

Predictive Value of Speckle Tracking Echocardiography to Detect Subclinical Cardiovascular Changes among Patients with Non-Alcoholic Fatty Liver Disease

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Background and study aim:

Considering the established correlation between non-alcoholic fatty liver disease (NAFLD) and cardiac abnormalities, To assess the relationship between fibroscan-proven NAFLD and subclinical cardiovascular changes utilizing speckle-tracking echocardiography (STE).

Patients and Methods: We recruited 50 patients from AL-Rajhy Hospital's Outpatient Clinic (internal medicine). Patients were diagnosed with NAFLD via abdominal ultrasound and confirmed by FibroScan. Demographic data, laboratory investigations, and anthropometric measurements were collected for all participants. Conventional echocardiography and STE were performed to assess cardiac function.

CHA2DS2-VASc and ASCVD risk scores were calculated for all patients.

Results: A marked negative correlation coefficient was observed between both fibrosis and steatosis scores with STE parameters TAPSE and GLS (RV and LV). Also, it was found that both steatosis and fibrosis scores increased significantly with an increase in CHADSVASC and ASCVD scores.

Conclusion: NAFLD, even in asymptomatic adults, may serve as an independent subclinical cardiovascular dysfunction risk factor, regardless of traditional cardiovascular risk factors. STE emerges as a sensitive and critical tool for detecting early subclinical left ventricular (LV) dysfunction.

INTRODUCTION

Currently, NAFLD is presently the third most common liver transplantation indicator globally [1, 2]. Key risk factors for its development encompass obesity, dyslipidemia, type-2 diabetes mellitus (T2DM), and hypertension [3]. Fibroscan, a rapid and non-invasive tool, is frequently utilized to assess liver fibrosis and steatosis via measuring liver stiffness in cases with liver diseases [4].

NAFLD has also been linked to early subclinical abnormalities in cardiac function and structure, besides an elevated risk of LV hypertrophy and dysfunction, valvular heart disease, heart failure, arrhythmias, and coronary artery disease. There is a positive association between cardiomyopathy risk (primarily LV hypertrophy and dysfunction) and

NAFLD severity, resulting in arrhythmias and heart failure [5].

STE is a non-invasive ultrasound imaging modality employed in research to assess regional and global myocardial function. It enables the assessment of LV function in conjunction with other diastolic as well as systolic echocardiographic parameters [6]. Thus, we aimed this study to investigate STE's role in identifying subclinical cardiac alterations in NAFLD cases.

PATIENTS AND METHODS

This observational study was performed at the outpatient clinics (Internal Medicine Department-Al-Rajhi Liver Hospital) between January 2023 and May 2025.

All patients >18 years old admitted for fatty liver assessment were included in the study.

Exclusion Criteria: Seropositivity for HIV, HCV, or HBV; autoimmune hepatitis; liver cirrhosis; being on steatosis-inducing drugs (such as amiodarone, methotrexate, high-dose estrogen, or corticosteroids within 6 months of inclusion); pre-existing malignancy, diabetes, or cardiac disease (arrhythmia, heart failure, ischemic and valvular heart disease)

- All patients were subjected to the following:

A complete medical profile was obtained, including age, sex, smoking, and comorbidities. Waist circumference (WC) and BMI (kg/m²) were recorded, ECG was performed for all patients to exclude arrhythmia

Collection of blood samples: Serology, lipid profile, CBC, liver function, and autoimmune profile (HBsAg, HIV antibody, and HIV antibody)

CHA₂DS₂-VASc-HS

The CHA₂DS₂-VASc score is a validated tool for predicting thromboembolic risk in atrial fibrillation patients. The acronym CHA₂DS₂ represents:

- Congestive heart failure
- Hypertension
- Age (≥ 75 years = 2 points; ≥ 65 years = 1 point)
- Diabetes mellitus
- Stroke/transient ischemic attack (TIA) (2 points)

The VASc component incorporates:

- Vascular disease (peripheral arterial disease, prior myocardial infarction, aortic atheroma)
- Age (reiterated for ≥ 75 years)
- Sex category (female sex)

Low risk equal 0 (male) or 1 (female), moderate risk equal 1 (male), high risk equal 2 or greater [7].

ASCVD (Atherosclerotic Cardiovascular Disease) risk score

The American College of Cardiology developed the ASCVD risk score. This calculation estimates the 10-year risk of experiencing a cardiovascular event, including strokes or heart attack. The risk estimate incorporates factors such as smoking status, age, diabetic status, medication use, race, blood pressure, cholesterol levels, and sex [8].

NAFLD Ultrasound assessment and diagnosis

All patients received an abdominal ultrasound examination to assess two ultrasonographic parameters: steatosis grade and presence. Steatosis grading and ultrasound diagnosis were conducted in accordance with prior research [9]. The ultrasonographic assessment was conducted following an 8-hour fasting period, utilizing a real-time electronic 3.75 MHz convex-type scanner connected to a high-resolution ultrasound machine (Aplio; Toshiba Medical Systems Corporation-Tochigi-Japan).

FibroScan assessment was conducted utilizing (Fibroscan® 502 Touch-Echosens-Paris-France). LSMs were performed following a 3-hour fasting period [10]. The cutoff value for limited fibrosis ($\geq F2$) is 7.1 kPa, whereas that for cirrhosis (F4) is 12.5 kPa [11].

Conventional transthoracic echocardiography (TTE)

Conventional TTE was performed utilizing the following systems:

- $\alpha 10$ ultrasound system (SSD- $\alpha 10$ -Aloka Medical Systems-Tokyo-Japan) with a UST-52,105 probe (1.5–4.3 MHz).

M-mode echocardiography from a parasternal long-axis view measuring left ventricular end systolic diameter (LVESD) and left ventricular end-diastolic diameter (LVEDD) and ejection fraction [12].

Fractional area change (FAC) can also be assessed at the level of papillary muscles in a short axis view of the LV: FAC (%) (normal value 36–64%) [12].

Speckle tracking echocardiography:

STE was performed utilizing a Philips epic 7 ultrasound machine to estimate GLS by averaging 18 segments from apical four-chamber (AP4), three-chamber (AP3), and two-chamber (AP2) views, with time-to-peak strain calculated for each segment.

GLS- LV : Global Longitudinal strain of the left ventricle , GLS- RV : Global Longitudinal strain of the Right ventricle were measured [13.]

Sample size and statistical analysis

The present study included 50 patients. Data coding, revision, collection, and tabulation were performed utilizing the SPSS software (Released 2015-NY: IBM Corp.Version 23.0-Armonk). Expression of quantitative data was in the form of $M \pm SD$ and ranges, while qualitative variables were presented as frequencies (percentages).

The comparison between groups concerning qualitative data was conducted utilizing the Chi-square test. The comparison of two independent groups with parametric distribution and quantitative data was conducted utilizing ANOVA and independent t-test. In addition, we assessed the association between study variables and liver stiffness using the Pearson correlation coefficient. The p-value is considered significant if it is less than 0.05.

RESULTS

Table (1) depicts the demographics of the studied patients. The subjects' mean age was 40.35 ± 10.23 between 25 and 57 years old. Most cases (60%) were females. The majority (80%) of patients came from rural areas, and only 7 (14%) patients were smokers.

The majority of patients, 30 (60%), exhibited an F1 fibrosis score, while 20 (40%) had F0 fibrosis. Controlled attenuation parameter (CAP) assessment revealed steatosis grades S0 in 23 (46%), S1 in 12 (24%), S2 in 10 (20%), and S3 in 5 (10%) patients. Ultrasonographic evaluation classified fatty liver severity as grade I in 20 (40%) ($n = 20$), grade II in 30% ($n = 15$), and grade III in 30% ($n = 15$) of patients (Table 2.)

Cardiovascular risk stratification (Table 3) demonstrated that 10% ($n = 5$), 60% ($n = 30$), and 30% ($n = 15$) of patients fell into high-, intermediate-, and low-risk ASCVD categories, respectively. Similarly, CHA₂DS₂-VASc scoring

identified 26% ($n = 13$) as low risk, 54% ($n = 27$) as moderate risk, and 20% ($n = 10$) as high risk.

Table 4 summarizes data from conventional echocardiography and STE among the study's patients. Fourteen (28%) patients had diastolic dysfunction, whereas 10 (20%) patients had valvular affection (Table 3.)

It was found that the grade of fatty liver increased significantly with an increase in the ASCVD score. All patients with low-risk scores had grade-I fatty liver, and all patients with high scores had grade-III fatty liver. A total of 10 (33.3%), 15 (50%), and 5 (16.7%) patients with intermediate-risk had grade-III, II, and I fatty livers, respectively (Table 5.)

It was found that the fatty liver grade increased significantly with the CHADSVASC score. The majority (77%) of patients with low-risk scores had grade-I fatty liver, and all patients with high scores had grade-III fatty liver. A total of 5 (18.6%), 12 (44.4%), and 10 (37%) patients with moderate risk had grade-III, II, and I fatty livers, respectively (Table 6.)

It was found that the fibrosis score increased significantly with the CHADSVASC score. The highest fibrosis was reported among patients with high-risk scores (11.11 ± 2.78), and the lowest fibrosis score was noticed among patients with low-risk scores (4.22 ± 1.33 .)

Also, the degree of fibrosis was F0 among all low-risk score cases and F1 in all patients with high-risk scores. A total of 7 (25.9%) and 20 (74.1%) patients with moderate risk scores have F0 and F1 fibrosis degrees, respectively.

Also, the steatosis score increased significantly with increasing in the ASCVD score. The highest steatosis score was reported among high-risk score cases (266.17 ± 29.10), and the lowest fibrosis score was noticed among low-risk score cases (219.11 ± 21.45 .)

The degree of steatosis increases substantially with the CHADSVASC risk score. Up to 30% of patients with a high score exhibited S3, whereas up to 84.6% of patients classified as low risk presented with S0 steatosis (Table 7.)

A significant negative correlation coefficient was observed between both fibrosis score and steatosis and speckle tracking echocardiographic parameters TAPSE and GLS (RV and LV). As

regards to atherosclerotic cardiovascular disease score revealed no significant correlation (Table 8)

Table (1): Baseline data of the studied patients

	N=50
Age (years)	40.35 ± 10.23
Range	25-57
Sex	
Male	20 (40%)
Female	30 (60%)
Residence	
Rural	40 (80%)
Urbane	10 (20%)
Obesity	
Normal N (%)	12 (24%)
Overweight N (%)	20 (40%)
Habits	
Smoking	7 (14%)
Measurements	
Waist circumference (cm)	88.09 ± 4.58
Body mass index (kg/m ²)	28.09 ± 4.56

Data expressed as mean (SD), frequency (percentage).

Table (2): Assessment of LSM and CAP in studied patients

	Total (n= 50)
FibroScan assessment	
LSM (kp)	8.45 ± 2.22
F0	20 (40%)
F1	30 (60%)
CAP assessment	
Steatosis score (dm)	265.55 ± 33.79
S0	23 (46%)
S1	12 (24%)
S2	10 (20%)
S3	5(10%)
Grade of fatty liver by US	
Grade-I	20 (40%)
Grade-II	15 (30%)
Grade-III	15 (30%)

Data expressed as frequency (percentage). LSM: liver stiffness measurements; CAP: controlled attenuation parameter; US: ultrasound , S: steatosis , F: fibrosis

Table (3): Assessment of risk scores in studied patients

	Total (n= 50)
ASCVD score	
Low risk	15 (30%)
Intermediate risk	30 (60%)
High risk	5 (10%)
CHADSVASC score	
Low risk	13 (26%)
Moderate risk	27 (54%)
High risk	10 (20%)

ASCVD: Atherosclerotic cardiovascular disease

CHADSVASC : C (congestive heart failure) , H (Hypertension) , A (Age> 75 years) , D (Diabetes mellitus) , S (Stroke , TIA , Systemic embolism) , V (Vascular disease) , A (Age 65 -74 years) , S (Sex category)

Table (4): Echocardiography and speckle tracking echocardiography in patients

	Total (n= 50)
Conventional echocardiography	
Ejection fraction (%)	56.78 ± 5.57
Diastolic dysfunction	14 (28%)
Valvular affection	10 (20%)
LVEDD (mm)	48.88 ± 8.78
LVESD (mm)	29.19 ± 3.10
FAC (%)	40.55 ± 3.97
TAPSE (mm)	22.18 ± 5.44
Speckle tracking	
GLS-RV (%)	21.11 ± 3.30
GLS-LV (%)	22.09 ± 2.86

Data expressed as frequency (percentage), mean (SD). FAC: fractional area change; TAPSE: tricuspid annular plane systolic excursion; LVEDD: left ventricular end diastolic diameter; LVESD: left ventricular end systolic diameter

GLS- LV : Global Longitudinal strain of the left ventricle , GLS- RV : Global Longitudinal strain of the Right ventricle

Table (5): Degree of fatty liver based on ASCVD risk score

	Low (n= 15)	Intermediate (n= 30)	High (n= 5)	P value
Degree of fatty liver				< 0.001
Grade-I	15 (100%)	5 (16.7%)	0	
Grade-II	0	15 (50%)	0	
Grade-III	0	10 (33.7%)	5 (100%)	

Data was expressed as frequency (percentage). P value was significant if < 0.05

Table (6): Degree of fatty liver based on CHADSVASC risk score

	Low (n= 13)	Moderate (n= 27)	High (n= 10)	P value
Degree of fatty liver				< 0.001
Grade-I	10 (77%)	10 (37%)	0	
Grade-II	3 (23%)	12 (44.4%)	0	
Grade-III	0	5 (18.6%)	10 (100%)	

Data was expressed as frequency (percentage). P value was significant if < 0.05

Table (7): CHADSVASC Score according to the degree of steatosis and fibrosis:

	Low (n= 13)	Moderate (n= 27)	High (n= 10)	P value
Fibrosis scores	4.22 ± 1.33	7.89 ± 2.54	11.11 ± 2.78	< 0.001
Degree of fibrosis				
F0	13 (100%)	7 (25.9%)	0	< 0.001
F1	0	20 (74.1%)	10 (100%)	
Steatosis score	219.11 ± 21.45	249.09 ± 33.18	266.17 ± 29.10	0.001
Degree of steatosis				
S0	11 (84.6%)	10 (37%)	2 (20%)	0.01
S1	2 (15.4%)	7(23.3%)	3 (30%)	
S2	0	8(29.6%)	2(20%)	
S3	0	2(7.4%)	3(30%)	

Data was expressed as mean (SD), frequency (percentage). P value was significant if < 0.05

Table (8): Correlation of steatosis and fibrosis scores with other variables

	Fibrosis score	Steatosis score
TAPSE (mm)	-0.52 (0.01)	-0.49 (0.02)
GLS-RV (%)	-0.67 (0.001)	0.36 (0.01)
GLS-LV (%)	-0.45 (0.001)	0.28(0.04)
ASCVD risk score	0.67(<0.001)	0.60(<0.001)
CHADSVASC risk score	0.50(0.03)	0.28(0.04)

Data expressed as r value indicates strength of correlation and p value indicates significance of correlation. FAC: fractional area change; TAPSE: tricuspid annular plane systolic excursion; LVEDD: left ventricular end diastolic diameter; LVESD: left ventricular end systolic diameter.

DISCUSSION

NAFLD is increasingly recognized for its association with early subclinical alterations in myocardial metabolism, cardiac structure, and function. NAFLD correlates with LV enlargement, impaired diastolic function, myocardial insulin resistance, abnormal cardiac energy metabolism. Nevertheless, the mechanistic pathways linking NAFLD to these cardiac abnormalities remain unclear [14.]

Numerous meta-analyses as well as systematic reviews have explored the relationship between NAFLD and cardiovascular event risk [15-17]. However, there is limited research addressing the correlation between STE, fibrosis degree, and cardiovascular risk scores (ASCVD and CHADSVASC) in NAFLD patients.

This study enrolled 50 patients with NAFLD to elucidate the atherosclerotic cardiovascular risk correlated with the condition. The study also investigates the correlation between fibrosis degree and ventricular strain assessed by STE. The studied patients' mean age was 40.35 years, with females comprising up to 60% of the cohort.

In concordance with our study, Karaoğlu and his colleagues [18] enrolled 61 NAFLD cases with a mean age of 44 years, and 40 (65.5%) were males, aligning with numerous prior findings [19,20,21]. Previous Egyptian studies also noticed male predominance of NAFLD [22,23,24]. NAFLD prevalence is more elevated in men compared to premenopausal women; however, this trend reverses post-menopause [25,26.]

A further finding in this study was derived from a US assessment. A total of 20 patients (40%) were classified with fatty liver grade-I, while 15 patients (30%) were categorized as grade-II and 15 patients (30%) as grade-III. Hsiao et al. conducted a study involving 600 patients diagnosed with NAFLD. In the US, a total of 499 patients (83.2%) were classified with grade-I fatty liver, 65 patients (10.8%) with grade-II, and 36 patients (6%) with grade-III fatty liver [27.]

Tissue Doppler echocardiography presents limitations in assessing myocardial function, primarily due to its dependence on the interrogation angle [28]. This underscores the necessity of developing an alternative imaging

technique, specifically STE, to assist clinicians in extending these limits alongside its clinical utility and reported accuracy in numerous pathologies [29.]

The present study revealed that fibrosis and steatosis scores negatively correlated with TAPSE and GLS (LV and RV) while exhibiting insignificant correlations with other echocardiographic parameters. Consistent with the aforementioned results, a prior study indicated that STE demonstrated a negative correlation between NAFLD cases and LV longitudinal systolic function despite the overall systolic ejection function not exhibiting a significant correlation (30). This observation is consistent with existing literature [31]. Singh et al. further corroborated these results, reporting substantially diminished early diastolic strain rates and LV global longitudinal systolic strain in obese individuals compared to lean controls, with further reductions in obese NAFLD individuals [32.]

GLS, a marker of systolic function, was notably lower in NAFLD patients than in non-NAFLD controls, indicating a greater subclinical systolic dysfunction degree in the NAFLD cohort. The comparison of LVEF between the two groups (NAFLD vs. Non-NAFLD) exhibited insignificant differences. This illustrates that reliance on this conventional tool may overlook the early stages of LV systolic dysfunction [33.]

The literature reveals a lack of studies assessing the ASCVD risk score in patients with NAFLD, and there is no research addressing the CHA2DS2-VASc score in this population. Our study revealed that patients with elevated ASCVD/CHA2DS2-VASc scores exhibited increased fibrosis and steatosis scores, as evaluated by fibroScan, along with an advanced fatty liver degree. Additionally, a greater degree of fibrosis and steatosis was observed in patients with elevated cardiovascular risk scores (CHA2DS2-VASc/ASCVD score.)

Huang Y-C et al. illustrated that NAFLD cases exhibited significantly elevated ASCVD risk rates ($\geq 7.5\%$; $p < 0.001$) in comparison to individuals without NAFLD. After controlling for cardiometabolic risk factors, the NAFLD grade among all participants and the NAFLD fibrosis score in NAFLD cases displayed a

marked association with elevated ASCVD risk [34].

Our study found a positive correlation between the CHA2DS2-VASc score and both fibrosis and steatosis scores. The majority of patients with F1 and S1 exhibited elevated CHA2DS2-VASc scores. This study represents the first examination of the CHA2DS2-VASc score in NAFLD individuals.

While this study is notable for being the first to address this issue in our locality and for determining the CHA2DS2-VASc score in NAFLD subjects, it also has several limitations. Initially, NAFLD was diagnosed in the absence of liver biopsy confirmation. A liver biopsy is considered the gold standard for diagnosing NAFLD; however, it is an invasive procedure that often causes distress and is unsuitable for asymptomatic patients. Abdominal ultrasonography demonstrated reliability and accuracy in detecting moderate to severe fatty liver.

CONCLUSION

NAFLD, even in asymptomatic adults, may serve as an independent subclinical cardiovascular dysfunction risk factor, regardless of traditional cardiovascular risk factors. STE emerges as a sensitive and critical tool for detecting early subclinical left ventricular (LV) dysfunction.

Ethical considerations: Prior to participating, all subjects provided written informed consent. The Faculty of Medicine's Ethical Committee granted the ethical approval (Assuit University-Egypt).

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Contribution:

Lobna Abdel-Wahid , Reem Ezzat Mahdy and Sohair M.Kasem are responsible for idea of the manuscript.

Omar Mohamed Magdy and Ahmad Abdel fadeel Maghraby are responsible for data collection.

Lobna Abdel-Wahid , Reem Ezzat Mahdy , Sohair M.Kasem , Omar Mohamed Magdy and

Ahmad Abdel fadeel Maghraby performed the statistical analysis and wrote the manuscript.

Echocardiography and speckle tracking echocardiography were performed to all patients by Salma Taha and Alaa Omar.

All authors revised the manuscript.

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Conflict of interest

None

HIGHLIGHTS

- Non-alcoholic fatty liver disease, diagnosed in asymptomatic adults may be a risk factor for remodeling the left ventricle over time, being associated with subclinical cardiovascular affection, regardless of the presence of other cardiovascular risk factors.
- This study showed that the new imaging technique, speckle tracking, represents both an important and sensitive tool in order to detect early subclinical dysfunction of the left ventricle, being applicable for patients diagnosed with non-alcoholic fatty liver disease. Also, we found that cardiovascular risk scores as determined by ASCVD risk score and CHADSVASC risk score were directly related to degree of fibrosis in patients with non-alcoholic fatty liver disease.

REFERENCES

1. McPherson S, Hardy T, Henderson E, Burt AD, Day CP, Anstee QM. European Association for the Study of the Liver. European Association for the Study of Diabetes (EASD) European Association for the Study of Obesity (EASO). EASL–

- EASD–EASO Clinical Practice Guidelines for the management of non-alcoholic fatty liver disease. 2016;64:1388-402.
2. Lv S, Jiang S, Liu S, Dong Q, Xin Y, Xuan S. Non-invasive quantitative detection methods of liver fat content in non-alcoholic fatty liver disease. *Journal of clinical and translational hepatology*. 2018;6(2):217-21.
 3. Dharmalingam M, Yamasandhi PG. Non-alcoholic fatty liver disease and type 2 diabetes mellitus. *Indian journal of endocrinology and metabolism*. 2018;22(3):421-8.
 4. Newsome PN, Sasso M, Deeks JJ, Paredes A, Boursier J, Chan W-K, et al. FibroScan-AST (FAST) score for the non-invasive identification of patients with non-alcoholic steatohepatitis with significant activity and fibrosis: a prospective derivation and global validation study. *The lancet Gastroenterology & hepatology*. 2020;5(4):362-73.
 5. Anstee QM, Mantovani A, Tilg H, Targher G. Risk of cardiomyopathy and cardiac arrhythmias in patients with non-alcoholic fatty liver disease. *Nat Rev Gastroenterol Hepatol*. 2018;15(7):425-39.
 6. Zamirian M, Samiee E, Moaref A, Abtahi F, Tahamtan M. Assessment of subclinical myocardial changes in non-alcoholic fatty liver disease: a case-control study using speckle tracking echocardiography. *Iranian Journal of Medical Sciences*. 2018;43(5):466.
 7. Joglar JA, Chung MK, Armbruster AL, Benjamin EJ, Chyou JY, Cronin EM et al. ACC/AHA/ACCP/HRS Guideline for the Diagnosis and Management of Atrial Fibrillation: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2024 Jan 2. 149 (1):e1-e156.
 8. Stone NJ, Robinson JG, Lichtenstein AH, Merz CB, Blum CB, Ekel RH et al. ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Circulation*. Jun 24; 2014 129(25 Suppl 2):S1–45.
 9. Petzold G. Role of Ultrasound Methods for the Assessment of NAFLD. *Journal of Clinical Medicine*. 2022;11(15):4581.
 10. Kamali L, Adibi A, Ebrahimian S, Jafari F, Sharifi M. Diagnostic performance of ultrasonography in detecting fatty liver disease in comparison with fibroscan in people suspected of fatty liver. *Advanced biomedical research*. 2019;8(1):69-72.
 11. Tada T, Nishimura T, Yoshida M, Iijima H. Non-alcoholic fatty liver disease and non-alcoholic steatohepatitis: new trends and role of ultrasonography. *Journal of Medical Ultrasonics*. 2020;47:511-20.
 12. Trovato FM, Martines GF, Catalano D, Musumeci G, Pirri C, Trovato GM. Echocardiography and NAFLD (non-alcoholic fatty liver disease). *Int J Cardiol*. 2016;221:275-9.
 13. Pastore MC, Mandoli GE, Contorni F, Cavigli L, Focardi M, D'Ascenzi F, et al. Speckle tracking echocardiography: early predictor of diagnosis and prognosis in coronary artery disease. *BioMed Research International*. 2021;2021:1-11.
 14. Moise CG, Donoiu I, Târtea G-C, Mirea O, Rogoveanu I. Contribution of modern echocardiographic techniques in the detection of subclinical heart dysfunction in young adults with non-alcoholic fatty liver disease. *Current Health Sciences Journal*. 2021;47(2):275.
 15. Moise CG, Donoiu I, Târtea G-C, Mirea O, Rogoveanu I. Contribution of modern echocardiographic techniques in the detection of subclinical heart dysfunction in young adults with non-alcoholic fatty liver disease. *Current Health Sciences Journal*. 2021;47(2):275.
 16. Fan N, Ding X, Zhen Q, Gu L, Zhang A, Shen T, et al. Association of the Non-Alcoholic Fatty Liver Disease Fibrosis Score with subclinical myocardial remodeling in patients with type 2 diabetes: A cross-sectional study in China. *Journal of Diabetes Investigation*. 2021;12(6):1035-41.
 17. Catena C, Brosolo G, Da Porto A, Donnini D, Bulfone L, Vacca A, et al. Association of non-alcoholic fatty liver disease with left ventricular changes in treatment-naïve patients with uncomplicated hypertension. *Frontiers in Cardiovascular Medicine*. 2022;9:1030968.
 18. Karaoğlu BB, Tulunay C, Uzun Ç, Peker E, Özyüncü N, Ellik Z, et al. Determining Subclinical Cardiovascular and Cardiac Diseases in Patients with Non-Alcoholic Fatty Liver Disease. *Turk J Gastroenterol*. 2023;34(3):242-53.
 19. Li Y, Chen Y, Tian X, Zhang S, Jiao J. Comparison of clinical characteristics between obese and non-obese patients with non-alcoholic fatty liver disease (NAFLD). *Diabetes, Metabolic Syndrome and Obesity*. 2021:2029-39.

20. Alon L, Corica B, Raparelli V, Cangemi R, Basili S, Proietti M, et al. Risk of cardiovascular events in patients with non-alcoholic fatty liver disease: a systematic review and meta-analysis. *European Journal of Preventive Cardiology*. 2022;29(6):938-46.
21. Fresneda S, Abbate M, Busquets-Cortés C, López-González A, Fuster-Parra P, Bennasar-Veny M, et al. Sex and age differences in the association of fatty liver index-defined non-alcoholic fatty liver disease with cardiometabolic risk factors: a cross-sectional study. *Biology of sex Differences*. 2022;13(1):64-7.
22. Abd El-Wahab EW, El-Abedin RAZ, Ahmed WM, Shatat HZ. Validation of a non-laboratory based screening tool for predicting non-alcoholic fatty liver disease in an Egyptian setting. *The American Journal of the Medical Sciences*. 2020;360(6):662-77.
23. Tomah S, Hamdy O, Abuelmagd MM, Hassan AH, Alkhouri N, Al-Badri MR, et al. Prevalence of and risk factors for non-alcoholic fatty liver disease (NAFLD) and fibrosis among young adults in Egypt. *BMJ open gastroenterology*. 2021;8(1):e000780.
24. Abdallah HR, Youness ER, Bedeir MM, Abouelnaga MW, Ezzat WM, Elhosary Y, et al. Clinical and diagnostic characteristics of non-alcoholic fatty liver disease among Egyptian children and adolescents with type1 diabetes. *Diabetology & Metabolic Syndrome*. 2023;15(1):52-6.
25. Ciardullo S, Oltolini A, Cannistraci R, Muraca E, Perseghin G. Sex-related association of non-alcoholic fatty liver disease and liver fibrosis with body fat distribution in the general US population. *The American Journal of Clinical Nutrition*. 2022;115(6):1528-34.
26. Fouad TR, Mohamad NE, Elabd M, Abd-Elwahab R, Elsary AY, Abd-Elghafar TS, et al. Non-alcoholic fatty liver disease and female sexual dysfunction in Egyptian premenopausal women: is there a link between metabolic syndrome and sexual function? *The Journal of Sexual Medicine*. 2024;21(9):770-6.
27. Hsiao CC, Teng PH, Wu YJ, Shen YW, Mar GY, Wu FZ. Severe, but not mild to moderate, non-alcoholic fatty liver disease associated with increased risk of subclinical coronary atherosclerosis. *BMC Cardiovascular Disorders*. 2021;21(1):244-8.
28. Mirea O, Corîci OM, Berceanu M, Donoiu I, Militaru C, Istratoaie O. Variability of longitudinal strain measurements: levelling the playing field. *Acta Cardiologica*. 2019;6(2):42-9.
29. Younossi ZM. Non-alcoholic fatty liver disease—a global public health perspective. *Journal of hepatology*. 2019;70(3):531-44.
30. Moise CG, Donoiu I, Târtea G-C, Mirea O, Rogoveanu I. Contribution of modern echocardiographic techniques in the detection of subclinical heart dysfunction in young adults with non-alcoholic fatty liver disease. *Current Health Sciences Journal*. 2021;47(2):275.
31. Geyer H, Caracciolo G, Abe H, Wilansky S, Carerj S, Gentile F, et al. Assessment of myocardial mechanics using speckle tracking echocardiography: fundamentals and clinical applications. *Journal of the American Society of Echocardiography*. 2010;23(4):351-69.
32. Singh GK, Vitola BE, Holland MR, Sekarski T, Patterson BW, Magkos F, et al. Alterations in ventricular structure and function in obese adolescents with non-alcoholic fatty liver disease. *J Pediatr*. 2013;162(6):1160-8, 8.e1.
33. Zamirian M, Samiee E, Moaref A, Abtahi F, Tahamtan M. Assessment of subclinical myocardial changes in non-alcoholic fatty liver disease: a case-control study using speckle tracking echocardiography. *Iranian Journal of Medical Sciences*. 2018;43(5):466.
34. Huang YC, Huang JC, Chien HH, Lin CI, Chuang YS, Cheng HY, et al. Performance of non-alcoholic fatty liver fibrosis score in estimating atherosclerotic cardiovascular disease risk. *Nutrition, Metabolism and Cardiovascular Diseases*. 2023;33(12):2479-87.

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