The association of non-alcoholic fatty liver disease and metabolic syndrome in a Chinese population

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BACKGROUND: Non-alcoholic fatty liver disease (NAFLD) is associated with features of metabolic syndrome. The aim of this study was to investigate the association between NAFLD and metabolic syndrome in a Chinese population.

METHODS: Data from subjects were retrospectively collected from 2006 to 2009. The exclusion criteria included significant consumption of alcohol and chronic hepatitis B and C. The patients were assigned to two groups according to ultrasound findings: normal group and fatty liver group. The liver function of patients was determined by assessing serum alanine aminotransferase (ALT). Metabolic syndrome was diagnosed based on the 2005 International Diabetes Federation criteria.

RESULTS: A total of 7568 subjects were enrolled and 5736 (75.8%) and 1832 (24.2%) patients were assigned to the normal and fatty liver groups, respectively. The fatty liver group had significant male predominance (69.7% vs 56.0%), higher body mass index (mean, 26.67 vs 23.55 kg/m^2) compared with the normal group. There were 441 (7.7%) and 377 (20.6%) cases with metabolic syndrome in the normal and fatty liver groups, respectively, with significant difference (P=0.001), and the subgroup of 385 cases with fatty liver and elevated ALT had higher prevalence (28.8%) of metabolic syndrome. The strongest association of an individual component of metabolic syndrome with NAFLD was hyperlipidemia (adjusted OR=2.55, 95% CI: 2.22-2.94).

CONCLUSION: The individuals with NAFLD had a higher ratio of metabolic syndrome. Hyperlipidemia had the strongest positive association with NAFLD.

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KEY WORDS: fatty liver; hyperlipidemia; metabolic syndrome

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a clinicopathologic condition characterized by abnormal lipid deposition in hepatocytes (steatosis) in the absence of excess alcohol intake, and it comprises a spectrum of diseases, ranging from simple hepatic steatosis to steatosis in association with necroinflammation and fibrosis (non-alcoholic steatohepatitis, NASH) to cirrhosis.[1] The reported prevalence of NAFLD when defined by liver ultrasound ranged between 17% and 46% depending on the population.[2] Metabolic syndrome describes a spectrum of disorders that may contribute to visceral obesity, insulin resistance, hyperglycemia, dyslipidemia, and hypertension.[3] Data indicate that the metabolic syndrome prevalence varies widely across populations. According to the National Health and Examination Survey (NHANES) III 1988-1994 and the NHANES 1999-2000, the age-adjusted prevalence rates of metabolic syndrome were 24.1% and 27%, respectively.[4] NAFLD has been reported to be associated with several features of metabolic syndrome including obesity, type 2 diabetes, atherogenic dyslipidemia, and hypertension, and is characterized by insulin resistance. Furthermore, it has been suggested that NAFLD may be a hepatic manifestation of metabolic syndrome.[5,6]

The aim of our study was to determine the association between NAFLD and metabolic syndrome in a Chinese population.

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Methods

Data from subjects who visited the Medical Screening Center at Taichung Veterans General Hospital were retrospectively collected from January 2006 to December 2009. The general data of enrolled patients, including age, gender, body mass index (BMI), waist circumference, blood pressure, fasting glucose, triglyceride (TG), and high-density lipoprotein (HDL) were recorded. All patients underwent a liver ultrasound which was conducted by experienced radiologists, and the findings of each case were collected. The exclusion criteria included significant consumption of alcohol (>40 g/day for males or >20 g/day for females) and chronic hepatitis B and C. These patients were assigned to two groups according to whether they had a normal liver appearance (normal group) or a fatty liver (fatty liver group). Liver function was determined by assessing levels of serum alanine aminotransferase (ALT). The definition of upper normal limit (UNL) of ALT was 50 U/L in men and 35 U/L in women.

Metabolic syndrome was diagnosed based on the 2005 International Diabetes Federation criteria with ethnicity-specific values: central obesity (waist circumference ≥90 cm for men and ≥80 cm for women), combined with any two of the following four conditions: (1) TG levels ≥150 mg/dL; (2) HDL levels <40 mg/dL for men and <50 mg/dL for women; (3) fasting glucose levels >100 mg/dL; and (4) systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg.

Statistical analysis

Data are expressed as mean±SD for each of the measured parameters. Gender, positive ratio of metabolic syndrome, and its associated components are expressed as a percentage of the total patient number. Statistical comparisons were made using Pearson's Chi-square test to compare the effects of gender and positive ratio of metabolic syndrome and individual components. Independent *t* test was used to analyze age and BMI. A *P* value below 0.05 was considered statistically significant. Multivariate Cox's regression was used to examine the strength of association between metabolic syndrome and fatty liver, as shown by odds ratios (ORs) with 95% confidence interval (CI).

Results

Among the 7568 subjects enrolled in our study, 5736 (75.8%) and 1832 (24.2%) were in the normal and fatty liver groups, respectively. Among the subjects wih fatty liver, 868 (47.4%), 622 (34.0%) and 342 (18.7%) belonged to mild, moderate and severe fatty liver respectively. Patients' characteristics are summarized in Table 1. The mean age of the cases with fatty liver was older than that without (53.66 vs 52.20 years). The individuals in the fatty liver group had significantly higher BMI than those in the normal group (26.67 vs 23.55 kg/m^2). Furthermore, there was significant male predominance in the fatty liver group (69.7%).

Table 1. The characteristics of enrolled cases

Characteristics	Normal liver (*n*=5736)	Fatty liver (*n*=1832)	*P* value
Age (yr)	52.20±12.30	53.66±11.24	**0.001***
BMI (kg/m^2)	23.55±3.13	26.67±3.14	**0.001***
Waist (cm)	79.63±9.75	88.81±0.14	**0.001***
Gender (male) (*n*, %)	3215 (56.0)	1277 (69.7)	**0.001#**

*: *P* values were analyzed with independent *t* test; #: Pearson's Chi-square test. BMI: body mass index.

Table 2. The characteristics of enrolled cases in each subgroup (*n*, %)

Characteristics	Normal liver (*n*=5736)	Fatty liver (*n*=1832)	*P* value
Metabolic syndrome	441 (7.7)	377 (20.6)	**0.001**
Waist	705 (12.3)	534 (29.1)	**0.003**
TG	3040 (53.0)	1505 (82.2)	**0.001**
HDL	638 (11.1)	339 (18.5)	0.086
Glucose	1215 (21.2)	758 (41.4)	**0.001**
BP	169 (2.9)	72 (3.9)	**0.037**

All *P* values were analyzed with Pearson's Chi-square test. TG: triglyceride; HDL: high-density lipoprotein; BP: blood pressure.

Among the 1832 individuals with fatty liver, 385 (21%) had elevated serum ALT. The cases with fatty liver and elevated ALT were significantly younger (mean 48.56 vs 55.02 years), had higher BMI (mean 27.61 vs 26.42 kg/m^2), and were more likely to be male (79.5% vs 67.1%) than those with fatty liver and normal ALT.

Associations between normal liver or fatty liver and metabolic syndrome are displayed in Table 2. There were 441 (7.7%) and 377 (20.6%) cases with metabolic syndrome in the normal and fatty liver groups, respectively (*P*=0.001). Among the cases in the fatty liver group, an extremely large portion of cases had hypertriglyceridemia (82.2%) and hyperglycemia (41.4%). All components of metabolic syndrome were significantly elevated in the cases with fatty liver than in those without, except HDL (18.5% vs 11.1%, *P*=0.086).

The strengths of associations between individual components of metabolic syndrome and fatty liver are shown in Table 3. After adjustment for measured potential confounders, including age, gender, and BMI, there were significant positive associations between all com-