Gastro Hep Advances 2022;1:352–358

ORIGINAL RESEARCH—CLINICAL

Prevalence of Metabolic-associated Fatty Liver Disease in Mexico and Development of a Screening Tool: The MAFLD-S Score

Jesus Ruiz-Manriquez,[1] Antonio Olivas-Martinez,[2] Luis Carlos Chávez-García,[1] Alfonso Fernández-Ramírez,[1] Carlos Moctezuma-Velazquez,[1] Eric Kauffman-Ortega,[1] Graciela Castro-Narro,[1] Francisco Astudillo-García,[1] Ivonne Escalona-Nandez,[1] Carlos A. Aguilar-Salinas,[3] Nalu Navarro-Alvarez,[1,4,5] and Aldo Torre[1,3]

[1]Hepatology and Liver Transplantation Unit, Department of Gastroenterology, Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", Ciudad de México, México; [2]Department of Biostatistics, University of Washington, Seattle, Washington; [3]Metabolic Unit, Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", Ciudad de México, México; [4]Universidad Panamericana School of Medicine, Campus México, Mexico City, Mexico; and [5]Department of Surgery, University of Colorado Anschutz Medical Campus, Denver, Colorado

BACKGROUND AND AIMS: Metabolic-associated fatty liver disease (MAFLD) is a leading cause of chronic liver disease. Nowadays, the prevalence of MAFLD in Mexico is unknown with no screening point-of-care tools. We aimed to estimate the prevalence of MAFLD in Mexico and to develop a score for MAFLD screening. **METHODS:** We conducted a cross-sectional study in 5 Mexican states, including adult subjects evaluated in checkup campaigns. Subjects underwent a liver ultrasound to look for hepatic steatosis. Based on the most clinically relevant variables associated with MAFLD, we developed the MAFLD-screening score (MAFLD-S). Discrimination and calibration of the score were evaluated using the area under the ROC curve and observed vs predicted plots, respectively. **RESULTS:** We included 3357 participants (60% female, mean age 47 ± 12 years). Fifty-two percent had hepatic steatosis, and 47% met MAFLD criteria. Subjects with MAFLD were older (48 ± 11 vs 45 ± 13 years, $P < .001$), were more frequently males (43% vs 36%, $P < .001$), and had a higher body mass index (31.6 + 4.9 vs 25.6 + 3.8 kg/m^2, $P < .001$) than subjects without MAFLD. The MAFLD-S includes age, body mass index, gender, diabetes, hypertension, and dyslipidemia and has an area under the curve of 0.852, 95% CI = 0.828–0.877, with a sensitivity of 78.8% and a specificity of 82.8% for the optimal cutoff. Using data from the National Health and Nutrition Survey 2018–2019, we predicted a MAFLD national prevalence of 49.6%. **CONCLUSION:** Nearly half of the Mexican population has MAFLD, representing a present and future challenge. With external validation, the MAFLD-S could be a valuable and practical screening tool.

Keywords: Metabolic Syndrome; Hepatic Steatosis; Steatohepatitis; Chronic Liver Disease; Latin America

Introduction

Nonalcoholic fatty liver disease (NAFLD) is defined as the presence of ≥5% of hepatic steatosis (HS). This previous definition merited the exclusion of secondary causes of HS (ie, excessive alcohol consumption). Recently, it has been proposed to redefine NAFLD as metabolic (dysfunction)-associated fatty liver disease (MAFLD), which focuses on a positive diagnosis. This new term also precludes the word alcohol to eliminate stigma in patients.[1] Despite the novelty of this definition, its use has not spread worldwide, and most data on this disease are known from studies using the previous definition.

Although liver outcomes of NAFLD such as steatohepatitis, cirrhosis, and hepatocellular carcinoma are not universal, this disease is becoming an alarming health care problem because of its high prevalence. Using imaging as a diagnostic tool for HS, the NAFLD prevalence is estimated to be 25% worldwide[2]; data from Latin America seem comparable, with prevalence rates ranging from 14% to 17% in Mexico.[3,4]

As MAFLD is intimately related to chronic metabolic diseases and an independent risk factor for cardiovascular diseases (CVDs), it represents an alarming issue for Mexico. As per the National Health and Nutrition Survey (ENSANUT),[5] 25% of adults older than 60 years suffer from diabetes, and 96% of those older than 50 years have abdominal obesity.

Abbreviations used in this paper: **AIC, Akaike information criterion; AUC, area under the curve; BMI, body mass index; CI, confidence interval; CVD, cardiovascular disease; DM, diabetes mellitus; ENSANUT, Encuesta Nacional de Salud y Nutrición; HS, hepatic steatosis; MAFLD, metabolic-associated fatty liver disease; MAFLD-S, MAFLD-screening score; NAFLD, nonalcoholic fatty liver disease; NASH, nonalcoholic steatohepatitis; US, ultrasound.**

Most current article

2772-5723
https://doi.org/10.1016/j.gastha.2021.12.011

Efforts have been made to develop a screening tool to identify fatty liver disease. To avoid costs related to mass implementation of imaging studies, scores such as the fatty liver index, lipid accumulation product, liver fat score, and clinical risk scoring for predicting NAFLD in patients with metabolic syndrome (NAFLD-MS) have been developed in the past decades.[6–9] Although these scores require simple laboratory results, few have been externally validated, and to date, no score can predict the presence of MAFLD solely with clinical characteristics, limiting their implementation.

Our study aims to estimate the prevalence of MAFLD in a Latin American country with a high burden of metabolic diseases and to develop a practical score for screening.

Methods

We performed a cross-sectional study from January 2017 to February 2019. Multiple checkup campaigns were performed for the general population from 5 Mexican states as a private initiative for timely diagnosis of MAFLD. Included subjects were adults (18 years or older) who self-proposed to participate and signed informed consent. Subjects were excluded if excessive alcohol consumption was self-reported (defined as more than 20 grams/d for women and 30 grams/d for men) and eliminated if their clinical data were incomplete. Every participant underwent a brief survey-based medical history that comprised family and personal history for metabolic diseases (ie, T2 diabetes mellitus [DM], hypertension, CVD) and daily alcohol intake. Past medical history for CVD (family and personal) included myocardial infarction, cerebrovascular diseases, peripheral artery disease, and chronic stable angina. After medical history was retrieved, weight and height were documented, and a liver ultrasound (US) was performed. All USs were performed by a single physician (fully capacitated in performing liver US) and supervised by a single radiologist. USs were performed using the same equipment (Welld 9618).

Overweight and obesity were defined according to World Health Organization criteria as a body mass index (BMI) greater than or equal to 25 kg/m^2 and a BMI greater than or equal to 30 kg/m^2, respectively. As per US findings, HS was defined as none, grade 1 (lower liver-to-spleen attenuation with normal visualization of intrahepatic vessels), grade 2 (moderate liver-to-spleen attenuation, intrahepatic vessels with lower attenuation than the liver), and grade 3 (higher liver-to-spleen attenuation and nonvisible liver vessels).[10] For this study, patients were considered as positive for steatosis if they had grade 1 or higher in their US assessment or negative otherwise. MAFLD was defined according to the 2020 International Consensus Panel.[1] A positive diagnosis was made if the liver US was positive for steatosis plus any of the following: overweight or obesity, T2DM, or at least 2 metabolic abnormalities (hypertension and dyslipidemia). Mild alcohol consumption was defined as a self-reported social or occasional consumption below the previously defined limit.

Statistical Analysis

Participants' characteristics are described in frequencies and percentages if categorical, or in mean and standard deviation if numerical, and are compared between subjects fulfilling and not fulfilling the MAFLD criteria using a t-test that allows for heteroscedasticity if numerical or using the χ^2 test for independence if categorical.

The prevalence of MAFLD was estimated in each state where the study was performed using the normal approximation to the binomial distribution to compute the 95% confidence intervals (CIs). The prevalence of MAFLD was extrapolated to all Mexican states using data from the ENSANUT 2018–2019 and the proposed score (see in the following). ENSANUT is a survey performed every 6 years by the National Institute of Public Health in Mexico to estimate information regarding health and nutrition in the Mexican population. This is a representative sample of the whole Mexican population, and data are acquired through questionnaires, in situ measurements (ie, weight, height, BMI, blood pressure, capillary blood analysis), and biologic samples for further analysis. Anthropometric measurements are collected from about 41% of the sample, and weighted statistics are used to obtain the population estimates with the weights corresponding to the number of subjects they represent. We used these weights for our predictions.

To develop a score for MAFLD prediction, we randomly split the sample into 2 sets: a generating set with 75% of the sample and a validation set with the remaining 25%. In the generating set, we fitted 10 different logistic regression models including MAFLD as the outcome of interest and combinations of age, gender, diabetes, hypertension, dyslipidemia, and BMI as predictors (see Table A1). These variables were chosen because we considered them as the most clinically relevant features to predict MAFLD. We selected the model to build our proposed score using the Akaike information criterion (AIC)[11] and the area under the ROC curve in the generating set. We evaluated the performance of the proposed score in the validation set using the area under the ROC curve (to assess discrimination) and graphically comparing the observed and predicted probabilities of having MAFLD in 10 equally sized groups based on deciles of the predicted probabilities (to assess calibration). We chose the optimal cutoff for the proposed score using the Kolmogorov-Smirnov index.[12] This score was then applied on patient-level data obtained from ENSANUT, using the optimal cutoff obtained in the validation set, to obtain predictions on the prevalence of MAFLD for the different states and for the entire country. The statistical analysis was performed using R, version 4.1.0. ROC curves and their corresponding area under the curve (AUC) were computed using the pROC package, and the 95% CIs for the AUC were estimated using the DeLong method.[13] A 2-sided significant level of 0.05 was considered for comparison of the patients' characteristics.

This protocol was approved by the Institutional Review Board of the National Institute of Medical Sciences and Nutrition Salvador Zubirán, Mexico City, Mexico (GAS-3901-21-21-1). All authors had access to the study data and reviewed and approved the final article.

Results

General Features

We retrieved 3695 evaluations; 138 were eliminated owing to incomplete information. The final sample consisted of 3557 subjects, of which 60% (n = 2147)

were female, and the mean age was 47 years (±12). Fifty-two percent (n = 1859) of individuals had HS as per US findings, 47% (n = 1684) met the criteria for MAFLD, and 4.9% (n = 175) had HS but did not fulfill the criteria. The estimated MAFLD prevalence in each of the 5 states is shown in Figure 1. The prevalence of self-reported diabetes, hypertension, and dyslipidemia was 9%, 14%, and 26%, respectively. The mean BMI was 28.5 kg/m^2 (±5.3); 41% of subjects were overweight, and 33% were obese.

Comparison Between Patients With and Without MAFLD

Patients with MAFLD were older (mean age of 48 years vs 45 years, $P < .001$), were mostly male (43% vs 36%, $P < .001$), had a higher BMI (mean BMI of 31.4 vs 25.7 kg/m^2, $P < .001$), and had higher prevalence of diabetes, hypertension, dyslipidemia, and prior history of HS but had a lower frequency of mild alcohol consumption (41% vs 46%, $P = .010$). Table 1 shows the population characteristics by MAFLD status.

Subgroups of Patients With MAFLD

Using the MAFLD criteria, subjects with the disease were further classified as follows: HS and overweight or obesity (group 1), HS and T2DM (group 2), and HS and hypertension-dyslipidemia (group 3). Patients could either belong to one group or a combination of them. The percentage of subjects fulfilling MAFLD criteria in each group is shown in Figure 2.

Proposed Score for MAFLD Prediction

The AIC and AUC for the assessed models are presented in Table A2. Model J had the lowest AIC (AIC = 2397) and largest AUC (AUC = 0.867) in the generating set. The formula for the proposed model is displayed in Figure A1 and their coefficients, in Table A3. The proposed score (MAFLD-screening score, MAFLD-S) includes terms for the following predictors: age (as a cubic polynomial), BMI (as a cubic polynomial), gender, diabetes, hypertension, dyslipidemia, and the interactions of gender with age and of gender with the BMI. The performance of the proposed score (obtained with model J) in the validating set is summarized in Figures A2 and A3. The AUC for the MAFLD-S score in the validation set is 0.852, 95% CI = 0.828–0.877, and the optimal cutoff is 0.548 with a sensitivity of 78.8% and a specificity of 82.8% (see Figure A2). Moreover, the actual probabilities for the grouped observations in the validation set are very close to their predicted probabilities (see Figure A3). The performance of the proposed score for cutoffs from 0.05 to 0.95 is provided in Table A4.

Predicted Prevalence of MAFLD in the Country

Using the individual patient data of the ENSANUT 2018 sample and the optimal cutoff of the MAFLD-S (0.548), we predicted a national MAFLD prevalence of 49.6%. The predicted prevalence at the state level is summarized in Figure 3 and Table A5. The states with the highest and lowest predicted prevalence were Baja California and Hidalgo, respectively. The predicted prevalence of MAFLD in the 5 states where our study was performed, using the ENSANUT 2018 database, is also presented in Table 2 and compared with the estimated and predicted prevalence in our sample. The ENSANUT 2018 demographic characteristics and prevalence of metabolic conditions for the 5 states where our study was performed are presented in Table A6 and compared with the corresponding summaries in our sample. Some features were slightly different between these populations. Compared with our studied subjects, people in

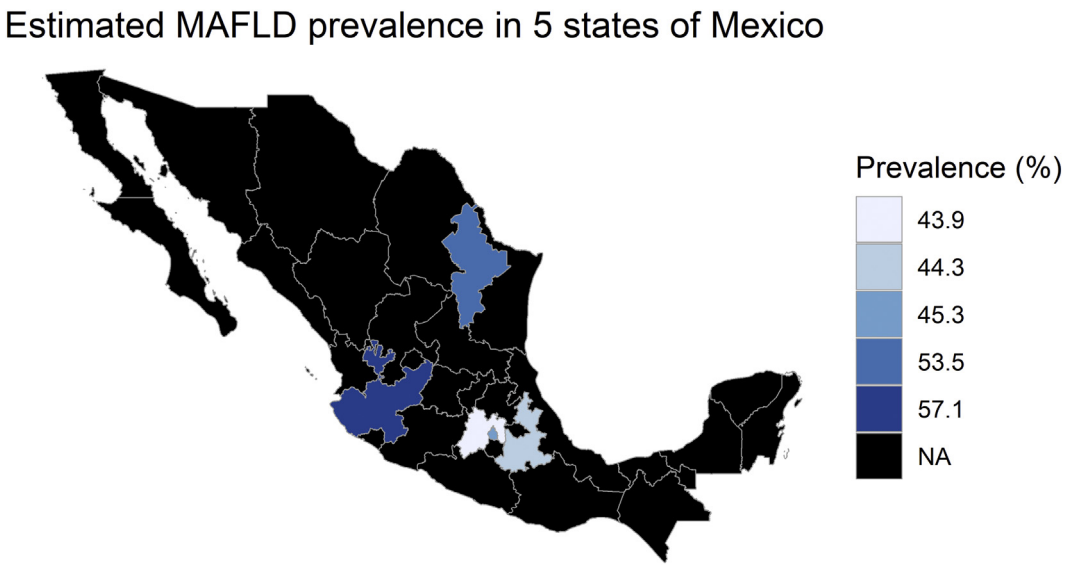

Figure 1. MAFLD prevalence in Mexico, as per the information from our study.

Table 1. Features of Subjects Fulfilling MAFLD Criteria, Compared With Those Who Did Not

Feature	MAFLD (n = 1684)	No MAFLD (n = 1873)	*P*-value[a]
Age (y) (SD)	48 (11)	45 (13)	<.001
Female, n (%)	954 (57)	1193 (64)	<.001
Weight (kg), mean (SD)	85 (16)	68 (12)	<.001
Height (mt), mean (SD)	1.63 (0.10)	1.63 (0.10)	.2
BMI (kg/m^2), mean (SD)	31.6 (4.9)	25.6 (3.8)	<.001
Obesity, n (%)	954 (57)	210 (11)	
Family history:			
Diabetes, n (%)	891 (53)	1022 (55)	.3
Hypertension, n (%)	790 (47)	869 (47)	.8
CVD, n (%)	425 (25)	467 (25)	.9
Obesity, n (%)	407 (24)	423 (23)	.3
Dyslipidemia, n (%)	243 (14)	323 (18)	.019
Hepatic steatosis, n (%)	51 (3)	71 (3.8)	.2
POS, n (%)	45 (2.7)	46 (2.5)	.7
Hypothyroidism, n (%)	76 (4.5)	86 (4.6)	.9
Comorbidities:			
Diabetes, n (%)	206 (12)	112 (6)	<.001
Hypertension, n (%)	317 (19)	175 (9.4)	<.001
CVD, n (%)	57 (3.4)	42 (2.3)	.04
Obesity, n (%)	756 (45)	210 (11)	<.001
Dyslipidemia, n (%)	555 (33)	372 (20)	<.001
Hepatic steatosis, n (%)	270 (16)	96 (5.2)	<.001
POS, n (%)	127 (7.6)	150 (8.1)	.5
Hypothyroidism, n (%)	77 (4.6)	74 (4)	.4
Mild alcohol consumption, n (%)	694 (41)	847 (46)	.010
Smoking, n (%)	345 (21)	398 (21)	.4

POS, polycystic ovarian syndrome; SD, standard deviation.
[a]t-test; Pearson's chi-squared test.

the ENSANUT sample from some states were younger (Jalisco, Nuevo Leon, and Puebla), were more overweight and obese (Ciudad de Mexico, Estado de Mexico, and Puebla), were with more hypertension (Ciudad de Mexico and Estado de Mexico), and had more dyslipidemia (Ciudad de Mexico).

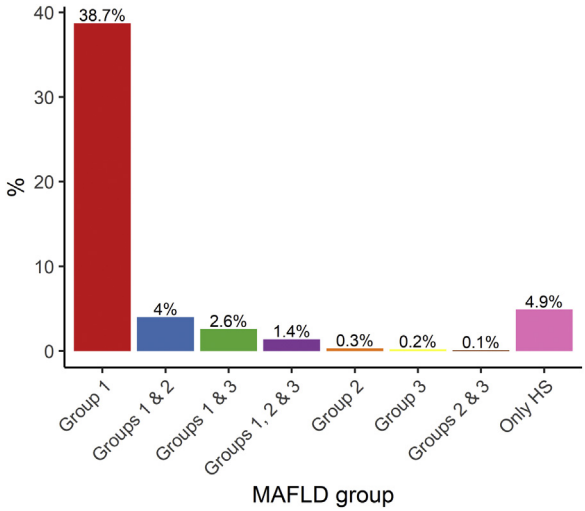

Figure 2. Groups of patients with MAFLD. Only HS accounts for patients with HS who did not fulfill MAFLD criteria.

Discussion

Herein, we describe the largest MAFLD epidemiological study in Mexico, finding an estimated MAFLD prevalence close to fifty percent in the general population. The prevalence found in our study is higher than reported elsewhere.[2,3] Yet, we did not find this surprising because there is an alarming and continuous rise of metabolic comorbidities in Mexico. In addition, Hispanics seem to be the most commonly affected ethnic race.[14,15] As per the ENSANUT, the prevalence of overweight adults in our country is over 70% (women 76.8%, men 73%), and 88.4% of the adult population have abdominal obesity.[5] Although relevant alcohol consumption was an exclusion criterion for our study, data from the National Survey of Addictions in Mexico show that 35.4% of men and 20.2% of women may have excessive alcohol consumption.[16] It is likely that the estimated prevalence of MAFLD would have been even higher if excessive alcohol consumption had not been excluded. This is relevant as the overlap between alcoholic steatohepatitis and nonalcoholic steatohepatitis (NASH) has been associated with a worse prognosis.

The prevalence described in our study is a worrisome finding, considering that patatin-like phospholipase domain–containing protein 3 gene polymorphisms are predominantly present in Hispanics. These polymorphisms have been associated with worse MAFLD severity and

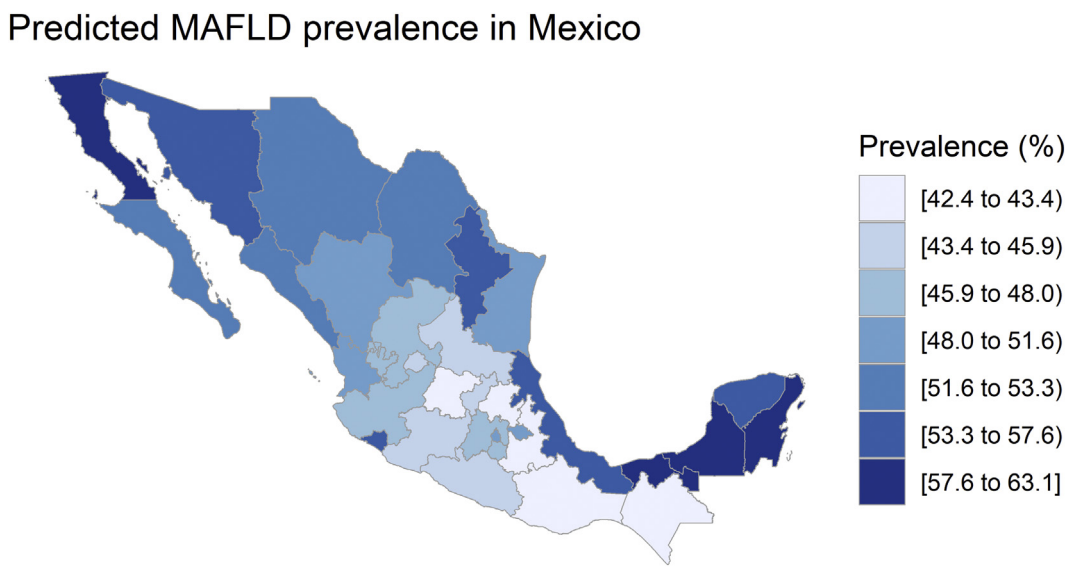

Figure 3. Predicted MAFLD prevalence using the developed score.

prognosis. Genome-wide association studies have confirmed this association in Mexican-American populations,[17] and previous studies of patients with MAFLD from the Mexican population have shown an overall frequency of 77% for a MAFLD-risk allele (haplotype GG).[18] If we analyze this high prevalence of MAFLD in the general population along with the high burden of patatin-like phospholipase domain–containing protein 3 polymorphisms in the Mexican population, many cases will progress to steatohepatitis, fibrosis, and hepatocellular carcinoma in the upcoming years.

Identifying MAFLD in every patient is crucial, first because of the comorbidities mentioned previously and second because of liver-related outcomes, which include steatohepatitis, hepatocellular carcinoma development, and fibrosis (and progression to cirrhosis). Regarding the latter, it is crucial to identify the presence of fibrosis because it is the solely most important predictor of both liver- and nonliver-related mortality, but the first step should be to diagnose MAFLD itself. Prevalence estimates for steatohepatitis among patients with NAFLD have been reported as high as 30%; conversely, 40.7% of patients with histological diagnosis of NASH progressed to fibrosis. Regarding hepatocarcinoma, the estimated incidence rates are 0.44 per 1000 person-years in patients with HS without inflammation and 5.29 per 1000 person-years in patients with steatohepatitis.[2] Comparatively, Estes et al[19] predicted that by 2030, fibrosis will affect up to 0.24% of all patients with HS, even without NASH. Considering these data, if MAFLD prevalence trends do not change for the upcoming years, we will be facing numerous complications of this entity.

Another relevant finding in this study is that 4.9% of the study population with HS could not be classified as MAFLD. This percentage could be overestimated as we did not collect data regarding waist circumference, C-reactive protein, prediabetes, and insulin resistance. However, this finding underscores the fact that we need more information regarding the characteristics and natural history of non-MAFLD HS.[20]

The score developed in this study (MAFLD-S) represents an invaluable tool for an early screening of MAFLD. Our score has a higher AUC than that reported for the hepatic steatosis index (AUC = 0.812), the fatty liver index (AUC = 0.84), the NAFLD-MS (AUC = 0.76), and the lipid accumulation profile (AUC = 0.80).[6–9] Given this high prediction capability and its simplicity, this score could be a useful tool

Table 2. MAFLD Prevalence Found in Our Study and After Calculating the MAFLD Score for Our Population and ENSANUT Population

State	Estimated prevalence in this study with its 95% CI	Predicted prevalence using the MAFLD score (our sample)	Predicted prevalence using the MAFLD score (ENSANUT sample)
Mexico City	45.3 (43.1–47.5)	44.5	50.8
Jalisco	57.1 (51.3–62.9)	65.6	44.1
Estado de México	43.9 (39.1–48.6)	422	47.9
Nuevo León	53.5 (49.6–57.4)	61.8	50.6
Puebla	44.3 (38.6–50.0)	42.0	43.7

Values are presented in percentages.

to identify those patients at high risk of having the disease, especially in low-resource settings. This might guide clinicians and primary care physicians for a timely diagnosis of MAFLD.

Strengths of this study include the high number of tests performed in the general population from the most populated states in our country. We also retrieved family history for relevant diseases, which let us compare the different family backgrounds in MAFLD and no-MAFLD subjects. As mentioned previously, the proposed score offers good sensitivity and specificity with accessible data even with low resources. Finally, this is the first study to include the MAFLD criteria in our region and the largest epidemiological study of HS to date; hence, this study shares important insight into the urgency and gravity of the problem.

This study has some limitations. First, although the score was developed and internally applied in a large sample, this was an internal validation that must be externally evaluated. Moreover, the score was developed based on US results, which is known to be suboptimal for the detection of mild HS. Second, it must be emphasized that we predicted the prevalence of MAFLD for the different states, and as the real prevalence for this disease in our population is not yet known, these data have to be confirmed in the future. Third, as this is a cross-sectional study, the self-report of alcohol consumption and family and personal history for the different diseases could lead to recall bias, and also self-report alcohol consumption could be underreported. Fourth, we did not collect information regarding diet and exercise, both known as risk factors and treatment for MAFLD. This information would be relevant, as sedentarism could also be used as another relevant clinical variable to screen for this disease; fifth, data regarding previous and current treatments were not retrieved, so we could not exclude the contribution of several drugs known to cause HS. In addition, because this study was based on self-enrollment, there could be some sort of referral bias; however, the prevalence rates of overweight, obesity, and diabetes closely resemble those reported on ENSANUT 2019, which argues in favor of the representativeness of the population. In addition, as the objective of the present study was to screen for MAFLD at a certain time in a random sample of the general population, we could not retrieve more crucial information such as laboratory and imaging surrogates of fibrosis or follow-up of any outcomes.

Conclusion

The prevalence of MAFLD in our sample is 47%, and the predicted national prevalence in Mexico is 49.7%. The MAFLD-S score is an accessible tool for screening MAFLD in the general population, showing a promising AUC (0.86) in the generation and validation samples. Appropriate screening for this disease using the proposed score could improve prompt diagnosis and treatment. External validation of our results is needed.

Supplementary Materials

Material associated with this article can be found in the online version at https://doi.org/10.1016/j.gastha.2021.12.011.

References

1. Eslam M, Sanyal AJ, George J, et al. MAFLD: a consensus-driven proposed nomenclature for metabolic associated fatty liver disease. Gastroenterology 2020;158:1999–2014.e1.
2. Younossi ZM, Koenig AB, Abdelatif D, et al. Global epidemiology of nonalcoholic fatty liver disease—meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology 2016;64:73–84.
3. López-Velázquez JA, Silva-Vidal KV, Ponciano-Rodríguez G, et al. The prevalence of nonalcoholic fatty liver disease in the Americas. Ann Hepatol 2014;13:166–178.
4. Lizardi-cervera J, Ivonne D, Laparra B, et al. Prevalencia de hígado graso no alcohólico y síndrome metabólico en población asintomática. Rev Gastroenterol Mex 2006;71:453–459.
5. Romero-Martínez M, Shamah-Levy T, Vielma-Orozco E, et al. Encuesta Nacional de Salud y Nutrición 2018-19: metodología y perspectivas. Salud Publica Mex 2019;61:917–923.
6. Bedogni G, Bellentani S, Miglioli L, et al. The fatty liver index: a simple and accurate predictor of hepatic steatosis in the general population. BMC Gastroenterol 2006;6:33.
7. Bedogni G, Kahn HS, Bellentani S, et al. A simple index of lipid overaccumulation is a good marker of liver steatosis. BMC Gastroenterol 2010;10:98.
8. Cheung CL, Lam KSL, Wong ICK, et al. Non-invasive score identifies ultrasonography diagnosed non-alcoholic fatty liver disease and predicts mortality in the USA. BMC Med 2014;12:1–11.
9. Saokaew S, Kanchanasuwan S, Apisarnthanarak P, et al. Clinical risk scoring for predicting non-alcoholic fatty liver disease in metabolic syndrome patients (NAFLD-MS score). Liver Int 2017;37:1535–1543.
10. Saadeh S, Younossi ZM, Remer EM, et al. The utility of radiological imaging in nonalcoholic fatty liver disease. Gastroenterology 2002;123:745–750.
11. Akaike H. Information theory and an extension of the maximum likelihood principle [Internet]. In: Csaki BNPF, ed. Budapest, Hungary CL - 2nd international symposium on information theory, Tsahkadsor, Armenia, USSR, September 2-8, 1971. Akadémiai Kiadó, 1973:267–281. Available from: https://heronet.epa.gov/heronet/index.cfm/reference/download/reference_id/591. Accessed February 11, 2022.
12. Young IT. Proof without prejudice: use of the Kolmogorov Smirnov test for the analysis of histograms from flow systems and other sources. J Histochem Cytochem 1977;25:935–941.
13. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. Biometrics 1988;44:837–845.
14. Vernon G, Baranova A, Younossi ZM. Systematic review: the epidemiology and natural history of non-alcoholic

fatty liver disease and non-alcoholic steatohepatitis in adults. Aliment Pharmacol Ther 2011;34:274–285.
15. Williams CD, Stengel J, Asike MI, et al. Prevalence of nonalcoholic fatty liver disease and nonalcoholic steatohepatitis among a largely middle-aged population utilizing ultrasound and liver biopsy: a prospective study. Gastroenterology 2011;140:124–131.
16. Villartoro-Velázquez JA, Resendiz Escobar E, Mujica Salzar A, et al. Encuesta Nacional de Consumo de Drogas, Alcohol y Tabaco 2016-2017: Reporte de Alcohol. Instituto nacional de Psiquiatria Ramón de la Fuente, 2017. Available from: https://www.gob.mx/salud|conadic/acciones-y-programas/encuesta-nacional-de-consumo-de-drogas-alcohol-y-tabaco-encodat-2016-2017. Accessed February 11, 2022.
17. Young KA, Palmer ND, Fingerlin TE, et al. Genome-wide association study identifies loci for liver enzyme concentrations in Mexican Americans: the GUARDIAN Consortium. Obesity 2019;27:1331–1337.
18. Martínez LA, Larrieta E, Calva JJ, et al. The expression of PNPLA3 polymorphism could be the key for severe liver disease in NAFLD in hispanic population. Ann Hepatol 2017;16:909–915.
19. Estes C, Razavi H, Loomba R, et al. Modeling the epidemic of nonalcoholic fatty liver disease demonstrates an exponential increase in burden of disease. Hepatology 2018;67:123–133.
20. Huang J, Kumar R, Wang M, et al. MAFLD criteria overlooks a number of patients with severe steatosis: is it clinically relevant? J Hepatol 2020;73:1265–1267.

Received December 2, 2021. Accepted December 29, 2021.

Correspondence:
Address correspondence to: Aldo Torre, MD, Address: Av. Vasco de Quiroga 15, colonia Belisario Domínguez Sección XVI, Tlalpan, Mexico City 14080, Mexico. e-mail: detoal@yahoo.com.

Authors' Contributions:
Jesus Ruiz-Manriquez contributed to study conception, protocol writing, manuscript preparation, and critical review; Antonio Olivas-Martinez contributed to study conception, protocol writing, manuscript preparation, critical review, and data analysis; Luis Carlos Chávez-García, Alfonso Fernández-Ramírez, Carlos Moctezuma-Velazquez, Eric Kauffman-Ortega, and Graciela Castro-Narro contributed to manuscript preparation and critical review; Francisco Astudillo-García and Ivonne Escalona-Nandez contributed to data collection and manuscript critical review; Nalu Navarro-Alvarez and Carlos A. Aguilar-Salinas contributed to manuscript critical review; Aldo Torre contributed to data collection, study conception, protocol writing, manuscript preparation, and critical review.

Conflicts of Interest:
The authors disclose no conflicts.

Funding:
Logistic and financial efforts to complete these screening tests were undertaken by Medix. This company did not participate in the protocol design, data analysis, results interpretation, or manuscript writing.

Ethical Statement:
The corresponding author, on behalf of all authors, jointly and severally, certifies that their institution has approved the protocol for any investigation involving humans or animals and that all experimentation was conducted in conformity with ethical and humane principles of research.

Data Transparency Statement:
Data, analytic methods, and study materials are not available for public access; however, this information could be requested directly with the corresponding author.