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Sex-Specific Patterns in Hepatic Morphometry: Anthropometric Correlates of Liver Dimensions in a North African Cohort

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ABSTRACT

Purpose: This study aimed to investigate and examines gender-based differences in hepatic morphometry and their somatic correlates.

Materials and Methods: In this cross-sectional analysis of 101 Southern Libyan adults (50 males, 51 females), we quantified hepatic dimensions via standardized midclavicular line sonography. Pearson correlation analyses assessed sex-specific relationships between hepatic length and anthropometric parameters (weight, height). Comparative statistics evaluated intersexual differences in correlation strengths.

Results: While absolute hepatic dimensions showed minimal sexual dimorphism (13.8 cm males versus 13.96 cm females), correlation patterns differed substantially. Males demonstrated stronger weight-hepatomegaly associations (r=0.66) compared to females (r=0.54), representing a 0.12 correlation unit difference. Similarly, height correlations favored males (r=0.56 versus 0.49). Hepatic dimensional variability was comparable between sexes (SD ~2.1 cm), though males exhibited greater anthropometric heterogeneity.

Conclusion: Sex-specific patterns exist in the relationship between somatic and hepatic dimensions, with males showing stronger scaling between body mass and liver size. These findings mandate gender-stratified reference intervals and individualized assessment protocols that account for both biological sex and body habitus in hepatic evaluation. (*Open J Med Radiol 2026;1:9-15*)

Keywords: Sex differences, Hepatic morphometry, Ultrasonography, Anthropometry, Correlation analysis

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AUDIOABSTRACT

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INTRODUCTION

The clinical assessment of hepatic dimensions represents a cornerstone of physical diagnosis, with deviations from normative values signaling potential pathology ranging from infectious hepatitis to malignant infiltration.[1] Despite universal recognition of hepatic importance, establishing optimal measurement standards remains complicated by significant population heterogeneity and the influence of constitutional factors including biological sex, body habitus, and metabolic status.[2]

Sexual dimorphism in visceral organ morphology is well-established, with males

typically demonstrating greater hepatic mass and volume compared to females.[3] However, the mechanisms underlying these differences whether reflecting absolute body size scaling, hormonal influences, or differential metabolic demands remain incompletely understood. Furthermore, geographic and ethnic variations in body composition suggest that sex-specific patterns may vary across populations, limiting the generalizability of European and Asian reference data to North African cohorts.[4]

Ultrasonography provides an ideal modality for examining sex-specific hepatic morphometry, offering non-invasive, radiation-free assessment accessible across diverse clinical settings.[5] The midclavicular line (MCL) measurement, quantifying the craniocaudal hepatic dimension, demonstrates strong correlation with total hepatic volume and functional capacity.[6]

Previous investigations have noted sex differences in hepatic dimensional correlations with anthropometric parameters. Bayramoğlu et al.[7] observed varying scaling relationships in Turkish adults, while Shrestha et al.[8] reported differential correlations in Nepalese populations. However, systematic examination of whether biological sex modifies the relationship between body habitus and hepatic dimensions remains limited, particularly for Mediterranean African populations.

This investigation examines sex-specific patterns in hepatic morphometry within a Southern Libyan cohort, testing the hypothesis that biological sex significantly influences the strength of correlations between somatic parameters and hepatic dimensions. We further evaluate whether absolute hepatic measurements or their anthropometric scaling relationships show greater sexual dimorphism.

MATERIALS AND METHODS

Study Population

We prospectively enrolled 101 consecutively sampled outpatients at Tasawah General Hospital, Southern Libya (November 2025–January 2026). Cohort composition included 50 males (49.5%) and 51 females (50.5%), aged 8–100 years. Exclusion criteria encompassed known chronic liver disease, previous hepatobiliary surgery, pregnancy, and abdominal pathology precluding sonographic assessment.

Anthropometric and Sonographic Protocol

Standing height (cm) and body weight (kg) were measured using calibrated instruments. Hepatic longitudinal dimension was quantified via ultrasonography (3.5–5 MHz curvilinear transducer) along the midclavicular line from the hepatic dome to the inferior margin, averaged across three respiratory cycles.[9]

Statistical Analysis

Sex-stratified descriptive statistics characterized anthropometric and hepatic parameters. Pearson correlation coefficients quantified relationships between somatic variables and hepatic dimensions within each sex. Fisher's z-transformation enabled comparison of correlation strengths between males and females. All analyses utilized two-tailed significance testing (α=0.05).

RESULTS

Cohort Characteristics and Sex Distribution

The study achieved balanced sex representation (50 males, 51 females) with comparable age distributions. Males demonstrated significantly greater mean body mass (71.82 kg versus 65.96 kg) and stature (166.46 cm versus 161.46 cm) compared to females. Notably, males exhibited greater anthropometric variability, with standard deviations exceeding female measurements for both weight (17.46 kg versus 15.05 kg) and height (17.08 cm versus 12.94 cm).

Absolute Hepatic Dimensions

Mean hepatic length showed minimal absolute difference between sexes: 13.8 cm (SD ±2.16) in males versus 13.96 cm (SD ±2.08) in females (Fig. 1). This 0.16 cm

difference represents approximately 1.2% of mean hepatic length and lacks clinical significance. The comparable standard deviations indicate similar dimensional variability across sexes, with coefficients of variation of 15.7% (males) and 14.9% (females).

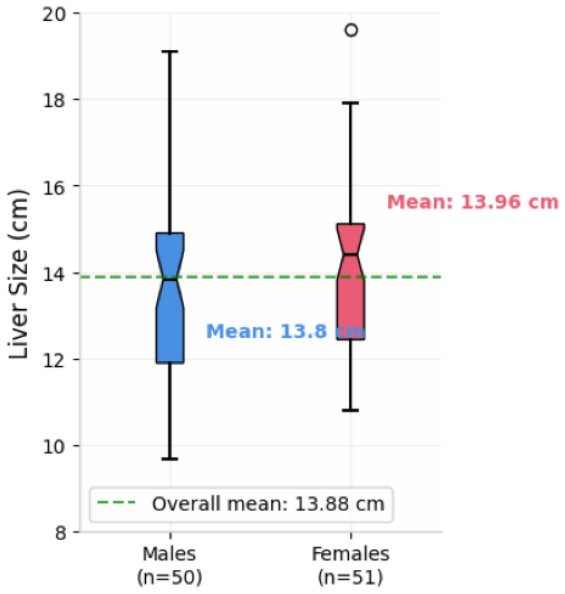


Fig. 1: Box plot distributions of hepatic dimensions by biological sex, demonstrating comparable median values with similar interquartile ranges.

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Sex-Specific Correlation Patterns

Weight-Hepatic Dimension Relationships: Males demonstrated a moderate-to-strong positive correlation between body mass and hepatic length (r=0.66), whereas females showed a moderate association (r=0.54) (Fig. 2,3). This 0.12-unit difference suggests that hepatic dimensional scaling with adiposity or body mass is more pronounced in male physiology. The male correlation explains approximately 44% of hepatic dimensional variance compared to 29% in females.

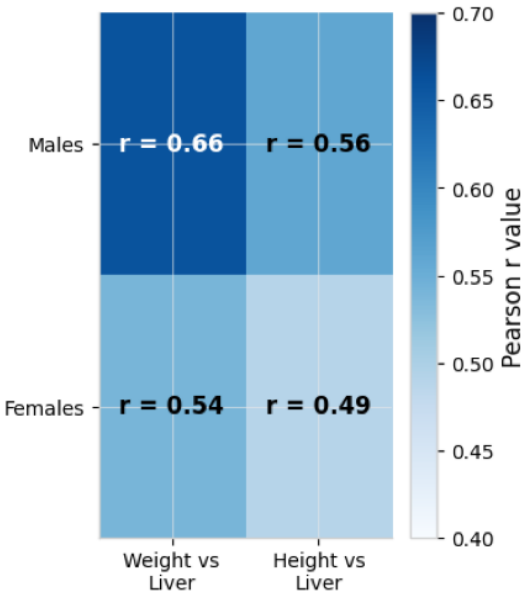


Fig. 2: Correlation coefficient heatmap illustrating stronger associations in males for both weight and height parameters.

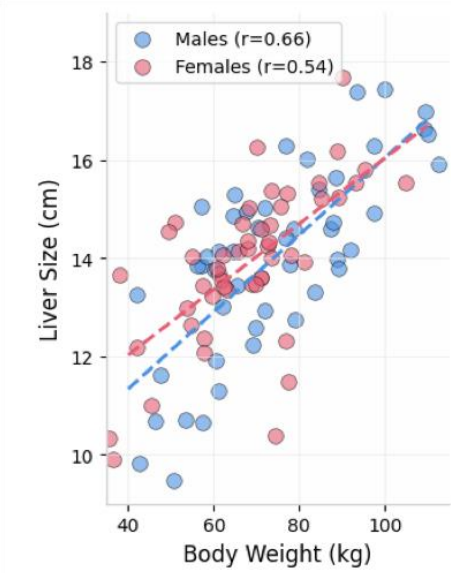


Fig. 3: Scatter plot with regression lines showing body mass and hepatic dimension relationships by gender.

Height-Hepatic Dimension Relationships: Similar patterns emerged for stature correlations, with males showing r=0.56 versus female r=0.49 (Fig. 2,4) (Figure 1, Panels B and E). The 0.07-unit difference, while smaller than the weight correlation divergence, indicates consistent sex-based variation in somatic-hepatic scaling relationships.

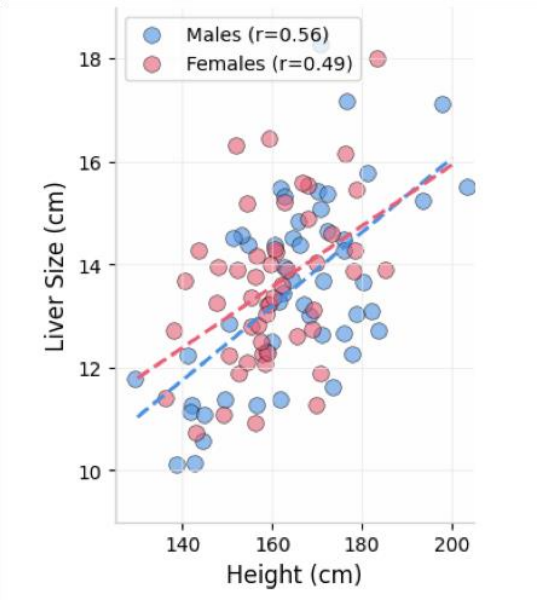


Fig. 4: Scatter plot illustrating stature-hepatic dimension correlations with sex-specific regression patterns.

Correlation Strength Comparison: The heatmap visualization (Fig. 2) and differential bar chart (Fig. 5) demonstrate uniformly stronger correlations in males across both anthropometric parameters. This consistency suggests that biological sex modifies the relationship between constitutional factors and hepatic dimensions in a systematic rather than parameter-specific manner.

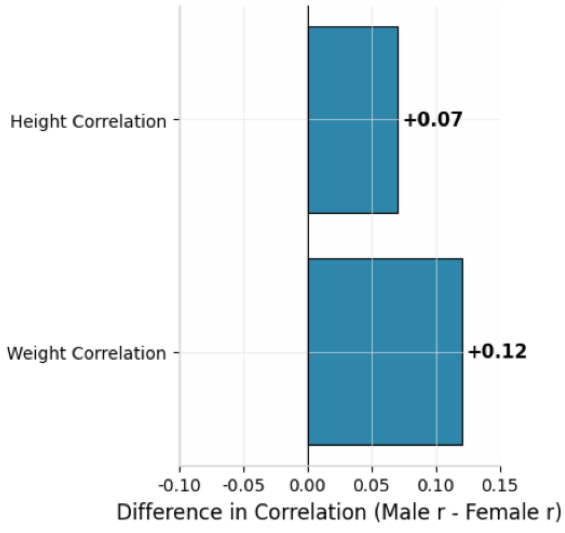


Fig. 5: Bar chart quantifying correlation strength differences between sexes (Male r – Female r).

Clinical Implications of Sex-Specific Patterns

The observed correlation differences carry significant diagnostic implications. In clinical practice, a 90 kg male would be expected to demonstrate proportionally larger hepatic dimensions than a 90 kg female, given the stronger male weight-hepatomegaly association. Conversely, hepatic dimensions in females appear relatively more independent of absolute body mass, potentially reflecting different patterns of visceral versus subcutaneous adipose distribution.[10]

DISCUSSION

This investigation reveals that while absolute hepatic dimensions remain remarkably similar between sexes in this North African cohort, the *relationships* between somatic parameters and hepatic size demonstrate consistent sexual dimorphism. Males exhibit stronger correlations between both body mass and stature with hepatic dimensions, suggesting sex-specific patterns of visceral organ scaling.

Our finding of comparable absolute hepatic lengths between sexes (13.8 versus 13.96 cm) contrasts with some prior reports suggesting larger male liver volumes.[3] This discrepancy may reflect several factors: (1) our MCL longitudinal measurement captures different dimensional information than volumetric assessments; (2) population-specific body composition patterns in North African cohorts may differ from European or Asian norms; and (3) the balanced age distribution in our sample may minimize sex differences apparent in older populations where hormonal changes differentially affect hepatic atrophy.[11] However, the correlation analysis reveals underlying sex-specific patterns obscured by simple dimensional comparison. The 0.12-unit stronger weight correlation in males indicates that hepatic dimensional interpretation must account for biological sex to avoid systematic misclassification. For instance, applying

uniform weight-adjusted norms would inappropriately classify larger males as normal while potentially over-diagnosing hepatomegaly in similarly sized females.

The stronger male correlations likely reflect multiple interrelated mechanisms. Testosterone-mediated anabolic effects may promote greater hepatic parenchymal mass relative to body size, while male-pattern visceral adiposity could increase hepatic steatosis and apparent sonographic dimensions.[12] Additionally, greater male anthropometric variability (evidenced by larger standard deviations) may provide stronger statistical power for correlation detection.

The attenuated female correlations, particularly for weight (r=0.54), suggest that female hepatic dimensions are regulated somewhat independently of absolute body mass. This may reflect the influence of estrogen-mediated hepatic enzyme induction, differential lipid metabolism, or gynecoid fat distribution patterns that minimize visceral adipose deposition. [13]

Our correlation values align with prior investigations while providing novel sex-stratified detail. Shrestha et al.[8] reported overall correlations between hepatic dimensions and anthropometric parameters in Nepalese adults, though without sex-specific quantification. Bayramoğlu et al.[7] noted 13–15 cm hepatic ranges in Turkish adults with variable anthropometric associations.

The meta-analysis by Abdul Ghani [14], synthesizing 45 studies of hepatic imaging, reported pooled sensitivity of 93% for ultrasonographic lesion detection but did not address sex-specific morphometric correlations. Our data suggest that future meta-analyses should incorporate biological sex as a moderator variable when synthesizing normative hepatic dimensional data.

These findings mandate gender-stratified reference intervals in clinical practice. We propose preliminary sex-specific interpretation guidelines:

Males: Hepatic length >16.0 cm (mean + 1 SD) in the context of elevated BMI warrants hepatological evaluation, with particular attention to metabolic fatty liver disease given the strong weight correlation.

Females: The same absolute threshold (16.0 cm) may represent more significant pathology given the weaker correlation with body mass, suggesting lower thresholds (15.5 cm) may be appropriate for overweight females.

Furthermore, the correlation differences support individualized assessment incorporating both absolute dimensions and body habitus. A tall, heavy male with 15.5 cm hepatic length likely represents normal variation, whereas a petite female with identical measurements may require further investigation.[15]

Our standardized MCL measurement protocol minimizes observer variability, though single-operator performance limits generalizability assessment. The cross-sectional design precludes evaluation of intra-individual variation across menstrual cycles, which may influence female hepatic dimensions through fluid retention and hormonal fluctuations.[16]

Sample size constraints (50 males, 51 females) limit statistical power for detecting subtle correlation differences. Future investigations should enroll larger cohorts to confirm these patterns and examine interactions with age, menopausal status, and metabolic variables. Multi-site recruitment across North Africa would enhance geographic generalizability. Additionally, incorporation of body composition analysis (visceral adipose quantification, lean mass assessment) would disentangle whether the observed sex differences reflect adipose-related hepatic steatosis or true parenchymal scaling differences. [17]

CONCLUSION

This investigation demonstrates that biological sex significantly influences the relationship between somatic parameters and

hepatic dimensions, with males showing stronger correlations between body habitus and liver size despite minimal absolute dimensional differences. These findings establish the necessity of sex-stratified reference intervals and individualized hepatic assessment protocols.

Clinical practice should incorporate both biological sex and anthropometric parameters when interpreting hepatic sonography, recognizing that identical absolute dimensions may carry different clinical significance across sexes. Future normative studies must power analyses for sex-stratified correlation assessment rather than relying solely on absolute dimensional comparisons.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

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