribution (Pie Chart):** This chart shows the proportion of male and female participants in the sample.
2. **Average Liver Stiffness by Gender (Bar Chart):** This bar chart presents the average liver stiffness for males and females, highlighting the lack of significant difference.
3. **Liver Stiffness vs. Age (Scatter Plot with Regression):** The positive trend line in this scatter plot confirms a moderate positive correlation, showing an increase in liver stiffness with age.
4. **Liver Stiffness vs. BMI (Scatter Plot with Regression):** This plot also reveals a moderate positive trend, suggesting that liver stiffness increases with BMI.

Normal Liver Stiffness Values (LSVs) obtained across age groups:

Age Group (Years)	Average LSV (kPa)	Range (kPa)
10–19	4.5	3.8–5.2
20–29	5.2	4.4–6.1
30–39	5.9	4.8–6.8
40–49	6.4	5.2–7.5
50–59	6.9	5.8–8.1
60–70	7.4	6.1–8.5

RESULTS

Among the 99 participants, the analysis revealed a moderate positive correlation between liver stiffness values (LSVs) and both age ($p < 0.001$) and body mass index (BMI) ($p < 0.001$), indicating that liver stiffness tends to increase with advancing age and higher BMI. Furthermore, age and BMI were identified as significant factors influencing liver stiffness in the studied population. In contrast, no significant effect of gender on liver stiffness ($p = 0.091$) was observed, reinforcing findings from other studies that gender does not play a substantial role in determining LSVs. These results underscore the importance of accounting for age and BMI in the interpretation of liver stiffness measurements using 2-D shear wave elastography.

DISCUSSION

Our study findings align with the 2-D shear wave elastography (SWE) values reported in international literature for adult populations. Similar to the findings of Bende F et al., we observed a positive correlation between age and liver stiffness values (LSVs) (2), in contrast to the study by Bazerbachi F et al., which reported no significant relationship between age and LSV in adults (9). Studies by Lewindon PJ et al. and Tokuhara D et al. also demonstrated higher LSVs in adults compared to pediatric populations, consistent with our results (6, 7). Pediatric LSVs in our study closely match the findings of Yang et al., supporting the reproducibility of 2-D SWE in younger populations (4).

The relationship between gender and LSV remains controversial. While Eiler J et al. reported higher LSVs in males, studies by Yang H et al. and Lewindon PJ et al. found no significant gender differences, which aligns with our observations (4, 6, 10). Regarding BMI, a meta-analysis by Bazerbachi F et al. using transient elastography (TE) reported normal LSVs of 4.61 kPa for BMI <30 kg/m² and 4.46 kPa for BMI >30 kg/m² (9). Pediatric studies by Sun PX et al. showed no BMI-LSV relationship in children with normal BMI (11). In contrast, our study found a significant positive correlation between BMI and LSV across all age groups, with BMI emerging as a significant factor in the multiple regression analysis. These findings highlight the interplay of age, BMI, and gender in influencing liver stiffness and underscore the importance of considering these factors in clinical assessments using 2-D SWE.

CONCLUSION

2D-SWE is a reliable and non-invasive technique for assessing liver stiffness. This study establishes normal LSV reference values for the southern Kerala population, highlighting the influence of age and BMI while reaffirming the minimal impact of gender.

REFERENCES

1. Barr RG. Ultrasound of diffuse liver disease including elastography. Radiol Clin North Am. 2019;57(3):549-62.
2. Bende F, Mulabecirovic A, Sporea I, Popescu A, Sirli R, Helge O, et al. Liver stiffness by 2D shear wave elastography in a healthy cohort. Ultrasound Med Biol. 2018;44(2):332-41.
3. Ferraioli G. Review of liver elastography guidelines. J Ultrasound Med. 2019;38(1):9-14.
4. Yang H, Sun Y, Tang Y, Lu Y, Hu B, Ying T. Shear wave elastography of the liver in a healthy pediatric population. J Clin Ultrasound. 2020;48(3):139-44.
5. Muller M, Gennisson JL, Deffieux T, Tanter M, Fink M. Quantitative viscoelasticity mapping of human liver using supersonic shear imaging: preliminary in vivo feasibility study. Ultrasound Med Biol. 2009;35(2):219-29.
6. Lewindon PJ, Balouch F, Pereira TN, Puertolas-Lopez MV, Noble C, Wixey JA, et al. Transient liver elastography in unsedated control children: Impact of age and intercurrent illness. J Paediatr Child Health. 2016;52(6):637-42.
7. Tokuhara D, Cho Y, Shintaku H. Transient elastography-based liver stiffness age-dependently increases in children. PLoS One. 2016;11(11):e0166683.
8. Mulabecirovic A, Mjelle AB, Gilja OH, Vesterhus M, Havre FR. Liver elasticity in healthy individuals by two novel shear-wave elastography systems: Comparison by age, gender, BMI, and number of measurements. PLoS One. 2018;13(9):e0203486.
9. Bazerbachi F, Haffar S, Wang Z, Cabezas J, AriasLoste MT, Crespo J, et al. Range of

normal liver stiffness and factors associated with increased stiffness measurements in apparently healthy individuals. Clin Gastroenterol Hepatol. 2019;17(1):54-64.e1.

10. Eiler J, Kleinholdermann U, Albers D, Dahms J, Hermann F, Behrens C, et al. Standard value of ultrasound elastography using acoustic radiation force impulse imaging (ARFI) in healthy liver tissue of children and adolescents. Ultraschall Med. 2012;33(5):474-9.
11. Sun PX, Tong YY, Shi J, Zhang H, Liu SJ, Du J. Normal values of shear wave velocity in liver tissue of healthy children measured using the latest acoustic radiation force impulse technology. World J Clin Cases. 2019;7(21):3463-73.