Detection Rate of Non-alcoholic Fatty Liver Disease and Its Influencing Factors: Analysis Based on Data from 320,000 Beijing Population (Postprint)

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Abstract

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Full Text

Detection Rate of Non-alcoholic Fatty Liver Disease and Its Influencing Factors: Analysis Based on Data from 320,000 Beijing Residents

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Abstract

Background: Non-alcoholic fatty liver disease (NAFLD) has demonstrated high prevalence with an increasing trend, particularly toward younger age groups. Early detection through physical examination and timely intervention are of significant public health importance for reducing disease burden.

Objective: To investigate the detection rate of NAFLD among Beijing's physical examination population from 2018 to 2021 and analyze its associated influencing factors.

Methods: Individuals who underwent physical examinations at the Beijing Physical Examination Center from January 1, 2018, to December 31, 2021, were selected according to inclusion criteria. Physical examination results, laboratory tests, and liver ultrasonography data were collected for analysis. Univariate analysis was performed using t-tests, Mann-Whitney U tests, and chi-square tests. Multivariate logistic regression was used to explore influencing factors of NAFLD.

Results: A total of 325,726 individuals were included, among whom 108,512 cases of NAFLD were detected, yielding a detection rate of 33.31%. Liver ultrasonography revealed 74,062 mild cases (68.25% of detected cases), 33,281 moderate cases (30.67%), and 1,169 severe cases (1.08%). The detection rate was significantly higher in males than females (^{2} = 17,518.893, P < 0.05). Trend chi-square tests revealed an age-dependent increase in detection rate before age 70, followed by a decline thereafter (^{2} = 14,397.61, P < 0.001). Among individuals aged 18-59 years, males showed higher detection rates than females (P < 0.05), while among those aged $ $70 years, males showed lower rates than females (P < 0.05). Multivariate logistic regression identified several influencing factors (all P < 0.001): male gender (OR = 1.173), aging (30-39 years: OR = 1.604; 40-49: OR = 1.948; 50-59: OR = 2.486; 60-69: OR = 2.663; 70-79: OR = 2.079; $ 80 : $OR = 1.149$), $BMI categories$(18.5 − 23.9kg/m^{2}: $OR = 2.997; 24.0 − 27.9kg/m^{2}$: OR = 3.911; $ 28.0kg/m^{2}: OR = 11.780), systolic blood pressure $ $140 mmHg (OR = 1.200), diastolic blood pressure $ $90 mmHg (OR = 1.177), fasting blood glucose $ $6.10 mmol/L (OR = 1.934), triglycerides $ $1.70 mmol/L (OR = 2.946), total cholesterol $ $5.20 mmol/L (OR = 1.050), high-density lipoprotein cholesterol <1.0 mmol/L (OR = 1.645), low-density lipoprotein cholesterol $ $3.4 mmol/L (OR = 1.499), and uric acid (male >420 mol/L, female >360 mol/L: OR = 2.067).

Conclusion: The NAFLD detection rate among Beijing's physical examination population was 33.31%, with the highest incidence in individuals aged 50-69 years. Males, overweight and obese individuals constitute high-risk groups, and abnormalities in blood lipids, blood pressure, and blood glucose represent additional risk factors for NAFLD.

Keywords: Non-alcoholic fatty liver disease; Physical examination population; Prevalence; Root cause analysis; Beijing

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Introduction

With continuous improvements in socioeconomic levels, lifestyle changes have led to chronic diseases gradually replacing infectious diseases as the primary

threats to human health [1-2]. Clinically, fatty liver is divided into alcoholic liver disease (ALD) and non-alcoholic fatty liver disease (NAFLD). NAFLD is the most common liver disease globally, with a prevalence of approximately 25% [3]. Studies show its prevalence is increasing yearly, with a concerning trend toward younger populations [4]. In Asia, the prevalence of NAFLD is approximately 27.4% [5], while in China, reported incidence ranges between 15% and 30% [6]. A meta-analysis demonstrated that China's NAFLD prevalence reached 32.9% in 2018 [7]. NAFLD has become the most significant chronic liver disease in the country and the leading cause of abnormal liver biochemical indicators in health check-ups [8].

Research indicates that NAFLD patients face significantly increased risks of overall mortality, liver-specific morbidity, and mortality [9]. NAFLD can also lead to adverse outcomes in hepatic organs and systems and is closely associated with high incidences of metabolic syndrome, type 2 diabetes, atherosclerotic cardiovascular diseases, and colorectal tumors [10]. The threat of NAFLD has surpassed that of hepatitis B and C, becoming the primary cause of liver-related deaths worldwide [11]. Because NAFLD is generally asymptomatic in early stages and not easily detected, early diagnosis and intervention are crucial for preventing adverse outcomes. Furthermore, NAFLD is reversible [12]; lifestyle and dietary modifications can effectively reverse the condition. Guidelines from the American Association of Clinical Endocrinology and the American Association for the Study of Liver Diseases indicate that NAFLD patients who reduce weight by more than 5% can decrease liver fat content and improve cardiometabolic health, while weight loss exceeding 10% can potentially reverse steatohepatitis or liver fibrosis [13]. Achieving weight reduction through lifestyle improvement is an effective approach to reducing NAFLD disease burden and is recommended as the primary preventive measure [14]. Therefore, early detection, diagnosis, intervention, and treatment of NAFLD are essential strategies for reducing disease burden, and physical examination represents an effective means for early NAFLD detection. This study, based on data from individuals undergoing health examinations at a Beijing examination center from 2018 to 2021, aims to analyze NAFLD detection rates and related characteristics to provide a theoretical basis for NAFLD prevention in Beijing.

Subjects and Methods

1.1 Study Subjects A total of 360,343 individuals who underwent health examinations at the Beijing Physical Examination Center from January 1, 2018, to December 31, 2021, were initially selected. Inclusion criteria were age $ $18 years. Exclusion criteria included chronic hepatitis C, history of malignant liver tumors, other liver and biliary diseases, missing vital information (height, weight, fatty liver detection indicators, age, gender), and self-reported heavy drinking. After applying these criteria, 325,726 individuals were included in the final analysis. The participant inclusion flowchart is shown in [Figure 1: see

original paper].

1.2 Examination Methods Physical Examination: Measurements included height, weight, and blood pressure. All examinees were measured in light clothing without shoes or hats after emptying their bladders. Height was measured to the nearest 0.001 m and weight to the nearest 0.1 kg. BMI was calculated from height and weight. Blood pressure was measured after a 5-minute rest in a quiet environment while seated, using an OMRON HBP-9020 automatic electronic blood pressure monitor.

Laboratory Tests: Blood samples were drawn after a 12-hour fast and analyzed using a Beckman AU5400 automatic biochemical analyzer to measure triglycerides (TG), fasting blood glucose (FBG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and uric acid (UA).

Liver Ultrasound: Performed by a radiologist using a GE LOGIQ E9 color Doppler ultrasound machine (abdominal probe frequency 1-6 MHz).

1.3 Diagnostic Criteria Fatty Liver: Diagnosis was based on the following ultrasonic characteristics [15]: (1) diffuse enhancement of near-field echoes in the liver area (stronger than kidney and spleen) with gradual attenuation of far-field echoes; (2) poor visualization of intrahepatic ductal structures; (3) mild to moderate liver enlargement with rounded edges; (4) reduced or difficult-to-visualize intrahepatic color flow signals in color Doppler flow imaging, though with normal vascular orientation; (5) poor or incomplete visualization of the right hepatic capsule and diaphragmatic echoes. Mild fatty liver was diagnosed with criterion 1 plus one of criteria 2-4; moderate fatty liver with criterion 1 plus two of criteria 2-4; and severe fatty liver with criterion 1, two of criteria 2-4, plus criterion 5.

Other Indicators: FBG >6.1 mmol/L indicates abnormal blood glucose [16]. Blood pressure $ $140/90 mmHg is considered abnormal according to the 2018 Chinese Hypertension Prevention Guide [17]. Abnormal lipid indicators include TG $ $1.7 mmol/L, TC $ $5.2 mmol/L, HDL-C <1.0 mmol/L, and LDL-C $ $3.4 mmol/L$ [18]. $Hyperuricemia is defined as UA > 420 \mu mol/L in men and UA > 360 \mu mol/L in women$ [19]. $BMI was evaluated according to "Adult Body Mass Determ$ 2013)[20] : $BMI < 18.5 kg/m^{2}$ (underweight), 18.5-23.9 kg/m^2 (normal), 24.0-27.9 kg/m^2 (overweight), and $ $28.0 kg/m^{2}$ (obesity).

1.4 Statistical Methods Examination data were exported and organized using Excel, with outlier values excluded based on professional judgment. SPSS 23.0 software was used for data analysis. Normally distributed quantitative data were expressed as mean ± standard deviation ($\bar{x} \pm s$), while non-normally distributed data were expressed as median (P25, P75). Independent sample t-tests and rank-sum tests were used for intergroup comparisons of quantitative data, and chi-square tests for categorical data. Influencing factors were analyzed

using unconditional logistic regression (backward LR), with αin = 0.05 and αout = 0.10. P < 0.05 was considered statistically significant.

Results

2.1 NAFLD Detection Among the 325,726 individuals examined, 170,256 (52.30%) were male and 155,470 (47.70%) were female, with ages ranging from 18 to 98 years and an average age of 42.4 ± 14.6 years. NAFLD was detected in 108,512 cases, yielding a prevalence of 33.31%. According to liver ultrasound diagnosis, 74,062 individuals (68.25% of detected cases) had mild NAFLD, 33,281 (30.67%) had moderate NAFLD, and 1,169 (1.08%) had severe NAFLD.

2.2 Comparison of General and Laboratory Data Between NAFLD and Non-NAFLD Populations The NAFLD group showed significantly higher age, FBG, SBP, DBP, TG, TC, LDL-C, and UA levels compared to the non-NAFLD group. Additionally, body weight and BMI were higher in the NAFLD group, while HDL-C was lower. All differences were statistically significant (P < 0.05), as shown in .

2.3 Comparison of NAFLD Detection Rates by Age, Gender, and BMI Significant differences in NAFLD detection rates were observed across age groups, genders, and BMI categories (P < 0.05). The detection rate was higher in males than females (P < 0.05), as shown in . Trend chi-square tests demonstrated a significant age-related trend in NAFLD detection rates (^{2} = 14,397.61, P < 0.001), with rates increasing with age until 70 years, then declining thereafter.

Among individuals aged 18-59 years, NAFLD detection rates were significantly higher in males than females (P < 0.05). Between ages 60-69, no significant gender difference was observed (P > 0.05). In individuals aged $ $70 years, detection rates were significantly lower in males than females (P < 0.05), as shown in .

2.4 Multifactorial Logistic Regression Analysis of NAFLD Influencing Factors NAFLD occurrence was set as the dependent variable (yes = 1, no = 0), and statistically significant indicators from Table 1 were included as independent variables (assignments shown in). Multifactorial unconditional logistic regression analysis indicated that gender, age, BMI, SBP, DBP, FBG, TG, TC, LDL-C, and UA were all influencing factors for NAFLD (P < 0.05), as detailed in .

Discussion

The liver serves as the primary site of lipid metabolism in humans, with functions including glycogen storage, metabolic regulation, detoxification, and biotransformation. NAFLD patients are prone to progression to cirrhosis, fibrosis, or even liver failure [21]. Although the progression rate to liver cancer is relatively low, a gradual increasing trend has been observed [22]. Connections between NAFLD and extrahepatic tumors have also been identified in various studies [23]. However, most patients exhibit no obvious symptoms in early stages [24], making prevention particularly crucial.

The pathogenesis of fatty liver remains unclear, but studies indicate associations with hyperlipidemia, hyperglycemia, obesity, and other factors [6]. Our study analyzed NAFLD detection and related risk factors among Beijing's physical examination population to provide fundamental data for understanding, monitoring, preventing, and managing NAFLD.

The results reveal a NAFLD detection rate of approximately 33% among individuals aged 18 and above, higher than some regional reports in China [25-26] but similar to other studies [27]. These variations may reflect differences in lifestyle and environmental factors across regions. Male NAFLD detection rates exceeded female rates, with the highest detection rate (>45%) occurring in the 50-69 age group—lower than the elderly population over 60 in Shanghai [28] but higher than elderly populations in certain Hebei province areas [29]. Nevertheless, results for older populations are generally consistent, with most studies finding decreased fatty liver prevalence after age 70 [30].

Multifactorial logistic regression revealed BMI as a significant risk factor for NAFLD. Obesity (BMI $ 28.0kg/m^{2}$) showed the highest OR value of 11.780, exceeding that reported in Ye Yao's study on elderly populations [24]. Weight reduction is an essential measure for preventing and treating NAFLD and its complications [31]. Dietary restriction has proven effective, reducing hepatic TG content by 6.9% compared to baseline over a 12-month clinical trial [32]. A weight reduction exceeding 10% maintained for one year is required to reverse liver fibrosis [33].

Interestingly, our study identified leanness as a risk factor for NAFLD. Despite lower metabolic syndrome incidence compared to overweight and obese populations, lean NAFLD patients demonstrate higher overall mortality rates [34]. Their risks for all-cause death, liver-related death, and tumors of the digestive system and obesity are elevated compared to both overweight/obese NAFLD and lean non-NAFLD populations [35]. Therefore, NAFLD risk in lean populations warrants special attention and regular monitoring. Additionally, using body composition analyzers to measure body fat content, BMI, and skeletal muscle mass is recommended to detect hidden obesity and sarcopenia [37].

Abnormalities in TG, TC, LDL-C, and HDL-C are consistent risk factors for NAFLD, aligning with other studies [38-39]. Our study's use of higher-

sensitivity diagnostic criteria for dyslipidemia, based on marginal elevation standards from the revised 2016 Chinese guidelines, may yield smaller OR values compared to studies using elevated standards. Elevated blood pressure represents another NAFLD risk factor, as confirmed by Yang Guiling's research [40], potentially due to associations with cardiovascular complications, particularly arteriosclerosis.

In summary, NAFLD detection rates are high among Beijing's examined population, particularly among males and those aged 50-69 years. Both lean and overweight individuals face risks, as do those with abnormalities in blood pressure, blood glucose, and blood lipids. Regular ultrasound or liver biopsies, lifestyle adjustments, and close monitoring of related indicators are essential for high-risk individuals.

Study limitations include the use of ultrasound rather than liver biopsy (the gold standard) for NAFLD diagnosis, and potential information and selection biases due to self-reported data and exclusion criteria. Future cohort and experimental studies are needed to further explore factors influencing NAFLD occurrence and development and to identify feasible intervention measures.

Author Contributions: Dou Ziyan and Zhang Jingbo conceived the research idea, designed the study, and wrote the manuscript. Qian Wenhong performed data analysis and interpreted results. Kong Lingrun and Li Mingliang handled data collection and organization. Chen Ye revised the manuscript.

Conflict of Interest Statement: The authors declare no conflicts of interest.

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Note: Figure translations are in progress. See original paper for figures.