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External validity of cardiovascular risk assessment tools in individuals with MASLD (NAFLD): a cohort study

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The present study was conducted to evaluate the external validity of various cardiovascular disease (CVD) risk assessment tools in predicting CVD events among individuals with metabolic dysfunction–associated steatotic liver disease (MASLD). The Amol prospective cohort study spanned a follow-up period of seven years, from 2009 to 2010 to 2016–2017. A total of 1,431 individuals aged 40–75 years were included. The 10-year cardiovascular risk was estimated for each participant using four risk assessment tools: the Pooled Cohort Equations of the American College of Cardiology/American Heart Association (ACC/AHA), the Systematic Coronary Risk Evaluation (SCORE) equations, the Framingham General Cardiovascular Risk Profile, and the SCORE2 equations. Receiver Operating Characteristic (ROC) curves were used to assess the discrimination ability of these tools. The ACC/AHA tool demonstrated the highest predictive ability for both fatal CVD events (AUC: 0.92, 95% CI: 0.88–0.97 for men; AUC: 0.87, 95% CI: 0.79–0.96 for women) and composite CVD events (AUC: 0.68, 95% CI: 0.62–0.75 for men; AUC: 0.79, 95% CI: 0.72–0.85 for women). Based on these findings, cardiovascular risk assessment tools, particularly the ACC/AHA tool, can be applied in clinical settings to evaluate the future risk of CVD events in women with MASLD. However, the SCORE equations also exhibited excellent predictive ability for fatal cardiac events, requiring fewer variables.

Metabolic dysfunction–associated steatotic liver disease (MASLD)[1], also known as non-alcoholic fatty liver disease (NAFLD), is projected to become the leading cause of liver malignancy, liver transplantation, and liver-related mortality in the near future[2]. The incidence and prevalence of MASLD have increased steadily in recent decades, driven by the global obesity epidemic[3,4]. A study in Iran estimated the total prevalence of MASLD at 33.9% in the adult population[5]. A more recent meta-analysis reported prevalence rates of 35% in men and 37% in women[6].

In addition to its association with liver-related complications, MASLD is linked to metabolic conditions, including insulin resistance, diabetes mellitus, and metabolic syndrome[7–9]. In recent years, MASLD has been recognized as a hepatic manifestation of metabolic syndrome. The non-liver-related complications of MASLD are so significant that they result in more deaths than liver-related complications[10].

Previous studies have demonstrated an association between MASLD and CVD events[11]. Consequently, estimating CVD risk in patients diagnosed with MASLD is of critical importance. This need becomes even more pronounced given the high prevalence of cardiovascular events and associated mortality in Iran, where CVD accounts for 46% of all deaths and 20–30% of the disease burden, a pattern observed in many parts of the world[12].

To assess CVD risk, several risk assessment tools have been developed, primarily for the general population. These include the Pooled Cohort Equations of the American College of Cardiology/American Heart Association

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(ACC/AHA), the Framingham General Cardiovascular Risk Profile for use in primary care, the Systematic Coronary Risk Evaluation (SCORE) equations, and, more recently, the SCORE2 Eqs.[13–16]. The Framingham tool has been validated in a recent study for patients with MASLD in Western countries[17]. The present study was conducted to evaluate the external validity of these tools in predicting fatal and nonfatal CVD events in individuals with MASLD in a Middle Eastern country, specifically among both men and women.

Methods

Setting and study population

Participants

The present study was conducted within the framework of the Amol Cohort Study, a prospective study. Phase I of the Amol Cohort Study enrolled 6,140 individuals from northern Iran. Participants aged 10–90 years were eligible for inclusion. The sampling frame was derived from primary health records obtained from local primary healthcare centers in urban and rural areas. The population was stratified into 16 strata based on gender and age groups, segmented at 10-year intervals within the 10–90-year age range: 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80–90. The probability proportional to size (PPS) sampling method was employed to randomly select participants from each stratum according to age and sex. In Phase II, which involved a comprehensive evaluation, participants from Phase I were invited to participate via direct phone calls. Of these, 5,394 (91.2%) agreed to join Phase II after the study's primary objectives were explained. Nonresponders were followed up through health houses in rural areas and health posts in urban areas using their postal addresses. Data on residency, migration, and mortality among nonresponders were recorded in our database. For deceased individuals, the cause, date, and additional details were obtained from a close family member, and relevant death certificates were reviewed. Nonresponders who remained residents of the same geographical area or had migrated to another covered region were also included. In the present study, a total of 1,431 individuals (717 men and 714 women) aged 40–74 years with NAFLD and no prior history of CVD events from Phase I were included. Figure 1 provides a schematic overview of the study population.

This study was approved by the Human Research Ethics Committee of Iran University of Medical Sciences, Tehran, Iran (approval code: IR.IUMS.REC.1397.165). All methods were performed in accordance with relevant guidelines and regulations. Informed consent was obtained from all participants.

Data collection

Height was measured using a calibrated, nonstretchable meter. Calibration of devices used to measure height and weight was performed with standard rods and weights, respectively. Blood pressure was measured with the participant seated in a chair, feet flat on the floor, and back supported, in a quiet room. Prior to measurement, participants were instructed to empty their bladders and refrain from smoking, consuming caffeine, or exercising for at least 30 min. Measurements were obtained using a calibrated auscultatory device. Additionally,

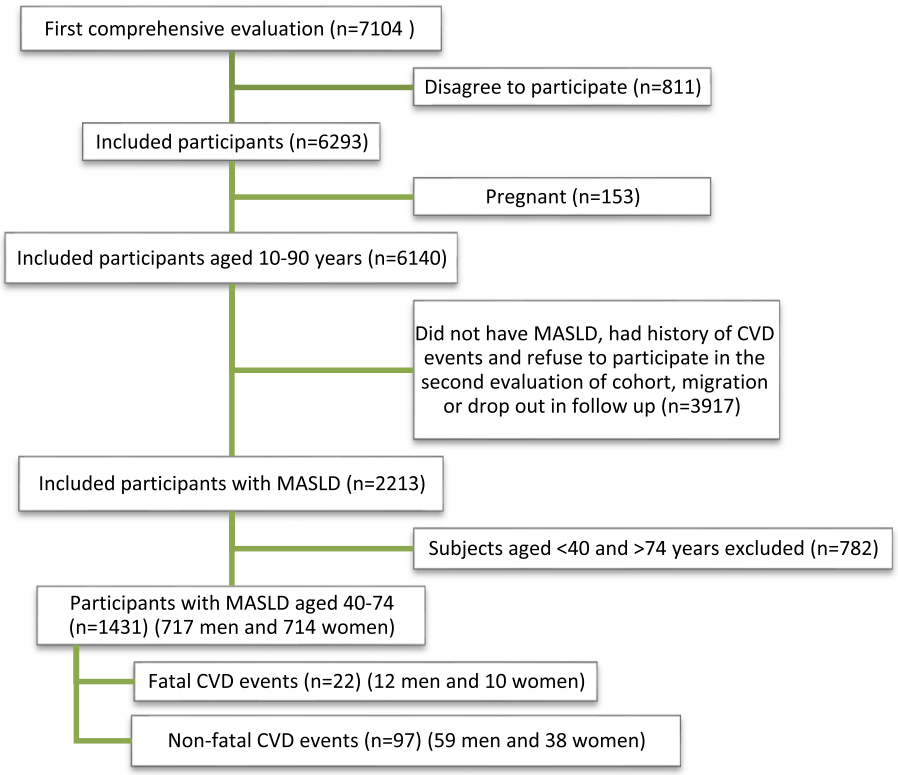

Fig. 1. Schematic view of study population of the present study.

10 mL of whole blood was collected after a 12-hour fast using a serum separator tube (Tiger Top Tube). Serum was then separated by centrifugation at 3,000 rpm and stored at − 20 °C until analysis. All tests—including fasting blood sugar (FBS), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyltransferase (GGT), and cholesterol—were assessed enzymatically and quantified colorimetrically using the Pishtaz Teb Commercial Kit (Pishtaz Teb Diagnostics, Tehran, Iran) and a BS200 Autoanalyzer (Mindray, China).

MASLD diagnosis

The diagnosis of MASLD was established using ultrasound (Sonoscape, China). MASLD was defined as evidence of hepatic steatosis in participants with no history of excessive alcohol consumption, drug-induced steatosis, or viral or hereditary steatogenic hepatic conditions. All ultrasound examinations were conducted by a single expert sonographer, who was blinded to the participants' status and not directly involved in the cohort study. Sagittal, longitudinal, lateral, and intercostal views of the liver were obtained using a 3–5 MHz transducer. The diagnostic criteria for confirming fatty liver included a marked increase in hepatic echogenicity and an abnormal visualization of hepatic vessels and the diaphragm.

CVD risk assessment

The CVD risk was estimated separately using the Pooled Cohort Equations of the American College of Cardiology/American Heart Association (ACC/AHA), the Framingham General Cardiovascular Risk Profile, the Systematic Coronary Risk Evaluation (SCORE) equations for low- and high-risk European populations, and the SCORE2 equations for low-, moderate-, high-, and very high-risk populations[13–15,18]. The inclusion criteria specific to each CVD risk assessment tool and data from Phase I of the cohort study, conducted in 2009–2010[19], were applied in these estimations.

Outcomes

Participants were evaluated annually, and the incidence of new atherosclerotic cardiovascular disease (ASCVD) events over a seven-year follow-up period was assessed as the primary outcome. ASCVD was defined as a history of nonfatal acute myocardial infarction, death due to ischemic heart disease, or cerebrovascular accident. Additional outcomes included acute myocardial infarction, other CVD events, hospital admissions, deaths, angiographically confirmed heart disease, and a history of percutaneous coronary intervention (PCI) or CVD events recorded from 2009 to 2010 to 2016–2017.

A trained nurse performed 12-lead electrocardiography (ECG) (EDAN-SE-300, China) for all participants in Phase II of the cohort study. As ECG data were not available for Phase I, the occurrence of silent CVD events potentially related to diabetes mellitus, aging, or other associated factors was excluded during the follow-up period. In cases where ECG abnormalities were detected (nine participants), these individuals were interviewed in detail by the study team's internist and subsequently referred to an expert cardiologist; however, these abnormalities were not classified as outcomes. All associated outcomes were verified by an internist from the cohort study team.

Statistical methods

To evaluate the predictive ability of the risk assessment tools, receiver operating characteristic (ROC) analyses were performed using data derived from outcomes, including fatal CVD events, nonfatal CVD events, and a composite of fatal and nonfatal CVD events, over a seven-year follow-up period from Phase I of our cohort study. The estimated risks from Phase I of the cohort were used as classification variables (predictors). The area under the ROC curve (AUC) was calculated by plotting the sensitivities of the estimated 10-year CVD risks across infinite decision thresholds against their corresponding false-positive rates. The AUCs and their 95% confidence intervals (CIs) were computed and reported. Based on the guidelines by Hosmer and Lemeshow (2013), AUC values were interpreted as follows: $0.5 < AUC < 0.7$ indicates poor discriminatory ability, $0.7 \leq AUC < 0.8$ indicates acceptable ability, $0.8 \leq AUC < 0.9$ indicates excellent ability, and $0.9 \leq AUC \leq 1$ indicates outstanding ability[20]. Youden's J statistic (J = sensitivity + specificity − 1) was applied to determine the optimal cutoff points for the estimated risks in predicting CVD events. ROC regression models and ROC curves were generated using the *rocreg* command in Stata, version 12 (StataCorp, USA), to estimate AUCs and plot the curves. Decision curve analysis (DCA) was conducted for each risk score, following guidance from www.decisioncurveanalysis.org. DCA, a statistical method, assesses the clinical utility of tests and models by quantifying the net benefit of a model relative to the default strategies of treating all or no patients[21].

Results

Basic characteristics

Of the participants, 717 were men and 714 were women. The mean age was 53.73 ± 9.11 years for men and 53.99 ± 8.57 years for women ($p = 0.559$). Fatal CVD events occurred in 12 men (1.67%) and 10 women (1.40%) ($p = 0.656$), while nonfatal CVD events occurred in 59 men (8.23%) and 38 women (5.32%) ($p = 0.025$).

No significant differences were observed between men and women in age, waist circumference (WC), systolic blood pressure (SBP), diastolic blood pressure (DBP), TG, or ALP. However, women exhibited significantly higher body mass index (BMI) ($p < 0.001$), FBS ($p < 0.001$), total cholesterol ($p < 0.001$), HDL ($p < 0.001$), LDL ($p = 0.006$), and homeostatic model assessment of insulin resistance (HOMA-IR) ($p < 0.001$) compared with men, whereas men had significantly higher levels of liver enzymes, including ALT ($p < 0.001$), AST ($p < 0.001$), and GGT ($p = 0.006$). Table 1 presents the baseline characteristics of the study population with MASLD for men and women from Phase I of our cohort study.

Characteristics	Men ($n=717$)	Women ($n=714$)	*P*-value
Age (year)	53.73 ± 9.11	53.99 ± 8.57	0.559
WC (cm)	99.81 ± 9.49	100.68 ± 10.46	0.091
BMI (kg/m^2)	29.60 ± 3.91	32.96 ± 4.65	< 0.001
SBP (mmHg)	122.52 ± 16.66	123.94 ± 18.22	0.112
DBP (mmHg)	81.16 ± 12.36	81.56 ± 12.93	0.543
FBS (mg/dL)	108.15 ± 37.16	119.45 ± 51.98	< 0.001
TG (mg/dL)	174.62 ± 103.64	179.38 ± 125.07	0.426
Cholesterol (mg/dL)	191.19 ± 39.85	202.87 ± 43.67	< 0.001
HDL (mg/dL)	40.64 ± 10.88	42.95 ± 11.84	< 0.001
LDL (mg/dL)	113.49 ± 30.31	118.00 ± 32.25	0.006
HOMA-IR	2.71 ± 2.18	3.40 ± 3.01	< 0.001
ALT (IU/L)	28.68 ± 16.83	22.12 ± 15.57	< 0.001
AST (IU/L)	24.88 ± 15.94	21.38 ± 11.84	< 0.001
GGT (IU/L)	36.76 ± 40.83	31.10 ± 26.74	0.006
ALP (IU/L)	190.54 ± 80.27	187.18 ± 82.28	0.426
Smoking (%) (95% CI)	24.6 (21.5–27.7)	0.66 (0.08–1.2)	< 0.001
Diabetes mellitus type 2 (%) (95% CI)	18.2 (15.4–20.9)	31.8 (28.5–35.1)	< 0.001

Table 1. Basic characteristics of the study population with MASLD of phase I of the cohort study (aged 40–74 years). Data are presented as mean ± SD unless otherwise stated BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, FBS: fasting blood sugar, HDL: high density lipoprotein, LDL: low density lipoprotein, HOMA- IR: Homeostatic model assessment of insulin resistance, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase GGT: Gamma glutamyl transferase, ALP: Alkaline phosphatase, SD: standard deviation, TG: triglyceride and WC: waist circumference.

Predictive ability of risk assessment tools

For fatal CVD events, ACC/AHA and Framingham demonstrated outstanding predictive ability in men (AUC: 0.92, 95% CI: 0.88–0.97 and AUC: 0.91, 95% CI: 0.85–0.96, respectively), while SCORE tools exhibited excellent predictive ability (AUC: 0.82, 95% CI: 0.72–0.93 for both low- and high-risk populations). In women, all four tools—ACC/AHA, Framingham, SCORE, and SCORE2—yielded excellent discriminatory ability ($0.8 \leq AUC < 0.9$). For nonfatal CVD events, all tools showed poor predictive ability in men ($0.5 < AUC < 0.7$), whereas in women, SCORE tools demonstrated poor predictive ability, but ACC/AHA, Framingham, and SCORE2 achieved acceptable predictive ability (AUC: 0.75, 95% CI: 0.67–0.83; AUC: 0.73, 95% CI: 0.65–0.80; and AUC: 0.73, 95% CI: 0.65–0.81, respectively). For composite (fatal and nonfatal) CVD events, all tools exhibited poor predictive ability in men ($0.5 < AUC < 0.7$) and acceptable ability in women ($0.7 \leq AUC < 0.8$). Notably, the ACC/AHA tool approached the excellent threshold for composite events in women (AUC: 0.79, 95% CI: 0.72–0.85).

Overall, the ACC/AHA tool demonstrated the highest predictive ability for fatal CVD events in both men and women (AUC: 0.92, 95% CI: 0.88–0.97 for men; AUC: 0.87, 95% CI: 0.79–0.96 for women). It also showed the highest ability to predict nonfatal CVD events across both sexes (AUC: 0.63, 95% CI: 0.56–0.70 for men; AUC: 0.75, 95% CI: 0.67–0.83 for women). Table 2; Fig. 2 present the predictive ability of these CVD risk assessment tools in men and women with MASLD.

Based on our results, the optimal cutoff point for estimating fatal CVD risk using the ACC/AHA tool was 20% for men (sensitivity = 100%, specificity = 76%) and 9% for women (sensitivity = 90%, specificity = 77%). For a sensitivity of 100% with maximum specificity (77%), the corresponding cutoff point was 5.3%. The optimal cutoff point for the ACC/AHA tool to predict composite CVD events (which demonstrated acceptable predictive ability) in women was 7.5% (sensitivity = 74%, specificity = 75%). Online Appendix 1 provides decision curve analysis (DCA) graphs for each prediction model, demonstrating the superiority of models with net benefits exceeding those of the default strategies—'intervening on all individuals' and 'intervening on no individuals'—at low threshold probabilities.

Discussion

Our results indicate that all risk assessment tools exhibit high predictive ability for identifying the risk of fatal CVD events in both men and women. The most effective tools for predicting fatal CVD events were the ACC/AHA tool and the primary care version of the Framingham approach, demonstrating outstanding ($AUC > 0.9$) predictive ability in men and excellent ($AUC > 0.8$) predictive ability in women, respectively, according to the guidelines by Hosmer and Lemeshow[20]. The other tools also displayed excellent predictive ability for fatal CVD events in women.

Regarding nonfatal CVD events, all four tools demonstrated poor predictive ability in men. In contrast, in women, the ACC/AHA pooled cohort equations, Framingham, and SCORE2 tools outperformed the SCORE approaches, yielding acceptable predictions for nonfatal CVD events. Among these risk assessment tools,

Gender	Risk assessment tools					*P*-value
	SCORE low European countries	SCORE high European countries	ACC/AHA tool	Framingham	SCORE2 for moderate, CVD risk populations***	
AUC (95% CI) for fatal CVD events						
Men*	0.8273 (0.7295–0.9304)	0.8273 (0.7302–0.9244)	0.9287 (0.8871–0.9703)	0.9119 (0.8586–0.9652)	0.8332 (0.7524–0.9139)	0.0015
Women**	0.8551 (0.7509–0.9593)	0.8540 (0.7495–0.9585)	0.8794 (0.7987–0.9601)	0.8609 (0.7797–0.9421)	0.8712 (0.7696–0.9728)	0.1604
AUC (95% CI) for non-fatal CVD events						
Men*	0.6297 (0.5536–0.7059)	0.6279 (0.5514–0.7043)	0.6370 (0.5642–0.7098)	0.6279 (0.5527–0.7032)	0.6351 (0.5624–0.7077)	0.5699
Women**	0.6933 (0.6002–0.7865)	0.6940 (0.6017–0.7863)	0.7553 (0.6766–0.8340)	0.7319 (0.6572–0.8066)	0.7318 (0.6549-8088)	0.0084
AUC (95% CI) for composite (fatal and non-fatal) CVD events						
Men*	0.6652 (0.5944–0.7360)	0.6636 (0.5924–0.7348)	0.6879 (0.6206–0.7552)	0.6774 (0.6081–0.7466)	0.6680 (0.6014–0.7345)	0.2107
Women**	0.7357 (0.6603–0.8110)	0.7359 (0.6612–0.8106)	0.7903 (0.7268–0.8538)	0.7674 (0.7058–0.8290)	0.7692 (0.7036–0.8348)	0.0019

Table 2. AUCs for predictive ability of CVD risk assessment tools for fatal, non-fatal and composite CVD events in phase I of the cohort based on gender. ACC/AHA: American College of Cardiology/American Heart Association, AUC: area under curve, CI: confidence interval, CVD: cardiovascular disease and SCORE: Systematic Coronary Risk Evaluation. *717 men aged 40–74 years with MASLD and without any history of CVD events in the first evaluation of the cohort. **714 women aged 40–74 years with MASLD and without any history of CVD events in the first evaluation of the cohort. ***Based on the Global Burden of Disease 2019 study results (http://ihmeuw.org/6e1f), we categorized Iran as a country with moderate CVD risk populations for SCORE2.

the ACC/AHA pooled cohort equations exhibited the highest predictive ability for composite CVD events in women, approaching the threshold for excellence (AUC = 0.7903).

Although the inclusion criteria for participants in CVD risk assessments vary across the different tools, we utilized a population with shared characteristics: aged 40–74 years, diagnosed with MASLD, and without a history of CVD events at the cohort study's outset. The SCORE equations were designed to predict fatal CVD events, whereas the ACC/AHA, Framingham, and SCORE2 tools were developed to predict both fatal and nonfatal CVD events. The ACC/AHA and the primary care version of Framingham demonstrated superior predictive ability for fatal CVD events compared with the SCORE and SCORE2 equations. Additionally, the ACC/AHA, Framingham, and SCORE2 incorporate more variables for risk estimation than the SCORE equations[13–16], potentially enhancing their discriminatory power.

We determined the optimal cutoff points for risks estimated by the ACC/AHA tool, which demonstrated the highest predictive ability. For fatal CVD events (outstanding ability) in men, the cutoff point was 20% (sensitivity = 100%, specificity = 76%), while in women, it was 9% (sensitivity = 90%, specificity = 77%). At a sensitivity of 100% with maximum specificity, the corresponding cutoff point was 5.3%. For composite CVD events in women, where the ACC/AHA tool exhibited acceptable predictive ability, the optimal cutoff point was 7.5% (sensitivity = 74%, specificity = 75%). This cutoff point aligns precisely with ACC/AHA guideline recommendations for initiating statin therapy in the general population aged 40–80 years[13]. However, a threshold of 5.3% achieved 100% sensitivity for predicting fatal CVD events, while a threshold of 9% maximized the Youden index for this prediction. Consequently, a cutoff point of 7.5% (falling between 5.3% and 9%) may be considered appropriate for statin therapy in women with MASLD aged 40–74 years. Previous studies have reported inconsistent findings regarding the efficacy of statins in individuals with MASLD. While earlier studies suggested potential hepatic harm from statins, more recent research has found no adverse effects and even indicated beneficial effects[22–27]. The Task Force has concluded that statins are safe for use in patients with MASLD[28]. Collectively, although a cutoff point of 7.5% aligns with ACC/AHA recommendations for composite CVD events, a cutoff point of 5.3% may be proposed for women aged 40–74 years with MASLD, given the safety and potential benefits of statins in this population.

As noted earlier, we demonstrated that the ACC/AHA tool exhibits greater predictive ability than the other tools evaluated. In contrast, Kavousi et al. reported superior predictive ability for the SCORE equations[28]. This discrepancy may be attributed to differences in the characteristics of the populations studied. Kavousi et al. included a general population aged 55 years and older, whereas our study focused on individuals aged 40–75 years with MASLD. Age, a key predictor, is incorporated into all risk assessment tools. However, the ACC/AHA tool and Framingham approaches assume a constant underlying survival probability, while the SCORE equations determine survival probability based on individuals' ages using exponential functions[13–15].

As age increases, the risk of CVD events rises significantly, particularly in women over 55 years of age, suggesting that age may outweigh other predictors in importance. Consequently, an exponential function based on individuals' ages as the underlying survival probability could more effectively capture the elevated CVD risk in women older than 55 years. The SCORE equations, as demonstrated by Kavousi et al., exhibit greater predictive confidence at older ages; their study included a general population aged 55 years and older[28]. Conversely, the

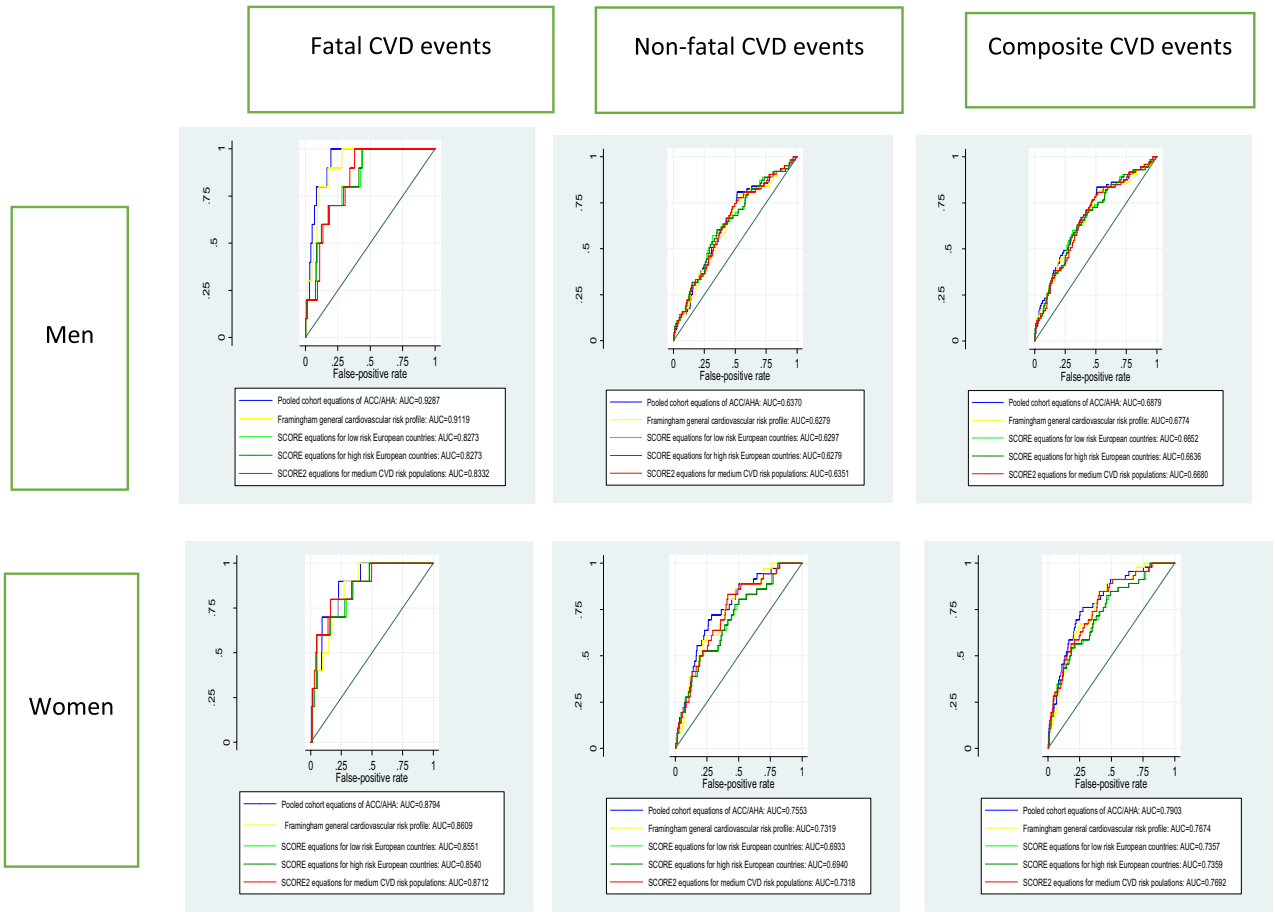

Fig. 2. ROC curves for predictive ability of CVD risk assessment tools for fatal, non-fatal and composite CVD events in phase I of the cohort based on gender. ACC/AHA: American College of Cardiology/American Heart Association, AUC: area under curve, CI: confidence interval, CVD: cardiovascular disease, ROC: Receiver operating characteristics and SCORE: Systematic Coronary Risk Evaluation. *Based on the Global Burden of Disease 2019 study results (http://ihmeuw.org/6e1f), we categorized Iran as a country with moderate CVD risk populations for SCORE2.

SCORE equations rely on fewer variables to predict CVD events. While this simplicity may reduce the tool's predictive power, it also lowers the cost of risk assessments at both individual and population levels, offering a more affordable option, particularly in developing countries.

Although Treeprasertsuk et al. evaluated the Framingham risk score in individuals with MASLD using a different methodology[17], to the best of our knowledge, our study is the first to assess the predictive ability of various cardiovascular risk assessment tools in individuals with MASLD within a large prospective cohort study. Given the high prevalence of MASLD in both developing and developed countries and its association with CVD events, the early identification of individuals with MASLD at risk of CVD events is of critical importance to public health programs. Our study provides preliminary but essential evidence supporting the application of CVD risk assessment tools in clinical settings to identify those with MASLD at risk of future CVD events. Additionally, thresholds and cutoff points play a vital role in clinical and public health decision-making for traits with continuous values. Our study proposes a threshold range of 5.3–7.5% for women with MASLD at risk of CVD events over the next decade, based on the ACC/AHA pooled cohort equations. This cutoff range can be used to determine the need for statin therapy in women with MASLD.

In our study, at low threshold probabilities (approximately 20% or lower), all risk prediction models demonstrated greater net benefits compared with the default strategies of universal intervention or no intervention, except for SCORE2 in high- or very high-risk populations. Personalized decision-making for individuals at elevated risk of CVD relies on the safety and efficacy of subsequent diagnostic or therapeutic interventions. For low-risk populations, interventions primarily involve lifestyle modifications or pharmacological management of risk factors, which are generally considered safe.

This study has several limitations that should be considered before generalizing its findings. The follow-up duration of 7 years, shorter than the typical 10-year period, may underestimate long-term risk. This 7-year follow-up in participants without a prior history of CVD events may be insufficient to fully assess and establish associations between CVD events and MASLD. Additionally, the regional scope of this cohort may limit the generalizability and broader applicability of the results. Furthermore, although liver biopsy is regarded as the

gold standard for diagnosing MASLD, it is invasive and has a relatively high false-negative rate[29–32]. In this study, MASLD was assessed using ultrasound.

Ultrasound is not an optimal tool for diagnosing MASLD due to its relatively low sensitivity. The sensitivity of B-mode ultrasound for detecting hepatic steatosis ranges from 53 to 76%, with specificity ranging from 76 to 93%[33]. Although MRI–proton density fat fraction (PDFF) and controlled attenuation parameter (CAP), typically measured using vibration-controlled transient elastography (VCTE), are more reliable than ultrasound for diagnosing steatosis, these methods are costly and less practical for widespread use in large research studies involving the general population[34]. Despite its limitations, ultrasound is noninvasive, safe, and inexpensive, making it a more reasonable and ethical choice for diagnosing MASLD in research settings, as determined in our study.

Conclusion

Based on the findings of this study, cardiovascular risk assessment tools, particularly the ACC/AHA tool, can be utilized to evaluate the future risk of CVD events in women with MASLD in clinical settings. Conversely, the SCORE equations demonstrated excellent predictive ability for fatal cardiac events while requiring fewer variables. Although a cutoff point of 7.5% is optimal for predicting composite CVD events in women with MASLD aged 40–74 years (based on the ACC/AHA tool), a cutoff point of 5.3% is proposed given the potential benefits of statins in individuals with MASLD. Further research in this area would help assess the potential advantages of adopting this lower threshold.

Data availability

The supporting data of the findings are not publicly available due to privacy or ethical restrictions. For additional information please contact the corresponding author, Farhad Zamani.

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Author contributions

The authors confirm contribution to the paper as follows: Conception and design of study: N.M., F.Z.Acquisition of data: M. KH., M.P., M.M., M.A.Analysis and/or interpretation of data: N.M., D.P., M. ML.Drafting the manuscript: B.A., F.S., MH. K. Revising the manuscript critically for important intellectual content: H.Aj., H. A. Approval of the version of the manuscript to be published: F.Z.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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