Differences Between Conventional and Newer Anthropometric Measures Among Individuals with and without Fatty Liver Disease

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ABSTRACT

A cross-sectional analysis was conducted to compare conventional and emerging anthropometric measures among male participants with and without fatty liver disease (FLD). The objective was to assess differences and diagnostic efficiency of anthropometric-parameters using receiver operating curve (ROC) analysis at Combined Military Hospital Multan, NUMS from April to October 2022. Comparison for anthropometric measurements between non-FLD (n=164) *vs.* FLD (n=85) indicated significant differences in weight (74.01 ± 11.96 *vs.* 85.91 ± 14.07 kg, p<0.001), waist circumference (9.38 ± 9.82 *vs.* 101.35 ± 10.74 cm, p<0.001), BMI (24.81 ± 4.0 *vs.* 29.21 ± 4.38 kg/m^2, p<0.001), waist-to-hip ratio (WHpR) (0.924 ± 0.054 *vs.* 0.971 ± 0.054, p<0.001), waist-to-height ratio (WHtR) (0.508 ± 0.054 *vs.* 0.578 ± 0.062, p<0.001), and abdominal volume index (AVI) (16.17 ± 3.56 *vs.* 20.77 ± 4.61, p<0.001). Fatty liver index (FLI) also showed significant difference between non-FLD *vs.* FLD groups (38.35 ± 27.12 *vs.* 72.01 ± 21.31, p<0.001). AUCs for various significant anthropometric measurements from highest to lowest as 0.821 (95% CI: 0.767-0.874) for FLI, 0.815 (95% CI: 0.761-0.869) for WHtR, 0.809 (95% CI: 0.754-0.863) for AVI, and 0.808 (95% CI: 0.754-0.863) for waist circumference with lowest recorded AUC for height as 0.422 (95% CI: 0.347-0.497).

Key Words: *Fatty liver disease (FLD), Body mass index (BMI), A body shape index (ABSI), C-index, Abdominal volume index (AVI), Body roundness index (BRI).*

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Fatty liver disease (FLD) or non-alcoholic fatty liver disease (NAFLD) has been associated with insulin-resistance, Type-2 Diabetes mellitus, and ischemic heart disease. The pathogenetic mechanisms behind FLD to metabolic diseases seem to be dysfunctional regulation of various metabolic pathways incorporating cellular functions due to exuberant and ectopic deposition of fat in and around hepatocytes. However, it has also been shown that perivisceral fat may not be related to altered hepatocyte functions due to FLD.[1] Some new anthropometric methods include abdominal volume index (AVI), body roundness index (BRI), body adiposity index (BAI), a body shape index (ABSI), and C-index fatty liver index (FLI).[2] A limited data exists for defining the association between these measures with underlying FLD or NAFLD.

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A simple-to-apply anthropometric measure can be a valuable solution for diagnosing FLD without ultrasound. Finally, the racial obesity patterns as highlighted previously as Asian obesity paradox can also be a compelling factor to define a better diagnostic measure to diagnose fat deposition in liver,[3] which therefore needs to be validated in the local population.

The aim of this study was to compare conventional and emerging anthropometric measures among participants with and without FLD and then to evaluate the diagnostic performance of these anthropometric markers by ROC analysis.

This cross-sectional research was carried out at Pathology and Radiology departments of Combined Military Hospital Multan, NUMS, from April to October 2022 after an ethical approval (ERC no. 3 dated 4 April 2022). The sample size (n=240) was calculated using online calculator: http://www.calculator.net/sample-size-calculator.html, based upon hospital's catchment area and expected visits, as confidence level=95%, overall male target population=10000 between 25-55 years of age (target population=20%), and margin of error=5%. Apparently, healthy male subjects were selected by non-probability convenience sampling who visited the hospital as patient attendants and requests were initiated for health screening.

Table I: Comparison of various conventional and emerging anthropometric measures among male participants with (n=85) and without FLD (n=164).

Anthropometric parameter	Presence or absence of fatty liver	Mean	Std. Deviation	Sig. (2-tailed)*
Weight (kg)	No fatty liver detected	74.01	11.96339	<0.001
	Fatty liver diagnosed	85.91	14.07	
Height (cm)	No fatty liver detected	172.85	6.30	0.096
	Fatty liver diagnosed	171.44	6.22	
Waist circumference (cm)	No fatty liver detected	89.38	9.82	<0.001
	Fatty liver diagnosed	101.35	10.74	
BMI (kg/m^2)	No fatty liver detected	24.81	4.00	<0.001
	Fatty liver diagnosed	29.21	4.38	
Waist-to-hip ratio (WHpR)	No fatty liver detected	0.924	0.054	<0.001
	Fatty liver diagnosed	0.971	0.054	
Waist-to-height ratio (WHtR)	No fatty liver detected	0.508	0.055	<0.001
	Fatty liver diagnosed	0.578	0.062	
Abdominal volume index (AVI)	No fatty liver detected	16.17	3.56	<0.001
	Fatty liver diagnosed	20.77	4.61	
Body roundness index (BRI)	No fatty liver detected	4.59	0.897	0.631
	Fatty liver diagnosed	4.64	0.819	
Body adiposity index (BAI)	No fatty liver detected	26.01	4.73	0.870
	Fatty liver diagnosed	25.91	4.14	
A body shape index (ABSI)	No fatty liver detected	1.87	0.597	0.956
	Fatty liver diagnosed	1.88	0.476	
C-Index	No fatty liver detected	1.27	0.103	0.562
	Fatty liver diagnosed	1.28	0.068	
Fatty liver index (FLI)	No fatty liver detected	38.35	27.12	<0.001
	Fatty liver diagnosed	72.01	21.31	

**Independent sample t-test.*

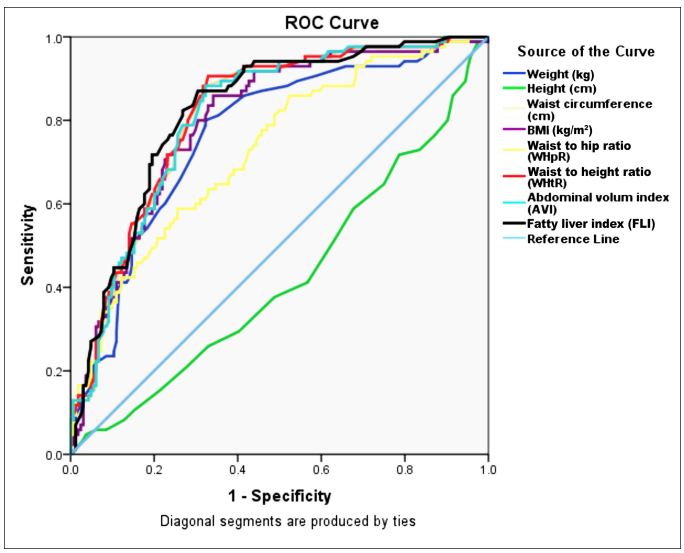

Figure 1: ROC analysis for various conventional and newer anthropometric measures including fatty liver index indicated from highest area under curve (AUC) as: FLI = 0.821 (95% CI: 0.767-0.874), WHtR = 0.815 (95% CI: 0.761-0.869), AVI = 0.809 (95% CI: 0.754-0.863), Waist circumference = 0.808 (95% CI: 0.754-0.863) with lowest recorded AUC for height as 0.422 (95% CI: 0.347-0.497).

Participants who were requested for inclusion in study were interviewed for disease or history of medication intake. Patients with known Type-2 Diabetes mellitus, hypertension, cardiac problem, acute or chronic infections were excluded from the study. Selected candidates were asked to report in medical fasting state, and on the day of reporting, an informed written consent was signed. Anthropometric measures were analysed as per standard methods.[2] Ten ml of blood was collected from study participants for measuring biochemical parameters, and all analyses were carried out on Cobas Instruments. FLI, and anthropometric measures including WHpR, WHtR, BMI, ABSI, C-index, AVI, and BRI were measured as per referenced protocols.[2,4] Later, patients were evaluated with ultrasound for diagnosing fatty liver disease. Further exclusions were made based upon positive status for hepatitis B, C, and other chronic diseases, n=23.

SPSS version-22 was employed for descriptive and inferential statistics. Comparison of various conventional and newer anthropometric measures among participants was done using independent sample t-test as mean $\pm$ SD. Area under curve (AUC) with 95% confidence interval for various candidate anthropometric measures was evaluated using ROC analysis. A p-value of <0.05 was considered significant.

FLD was diagnosed in 85 participants while 164 had no FLD. Average age among participants was 36.41 $\pm$ 7.39 years. Table I shows the differences for conventional and newer anthropometric measures between participants with or without FLD. FLI had the highest AUC, followed by conventional measures and AVI (Figure 1).

Conventional anthropometric indices including waist circumference, weight, BMI, WHpR, WHtR, AVI and FLI showed higher AUC values for diagnosing FLD/NAFLD. Earlier literature suggested strong association between conventional anthropometric measures and underlying FLD/NAFLD.[5] The new anthropometric measures except abdominal volume index (AVI) were not able to have the discriminatory potential to differentiate among participants with and without FLD/-NAFLD from lower values. The search of literature identified very few studies relating specifically to the NAFLD/FLD with these new anthropometric markers. Most literature high-

lighted varying results for AVI, BRI, ABSI and other newer anthropometric parameters for identifying FLD.

Earlier literature has observed little utility for ABSI and BMI as markers for predicting metabolic syndrome, while identifying waist circumference, WHtR and BRI to be useful in predicting underlying metabolic disease at the same time.[1,5] FLD/NAFLD patients can be lean or obese pointing towards genetic predisposition; this is recently highlighted as genetically acquired fatty liver disease (GAFLD). The emerging data defines the presence of polymorphisms in *TMP6SF2* and *PNPLA3* in lean subjects with NAFLD, which have been linked with accelerated development and onward complications like NASH, cirrhosis and hepatocellular carcinoma (HCC).[6]

The take-home message from these shared studies is two-fold: firstly, the data between studies have shown marked differences for different newer anthropometric measures for diagnosing underlying NAFLD/FLD; secondly, there could be race and ethnic specific differences between population groups for various anthropometric indices.[3] However, local studies are needed to further evaluate the differences for the population including genome-wide association studies.

Limitations to these results include confinement to the local population and probability of Type-2 statistical error which highlight the need for a community-based study to augment these findings. Despite the limitations, the authors believe this to be the first regional study which has attempted to develop an association of FLD conventional and newer anthropometric biomarkers. The authors feel that newer anthropometric measures apart from AVI also involve complex calculations and thus, remain time-consuming, especially in OPD settings.

Newer anthropometric measures except AVI in comparison to BRI, ABSI, and C-index did not show significant differences between male participants with or without FLD in comparison to conventional measures including weight, waist circumference, WHtR, BMI and WHpR.

ETHICAL APPROVAL:
An ethical approval, IERC No. 3, 4 April 2022, was taken prior to conduct of the study.

PATIENTS' CONSENT:
Informed written consents were taken before inclusion of the subject into the study.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
SHK: Lead author conceiving the idea, the plan of execution, selection of study participants based upon their knowledge, expertise and research interest, and overviewed all aspects of the research.
AH: SPSS data output analysis, medical writing, and results' preparation.
YK: Idea of study, data analysis, radiological analysis, and manuscript writing.
NC: Data analysis, anthropometric data compilation, and help in medical writing.
UBK: Sample selection, history from participants, manuscript writing, and biostatistical review.
SS: Sample selection, history from participants, manuscript writing, and biostatistical review.
All authors read and approved the final manuscript.

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