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ORIGINAL

Relationship between nonalcoholic fatty liver disease and liver fibrosis risk scales with overweight and obesity scales in 219,477 spanish workers

Relación entre escalas de riesgo de higado graso no alcohólico y fibrosis hepática con escalas de sobrepeso y obesidad en 219.477 Trabajadores españoles

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Abstract

Introduction: Non-alcoholic fatty liver disease (NAFLD) is a highly prevalent pathology of multifactorial etiology that can lead to liver fibrosis. The aim of this study is to assess the association between NASFLD and liver fibrosis risk scales and overweight-obesity scales.
Material and methods: Descriptive and cross-sectional study in 219477 Spanish workers in which the relationship between the values of different NASH risk scales such as Fatty liver index (FLI), Hepatic steatosis index (HSI), Zhejiang University index (ZJU), Fatty liver disease index (FLD), Framingham steatosis index (Framingham steatosis index), Zhejiang University index (ZJU) and Fatty liver disease index (FLD) was determined, Framingham steatosis index (FSI), Lipid accumulation Product (LAP) and liver fibrosis (BARD score) with values of overweight-obesity scales (waist/height index, body mass index, Clínica Universitaria de Navarra Body Fat Estimator (CUN BAE) and Metabolic Score for Visceral Fat (METS-VF).
Results: Both the mean values and the prevalence of high-risk values for NASH and liver fibrosis are higher in people with obesity determined with all the scales. The highest prevalences are obtained when applying the BMI and CUN BAE scales.
Conclusion: The close relationship between the values of different NASH and liver fibrosis risk scales and the values of overweight-obesity scales is confirmed.

Keywords: Non-alcoholic fatty liver disease (NAFLD). Liver fibrosis, overweight, obesity.

Resumen

Introducción: La Enfermage del hígado graso no alcohólico (EHGNA) es una patología altamente prevalente y de etiología multifactorial que puede terminar en fibrosis hepática. El objetivo de este estudio es valorar la asociación entre escalas de riesgo de EHGNA y fibrosis hepática y escalas de sobrepeso-obesidad.
Material y métodos: Estudio descriptivo y transversal en 219477 trabajadores españoles en los que se determina la relación entre los valores de diferentes escalas de riesgo de EHGNA como Fatty liver index (FLI), Hepatic steatosis index (HSI), Zhejian University index (ZJU), Fatty liver disease index (FLD), Framingham steatosis index (FSI), Lipid accumulation Product (LAP) y fibrosis hepática (BARD score) con valores de escalas de sobrepeso-obesidad (índice cintura/altura, índice de masa corporal, Clínica Universitaria de Navarra Estimador de grasa corporal (CUN BAE) y Metabolic Score for Visceral Fat (METS-VF).
Resultados: Tanto los valores medios como la prevalencia de valores de alto riesgo de presentar EHGNA y fibrosis hepática son más elevados en las personas con obesidad determinados con todas las escalas. Las prevalencias más elevadas se obtienen al aplicar las escalas de BMI y CUN BAE.
Conclusión: Se confirma la estrecha relación entre los valores de diferentes escalas de riesgo de EHGNA y fibrosis hepática con los valores de escalas de sobrepeso-obesidad.

Palabras clave: Enfermedad del hígado graso no alcohólico (EHGNA). Fibrosis hepática, sobrepeso, obesidad.

Introduction

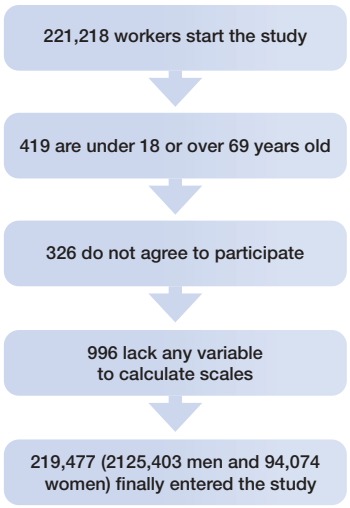
Non-alcoholic fatty liver disease (NAFLD) is a clinical entity that brings together various liver conditions in people who do not consume or consume small amounts of alcohol[1]. The most characteristic histological lesion of NAFLD is the excessive accumulation of fat at the level of liver cells[2]. We know that NASH is increasing in prevalence in all countries of the world, but these figures are especially worrying in the most developed countries[3], in some cases, such as the United States, where it affects one in four people[4]. NAFLD can progress to non-alcoholic steatohepatitis, which is considered one of the most aggressive forms of the disease. This condition presents high levels of liver inflammation that can lead to significant scarring (cirrhosis) and even liver failure. Many risk factors have been associated with NAFLD, the most significant being dyslipidemia[5], obesity[6], mainly abdominal obesity[7], polycystic ovary syndrome[8], diabetes mellitus[9], hypothyroidism[10], hypopituitarism[11] and advanced age[12].

The aim of our study was to determine the relationship between the values of different scales that assess the risk of NAFLD and liver fibrosis with scales that assess overweight and obesity in a group of Spanish workers.

Material and methods

Descriptive and cross-sectional study conducted in 219,477 Spanish workers from different regions and labor sectors (public administration, health, hospitality, construction and commerce mainly). The workers included in the study were selected from those who attended occupational medical examinations performed between January 2017 and December 2019. See Flow chart in **Figure 1**.

Figure 1: Flow chart of participants in the study.



Inclusion criteria:

- Ages between 18 and 69 years.
- Acceptance to participate in the study.
- Authorize the use of the data obtained for epidemiological purposes.
- Belonging to one of the companies included in the study and not being on temporary disability at the time of the study.

All measurements, whether anthropometric (height, weight and waist circumference), analytical or clinical, were performed by the occupational health professionals of the participating companies after standardization of the processes to avoid interobserver bias.

Weight (in kg) and height (in cm) were obtained with a SECA 700 scale-measuring device. Waist circumference was determined with a tape measure placed parallel to the floor at the level of the last floating rib while the person was standing upright, with feet together and abdomen relaxed.

Blood pressure is determined after 10 minutes of rest and with the person in a seated position. Three measurements are taken at one-minute intervals and the average of the three is obtained.

The blood test is obtained after at least 12 hours of fasting and processed within 48-72 hours. Automated enzymatic techniques are used for blood glucose, total cholesterol and triglycerides. For HDL-cholesterol the Cl2Mg dextran sulfate precipitation technique is used. LDL-cholesterol is determined indirectly by applying the Friedewald formula which is only valid when triglycerides do not exceed 400. All analytical parameters are expressed in mg/dL.

LDL= Total colesterol total -HDL-c- triglycerides/5

As scales of overweight and obesity were used:

- Waist/height index. It is obtained by dividing waist circumference by height, both in cm. The cut-off point was 0.50[13].
- Body mass index. It is obtained by dividing weight (in kg) by height^2 (in m). Underweight < 18.5, normal weight between 18.5 and 24.9, overweight between 25 and 29.9 and obesity over 30 kg/m^2 are considered.
- Clínica Universitaria de Navarra-Body Fat Estimator (CUN BAE)[14].

CUN BAE = -44.988 + (0.503 x age) + (10.689 x sex) + (3.172 x age) - (0.026 x BMI2) + (0.181 x BMI x sex) - (0.02 x BMI x age) - (0.005 x BMI2 x sex) + (0.00021 x BMI2 x age).

Man = 0 woman = 1.

The cut-off points are: normal weight (< 30 in women and < 20 in men), overweight (30-35 in women and 20-25 in men) and obesity (> 35 in women and > 25 in men).

- Metabolic score for visceral fat (METS-VF)[15]

METS-VF = 4.466 + 0.011*(Ln(METS-IR))^3 + 3.239*(Ln(WtHR))3 + 0.319*(Sex) + 0.594*(Ln(age)). Man = 1 woman = 0

METS-IR = Ln [(2*glycaemia) + Triglycerides]*BMI)/ (Ln[HDLc])[16]
High risk is considered as from 7,18.

The following risk scales for nonalcoholic fatty liver disease and liver fibrosis were used:

- Fatty liver index (FLI)[17]

$FLI = (e^{0.953*\log_e (triglycerides) + 0.139*BMI + 0.718*\log_e (GGT) + 0.053*waist\ circumference - 15.745}) / (1 + e^{0.953*\log_e (triglycerides) + 0.139*BMI + 0.718*\log_e (GGT) + 0.053*waist\ circumference - 15.745}) \times 100$

High risk is considered as from 60

- Hepatic steatosis index (HSI)[18]
HSI = 8 × AST/ALT + BMI + 2 if diabetes, + 2 if woman.
High risk is considered as from 36.

- Zhejian University index (ZJU index)[19]
ZJU = BMI + Glycaemia (mmol L) + Triglycerides (mmol L) +3 AST/ALT +2 if woman.
High risk is considered as from 38.

- Fatty liver disease index (FLD)[20]
FLD = BMI+Triglycerides+3 × (AST/ALT) +2 × Hyperglycaemia (present=1; absent=0).
High risk is considered as from 37.

- Framingham esteatosis index (FSI)[21]
FSI = -7,981 + 0,011 x age – 0,146 x sex (woman =1, man = 0) + 0,173 x BMI + 0,007 x triglycerides + 0,593 x hypertension (yes = 1, no =0) + 0,789 x diabetes (yes = 1, no =0) + 1,1 x AST/ALT ratio ≥1,33 (yes = 1, no =0)

- Lipid accumulation product (LAP)[22]

- Men: (waist (cm) - 65) x (triglycerides (mMol)).

- Women: (waist (cm) - 58) x (triglycerides (mMol)).
High risk is considered as from 42,7.

- BARD score[23]

It is a risk scale for liver fibrosis.
BMI from 28 (1 point), AST/ALT from 0.8 (2 points), diabetes mellitus (2 points). Values between 2-4 points indicate high risk.

We considered a smoker to be a person who has smoked at least one cigarette (or its equivalent in other types of consumption) in the last month or who has quit smoking less than a year ago.

The social class is obtained using the proposal of the Spanish Society of Epidemiology based on the 2011 National Classification of Occupations[24]. Three groups are considered: class I (directors, managers and university professionals), class II (intermediate occupations and self-employed workers) and class III (manual workers).

Statistical analysis

A descriptive analysis of the categorical variables was performed, calculating the frequency and distribution of the responses for each of them. For quantitative variables, the mean and standard deviation were calculated following a normal distribution.

Bivariate association analysis was performed using the chi2 test (with correction for Fisher's exact statistic when conditions required it) and Student's t test for independent samples (for comparison of means). Multivariate techniques were used to establish the variables associated with the most significant risk factors. Logistic regression was used for multivariate analysis, with calculation of the odds ratio and the Hosmer-Lemeshow goodness-of-fit test. Statistical analysis was performed with the Statistical Package for the Social Sciences (SPSS) version 28.0 (IBM Company, New York, NY, USA) for Windows, with an accepted statistical significance level of 0.05.

Ethical considerations and/or aspects

The research team undertook at all times to follow the ethical principles of health sciences research established nationally and internationally (Declaration of Helsinki), paying special attention to the anonymity of the participants and the confidentiality of the data collected. Approval was requested from the Ethics and Research Committee of the Balearic Islands (CEI-IB), which was obtained with indicator IB 4383/20. Participation in the study was voluntary, so the participants gave their written and oral consent to participate in the study after receiving sufficient information about the nature of the study. To this end, they were given an informed consent form, as well as an information sheet explaining the objective of the study.

The data collected for the study were identified by a code and only the person responsible for the study can relate these data to the participants. The identity of the participants will not be disclosed in any report of this study. The investigators will not disseminate any information that could identify them. In any case, the research team undertakes to strictly comply with the Organic Law 3/2018, of December 5, on the protection of personal data and guarantee of digital rights, guaranteeing the participant in this study that he/she may exercise his/her rights of access, rectification, cancellation and opposition of the data collected

The cut-off points are: normal weight (< 30 in women and < 20 in men), overweight (30-35 in women and 20-25 in men) and obesity (> 35 in women and > 25 in men).

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Results

The mean age of the sample is slightly older than 40 years, the majority being between 30 and 49 years of age. Anthropometric, clinical and analytical variables show more unfavorable values in men. The majority social class is III. Approximately one third of the patients were smokers. The complete data are presented in **table I**.

Table II shows the mean values of different scales of non-alcoholic fatty liver disease and liver fibrosis according to the values of the overweight and obesity scales. The mean values of all the aforementioned risk scales increase as the value of the overweight-obesity scales increases. The mean values in all cases are higher in men. In all cases the differences observed are statistically significant.

Table I: Characteristics of the population.

	Men n=125,403 Mean (SD)	Women n=94,074 Mean (SD)	p
Age	41.8 (10.5)	39.9 (10.5)	<0.0001
Height	175.2 (6.8)	162.3 (6.3)	<0.0001
Weight	82.6 (15.0)	68.0 (14.7)	<0.0001
SBP	126.1 (15.6)	115.4 (15.5)	<0.0001
DBP	77.3 (11.1)	72.3 (10.5)	<0.0001
Cholesterol	195.6 (37.9)	192.1 (35.5)	<0.001
HDL-c	52.1 (9.8)	57.2 (10.3)	<0.0001
LDL-c	118.4 (35.1)	116.3 (33.5)	<0.001
Tryglicerides	125.7 (76.0)	93.1 (45.6)	<0.0001
Glycaemia	93.4 (21.5)	88.3 (16.0)	<0.0001
AST	29.0 (17.5)	18.7 (11.6)	<0.0001
ALT	24.4 (13.3)	18.2 (7.9)	<0.0001
GGT	32.7 (31.8)	18.8 (16.3)	<0.0001
Creatinine	0.86 (0.17)	0.68 (0.14)	<0.0001
	%	**%**	**p**
18-29 years	14.4	19.4	<0.0001
30-39 years	26.6	28.9	
40-49 years	33.6	32.0	
50-59 years	21.5	16.8	
60-69 years	3.9	2.9	
Social class I	6.1	7.5	<0.0001
Social class II	14.5	20.5	
Social class III	79.4	72.0	
Non smokers	67.5	66.7	<0.001
Smokers	32.5	33.3	

SBP systolic blood pressure. DBP diastolic blood pressure. HDL High density lipoprotein. LDL Low density lipoprotein. AST aspartate transaminase. ALT alanine transaminase. GGT gamma-glutamyl transferase.

Table II: Mean values of the different risk scales for fatty liver and liver fibrosis according to the values of the overweight and obesity scales by sex.

		FLI	HSI	ZJU	FLD	FSI	LAP	BARD
Men	**n**	**Media (dt)**	**Media (dt)**	**Media (dt)**	**Media (dt)**	**Media (dt)**	**Media (dt)**	**Media (dt)**
WtHR <0.50	68703	23.3 (16.3)	33.7 (5.1)	34.1 (3.7)	29.1 (3.5)	0.12 (0.11)	20.3 (14.7)	0.72 (0.85)
WtHR ≥0.50	56700	59.6 (23.3)	40.6 (6.5)	40.8 (5.5)	35.6 (5.1)	0.30 (0.21)	49.9 (33.5)	1.64 (1.06)
Underweight	936	5.4 (4.6)	25.7 (3.0)	26.6 (2.0)	21.7 (1.4)	0.03 (0.03)	8.1 (8.0)	0.33 (0.54)
Normalweight BMI	44979	16.8 (11.5)	31.8 (4.2)	32.3 (2.6)	27.4 (2.4)	0.09 (0.08)	17.4 (12.6)	0.50 (0.69)
Overweight BMI	53751	41.9 (18.5)	37.3 (4.6)	37.6 (2.8)	32.5 (2.5)	0.19 (0.13)	34.6 (23.0)	1.17 (0.98)
Obesity BMI	25737	76.2 (15.7)	44.8 (5.9)	45.0 (4.6)	39.6 (4.3)	0.44 (0.20)	61.2 (38.5)	2.18 (0.86)
Normalweight CUN BAE	21081	11.6 (7.9)	30.0 (3.9)	30.5 (2.4)	25.7 (2.1)	0.06 (0.05)	14.4 (10.3)	0.30 (0.54)
Overweight CUNBAE	35814	23.7 (13.8)	33.9 (4.3)	34.2 (2.3)	29.3 (2.2)	0.11 (0.09)	22.0 (15.4)	0.58 (0.71)
Obesity CUN BAE	68508	56.7 (23.0)	40.4 (6.1)	40.7 (4.9)	35.4 (4.6)	0.30 (0.20)	45.7 (32.5)	1.68 (1.00)
METS-VF normal	116616	34.1 (22.8)	35.6 (5.9)	35.9 (4.5)	30.9 (4.3)	0.16 (0.14)	28.6 (22.2)	0.97 (0.97)
METS-VF high	14787	81.5 (14.1)	45.6 (6.3)	46.2 (5.3)	40.6 (5.0)	0.50 (0.21)	71.4 (43.1)	2.35 (0.87)
Women	**n**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Cintura/altura<0.50	72132	9.9 (9.6)	33.9 (5.0)	34.5 (3.9)	27.7 (3.7)	0.09 (0.08)	12.9 (9.8)	0.42 (0.68)
Cintura/altura≥0.50	21942	50.8 (24.2)	44.2 (6.3)	44.8 (5.6)	37.7 (5.3)	0.33 (0.21)	40.3 (23.2)	1.37 (0.83)
Underweight BMI	2844	2.2 (1.3)	27.1 (3.0)	27.9 (1.5)	21.2 (1.4)	0.03 (0.02)	4.7 (4.2)	0.13 (0.38)
Normalweight BMI	46083	6.0 (4.5)	32.2 (3.9)	32.8 (2.4)	26.1 (2.3)	0.06 (0.05)	10.2 (7.2)	0.24 (0.49)
Overweight BMI	27090	19.1 (11.3)	37.9 (3.9)	38.5 (2.4)	31.5 (2.1)	0.14 (0.10)	20.7 (12.5)	0.74 (0.82)
Obesity BMI	18057	57.1 (21.6)	45.9 (5.7)	46.4 (4.8)	39.3 (4.5)	0.37 (0.20)	42.6 (23.9)	1.56 (0.75)
Normalweight CUN BAE	20523	3.8 (2.6)	29.8 (3.4)	30.5 (2.0)	23.9 (1.9)	0.04 (0.03)	8.4 (6.3)	0.09 (0.31)
Overweight CUNBAE	24492	6.8 (4.7)	33.2 (3.5)	33.8 (1.9)	27.0 (1.8)	0.07 (0.05)	11.0 (7.6)	0.24 (0.48)
Obesity CUN BAE	49059	32.3 (24.7)	40.6 (6.3)	41.1 (5.4)	34.1 (5.2)	0.23 (0.18)	28.0 (20.8)	1.06 (0.87)
METS-VF normal	92934	18.6 (21.1)	36.1 (6.6)	36.7 (5.8)	29.8 (5.5)	0.14 (0.15)	18.6 (17.0)	0.62 (0.81)
METS-VF high	1140	91.6 (7.9)	55.5 (5.5)	56.2 (5.0)	48.7 (4.7)	0.73 (0.16)	72.5 (34.5)	1.76 (0.85)

FLI Fatty liver index. HSI Hepatic steatosis index. ZJU Zhejiang University index. FLD Fatty liver disease. FSI Framingham Steatosis index. LAP Lipid accumulation product. BMI Índice de masa corporal. CUN BAE Clínica Universitaria de Navarra Body Adiposity Estimator. METS-VF Metabolic Score for Visceral Fat. WtHR Waist to height ratio. Statistically significant differences (p<0.001) in all cases.

Table III shows the prevalence of elevated values of different nonalcoholic fatty liver disease and liver fibrosis risk scales according to the overweight-obesity scales. The same trend that we have seen with the mean values is observed, i.e. an increase in the prevalences as the values of the overweight-obesity scales increase. Prevalences are lower in women. In all cases the differences found are statistically significant.

Table IV shows the results of the multivariate analysis using multinomial logistic regression. The risk of presenting elevated values of all the nonalcoholic fatty liver disease and liver fibrosis scales is greater in those who present higher values of the overweight-obesity scales, with the greatest differences being observed when considering BMI and CUN BAE.

Table III: Prevalence of high values of the different risk scales for fatty liver and liver fibrosis according to values of the overweight and obesity scales by sex.

		FLI high	HSI high	ZJU high	FLD high	LAP high	BARD high
Men	**n**	**%**	**%**	**%**	**%**	**%**	**%**
WtHR <0.50	68703	3.9	27.0	13.5	60.7	16.3	17.0
WtHR ≥0.50	56700	51.3	76.7	68.3	62.0	71.6	54.0
Underweight BMI	936	0.0	0.3	0.3	0.0	1.0	3.5
Normalweight BMI	44979	0.9	11.7	1.9	30.8	10.5	9.3
Overweight BMI	53751	18.4	58.5	39.9	39.5	46.6	34.3
Obesity BMI	25737	83.3	98.6	99.7	95.2	85.6	76.4
Normalweight CUN BAE	21081	0.1	5.8	0.5	11.7	5.4	3.5
Overweight CUNBAE	35814	2.4	22.4	4.9	72.6	19.8	11.0
Obesity CUN BAE	68508	45.1	77.1	67.3	70.6	63.6	55.0
METS-VF normal	116616	15.6	41.0	28.9	24.5	32.5	25.8
METS-VF high	14787	91.4	96.8	97.0	62.8	93.9	83.1
Women	**n**	**%**	**%**	**%**	**%**	**%**	**%**
WtHR <0.50	72132	0.3	30.1	18.9	43.1	12.1	7.9
WtHR ≥0.50	21942	35.9	92.9	90.2	49.2	81.2	35.6
Underweight BMI	2844	0.0	0.8	0.0	0.2	0.1	1.3
Normalweight BMI	46083	0.01	12.6	1.5	18.9	4.4	2.6
Overweight BMI	27090	0.7	67.3	54.1	37.4	34.3	17.0
Obesity BMI	18057	43.6	99.7	100.0	97.4	84.3	42.6
Normalweight CUN BAE	20523	0.0	3.8	0.2	1.7	2.3	0.5
Overweight CUNBAE	24492	0.02	16.4	1.7	26.5	5.9	2.3
Obesity CUN BAE	49059	16.4	76.0	67.1	71.4	50.2	26.2
METS-VF normal	92934	7.5	44.0	34.7	2.1	27.4	13.9
METS-VF high	1140	99.2	100.0	100.0	45.3	99.2	53.4

FLI Fatty liver index. HSI Hepatic steatosis index. ZJU Zhejiang University index. FLD Fatty liver disease. FSI Framingham Steatosis index. LAP Lipid accumulation product. BMI Índice de masa corporal. CUN BAE Clínica Universitaria de Navarra Body Adiposity Estimator. METS-VF Metabolic Score for Visceral Fat. WtHR Waist to height ratio. Statistically significant differences (p<0.001) in all cases.

Table IV: Multinomial logistic regression.

	FLI high OR (95% CI)	HSI high OR (95% CI)	ZJU high OR (95% CI)	FLD high OR (95% CI)	LAP high OR (95% CI)	BARD high OR (95% CI)
Cintura/altura<0.50	1	1	1	1	1	1
Cintura/altura≥0.50	5.68 (5.43-5.95)	1.39 (1.35-1.43)	1.42 (1.38-1.47)	0.82 (0.78-0.85)	4.63 (4.51-4.76)	1.57 (1.53-1.62)
Bajo-Normalweight BMI	1	1	1	1	1	1
Overweight BMI	4.30 (4.16-4.45)	3.98 (3.81-4.15)	8.72 (8.51-8.93)	1.45 (1.28-1.63)	2.51 (2.43-2.60)	1.97 (1.91-2.03)
Obesity BMI	16.04 (14.16-18.17)	8.38 (8.22-8.55)	23.11 (22.89-23.33)	3.18 (2.94-3.40)	7.25 (6.86-7.67)	2.53 (2.39-2.68)
Normalweight CUN BAE	1	1	1	1	1	1
Overweight CUNBAE	2.88 (2.65-3.13)	3.06 (2.96-3.16)	8.17 (7.77-8.59)	1.92 (1.84-2.01)	1.56 (1.51-1.62)	4.09 (3.91-4.28)
Obesity CUN BAE	26.63 (17.93-39.54)	10.54 (9.96-11.15)	32.42 (27.44-38.32)	19.62 (18.52-20.78)	3.94 (3.69-4.21)	14.62 (13.47-15.87)
METS-VF normal	1	1	1	1	1	1
METS-VF high	11.19 (10.53-11.90)	1.48 (1.34-1.65)	2.17 (1.95-2.43)	4.02 (3.88-4.17)	4.04 (3.76-4.34)	3.99 (3.82-4.17)

FLI Fatty liver index. HSI Hepatic steatosis index. ZJU Zhejiang University index. FLD Fatty liver disease. FSI Framingham Steatosis index. LAP Lipid accumulation product.
BMI Índice de masa corporal. CUN BAE Clínica Universitaria de Navarra Body Adiposity Estimator. METS-VF Metabolic Score for Visceral Fat. Statistically significant differences (p<0.001) in all cases.

Figure 2 and **table V** show the areas under the curve with their 95% confidence intervals of the cardiovascular risk scales for predicting the presence of high values of the NASH and liver fibrosis risk scales. The largest areas under the curve were found with high FLI and high ZJU while the lowest values were found with high FLD.

Figure 1: ROC curve.

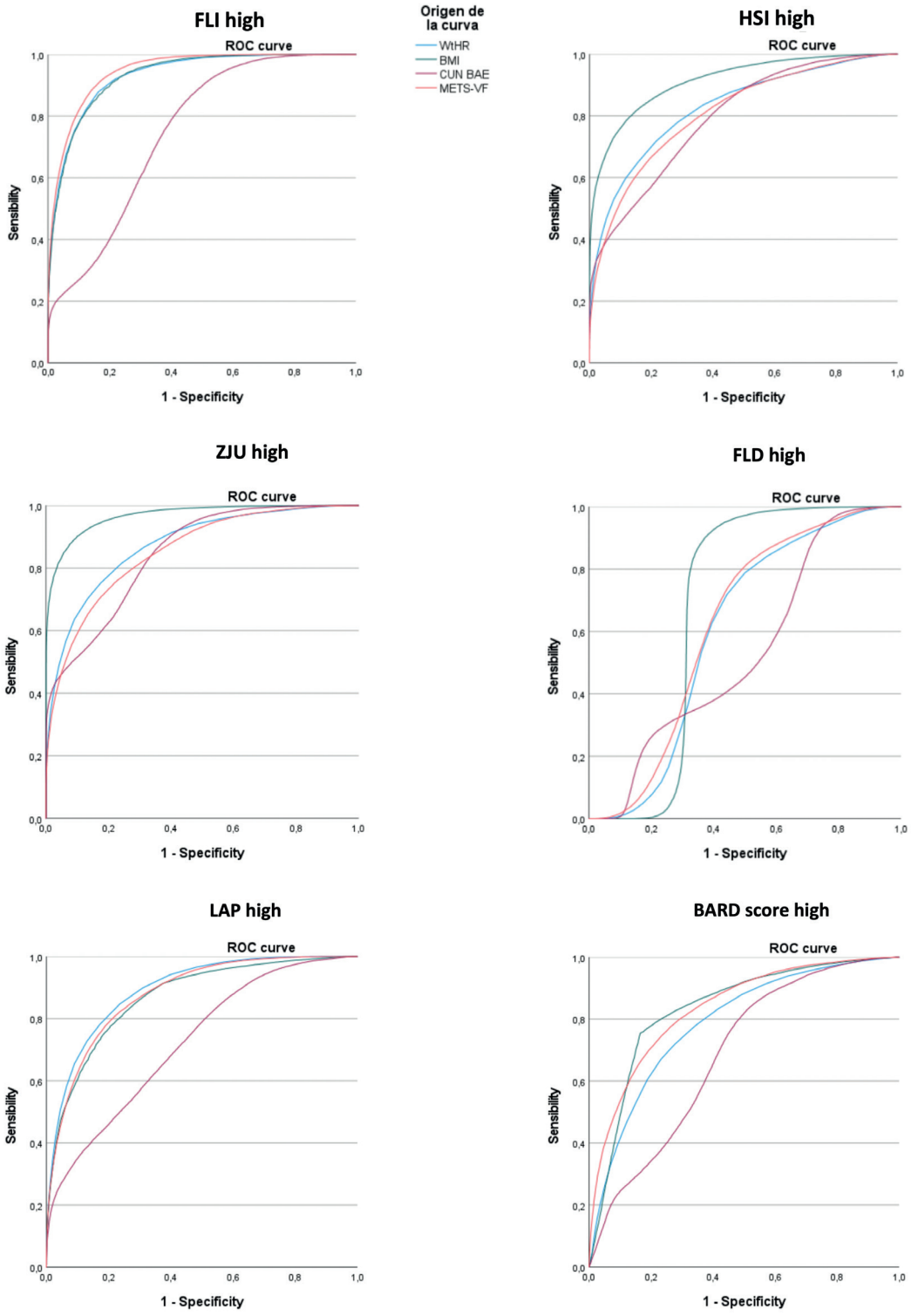

Table V: ROC curve (Area under the curve).

	FLI high AUC (95% CI)	HSI high AUC (95% CI)	ZJU high AUC (95% CI)	FLD high AUC (95% CI)	LAP high AUC (95% CI)	BARD high AUC (95% CI)
WtHR	0.933 (0.931-0.935)	0.828 (0.826-0.829)	0.875 (0.873-0.876)	0.603 (0.600-0.605)	0.893 (0.891-0.894)	0.788 (0.785-0.790)
IMC	0.932 (0.931-0.933)	0.914 (0.913-0.916)	0.968 (0.967-0.968)	0.677 (0.674-0.679)	0.868 (0.867-0.870)	0.834 (0.832-0.835)
CUN BAE	0.749 (0.747-0.751)	0.795 (0.794-0.797)	0.847 (0.845-0.848)	0.535 (0.532-0.537)	0.723 (0.720-0.725)	0.685 (0.682-0.687)
METS-VF	0.946 (0.945-0.947)	0.811 (0.809-0.813)	0.854 (0.863-0.856)	0.623 (0.620-0.625)	0.879 (0.878-0.880)	0.835 (0.833-0.837)

FLI Fatty liver index. HSI Hepatic steatosis index. ZJU Zhejiang University index. FLD Fatty liver disease. FSI Framingham Steatosis index. LAP Lipid accumulation product. WtHR Waist to height ratio. BMI Body mass index. CUN BAE Clínica Universitaria de Navarra Body Adiposity Estimator. METS-VF Metabolic Score for Visceral Fat.

Discussion

In our study, the mean values and the prevalence of high values for all the nonalcoholic fatty liver disease and liver fibrosis risk scales analyzed were higher in those individuals with higher values for the overweight-obesity scales.

When we performed the analysis using multinomial logistic regression we found that in all cases the level of risk with the scales that assess NAFLD and liver fibrosis is higher in the overweight-obese group, with the highest values in the case of obesity assessed with BMI and CUN BAE.

The multivariate analysis showed that the variable that most increased the risk of presenting high values of the different non-alcoholic fatty liver disease and liver fibrosis risk scales was age, followed by sex and social class, without finding any influence of tobacco consumption.
We have not found any article that simultaneously assesses the influence that exists between different scales of NAFLD and liver fibrosis risk and scales of overweight-obesity, so we will focus our discussion on the relationship between NAFLD and obesity.

The relationship between obesity and NAFLD is well established. Obesity is related not only to the initial stages of the disease, the so-called simple steatosis (SS), but also to its progression. Epidemiologically, both pathologies have an increasing prevalence worldwide. Pathogenically, obesity and its associated insulin resistance favor the initial accumulation of fat in hepatocytes (ES) and also the progression of ES to non-alcoholic steatohepatitis (NAFLD), cirrhosis and even hepatocellular carcinoma.

A study performed in transgenic mice showed that NASH and obesity are epidemiologically correlated with each other[25]. In the same vein, a study by Milić et al[26] expressed that up to 80% of NASH patients are obese, defined as a body mass index (BMI) > 30 kg/m^2, although it was especially relevant in those with morbid obesity in whom visceral adipose tissue is very abundant.

Strengths and limitations

As strengths of the study, we can especially highlight the large sample size, which exceeds 200,000 individuals, and the large number of NASH and liver fibrosis risk scales and overweight and obesity scales used. The main limitation is that no objective diagnostic techniques for NAFLD or liver fibrosis other than the risk scales were used.

Conclusions

Taking into account the results obtained in our study, we can conclude that in this Spanish working population there is a direct relationship between the values of the different NASH risk scales and liver fibrosis and the values of the overweight-obesity scales. We found high predictive values for the different overweight-obesity scales to predict the occurrence of high risk values for NAFLD and liver fibrosis except for FLD.

Conflict of Interest

The authors declare that no competing interests exist.

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