The prevalence and risk factors on different degrees of non-alcoholic fatty liver disease in Shanghai

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Abstract

[Background and aims]

NAFLD is a common chronic liver disease. The purpose of this study is to carry out a current large-scale epidemiological survey and analyse factors related to the incidence and the severity of NAFLD.

[Methods]

Three communities of Shanghai were selected by stratified random sampling in 2019.

The residents older than 18 years old underwent medical history taking, physical examination, laboratory examination and liver ultrasonography examination. The prevalence of different degrees of NAFLD, the prevalence of metabolic factors, and factors associated with the severity of NAFLD was analysed.

[Results]

A total of 19250 subjects were enrolled. The total prevalence of NAFLD in Shanghai was 45.55%, 62.00% in males and 27.54% in females. Age, FLI, BMI, WC, ALT, AST, AKP, GGT, CR, FPG, UA, TC, TG and LDL in NAFLD patients were higher than those in non-NAFLD people. The distribution of NAFLD prevalence was different in different age groups. The prevalence of diabetes, obesity and hypertriglyceridemia in the NAFLD group were higher than that in the non-NAFLD group. In males, FLI, weight, WC, ALT, UA, TG, GGT and metabolic syndrome were positively correlated with the severity of NAFLD; while HDL was negatively correlated with it. In females, age, FLI, weight, WC, ALT, FPG, UA, TG, LDL, GGT, AKP and metabolic syndrome were positively correlated with the severity of NAFLD; while HDL was negatively correlated with it.

[Conclusions]

The prevalence of NAFLD in Shanghai is high. The distribution of NAFLD prevalence was different in different age groups. Many factors are related to the incidence of NAFLD and the severity of NAFLD.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a clinicopathological syndrome characterized by excessive fat deposition in hepatocytes in the absence of chronic viral hepatitis, significant alcohol consumption, drug-induced liver injury, autoimmune hepatitis and other chronic liver diseases such as or Wilson's disease. NAFLD consists of a wide spectrum of diseases, including non-alcoholic fatty liver (NAFL), non-alcoholic steatohepatitis (NASH), and NASH-related liver fibrosis and cirrhosis, and can even progress to liver carcinoma or liver failure, posing a serious threat to human health[1]. The prevalence of NAFLD varies in different regions. The global prevalence of NAFLD is 25.24%. The highest prevalence of NAFLD is in the Middle East and South America, with rates of 31.79% and 30.45%, respectively, while the lowest prevalence of NAFLD is in Africa, with a rate of 14%. However, the prevalence of NAFLD in Asia is approximately 27.37% which has surpassed that in Europe (23.71%)[2]. Some epidemiological investigations have been conducted in China in recent years. The average prevalence of NAFLD in China was approximately 20.1% in 2014[3]. The prevalence of NAFLD in males was approximately 43.3% in Shanghai in 2016[4]. Our previous study showed that the total prevalence of NAFLD was 38.17% in the Shanghai working population in 2012[5]. However, the latest prevalence of NAFLD in the whole population in Shanghai is unknown.

NAFLD is closely related to metabolic syndrome such as hypertension, type 2 diabetes, coronary heart disease and colorectal cancer. Therefore, we conducted a large-scale survey to investigate the epidemiological status of NAFLD, and to analyse the risk factors related to the severity of NAFLD which might have important clinical significance for the prevention, early diagnosis and treatment of NAFLD.

Materials And Methods

Subject recruitment

The subjects of this study were permanent residents in Shanghai from June 2019 to September 2019. We randomly selected three districts from 16 districts in Shanghai and then selected three communities by a cluster random sampling method. The permanent residents over 18 years old in the community were taken as the research subjects. The study was approved by the Research Ethics Committee of Huadong Hospital, Fudan University. All the subjects signed the informed consent form for blood samples or tissue samples to be used in clinical experiments.

History taking

Questionnaires were used to collect information on sex, age, education, occupation, past history of diseases, infectious diseases such as hepatitis and tuberculosis, smoking history, drinking history and daily alcohol consumption, medication status, history of rheumatic immune diseases and family history of diseases.

Physical examination

All participants fasted overnight before the medical examination. Blood pressure (BP), weight, height and waist circumference (WC) were measured by a trained examiner. Body mass index (BMI) was calculated as weight (kg)/stature (m^2)[5].

Laboratory assessments

Serum levels of alanine aminotransferase(ALT), aspartate aminotransferase(AST), alkaline phosphatase(AKP), gamma-glutamyl transferase(GGT), fasting plasma glucose(FPG), total cholesterol (TC), triglyceride(TG), low density lipoprotein cholesterol(LDL), high density lipoprotein cholesterol(HDL), creatinine (CR) and uric acid (UA) were measured by a multichannel autoanalyser. The participants with evidence of abnormal blood tests of liver function had further investigations performed including serology of hepatitis B and C, and autoimmune markers such as antinuclear antibody(ANA), antismooth muscle antibody(AMA), and antimito-chondrial antibody.

Ultrasonographic examination

Liver ultrasonography (US) was performed in all participants by five trained operators. The diagnosis of fatty liver meets the three criteria as follows: increased hepatic echogenicity, blurring of liver vasculature and deep attenuation of the ultrasonographic signal. NAFLD was divided into mild, moderate and severe fatty liver according to the ultrasonographic manifestations[5].

Diagnostic criteria

Patients with a clinical systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg were defined as having hypertension[6]. FPG level ≥ 7.0 mmol/L was defined as diabetes, 5.6 mmol/L ≤ FPG < 7.0 mmol/L was defined as pre-diabetes[7]. Metabolic syndrome was diagnosed following the criteria raised by the National Cholesterol Education Panel- Adult Treatment Panel III, and the modified guidelines in the Asia-Pacific region[8, 9]. The diagnostic criteria for NAFLD are as follows: negative tests for the presence of hepatitis B surface antigen and antibody to hepatitis C virus; no drinking history or the average alcohol consumption less than 20 g/day (140 g/w) in males and 10 g/day (70 g/w) in females; no history of receiving or having recently received hepatotoxic drugs; no history of systematic illness known to cause fatty liver disease; no history of clinical, biochemical and US findings consistent with other chronic liver diseases, such as autoimmune liver disease, Wilson's disease or alpha-1-antitrypsin deficiency[10, 11]. Fatty liver index (FLI) was used to predict the risk of NAFLD. FLI= $(e^{0.953*\log e(TG/0.0113)+0.139*BMI+0.718*\log e(GGT)+0.053*WC-15.745})/(1+e^{0.953*\log e(TG/0.0113)+0.139*BMI+0.718*\log e(GGT)+0.053*WC-15.745})*100$.

Statistical Analyses

Data were expressed as the mean ± standard deviation (SD), inter-quartile range (IQR) or percentage. The *t* test or rank sum test of two independent samples was used to compare the differences between the two groups in the measurement data, and the non-parametric test was used to compare the differences between two groups in the enumeration data. Chi-square test or Fisher's exact probability method was used to compare the prevalence between two or more groups. Spearman correlation analysis was used to analyzed the risk factors associated with the severity of NAFLD. All statistical analyses were performed using by SPSS 22.0. $P < 0.05$ was considered a significant difference.

Results

Characteristics of the participants

A total of 19250 subjects were enrolled in this study, including 10062 males and 9188 females. A total of 8768 subjects were NAFLD patients, with a prevalence of 45.55%. In the male population, 6238 subjects were NAFLD patients, accounting for 62%. The age, FLI, height, weight, BMI, WC, ALT, AST, AKP, GGT, CR, FPG, UA, TC, TG and LDL indexes of the male NAFLD patients were significantly higher than those of non-NAFLD subjects ($P < 0.05$), while HDL in the NAFLD group was lower than that in the non-NAFLD group ($P < 0.05$). In the female population, 2530 subjects were NAFLD patients, accounting for 27.54%. The age, FLI, height, weight, BMI, WC, ALT, AST, AKP, GGT, CR, FPG, UA, TC, TG and LDL indexes of the female NAFLD patients were significantly higher than those of non-NAFLD subjects ($P < 0.05$), while HDL in the NAFLD group was lower than that in the non-NAFLD group ($P < 0.05$).(Table 1)

Table 1
Differences between NAFLD patients and non-NAFLD subjects in males and females (mean ± standard deviation)

	Males				Females			
	Non-NAFLD (n = 3824)	NAFLD (n = 6238)	*t*/*Z*	*P*-value	Non-NAFLD (n = 6658)	NAFLD(n = 2530)	*t*/*Z*	*P*-value
Age(years)	45.62 ± 14.60	49.17 ± 13.30	12.249	< 0.001	42.11 ± 12.35	53.15 ± 13.25	36.334	< 0.001
FLI	13.45 (20.78–31.71)	30.94 (48.15–67.56)	53.954	< 0.001	5.18 (8.37–14.11)	16.70 (26.91–43.37)	53.345	< 0.001
Height (cm)	171.76 ± 6.39	171.43 ± 6.13	2.528	0.012	160.04 ± 6.03	158.37 ± 5.91	11.918	< 0.001
Weight (kg)	67.17 ± 5.67	77.57 ± 10.47	53.904	< 0.001	54.87 ± 6.87	64.58 ± 9.12	48.554	< 0.001
SBP (mmHg)	121.87 ± 16.85	121.82 ± 16.48	0.152	0.879	120.86 ± 16.83	121.56 ± 16.65	1.800	0.072
DBP (mmHg)	75.80 ± 12.53	75.95 ± 12.26	0.609	0.543	75.42 ± 12.53	75.40 ± 11.99	0.051	0.959
BMI	23.17 ± 3.20	24.86 ± 3.61	24.418	< 0.001	22.81 ± 3.38	24.52 ± 3.92	19.405	< 0.001
WC (cm)	88.09 ± 1.38	93.50 ± 7.80	53.516	< 0.001	79.35 ± 2.17	86.12 ± 7.10	47.139	< 0.001
ALT(U/L)	13.00 (17.00–23.00)	18.00 (26.00–38.00)	39.206	< 0.001	9.00 (11.00–15.00)	13.00 (17.00–26.00)	35.633	< 0.001
AST(U/L)	16.00 (18.00–22.00)	17.00 (21.00–26.00)	23.006	< 0.001	14.00 (16.00–19.00)	15.00 (18.00–23.00)	21.366	< 0.001
AKP(U/L)	69.58 ± 17.02	72.36 ± 17.84	7.824	< 0.001	58.78 ± 19.13	72.16 ± 20.96	27.988	< 0.001
GGT(U/L)	16.00 (20.80–29.70)	24.10 (33.90–52.30)	27.272	< 0.001	11.10 (13.80–18.10)	15.50 (21.10–31.40)	37.064	< 0.001
CR(μmol/L)	84.64 ± 11.14	85.07 ± 11.58	2.478	0.013	62.77 ± 11.05	63.02 ± 9.44	1.099	0.272
FPG(mmol/L)	4.60 (4.90–5.30)	4.80 (5.20–5.70)	21.501	< 0.001	4.60 (4.90–5.20)	4.90 (5.20–5.70)	29.395	< 0.001
UA(μmol/L)	353.35 ± 68.81	393.60 ± 76.74	27.243	< 0.001	262.91 ± 53.07	306.67 ± 65.67	30.002	< 0.001
TC(mmol/L)	4.83 ± 0.87	5.23 ± 0.96	21.357	< 0.001	4.96 ± 0.92	5.44 ± 1.00	20.896	< 0.001
TG(mmol/L)	0.80 (1.00-1.40)	1.20 (1.60–2.30)	42.039	< 0.001	0.60 (0.80–1.10)	1.00 (1.40–1.90)	45.243	< 0.001
HDL(mmol/L)	1.46 ± 0.28	1.30 ± 0.23	30.127	< 0.001	1.71 ± 0.31	1.50 ± 0.28	31.183	< 0.001
LDL(mmol/L)	2.70 ± 0.69	3.04 ± 0.73	23.956	< 0.001	2.62 ± 0.71	3.11 ± 0.78	27.651	< 0.001

FLI: fatty liver index;SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body max index; WC: waist circumference; ALT: alanine aminotransferase; AST: aspartate aminotransferase; AKP: alkaline phosphatase; GGT: gamma-glutamyl transferase; CR: creatinine; FPG: fasting plasma glucose; UA: uric acid; TC: total cholesterol; TG: triglyceride; HDL: high density lipoprotein cholesterol; LDL: low density lipoprotein cholesterol; The statistical descriptions of FLI, ALT, AST, GGT, FPG and TG are expressed by median and inter-quartile range.

Table 2
Prevalence of NAFLD in different age groups of male and female population (n/%)

	Males					Females				
Age	Non NAFLD	Mild NAFLD	Moderate NAFLD	Severe NAFLD	Total	Non NAFLD	Mild NAFLD	Moderate NAFLD	Severe NAFLD	Total
< 30	450(64.8)	159(22.9)	83(12.0)	2(0.3)	694(100.0)	846(94.0)	40(4.4)	14(1.6)	0(0.0)	900(100.0)
[30 ~ 45	1645(41.2)	1349(33.8)	986(24.7)	12(0.3)	3992(100.0)	3457(84.0)	491(11.9)	164(4.0)	2(0.0)	4114(100.0)
[45 ~ 60)	908 (30.0)	1236(40.8)	870(28.8)	12(0.4)	3026(100.0)	1589(62.6)	727(28.7)	219(8.6)	2(0.1)	2537(100.0)
[60 ~ 75)	683(34.1)	778(38.8)	535(26.7)	8(0.4)	2004(100.0)	655(46.5)	511(36.3)	240(17.1)	2(0.1)	1408(100.0)
≥ 75	138(39.9)	112(32.4)	95(27.4)	1(0.3)	346(100.0)	111(48.5)	75(32.8)	42(18.3)	1(0.4)	229(100.0)
Total	3824(38.0)	3634(36.1)	2569(27.5)	35(0.3)	1006(100.0)	6658(72.5)	1844(20.1)	679(7.4)	7(0.1)	9188(100.0)

Table 3
Prevalence of metabolic syndromes in males and females (n/%)

	Male				Female			
	Non-NAFLD (n = 3824)	NAFLD (n = 6238)		*P*-value	Non-NAFLD (n = 6658)	NAFLD (n = 2530)		*P*-value
BP > 130/85 or HBP	1475(38.6)	2380(38.2)	0.176	0.675	2411(36.2)	930(36.8)	0.237	0.626
FPG > 5.6 or 2-DM	569(14.9)	1920(30.8)	321.896	< 0.001	616(9.3)	805(31.8)	714.090	< 0.001
Obesity	1228(32.1)	4638(74.4)	1739.692	< 0.001	3215(48.3)	2190(86.6)	1108.790	< 0.001
Dyslipidemia	650(17.0)	3146(50.4)	1128.059	< 0.001	829(12.5)	1153(45.6)	1188.827	< 0.001

Metabolic syndromes: (1) Blood pressure (BP) ≥ 130/85 mmHg or hypertension (HBP); (2) Fasting blood glucose (FPG) ≥ 5.6 mmol/L or type 2 diabetes (2-DM); (3) Obesty: Body mass index ≥ 25 kg/m^2; (4) Dyslipidemia: Triglycerides (TG) ≥ 1.7 mmol/L, and/or high density lipoprotein (HDL) ≤ 1.03 mmol/L (male) < 1.29 mmol/L (female).

Table 4
Spearman analysis of correlative factors with the severity of NAFLD

	male		female	
	Relative factors(r)	*P*-value	Relative factors(r)	*P*-value
Age	0.128	< 0.001	0.363	< 0.001
FLI	0.605	< 0.001	0.567	< 0.001
Height	-0.010	0.314	-0.127	< 0.001
Weight	0.531	< 0.001	0.502	< 0.001
SBP	-0.002	0.840	0.020	0.050
DBP	-0.000	0.972	0.005	0.663
BMI	0.266	< 0.001	0.209	< 0.001
WC	0.507	< 0.001	0.545	< 0.001
ALT	0.471	< 0.001	0.388	< 0.001
AST	0.298	< 0.001	0.237	< 0.001
CR	-0.029	0.003	0.005	0.610
FPG	0.240	< 0.001	0.313	< 0.001
UA	0.301	0.000	0.329	< 0.001
TC	0.229	< 0.001	0.228	< 0.001
TG	0.461	< 0.001	0.480	< 0.001
HDL	-0.325	< 0.001	-0.318	< 0.001
LDL	0.257	< 0.001	0.302	< 0.001
GGT	0.448	< 0.001	0.399	< 0.001
AKP	0.087	< 0.001	0.334	< 0.001
MSTOTAL	0.474	< 0.001	0.424	< 0.001

FLI: fatty liver index;SBP: systolic blood pressure; DBP: diastolic blood pressure; BMI: body max index; WC: waist circumference; ALT: alanine aminotransferase; AST: aspartate aminotransferase; AKP: alkaline phosphatase; GGT: gamma-glutamyl transferase; CR: creatinine; FPG: fasting plasma glucose; UA: uric acid; TC: total cholesterol; TG: triglyceride; HDL: high density lipoprotein cholesterol; LDL: low density lipoprotein cholesterol;

Prevalence of different degrees of NAFLD in different age groups

Because of the difference of sexual prevalence between men and women, this study analyzed the prevalence of NAFLD in different age groups of men and women respectively. In male, the distribution of NAFLD prevalence was different in different age groups, and the prevalence of NAFLD were higher in the 44–59, 60–74 and ≥ 75 age groups (= 331.014,*P*< 0.001). The results were shown in Table.2 and Figure.1a.

In the female subjects, the distribution of NAFLD prevalence was also different in different age groups, and the prevalence of NAFLD were higher in the 60–74 and ≥ 75 age groups (= 1189.514,P< 0.001). The results were shown in Table.2 and Figure.1b.

Prevalence of metabolic syndrome in different age groups

The cumulative prevalence of hypertension, diabetes, obesity and hypertriglyceridemia was 38.2%, 30.8%, 74.4% and 50.4% respectively in male NAFLD patients, while it was 38.6%, 14.9%, 32.1% and 17.0% respectively in male non-NAFLD subjects. The prevalence of diabetes, obesity and hypertriglyceridemia in male NAFLD patients was higher than that in male non-NAFLD subjects (P< 0.05). There was no significant difference in hypertension between male NAFLD patients and non-NAFLD subjects (P > 0.05) (Table.3). The prevalence of metabolic syndrome in all male age groups is shown in Figure.2a.

The cumulative prevalence of hypertension, diabetes, obesity and hypertriglyceridemia was 36.8%, 31.8%, 86.6% and 45.6%, respectively, in female NAFLD patients, while it was 36.2%, 9.3%, 48.3% and 12.5%, respectively, in female non-NAFLD subjects. The prevalence of diabetes, obesity and hypertriglyceridemia in female NAFLD patients was higher than that in female non-NAFLD subjects (P < 0.05). There was no significant difference in hypertension between female NAFLD patients and non-NAFLD subjects (P > 0.05) (Table.3). The prevalence of metabolic syndrome in all female age groups is shown in Figure.2b.

Risk factors associated with the severity of NAFLD

All subjects were divided into four groups: non-NAFLD group, mild NAFLD group, moderate NAFLD group and severe NAFLD group. Spearman correlation analysis was conducted to analyse the risk factors of NAFLD.

In the male population, the correlation coefficients of FLI, body weight, WC, ALT, UA, TG, GGT and metabolic syndrome with the severity of NAFLD were 0.605, 0.531, 0.507, 0.471, 0.301 and 0.461, respectively, which were positively correlated with the severity of NAFLD. The correlation coefficients of age, height, systolic blood pressure, diastolic blood pressure, BMI, AST, CR, FPG, TC, LDL and AKP with the severity of NAFLD were 0.128, -0.010, -0.002, -0.000, 0.266, 0.298, -0.029, 0.240, 0.229, 0.257 and 0.087, respectively, which had a weak correlation with the severity of NAFLD. The correlation coefficient between HDL and the severity of NAFLD was − 0.325, which was negatively correlated with the severity of NAFLD. The results were shown in detail in Table.4.

In the female population, the correlation coefficients of age, FLI, body weight, WC, ALT, FPG, UA, TG, LDL, GGT, AKP and metabolic syndrome with the severity of NAFLD were 0.363, 0.567, 0.502, 0.545, 0.388, 0.313, 0.329, 0.480, 0.302, 0.399, 0.334 and 0.424, respectively. The above indexes were positively correlated with the severity of NAFLD. The correlation coefficients of height, systolic pressure, diastolic pressure, BMI, AST, CR and TC with the severity NAFLD were − 0.127, 0.020, 0.005, 0.209, 0.237, 0.005 and 0.228, respectively, which were weakly correlated with the severity of NAFLD. The correlation coefficients between HDL and the severity of NAFLD were − 0.318, which was negatively correlated with the severity of NAFLD. The results were shown in detail in Table.4.

Discussion

NAFLD has become the most common chronic liver disease in the world. Studies have reported that the prevalence of NAFLD is 24–46% in western countries[12–14]. Recent studies have reported that the prevalence of NAFLD exceeded that of viral hepatitis, making it the most common liver disease in Asia. The prevalence of NAFLD in Asia is widely variable, ranging from 7.9% in Indonesia to 54.0% in the elderly female population in Taiwan[15]. The average prevalence of NAFLD in China was 20.1%[16]. In the developed cities of Beijing, Shanghai and Hong Kong, the prevalence of NAFLD was 39.5%, 43.2% and 42%, respectively[4, 17–19]. However, these findings might have some bias due to the study selection bias. A large-scale epidemiological investigation of NAFLD is still lacking in China. Therefore, we conducted a large cross-sectional survey to study the prevalence of NAFLD in Shanghai. Our results showed that the prevalence of NAFLD was 45.55% in Shanghai, 62% in males and 27.54% in females. The prevalence of NAFLD is continuously increasing. It was reported that the global prevalence of NAFLD increased from 15–25% in five years (2005–2010)[2]. The prevalence of NAFLD in the United States had increased from 5.5% in 1988–1994 to 21.2% in 2014[20, 21]. It increased by about 18% from 1989 to 1998 in Japan[22]. The prevalence of NAFLD in Hong Kong increased by 13.5% in 3–5 years[23]. In our previous research, we found that the prevalence of NAFLD in the Shanghai working population was 38.17%in 2012[5]. In this study, we found that the prevalence of NAFLD in the Shanghai working population increased to 41.72%. Recently, a Markov model based on an international multi-centre study was established to assess the progress of NAFLD and NASH. It predicted that the prevalence of NAFLD in all countries will grow at a moderate level (0–30%) in 2016–2030 with the increase of population and the ageing of population. Urbanization will lead to the highest growth of NAFLD in China, with a growth rate of 29.1%[24].

The prevalence of NAFLD shows obvious regional differences, which are closely related to the local economic development level and people's lifestyle (sedentary or low physical activity, high-fat and high-sugar food intake, etc.). Studies have pointed out that the prevalence of NAFLD is lower in poor or emaciated people, in those with long-term physical activity, or in those living in rural areas[25]. However, the prevalence of NAFLD in Shanghai is higher than that in the total population in China due to Shanghai’s high level of economic development.

NAFLD can occur in any age group. Ageing is an important risk factor for the increasing prevalence of NAFLD[26]. Although most studies were conducted among people at 30–70 years old, the general trend was that the incidence of NAFLD in males peaked at 50–60 years old [27], while the prevalence of NAFLD in females increased with increasing age, especially after menopause[28]. Our research suggested that the prevalence of NAFLD

varies among different age groups. The prevalence of NAFLD in males was higher in the 44–59 years age group, 60–75 years age group and over 75 years age group; and peaked in the 44–59 years age group. The prevalence of NAFLD in females was higher in the 60–75 years and over 75 years age groups. In this study, we further classified NAFLD into mild, moderate and severe fatty liver. Statistical analysis showed that the proportion of mild to severe NAFLD increased significantly with increasing age.

Being male is also a risk factor for NAFLD[26]. A number of studies have shown that the prevalence of NAFLD in males is higher than in females before the age of 50[26, 27, 29]. Our study suggests that the prevalence of NAFLD in males is significantly higher than that in females in people younger than 60 years old. The lower prevalence of NAFLD in young and middle-aged females may be related to the protective effect of female oestrogen.

Obesity, diabetes, hyperlipidaemia and hypertension are also risk factors for NAFLD. In Asia-Pacific Region, the prevalence of NAFLD in obese people ranges from 10–80%[30]. The increase of BMI was positively correlated with the incidence of NAFLD[31]. The prevalence of NAFLD in type 2 diabetes mellitus ranges from approximately 50–75%[32]. Our study showed that the cumulative prevalence of diabetes, obesity and hypertriglyceridemia of NAFLD patients was higher than that of non-NAFLD normal people, but that there was no significant difference in hypertension between the two groups. There was no significant difference in the prevalence of hypertension between NAFLD patients and normal people. This may be related to the early diagnosis and treatment, good compliance, and good blood pressure control of hypertension patients in Shanghai, which may lead to no impact on the progress of NAFLD.

There are many studies on the risk factors related to NAFLD, but there are no data on the risk factors related to the severity of NAFLD at present. In this study, we further analysed the risk factors related to the severity of NAFLD by Spearman correlation analysis. The results showed that FLI, body weight, WC, ALT, UA, TG, GGT and metabolic syndrome were positively correlated with the severity of NAFLD in the male population. Age, height, systolic pressure, diastolic pressure, BMI, AST, CR, FPG, TC, LDL and AKP were weakly correlated with the severity of NAFLD. HDL was negatively correlated with the severity of NAFLD. In the female population, age, FLI, body weight, WC, ALT, FPG, UA, TG, LDL, GGT, AKP and metabolic syndrome were positively correlated with the severity of NAFLD. Height, systolic pressure, diastolic pressure, BMI, AST, CR and TC were weakly correlated with the severity of NAFLD. HDL was negatively correlated with the severity of NAFLD.

Our research had some limitations. First, we used abdominal ultrasonography to diagnosis fatty liver. The sensitivity of the results is poor, and it was also related to the level of operation of the examiner. Second, we used a large-scale population census, which excluded the fatty liver patients with drug-induced liver damage due to the increase in drug use in the elderly population, and may have underestimated the prevalence of NAFLD in the elderly population. Moreover, in a large-scale population screening, the cost of rheumatism- and autoimmune liver disease related- indicators is high, which is not suitable for all population screenings, and may not completely exclude some patients with autoimmune liver disease.

In conclusion, the prevalence of NAFLD in Shanghai is high. Multiple factors are related to the incidence of NAFLD and the severity of NAFLD. Prevention and early intervention of NAFLD may have great social and economic benefits.

Declarations

Conflicts of interest

There are no competing interests to declare.

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Figures

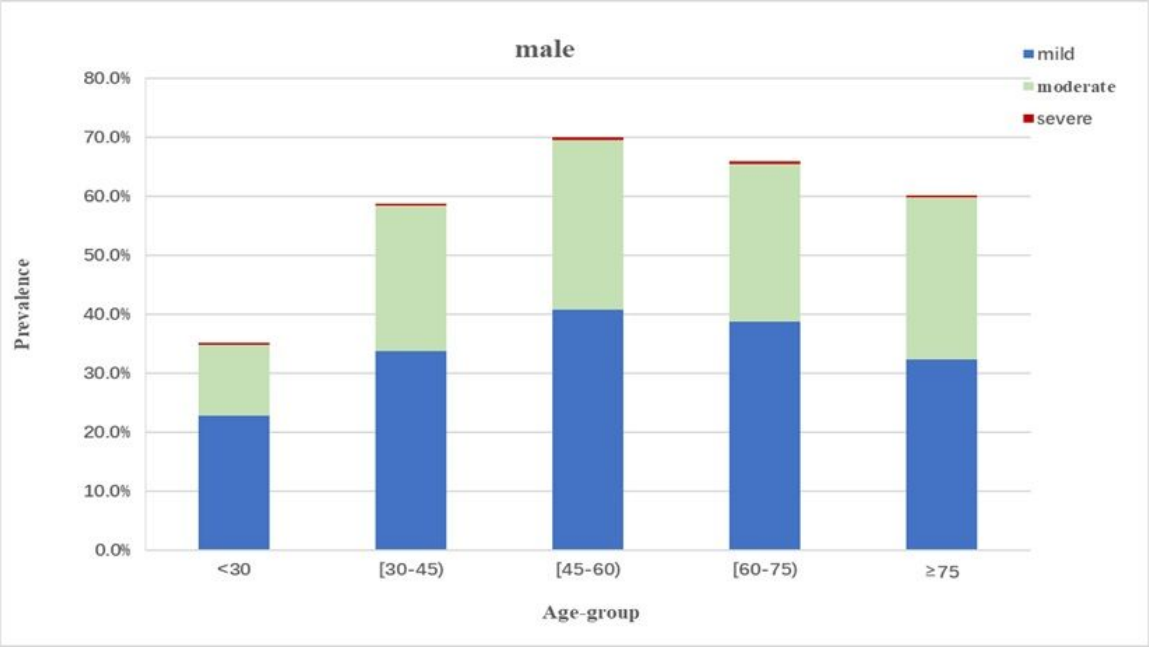
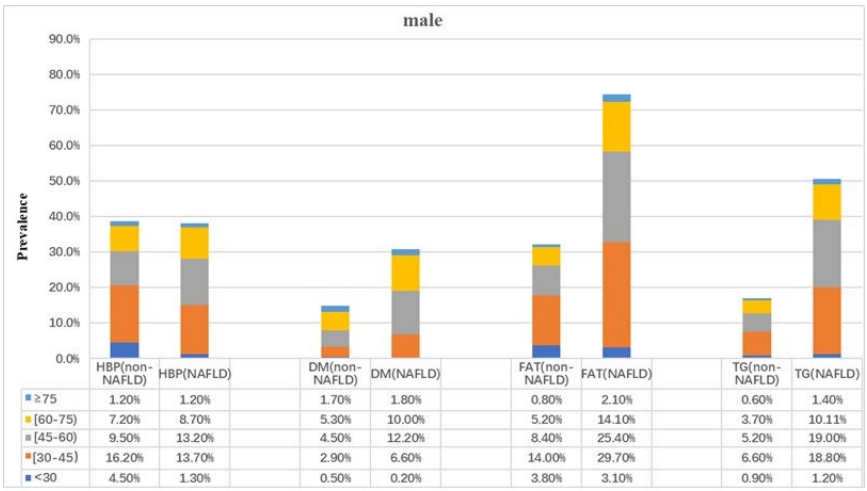
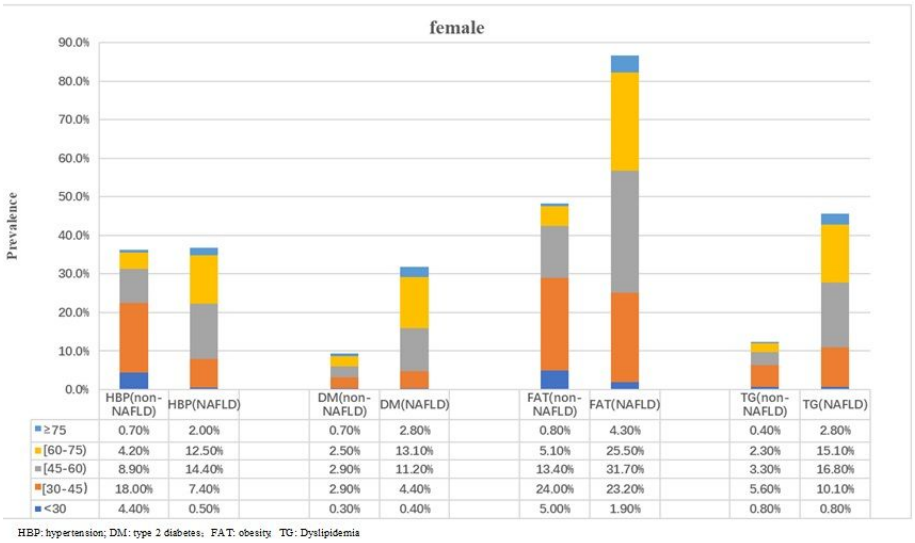


Figure 1

Age-specific prevalence of NAFLD in males and females



	HBP(non-NAFLD)	HBP(NAFLD)	DM(non-NAFLD)	DM(NAFLD)	FAT(non-NAFLD)	FAT(NAFLD)	TG(non-NAFLD)	TG(NAFLD)
≥75	1.20%	1.20%	1.70%	1.80%	0.80%	2.10%	0.60%	1.40%
[60-75)	7.20%	8.70%	5.30%	10.00%	5.20%	14.10%	3.70%	10.11%
[45-60)	9.50%	13.20%	4.50%	12.20%	8.40%	25.40%	5.20%	19.00%
[30-45)	16.20%	13.70%	2.90%	6.60%	14.00%	29.70%	6.60%	18.80%
<30	4.50%	1.30%	0.50%	0.20%	3.80%	3.10%	0.90%	1.20%



	HBP(non-NAFLD)	HBP(NAFLD)	DM(non-NAFLD)	DM(NAFLD)	FAT(non-NAFLD)	FAT(NAFLD)	TG(non-NAFLD)	TG(NAFLD)
≥75	0.70%	2.00%	0.70%	2.80%	0.80%	4.30%	0.40%	2.80%
[60-75)	4.20%	12.50%	2.50%	13.10%	5.10%	25.50%	2.30%	15.10%
[45-60)	8.90%	14.40%	2.90%	11.20%	13.40%	31.70%	3.30%	16.80%
[30-45)	18.00%	7.40%	2.90%	4.40%	24.00%	23.20%	5.60%	10.10%
<30	4.40%	0.50%	0.30%	0.40%	5.00%	1.90%	0.80%	0.80%

HBP: hypertension; DM: type 2 diabetes; FAT: obesity TG: Dyslipidemia

Figure 2

Age specific prevalence of metabolic syndrome in male and female