

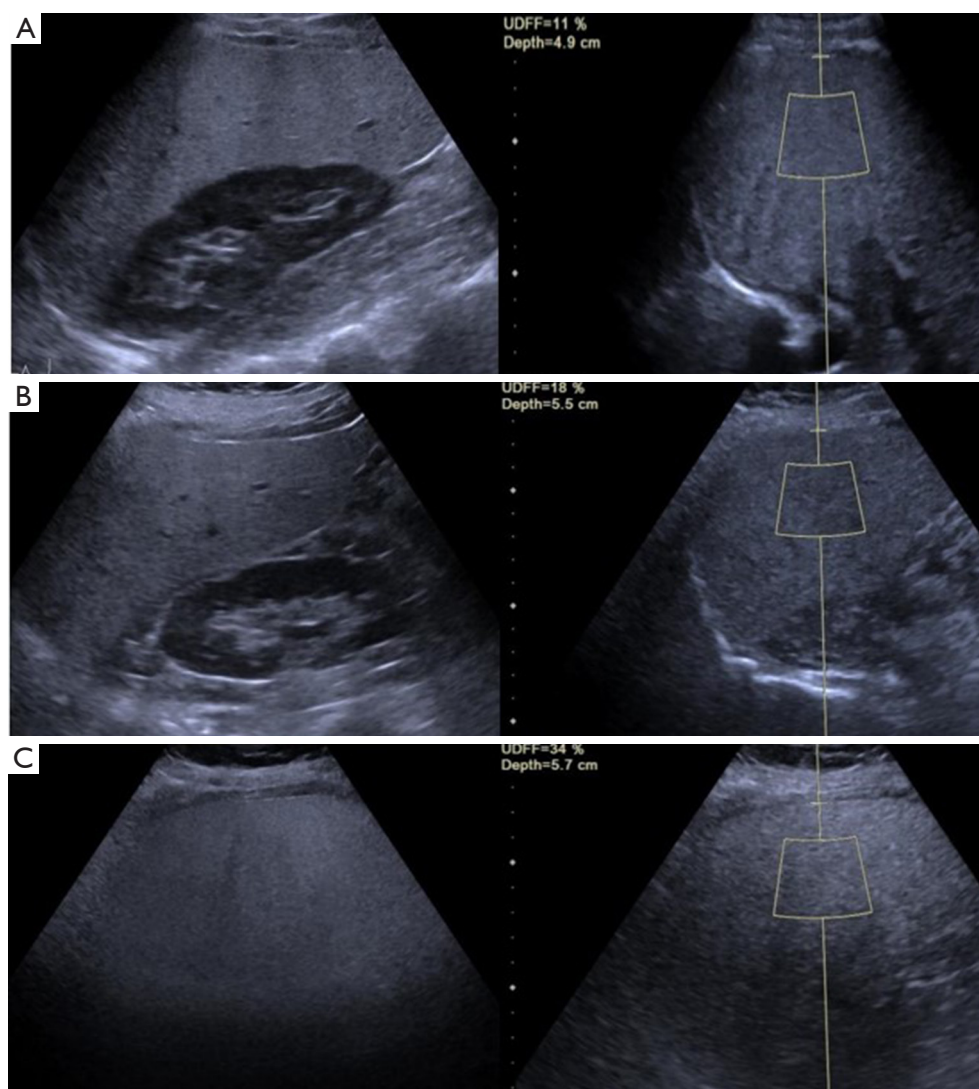


Figure S1 Representative two-dimensional grayscale ultrasound and UDF measurement images across different grades of hepatic steatosis. (A) A patient with mild hepatic steatosis, showing a UDF value of 11% (measurement depth: 4.9 cm). (B) A patient with moderate hepatic steatosis, showing a UDF value of 18% (measurement depth: 5.5 cm). (C) A patient with severe hepatic steatosis, showing a UDF value of 34% (measurement depth: 5.7 cm). Each panel displays a conventional B-mode grayscale image (left) and the corresponding UDF acquisition map with the region of interest (ROI) sampling box (right). The UDF values demonstrate a distinct stepwise increase corresponding to the severity of hepatic steatosis.

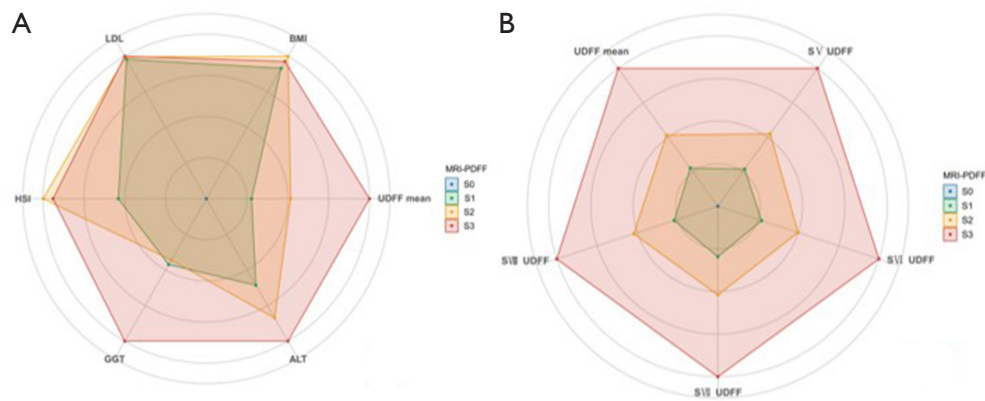


Figure S2 Comparative analysis of clinical and ultrasonic parameters across different MRI-PDFF grades using radar plots. The radar plots illustrate the relative distribution of standardized parameters across different steatosis grades: S0 (blue), S1 (green), S2 (orange), and S3 (red). The center point represents the minimum value for each index, with outward extension indicating increasing values. (A) Comprehensive comparison of clinical biochemical markers and ultrasonic indicators. The six dimensions include BMI, UDF mean, ALT, GGT, HSI, and LDL. As the MRI-PDFF grade increases, the coverage area for each index expands, with UDF mean and HSI demonstrating the most pronounced stepwise differences. (B) Comparison of UDF spatial consistency. The five dimensions represent the total UDF mean and local UDF values from four liver segments (SV, SVI, SVII, and SVIII). The plot reveals high symmetry and consistency across the different liver segments within the same grade, with clear boundaries between grades, reflecting the excellent spatial stability of UDF in assessing global liver fat content. MRI-PDFF, magnetic resonance imaging-proton density fat fraction.

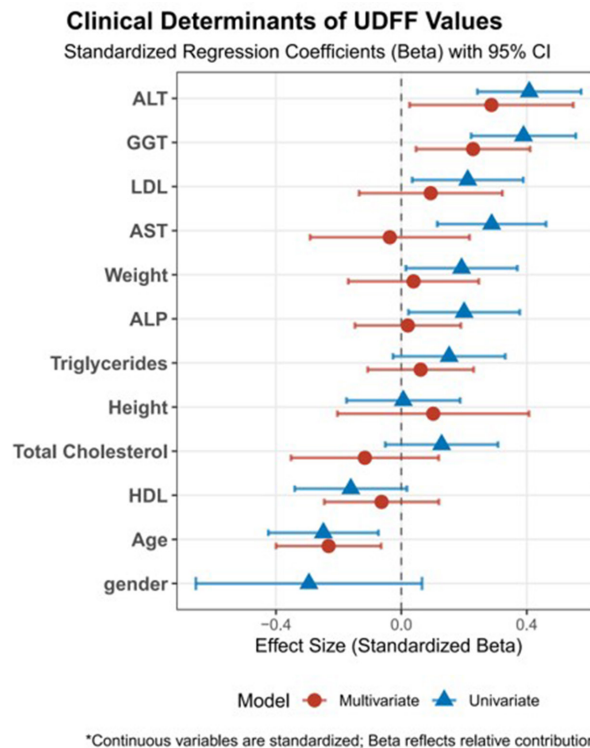


Figure S3 Standardized regression coefficients (Beta) for clinical determinants of UDF values. The forest plot displays the relative contribution of various clinical and biochemical parameters to the Ultrasound-Derived Fat Fraction (UDFF) values. Standardized regression coefficients (Beta) are presented with their corresponding 95% confidence intervals (CI).

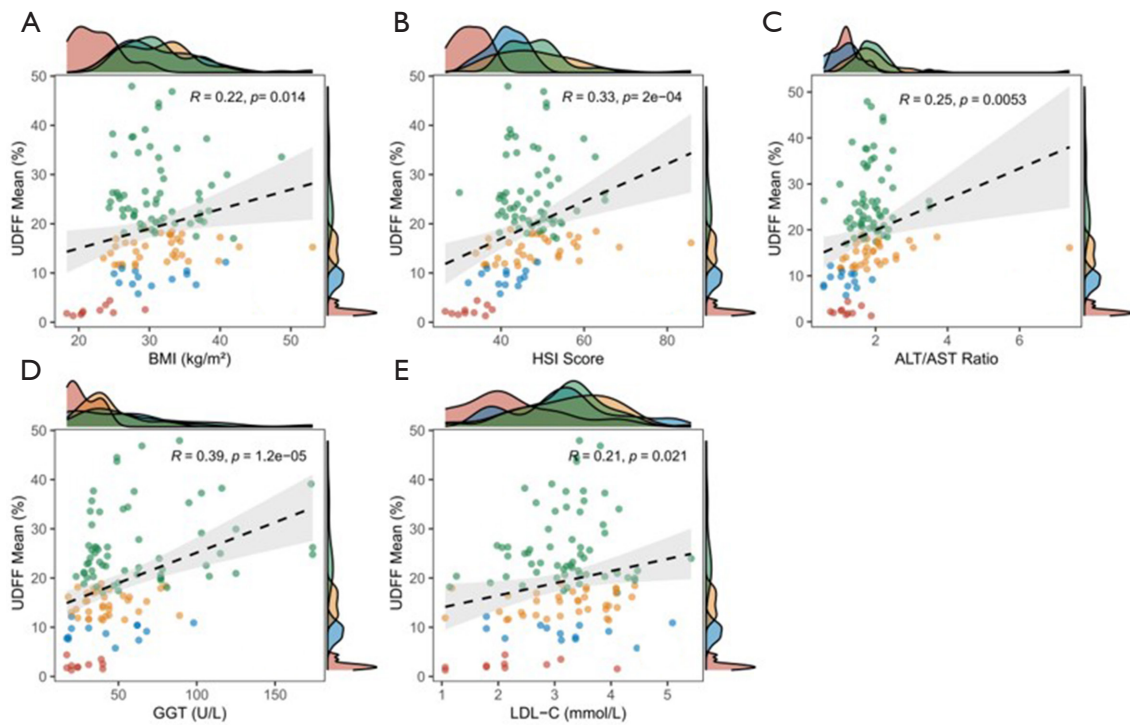


Figure S4 Correlation analysis between UDF mean and clinical parameters. The scatter plots with linear regression lines illustrate the relationships between UDF mean (%) and various parameters. Each data point is color-coded by its MRI-PDFF steatosis grade (S0: red; S1: blue; S2: orange; S3: green). Marginal density plots on the top and right of each panel show the distribution of the respective variables. (A) BMI: a positive correlation was observed between UDF mean and BMI ($R=0.22$, $P=0.014$); (B) HSI score: UDF mean showed a significant positive correlation with the HSI score ($R=0.33$, $P=2e-04$); (C) ALT/AST ratio: a significant positive correlation was identified with the ALT/AST ratio ($R=0.25$, $P=0.0053$); (D) GGT: UDF mean exhibited the strongest positive correlation with GGT levels ($R=0.39$, $P=1.2e-05$); (E) LDL-C: a weak but significant positive correlation was found with LDL-C ($R=0.21$, $P=0.021$).

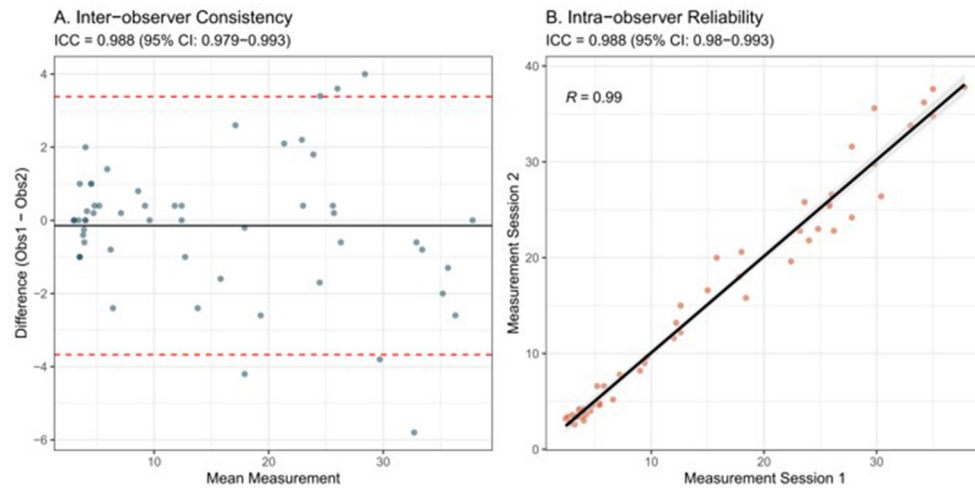


Figure S5 Reliability and consistency analysis of UDFD measurements. (A) Inter-observer consistency. The Bland-Altman plot illustrates the agreement between two independent observers (Obs1 and Obs2). The solid black line represents the mean difference (-0.15), and the dashed red lines indicate the 95% limits of agreement (LOA: -3.67 to 3.37). The intraclass correlation coefficient (ICC) is 0.988 (95% CI: 0.979–0.993), indicating excellent inter-observer agreement. (B) Intra-observer reliability. The scatter plot shows the correlation between two separate measurement sessions conducted by the same observer. The linear regression line (black) and the shaded 95% confidence interval demonstrate high reproducibility, with a Pearson correlation coefficient (R) of 0.99 and an ICC of 0.988 (95% CI: 0.98–0.993).

Table S1 Diagnostic agreement and measurement reproducibility of segmented UDFF against MRI-PDFF

Hepatic Segment	ICC	95% CI of ICC	CCC	Mean Bias (%)	Lower LoA	Upper LoA	CV (%)
SV UDFF	0.988	0.944 to 0.989	0.984	1.09	-2.50	4.68	9.65
SVI UDFF	0.984	0.975 to 0.989	0.984	0.56	-2.84	3.95	9.25
SVII UDFF	0.981	0.973 to 0.987	0.987	0.26	-3.44	3.96	10.16
SVIII UDFF	0.986	0.939 to 0.989	0.985	1.14	-2.39	4.66	9.46

CCC, concordance correlation coefficient; CV, coefficient of variation; ICC, intraclass correlation coefficient; LoA, limits of agreement; MRI-PDFF, magnetic resonance imaging-proton density fat fraction; UDFF, ultrasound-derived fat fraction.

Table S2 Comparison of UDFF Measurements across different hepatic segments in MASLD and control groups

Characteristic	N	Overall (N=129)	MASLD (N=109)	Non-MASLD (N=20)	P value [†]
SV UDFF	129	18.70 (12.60, 24.80)	19.50 (14.70, 25.20)	2.10 (1.90, 3.40)	<0.001
SVI UDFF	129	18.60 (11.60, 24.60)	19.40 (13.30, 25.30)	2.10 (1.50, 2.80)	<0.001
SVII UDFF	129	18.20 (12.00, 23.60)	18.90 (13.30, 24.30)	1.90 (1.40, 2.60)	<0.001
SVIII UDFF	129	18.30 (12.80, 24.70)	19.20 (14.30, 24.80)	2.15 (1.60, 3.30)	<0.001
UDFF mean	129	18.20 (12.28, 24.48)	19.03 (14.03, 25.00)	2.06 (1.78, 2.55)	<0.001

Data are presented as median (Q1, Q3). [†], Wilcoxon rank sum test. MASLD, metabolic dysfunction- associated steatotic liver disease; UDFF, ultrasound-derived fat fraction.

Table S3 Pairwise comparison of ROC curves between UDFF and other clinical indices using DeLong test

Stage	Comparison Pairs	AUC (Model A)	AUC (Model B)	Delta AUC	P value (DeLong)
Grade =1	BMI vs. UDFF mean	0.950	1.000	0.050	0.032
	GGT vs. UDFF mean	0.820	1.000	0.180	0.004
	LDL vs. UDFF mean	0.801	1.000	0.199	0.026
	HSI vs. UDFF mean	0.972	1.000	0.028	0.044
	ALT/AST vs. UDFF mean	0.820	1.000	0.180	0.002
Grade =2	BMI vs. UDFF mean	0.712	0.997	0.285	< 0.001
	GGT vs. UDFF mean	0.711	0.997	0.286	< 0.001
	LDL vs. UDFF mean	0.653	0.997	0.344	< 0.001
	HSI vs. UDFF mean	0.856	0.997	0.141	< 0.001
	ALT/AST vs. UDFF mean	0.880	0.997	0.118	0.002
Grade =3	BMI vs. UDFF mean	0.577	0.994	0.416	< 0.001
	GGT vs. UDFF mean	0.691	0.994	0.303	< 0.001
	LDL vs. UDFF mean	0.548	0.994	0.446	< 0.001
	HSI vs. UDFF mean	0.650	0.994	0.344	< 0.001
	ALT/AST vs. UDFF mean	0.674	0.994	0.319	< 0.001

ALT, alanine aminotransferase; AST, aspartate aminotransferase; AUC, area under the curve; BMI, body mass index; GGT, gamma-glutamyl transferase; HSI, hepatic steatosis index; LDL, low-density lipoprotein; ROC, receiver operating characteristic; UDFF, ultrasound-derived fat fraction.

Table S4 Comparison of diagnostic accuracy of UDFF measurements across four hepatic segments (SV-SVIII) for hepatic steatosis

Variable	AUC (95% CI)	Cut-off (%)	Sensitivity	Specificity
$\geq$ S1				
UDFF mean	1.00 (1.00–1.00)	5.09	1.00	1.00
SV UDFF	1.00 (1.00–1.00)	5.05	1.00	1.00
SVI UDFF	1.00 (1.00–1.00)	4.70	1.00	1.00
SVIII UDFF	1.00 (1.00–1.00)	5.45	1.00	1.00
SVII UDFF	0.99 (0.99–1.00)	6.25	0.99	1.00
$\geq$ S2				
UDFF mean	0.99 (0.99–1.00)	11.18	1.00	0.96
SVIII UDFF	0.99 (0.98–1.00)	12.60	0.94	1.00
SVI UDFF	0.99 (0.98–1.00)	11.55	0.94	1.00
SV UDFF	0.99 (0.98–1.00)	11.55	0.98	0.96
SVII UDFF	0.98 (0.97–1.00)	10.80	0.96	0.91
S3				
UDFF mean	0.99 (0.98–1.00)	18.46	0.93	0.98
SVI UDFF	0.98 (0.97–1.00)	18.20	0.95	0.95
SVIII UDFF	0.98 (0.96–1.00)	18.55	0.92	0.97
SV UDFF	0.98 (0.96–0.99)	18.45	0.93	0.93
SVII UDFF	0.98 (0.96–1.00)	17.60	0.97	0.93

AUC, area under the curve; CI, confidence interval; UDFF, ultrasound-derived fat fraction.