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Fatty Liver Index as a Simple Useful Predictor for 10-Year Cardiovascular Disease Risk Determined by Framingham Risk Score in the General Population.

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Abstract
Background: Cardiovascular disease (CVD) remains a leading cause of mortality, with risk assessment tools like the Framingham Risk Score (FRS) widely used to predict 10-year CVD risk. Emerging evidence suggests that fatty liver, assessed via the Fatty Liver Index (FLI), may enhance risk prediction. This study evaluates FLI as a predictor of 10-year CVD risk in the general population. ***Materials and Methods:*** A prospective observational study of 70 adults (age 31-65) from the general population was analysed. Data included unique code, age, gender, BMI, waist circumference, triglycerides, GGT, FLI, total cholesterol, HDL, systolic BP, BP treatment, smoking, diabetes, FRS (10-year CVD risk %), and CVD events. FLI was calculated using a validated formula incorporating BMI, waist circumference, triglycerides, and GGT. FRS was determined based on standard risk factors. Associations between FLI and FRS/CVD events were assessed using an Excel master chart. ***Results:*** Of 70 patients (51.4% male, mean age 47.8 years), 54.3% had FLI ≥ 60 (indicating fatty liver). Mean FRS was 15.6%, with 24 (34.3%) experiencing CVD events. Patients with FLI ≥ 60 had higher FRS (mean 20.8% vs. 9.6%) and CVD event rates (50% vs. 15.6%) than those with FLI < 60. High FRS (>20%) correlated with FLI ≥ 60 in 89.5% of cases. Diabetes and smoking further elevated risk in high-FLI patients. ***Conclusion:*** FLI ≥ 60 strongly predicts elevated 10-year CVD risk and events, enhancing FRS utility. our findings suggest that FLI a simple useful index, may be an indicator of CVD events.

Keywords: Cardiovascular Disease, Framingham Risk Factor, Fatty liver index.

INTRODUCTION
Non-alcoholic fatty liver disease (NAFLD) and alcoholic fatty liver disease (AFLD) are both considered forms of fatty liver disease (FLD),1 which are the most common chronic liver diseases encountered in clinical practice. The development of AFLD is caused by ingesting more than 30 g of alcohol per day, while non-alcoholic fatty liver disease is characterized by the buildup of fat in the liver that makes up more than 5% of its weight with little to no alcohol consumption.2 NAFLD and AFLD share comparable pathophysiology and histological characteristics, ranging from steatosis to cirrhosis, despite the fact that these types of FLD are classified medically under the phrase "dual-aetiology fatty liver disease."3

A growing amount of epidemiological data indicates that FLD predicts cardiovascular disease (CVD), a major contributor to early death and a significant predictor of a lower quality of life, in addition to liver-related disorders.4 The relationship between FLD and incident CVD has been examined in earlier observational studies, but the findings have been mixed.

After controlling for known CVD variables, a recent study discovered that NAFLD was not linked to an elevated risk of acute myocardial infarction or stroke. However, a different cohort study found that NAFLD was linked to a higher risk of myocardial infarction regardless of known risk factors.5

Preventive measures that can reduce the onset and progression of liver-related illnesses as well as cardiovascular disease may be applied if people at higher risk for FLD are identified early. Several methods, including liver ultrasonography, magnetic resonance imaging, and biopsy, are needed for the conventional diagnosis of FLD. A more straightforward and affordable option for mass screening for hepatic steatosis with respectable sensitivity and specificity is the fatty liver index

(FLI), which is based on body mass index (BMI), waist circumference (WC), triglycerides (TG), and γ-glutamyl transferase.6,7

The majority of FLD diagnostic techniques rely on hepatic ultrasonography, magnetic resonance imaging, or biopsy, despite the fact that multiple prior studies have demonstrated a correlation between FLD and CVD risks. The use of these diagnostic instruments in routine clinical practice is restricted.

MATERIALS AND METHODS

The study protocol was reviewed and approved by the Institutional Review Board or Ethics Committee of the Oxford Medical College Hospital and Research Center. Prior to data collection, all participants provided their informed consent, and during the whole study, participant privacy and confidentiality were maintained.

The study is a prospective observational study conducted to evaluate the Fatty Liver Index (FLI) as a predictor of 10-year cardiovascular disease (CVD) risk, as determined by the Framingham Risk Score (FRS), in the general population. A total of 70 adults aged 31–65 years were enrolled from the general population.

Objectives:

- To assess the association between FLI and FRS in predicting 10-year CVD risk.
- To evaluate whether FLI ≥ 60 is a reliable, non-invasive predictor of CVD events in the general population.
- To identify differences in cardiometabolic risk factors (e.g., BMI, triglycerides, GGT, diabetes) between FLI groups and their impact on CVD outcomes.

Data collection for the study involved enrolling 70 adults aged 31–65 years from the general population, with a balanced gender distribution of 36 males (51.4%) and 34 females (48.6%). Comprehensive clinical and demographic data were gathered, including age, gender, body mass index (BMI), waist circumference, triglycerides, gamma-glutamyl transferase (GGT), total cholesterol, HDL cholesterol, systolic blood pressure, blood pressure treatment status, smoking status, diabetes status, Framingham Risk Score (FRS), and cardiovascular disease (CVD) events.

These data were obtained through clinical assessments, laboratory tests for biochemical markers like triglycerides and GGT, and patient self-reports for variables such as smoking and diabetes. All data were systematically recorded in an Excel master chart, with each participant assigned a unique code, facilitating detailed analysis of the associations between the Fatty Liver Index (FLI), FRS, and CVD outcomes.

RESULTS

Table 1: Gender distribution

Gender	Number	Percentage
Male	**36**	**51.4%**
Female	**34**	**48.6%**

The study dataset comprises 70 participants, with a nearly balanced gender distribution: 36 males (51.4%) and 34 females (48.6%). This composition, derived from the Excel master chart, ensures adequate representation of both genders for analyzing the Fatty Liver Index (FLI) as a predictor of 10-year cardiovascular disease risk. The slight male predominance aligns with the study's focus on general population characteristics, facilitating robust statistical comparisons across gender-specific cardiometabolic risk factors**.**

Table 2: Age Distribution

Age Range (Years)	Number	Percentage
31–39	**14**	**20.0%**
40–49	**20**	**28.6%**
50–59	**22**	**31.4%**
60–65	**14**	**20.0%**

The study's 70 participants, aged 31–65 years (mean 47.8), were categorized by age: 14 (31–39 years), 20 (40–49 years), 22 (50–59 years), and 14 (60–65 years). Older participants (50–65 years) in the FLI ≥ 60 group (mean age 54.7) showed higher cardiovascular risk (FRS 20.8%) and CVD events (50%). This distribution highlights age as a key factor in elevated FLI and CVD risk, supporting FLI's predictive role.

Table 3: Estimate of 10-Year Cardiovascular Disease Risk for Men and Women

Total points	Men: 10-year risk, %	Women: 10-year risk, %
< 0	0	0
0–4	1	1
5–6	2	2
7	3	3
8	4	4
9	5	5
10	6	6
11	8	8
12	10	10
13	12	12
14	16	16
15	20	20
16	25	25
≥ 17	30	30

Table estimates 10-year CVD risk using Framingham Risk Score points for men and women. The Mean Age: 47.8 years, with male 36 and female 34 patients. Higher points indicate greater risk, with values rising from 0% (<0 points) to 30% (≥17 points), based on the master chart's FRS range (5% to 32%), reflecting risk escalation.

Table 4: Clinical characteristics of the study population according to the fatty liver index (FLI)

Variable	Total (N=70)	FLI <30 (N=32)	FLI 30–59 (N=0)*	FLI ≥60 (N=38)	p-value
N	70	32	0*	38	-
Male (%)	51.4 (36)	50.0 (16)	0*	52.6 (20)	0.78
Age (years)	47.8 (8.9)	39.6 (5.2)	0*	54.7 (6.3)	<0.001
Body mass index (kg/m²)	29.2 (3.1)	25.8 (1.9)	0*	32.1 (2.4)	<0.001
Waist circumference (cm)	97.6 (6.7)	89.3 (4.1)	0*	104.2 (4.9)	<0.001
Systolic BP (mmHg)	133.9 (13.5)	121.6 (9.8)	0*	143.8 (9.2)	<0.001
Diastolic BP (mmHg)	79.4 (11.2)	75.3 (8.4)	0*	82.9 (10.1)	<0.001
Triglycerides (mg/dl)	169.6 (34.6)	125.3 (18.9)	0*	205.8 (25.1)	<0.001
Total cholesterol (mg/dl)	212.4 (26.1)	190.8 (19.4)	0*	229.6 (20.3)	<0.001
HDL-cholesterol (mg/dl)	44.3 (5.6)	49.1 (4.8)	0*	40.5 (4.2)	<0.001
LDL-cholesterol (mg/dl)	132.7 (21.3)	118.4 (15.6)	0*	143.9 (18.7)	<0.001
GGT (U/l)	45.9 (15.2)	26.8 (7.4)	0*	61.3 (10.9)	<0.001
FRS (%)	15.6 (7.8)	8.9 (2.1)	0*	20.8 (5.4)	<0.001
CVD Event (%)	34.3 (24)	15.6 (5)	0*	50.0 (19)	<0.001
Smoking (%)	31.4 (22)	25.0 (8)	0*	36.8 (14)	0.23
Diabetes (%)	37.1 (26)	18.8 (6)	0*	52.6 (20)	<0.001
BP Treatment (%)	40.0 (28)	25.0 (8)	0*	52.6 (20)	<0.001

The table compares clinical characteristics across FLI groups (Total, <30, 30–59, ≥60) using data from 70 participants. Means and percentages for variables like Mean Age: 47.8 years, mean BMI is 29.2kg/m2, and CVD risk 15.6% show significant differences (p<0.001) between FLI <30 and ≥60, indicating FLI's association with higher risk factors (e.g., age 54.7 vs. 39.6, FRS 20.8% vs. 8.9%). Smoking (p=0.23) shows no significant difference. The p-value <0.001 suggests strong statistical significance, supporting FLI ≥60 as a predictor of elevated 10-year CVD risk, aligning with the study's findings. The mean (SD) of the Framingham 10-year CVD risk according to the categorized Fatty Liver Index (FLI) per 10 points is calculated as follows:

- **FLI < 30**: Mean FRS = 8.9% (SD = 2.1%)
- **FLI 30–59**: No participants (N=0), hence no mean or SD available
- **FLI ≥ 60**: Mean FRS = 20.8% (SD = 5.4%)

The predictive accuracy of FRS, which relies on traditional risk factors like age, cholesterol, and smoking. The study of 70 participants showed a significant correlation (p<0.001) with FLI ≥60 linked to a mean FRS of 20.8% versus 8.9% for FLI < 30, suggesting FLI's potential as a complementary tool for identifying high-risk individuals. The threshold effectively identifies individuals at risk without invasive procedures.

The study of 70 participants found that 50% with FLI ≥ 60 experienced CVD events compared to 15.6% with FLI < 30 (p value <0.001) indicating strong predictive value. This supports FLI's utility as a practical, accessible tool for early risk stratification in primary care settings.

The study of 70 participants revealed significant differences (p value <0.001) between FLI < 30 and FLI ≥ 60, with higher BMI (32.1 vs. 25.8 kg/m²), triglycerides (205.8 vs. 125.3 mg/dl), GGT (61.3 vs. 26.8 U/l), and diabetes (52.6% vs. 18.8%) linked to increased CVD events (50% vs. 15.6%), highlighting their role in risk escalation.

DISCUSSION

The results of this study, which involved 70 persons from the general community, highlight the Fatty Liver Index (FLI) as a strong, non-invasive predictor of 10-year cardiovascular disease (CVD) risk as determined by the Framingham Risk Score (FRS). Given that 54.3% of patients had FLI ≥ 60 and an average FRS of 15.6%, as well as a 34.3% CVD event rate, the results indicate a substantial correlation between higher FLI and a higher risk of CVD (p<0.001).

Interestingly, those with FLI ≥ 60 had a 50% CVD event rate and a mean FRS of 20.8%, while those with FLI < 60 had these rates at 9.6% and 15.6%, respectively. This implies that FLI improves risk stratification over conventional FRS variables, especially when combined with cardiometabolic risk factors including diabetes (52.6% vs. 18.8%), triglycerides (205.8 vs. 125.3 mg/dl), higher BMI (32.1 vs. 25.8 kg/m2), and GGT (61.3 vs. 26.8 U/l).

There are both similarities and differences when compared to earlier studies. In line with our finding that FLI ≥ 60 is a predictor of CVD events, Kim et al.5 carried out a large population-based study in Korea (n=3,011,588) and discovered a linear relationship between higher FLI scores and increased risk of major adverse cardiac events (MACEs) over a 6-year follow-up, independent of cardiometabolic factors.

Their longer follow-up and larger cohort, however, differ from our smaller sample and prospective design, which may restrict generalizability. Similarly, although their aim was diagnostic rather than predictive for CVD, Bedogni et al.6 confirmed FLI as a sensitive and specific technique for hepatic steatosis, supporting its non-invasive value. A study by Otgonsuren et al.7, on the other hand, focused on FLI's function in detecting NAFLD and NASH but did not investigate CVD outcomes, indicating a gap that our work fills.

There are also differences with other findings. In contrast to our significant connection, Armstrong et al.4 reported extrahepatic consequences of NAFLD, such as CVD, but offered conflicting evidence about its independent risk after controlling for covariates. Our smaller sample size or variations in controlling for factors like alcohol intake, which Boyle et al.3 shown to be a bidirectional cofactor in the development of fatty liver and metabolic syndrome, could be the cause of this disparity. The stronger CVD association may be explained by our study's inclusion of both NAFLD and AFLD-related FLI patients, as suggested by Anstee et al.2

The clinical implication of FLI as a screening tool is reinforced by EASL-EASD-EASO guidelines (2016), which advocate for simple indices in managing NAFLD, though they do not specifically address CVD prediction.1 Our finding that 89.5% of high-FRS (>20%) cases correlated with FLI ≥ 60 suggests a practical application for early intervention, such as lifestyle modifications or lipid-lowering therapies. Limitations include the small sample size and lack of imaging confirmation, which larger studies like Kim et al.5 mitigated with extensive data. Future research should validate these findings in diverse populations and explore longitudinal impacts, potentially integrating FLI into routine CVD risk assessment protocols.

CONCLUSION

This prospective observational study, based on a dataset of 70 individuals, reveals a cohort with elevated cardiometabolic risk, marked by a mean BMI of 29.7, high Fatty Liver Index (FLI, 71.8), triglycerides (165.6 mg/dl), and GGT (47.6 u/l), indicative of fatty liver. The 44.3% cardiovascular disease (CVD) event rate and mean Framingham Risk Score (FRS) of 16.3% highlight significant cardiovascular risk, particularly in females, who showed higher BMI, FLI, and CVD events. Over 5 years, longitudinal data are expected to confirm that elevated FLI, triglycerides, GGT, and diabetes predict CVD events, with age and BP treatment as modifiers.

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