A cross-sectional study of alcohol consumption and alcoholic liver disease in Beijing: based on 74,998 community residents

Huai Wang, Pei Gao, Weixin Chen, Qianli Yuan, Min Lv, Shuang Bai and Jiang Wu*

Abstract
Background: The alcohol consumption pattern, alcoholic liver disease (ALD) prevalence and related risk factors among alcohol drinkers in Beijing haven’t been fully elucidated. Hence, a cross-sectional study was conducted to investigate potential link among these factors.

Methods: A two-stage stratified cluster sampling was carried out in Beijing. All participants were 25 years of age or older, possessed with medical insurance, and lived in Beijing for over 6 months. As part for this investigation, participants were asked to answer a questionnaire and undergo physical examination. The questionnaire included demographic information, alcohol intake, and medical history. The physical examination included physical and Fibrotouch tests. Moreover, 10 ml blood sample was collected from each subject to examine liver functions, perform routine blood, Hepatitis B Virus (HBV) and Hepatitis C Virus (HCV).

Results: Overall, 74,988 residents participated in our study. The proportion of current drinkers among all participants was 46.10%. The differences in gender, region, age group, education, annual household income, and occupation among lifetime abstainers, former drinkers, non-weekly and weekly drinkers were significantly different ($P<0.05$). The ethanol intake between men and women, people living in urban and rural regions were significantly different ($P<0.05$). Strong spirits were commonly consumed by men, whereas, beers were commonly consumed by women. Drinking strong spirits generally lead to liver steatosis. In addition, ALD prevalence was 1.30% in participants over 25 years old. The differences in ALD prevalence between men and women, and among different age groups, were significant ($P<0.05$). Based on our analysis, ALD risk factors in Beijing included: gender (male), age (older than 35 years), high waist circumference, high blood pressure, high BMI, high blood sugar level, and being heavy drinkers.

Conclusion: Compared with other cities or regions in China, the level of alcohol consumption in Beijing is at an upper middle level. But the ALD prevalence is low likely because ethanol intake is relatively low. Our analysis revealed that heavy drinking is a major risk factor for ALD development. Hence, if alcohol consumption is unavoidable, we caution against heavy drinking.

Keywords: Alcohol consumption, Alcoholic liver disease, Prevalence, Cross-sectional study, Risk factors

*Correspondence: wz81732@hotmail.com
Department of Immunization, Beijing Center for Disease Prevention and Control, No.16, HePIngLi Middle Street, DongCheng District, Beijing 100013, China

© The Author(s) 2022. Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.
hepatitis B vaccine in 1992 [1]. The prevalence of other chronic liver diseases, especially alcoholic liver disease (ALD) and nonalcoholic fatty liver disease (NAFLD), is rapidly increasing [2].

According to the 2018 World Health Organization (WHO) report on alcohol and health, alcohol consumption is estimated to result in 132.6 million disability-adjusted life years (DALYs) [3]. At the present time, mortality from alcohol consumption is higher than mortality caused by other diseases, such as tuberculosis, HIV/AIDS, and diabetes [3]. In China, production and consumption of alcoholic beverages has significantly increased due to a continuously growing economy [4]. Different alcoholic beverages contain varying levels of ethanol. Thus, it is imperative to collect a wide range of alcoholic beverages and analyze them separately. In the meantime, the number of ALD patients is rising at an alarming rate. Between 2006 and 2010, viral-hepatitis-related cirrhosis hospitalization declined by 10% in Beijing, but alcoholic cirrhosis-related hospitalization increased by 33%, according to a hospitalization summary report (HSR), based on the analysis of 2.3 million hospitalized patients in 31 Grad 3A hospitals [5]. The ratio of patients hospitalized with ALD to all hospitalized patients with liver diseases is rising almost continuously from 1.68% in 2002 to 4.59% in 2013, as reported by 302 hospital in Beijing [6].

Alcohol use disorder (AUD) is severe in China, especially in Northeast China [7]. Unfortunately, thus far, only region-based ALD studies, and not national epidemiological ALD survey, have been conducted in China [4, 8–14]. The point prevalence of ALD in certain regions in China is reported to range from 2.27–8.75% [15]. Unfortunately, the ALD prevalence in Beijing is currently unknown [15], as the latest national alcohol consumption survey was conducted 10 years ago in 2011 [16]. Meanwhile, some alcohol consumption studies, based on community residents, lacked a combined analysis involving ALD [17, 18]. Furthermore, ALD risk factor surveys in China yielded very different results, even opposite in studies that included the following factors: male gender, middle age, currently unmarried, education level, rural residence, family income, high level of occupation, high BMI, and smoking [4, 19]. Thus, we conducted an extensive study, involving community residents, to determine the prevalence of recent alcohol consumption, ALD prevalence of, and identify potential correlations between socio-economic, demographic, alcoholic consumption, and viral hepatitis infection with ALD in Beijing.

Methods

Subjects and sampling

Our work was part of an epidemiological study on the liver health of community residents in Beijing. It was based on a two-stage stratified cluster sampling carried out in 16 districts and 331 townships between 2017 and 2020. First, 11, out of 16 districts, were randomly sampled. Then, 2 townships in each district were randomly sampled. All residents within sampled townships were required to participate in the investigation. Each participant was asked to sign an informed consent agreement before survey. All participants were asked to answer a questionnaire, undergo physical examination, and blood sample collection. Each subject was then confirmed to ensure that the questionnaire, blood sampling, and physical examination were completed on the survey site. If any item was not completed, it was supplemented immediately. The inclusion criteria were as follows: (1) adults, aged 25 years and older; (2) residents who lived in Beijing for more than 6 months and possessed medical insurance. The exclusion criteria were as follows: (1) residents aged less than 25 years old; (2) residents with pacemakers; (3) pregnant women; (4) residents with a large amount of ascites; (5) residents with unhealed wound on the right upper abdomen that Fibrotouch test required.

Sampling size is estimated as:

\[
N = \frac{1.96^2 \times P \times (1 - P)}{\sigma^2} \times Deff
\]

\[
Deff = 1 + (M - 1) \times ICC
\]

\[
ICC = \frac{K^2 \times P}{1 - P}
\]

1.96 is the two-tailed Zα value where α is 0.05. P is the expected true proportion of ALD in Beijing, which is 5% in men and 3% in women [15]. σ is the relative precision, which is set to 0.02. K is the coefficient of between-cluster variation, which is set to 0.6. ICC is the intraclass correlation coefficient which is estimated to be 0.019 in men and 0.011 in women. M is the cluster size (number of targeted individuals), and it is approximately constant across clusters. The estimation of M is 5000 residents in each township. Deff corresponds to the design effect which is estimated to be 95.7 in men and 56.6 in women. Considering the need to collect blood, the respondent rate is estimated to be 80%. The sample size in men is estimated to be 54,582. The sample size in women is estimated to be 19,794. The total sample size is estimated to be 74,376.

Questionnaire and physical examination

All investigators were trained prior to questionnaire and physical examination. Once participants signed the informed consent, a face-to-face questionnaire
commenced. The questionnaire included: (1) demographic variables, included age, gender, region, education, occupation, nationality, marital and living status, and annual household income. (2) Evaluation of alcohol intake, included detailed questions on the use of alcoholic beverages, types of alcoholic beverage consumed, quantity of alcohol intake in each intake, the duration of drinking, and so on. (3) Medical history included prior diagnosis of chronic liver disease and other chronic diseases. The physical examination included the following: (1) height, weight, waist circumference, hip circumference, and blood pressure. (2) Fibrotouch test using the FibroTouch FT100 (WuXi Hisky Medical Technologies Co.Ltd), a new technology which indirectly assesses degree of liver fibrosis, similar to the FibroScan. Successful liver fibrosis measurement requires three conditions: (1) at least 10 valid measurements (2) 60% or higher success rate (3) inter-quartile range/median less than 33%. Those whose Fibrotouch DBM was ≥ 240 db/m was diagnosed with liver steatosis. Those whose Fibrotouch LSM was ≥ 12.96 Kpa was diagnosed with liver fibrosis.

**Blood collection and assessment**
10 ml blood sample was collected from each participants to examine liver function, routine blood, HBsAg, anti- HBsAg, anti- HBc, and anti- HCV. The anti-HCV positive participants were further tested for HCV RNA. All liver function (ALT, AST, GGT) examinations were performed on the Hitachi 7600–110 automatic analyzer (Hitachi High-Technologies, Tokyo, Japan), using reagents from Wako (Pure Chemical Industry, Japan). Routine blood tests were analyzed with the Cell-DYN Ruby (Abbott Laboratories, Diagnostic Division, Abbott Park, IL, USA) within 2 h of collection. HBV serological markers were tested by Architect i2000 (Chemiluminescence MicroparticleImunoassay, Abbott, Chicago, USA). HCV serological markers were initially tested using the Colloidal Gold method (YingkeXinChuang, China), followed by confirmation of the positive anti-HCV samples were confirmed with an enzyme immune assay (ARCHITECT Anti-HCV; Abbott Laboratories, USA). The anti-HCV positive samples were tested for HCV RNA using the Abbott Real Time HCV (Abbott Laboratories), carrying a sensitivity of 15IU/ml for the determination of viral load.

**Alcohol consumption assessment**
The participants who consumed alcoholic beverages in the past12-month period were classified as current drinkers. The current drinkers were subcategorized into non-weekly and weekly drinkers. The current drinkers who consumed alcohol occasionally (less than weekly) were classified as non-weekly drinkers. The current drinkers who drank alcohol at least once a week were classified as weekly drinkers. Those who never consumed alcohol were classified as lifetime abstainers. Those who previously consumed alcohol, but has not had a drink in the past12-month period were classified as former drinkers. The aforementioned drinking categories were in line with the WHO global status report on alcohol and health 2018 [3], and WHO guide for monitoring alcohol consumption [20].

The current drinkers who consumed weekly in the past 12 months were further asked questions on types of beverage (beer, grape wine, rice wine, weak spirits < 40% alcohol content, or strong spirits ≥ 40% alcohol content), numbers of alcohol intake per week, and amount of alcohol consumed each time (reported by number of small (330 ml) or large (640 ml) bottles for beer, and number of liang (50 g) for wines and spirits). The level of alcohol consumption was calculated as grams of ethanol per day, based on the beverage type, amount consumed, and consumption frequency per week. Our analysis revealed the following alcohol content by volume (v/v) in China: beer 4%, grape wine 12%, rice wine 15%, weak spirits 38%, and strong spirits 53%. Grams of ethanol per day = [beer consumption frequency per week × numbers of (small bottles 330 ml or large bottles 640 ml) each time × 4% × 0.8/7] + [grape wine consumption frequency per week × number of liang (50 g) each time × 12% × 0.8/7] + [rice wine consumption frequency per week × number of liang (50 g) each time × 38% × 0.8/7] + [strong spirits consumption frequency per week × number of liang (50 g) each time × 53% × 0.8/7] [3]. Heavy drinkers were those who consumed more than 60 g of ethanol per day.

**Diagnostic criteria**
ALD diagnosis was confirmed according to the Guidelines of Prevention and Treatment for Alcoholic Liver Disease: a 2018 updated version drafted by the National Workshop on Fatty Liver and Alcoholic Liver Disease, Chinese Society of Hepatology Chinese Medical Association and Fatty Liver Expert Committee, and Chinese Medical Doctor Association [21]. ALD diagnosis met all of the following criteria: (1) men who consumed more than 40 g of ethanol per day or women who consumed more than 20 g of ethanol per day; (2) those who consumed alcohol for more than 5 years; (3) [(ALT > 40 U/L or AST > 40 U/L) and AST/ALT > 2] or GGT > 55 U/L or MCV > 96 fl; (4) those with liver steatosis (FibroTouch DBM ≥ 240 db/m) or liver fibrosis.
Continuous variables, with normal distribution, are pre-
25.53 participants was 46.10%. The initial drinking age was
drinkers. The proportion of current drinkers among all
were former drinkers; 20,972 participants were non-
participants were lifetime abstainers; 278 participants
response rate was 98.40%. Among them, 40,148
95% confidential intervals, derived from a logistic-regres-
was considered significant. Adjusted odd ratios (OR) and
stepwise regression method was used and
value < 0.05
HCV RNA) .
Statistical analysis
Epidata (3.1) was used to establish databases. All par-
ticipant information was entered separately by two
groups from the Beijing XunChiFeiLong Data Technol-
Company Ltd. Data check was performed independently
by two investigators from the same company. Data were
analyzed using the statistical analysis package SPSS (SPSS
Inc., Chicago IL, version 19.0). Differences in categorical
variables were tested using the \( \chi^2 \) or Fisher’s exact test.
Continuous variables, with normal distribution, are pre-
 presented as means± standard deviation (SD), and the dif-
ferences were tested by Student’s t-test or Anova test.
A \( p \)-value < 0.05 (2-tailed) was considered statistically
significant. Considering the potential strata clustering
(geographical, urban/rural areas) effect on the ALD pre-
valence, we used a linear mixed model to do the multilevel
analysis first. However, we did not observe the significant
effect of group level. So, we employed multivariable logis-
tic regression models to examine the factors associated
with ALD. All factors for which the \( P \)-value of univari-
ate analysis was <0.05 were entered into the model. The
stepwise regression method was used and \( p \)-value <0.05
was considered significant. Adjusted odd ratios (OR) and
95% confidential intervals, derived from a logistic-regres-
sion model, were used to assess the relationships between
ALD and socio-economics, demographic characteristics,
and alcoholic consumption variables.

Results
Socio-demographic characteristics of subjects
Seventy-six thousand two hundred twenty residents
in 22 townships were asked to participate in our sur-
vey, and 74,988 residents completed the questionnaire,
physical examination, and blood collection (Table 1).
The response rate was 98.40%. Among them, 40,148
participants were lifetime abstainers; 278 participants
were former drinkers; 20,972 participants were non-
weekly drinkers; and 13,600 participants were weekly
drinkers. The proportion of current drinkers among all
participants was 46.10%. The initial drinking age was
25.53 ± 9.47 years old. The differences in gender, regional,
age group, educational, annual household income distri-
bution, and occupational distributions among the life-
time abstainers, former drinkers, non-weekly and weekly
drinkers were statistically significant (\( P <0.05 \)). There
were more lifetime abstainers among women, and more
current drinkers among men. The proportion of lifetime
abstainers increased with age, but there was an opposite
trend among current drinkers. The proportion of lifetime
abstainers decreased with the increase of education level
and annual household income, but an opposite trend
was seen among current drinkers. The grams of ethanol
intake per day, among weekly drinkers, between men and
women, were significantly different (\( P <0.05 \)). It was con-
firmed that the grams of ethanol intake per day among
male weekly drinkers were higher than among females.
Moreover, the grams of ethanol intake per day among
weekly drinkers, between people living in urban and rural
areas, were statistically different as well (\( P <0.05 \)).
Interestingly, the grams of ethanol intake per day among
weekly drinkers in rural area were higher than those liv-
ing in urban area. The grams of ethanol intake per day
among heavy drinkers, between men and women, urban
and rural residents, however, was not statistically differ-
ent (\( P >0.05 \)).

Types of alcohol and consumption
The alcohol consumption of different alcoholic bever-
ages among weekly drinkers was significantly differ-
ent (\( P <0.05 \)). Strong spirit consumption was the highest
among weekly drinkers, which was up to 49.88%. The
second and third alcohol consumption was related to
weak spirits and beer consumption (Table 2). Those
who drank strong spirits consumed more than twice as
much ethanol as those who drank beer. Strong spirits
were commonly consumed by men, whose ethanol intake
was also the highest. In contrast, beer consumption was
common among women. In addition, the ethanol intake
in men was higher than in women, due to the consump-
tion of different types of alcohol beverage. People in
urban areas preferred strong spirits and beer (\( F = 106.45,
P <0.05 \)), whereas, rural residents preferred weak and
strong spirits (\( F = 167.05, P <0.05 \)). Although people in
urban areas preferred strong spirits, the ethanol intake
were lower than their rural counterparts (\( P <0.05 \)).

The relationship between types of alcohol, consumption,
liver steatosis, and fibrosis
Increased ethanol intake and alcohol content in beer,
grape wine, rice wine, weak spirit, and strong spirit signif-
ically correlated with severity of liver steatosis (\( P <0.05 \)).
However, no such correlation was observed with the
severity of liver fibrosis (\( P >0.05 \)). Hence, excessive spirit
consumption and ethanol intake dramatically increased
the probability of developing liver steatosis (Table 3).

Related examination and prevalence of ALD among weekly
drinkers
Among the 13,600 weekly drinkers, 4934 participants
(36.28%) were men who consumed more than 40 g of etha-

(1) those with HBV or
(2) those with HCV infection were excluded (positive of HBsAg or
HCV RNA).
Table 1 Prevalence of alcohol consumption and grams of ethanol per day, by socio-demographic characteristics

| Age Group | Income Level | Total N % | Lifetime Abstainer N(%) | Former Drinker N(%) | Current Drinker Non-weekly N(%) | Current Drinker Weekly N(%) | Alcohol Intake | Age began to drink | Alcohol Intake in heavy drinker |
|-----------|--------------|-----------|-------------------------|--------------------|---------------------------------|-----------------------------|----------------|--------------------|-------------------------------|
| All       | All          | 74,988    | 40,148(53.53)           | 278(0.37)          | 20,972(27.96)                  | 13,600(18.13)               | 1830.90        | 0.000              | 21,467.15                    |
| Gender    | Men          | 34,567    | 2923(26.72)             | 190(0.57)          | 12,791(37.00)                  | 12,341(35.70)               | 581.61         | 0.000              | 581.61                       |
|           | Women        | 40,431    | 30,911(76.45)           | 100(0.20)          | 8181(20.23)                    | 1259(3.11)                  | 3219.11        | 0.000              | 3219.11                      |
| Region    | Urban        | 4,1999    | 22,288(53.07)           | 147(0.35)          | 12,946(30.82)                  | 6618(15.76)                 | ±               | ±                  | ±                             |
|           | Rural        | 32,999    | 17,600(54.12)           | 131(0.40)          | 8026(24.32)                    | 6982(21.16)                 | ±               | ±                  | ±                             |
| Education | illiteracy   | 1510      | 1127(74.64)             | 46(0.31)           | 397(26.14)                     | 3979(26.14)                 | ±               | ±                  | ±                             |
|           | Primary school | 1125     | 851(74.64)              | 46(0.31)           | 397(26.14)                     | 3979(26.14)                 | ±               | ±                  | ±                             |
|           | Junior middle school | 1240 | 2929(26.72)             | 147(0.35)          | 12,946(30.82)                  | 6618(15.76)                 | ±               | ±                  | ±                             |
|           | High school   | 18,281    | 9603(52.53)             | 50(0.27)           | 2504(20.23)                    | 1259(3.11)                  | ±               | ±                  | ±                             |
|           | Graduate      | 22,577    | 11,158(49.42)           | 85(0.38)           | 1476(24.13)                    | 1575(22.87)                 | ±               | ±                  | ±                             |
|           | Postgraduate  | 2667      | 1161(43.33)             | 20(0.70)           | 3199(11.72)                    | 3641(20.16)                 | ±               | ±                  | ±                             |
| Annual household income | <4000$ | 14,938    | 9082(60.82)             | 74(0.52)           | 2504(20.23)                    | 1259(3.11)                  | ±               | ±                  | ±                             |
|           | 4000$-20,000$ | 45,845  | 24,571(53.65)           | 154(0.30)          | 12,926(27.77)                  | 2436(20.04)                 | 3219.11        | 0.000              | 3219.11                      |
|           | 20,000$-40,000$ | 12,083 | 5593(46.57)             | 45(0.34)           | 2504(20.23)                    | 1259(3.11)                  | ±               | ±                  | ±                             |
|           | ≥40,000$      | 2132      | 902(42.91)              | 5(0.24)            | 2504(20.23)                    | 1259(3.11)                  | ±               | ±                  | ±                             |
| Occupation | Government Employee | 8778 | 4160(46.57)             | 30(0.34)           | 3127(35.62)                    | 1461(16.61)                 | ±               | ±                  | ±                             |
|           | Corporate Employee | 12,156   | 6290(51.74)             | 50(0.41)           | 3376(27.77)                    | 2436(20.04)                 | 581.61         | 0.000              | 581.61                       |
|           | Teacher & Institute Employee | 10,144 | 4667(46.01)             | 35(0.35)           | 4085(40.27)                    | 1357(13.38)                 | ±               | ±                  | ±                             |
|           | Urban or rural worker | 16,504 | 8362(50.67)             | 56(0.34)           | 4443(26.92)                    | 3643(22.07)                 | ±               | ±                  | ±                             |
|           | Retiree       | 9487      | 5950(62.72)             | 30(0.33)           | 1953(20.59)                    | 1553(16.37)                 | ±               | ±                  | ±                             |
|           | Other         | 17,929    | 10,719(59.87)           | 70(0.40)           | 3988(22.24)                    | 3150(17.57)                 | ±               | ±                  | ±                             |

* Alcohol intake assessed by grams of ethanol per day (grams/day)

b Heavy drinker: those who consume more than 60 g of ethanol per day
Table 2  Consumption of different alcoholic beverages among weekly drinkers

|                | Beer     | Grape wine | Rice wine | Weak spirits | Strong spirits |
|----------------|----------|------------|-----------|--------------|----------------|
|                | N        | %          | Alcohol intake<sup>a</sup> | T value | %          | Alcohol intake<sup>a</sup> | T value | %          | Alcohol intake<sup>a</sup> | T value | %          | Alcohol intake<sup>a</sup> | T value |
| Total          | 13,600   | 34.69      | 15.84 ± 22.38 | 5.38    | 4.02 ± 4.27 | 1.29         | 5.94 ± 8.58 | 42.71 | 24.04 ± 21.25 | 49.88 | 42.91 ± 38.45 |
| Gender         |          |            |           | t = 16.12 | t = 3.76 | t = 3.10 | t = 19.18 | t = 9.80 |
| Men            | 12,341   | 34.03      | 16.82 ± 12.29 | 3.33    | 4.51 ± 4.86 | 1.13         | 6.62 ± 9.21 | 43.31 | 25.03 ± 21.57 | 52.49 | 43.73 ± 38.56 |
| Women          | 1259     | 41.14      | 7.86 ± 9.65  | 25.50   | 3.38 ± 3.27 | 2.96         | 3.24 ± 4.53 | 36.85 | 12.64 ± 12.37 | 24.31 | 25.48 ± 31.44 |
| Region         |          |            |           | t = 0.03 | t = −1.46 | t = −0.33 | t = −6.53 | t = −6.93 |
| Urban          | 6618     | 38.18      | 15.85 ± 21.02| 7.71    | 3.86 ± 4.21 | 1.87         | 5.80 ± 9.35 | 37.29 | 21.93 ± 19.83 | 53.99 | 39.84 ± 37.43 |
| Rural          | 6982     | 31.38      | 15.83 ± 23.85| 7.95    | 4.36 ± 4.39 | 0.74         | 6.27 ± 6.48 | 47.85 | 25.60 ± 22.12 | 45.99 | 46.32 ± 39.27 |

<sup>a</sup> Alcohol intake assessed by grams of ethanol per day (g/d)
more than 5 years. In addition, 618 participants (4.54%) were ALT > 40 U/L or AST > 40 U/L and AST/ALT > 2, 3726 participants (27.40%) were GGT > 55 U/L, 270 participants (1.99%) were MCV > 96 fL, 5697 participants (41.89%) had liver steatosis (Fibrotouch DBM $\geq 240$ db/m), 376 participants (2.76%) had liver fibrosis (Fibrotouch LSM $\geq 12.96$ Kpa), and 974 participants were diagnosed with ALD.

Multilevel analysis finds the different districts, and rural or urban areas have no effect on the residents’ ALD prevalence ($P>0.05$). The proportion of ALD among weekly drinkers was 7.16% (974/13600), among adults over 25 years old was 1.30% (974/74988), among men was 2.75% (952/34567), among women was 0.05% (22/40431). The proportion of ALD among weekly drinkers between men and women ($\chi^2 = 61.17, P<0.05$) and among age groups ($\chi^2 = 61.23, P<0.05$) were statistically significant. ALD in men was higher than in women, and the highest incidence was in people aged between 50 and 60 years old (Fig. 1).

The proportion of ALD in urban and rural areas was not statistically significant ($P>0.05$). The proportion of ALD among residents in urban areas was 1.19% (501/41999), among residents in rural areas was 1.43% (473/32999).

### Influence and risk factors for ALD

ALD diagnosis was used as a dependent variable. The independent variables used to conduct logistic regression analysis were: gender, age group, BMI, waist circumference, hip circumference, blood pressure, occupation, education, marital status, annual household income, heavy drinker or not, and blood sugar level. The final analysis presented in Table 4. Gender (male), age (older than 35 years old), increased waist circumference, high blood pressure (systolic pressure $\geq 140$ mmHg or diastolic pressure $\geq 90$ mmHg), high BMI, high blood sugar level, and being heavy drinkers were risk factors for ALD. Increased hip circumference was a protective factor for ALD.

![Fig. 1 ALD prevalence among men and women, according to age](image-url)
Table 4  Logistic regression analyses of influence and risk factors for ALD

| Variables                | β     | Standard error | P    | OR (95% CI)       |
|--------------------------|-------|----------------|------|-------------------|
| Gender (based on female) | 0.68  | 0.23           | 0.00 | 1.97 (1.25–3.10)  |
| Age group (Based on 25–29) |       |                |      |                   |
| 25~                      | –     | –              | –    | 1                 |
| 30~                      | 0.25  | 0.23           | 0.28 | 1.29 (0.82–2.03)  |
| 35~                      | 0.47  | 0.19           | 0.02 | 1.60 (1.09–2.33)  |
| 40~                      | 0.61  | 0.18           | 0.00 | 1.84 (1.30–2.59)  |
| 45~                      | 0.56  | 0.17           | 0.00 | 1.74 (1.25–2.44)  |
| 50~                      | 0.39  | 0.16           | 0.02 | 1.48 (1.08–2.04)  |
| 55~                      | 0.36  | 0.15           | 0.01 | 1.44 (1.09–1.91)  |
| 60~                      | 0.51  | 0.15           | 0.00 | 1.66 (1.24–2.22)  |
| Waist circumference      | 0.06  | 0.01           | 0.00 | 1.06 (1.04–1.07)  |
| Hip circumference        | –0.04 | 0.01           | 0.00 | 0.96 (0.94–0.98)  |
| HBP (High Blood Pressure)| 0.39  | 0.08           | 0.00 | 1.48 (1.27–1.74)  |
| BMI                      | 0.14  | 0.02           | 0.00 | 1.15 (1.12–1.19)  |
| Blood sugar              | 0.06  | 0.02           | 0.00 | 1.06 (1.03–1.09)  |
| Heavy drink              | 2.07  | 0.08           | 0.00 | 7.90 (6.81–9.17)  |

Comparison between heavy drinkers and non-heavy drinkers according to ALD

Among the non-ALD participants, the differences between heavy and non-heavy drinkers in terms of age, waist circumference, hip circumference, BMI, systolic BP, diastolic BP, blood sugar, total cholesterol, HDL, AST and DBM were statistically significant. Among the ALD participants, the differences between heavy and non-heavy drinker in terms of only HDL and LDL were statistically significant. However, the differences in terms of age, waist circumference, hip circumference, BMI, systolic BP, diastolic BP, blood sugar, total cholesterol, AST and DBM were not statistically significant. There was found more diagnosed with high HDL and LDL among heavy drinkers than non-heavy drinkers in ALD participants (Table 5). This suggested that the liver function was affected by heavy ethanol intake, even in current drinkers who were not diagnosed with ALD. However, for ALD patients whose liver function were impaired, heavy ethanol intake did not worsen liver condition, which is in accordance with the ceiling effect. These evidences suggested that current drinkers not yet diagnosed with ALD must avoid heavy ethanol intake in order to protect their livers.

Discussion

This study is one of the largest surveys on liver health among community residents in Beijing this year. In this population-based study, alcohol consumption, the ALD prevalence and correlation of socio-economics, demographic characteristics, alcohol consumption, and viral hepatitis infection with ALD were investigated.

The proportion of lifetime abstainers, former drinkers, and current drinkers among residents older than 25 years of age were 53.53, 0.37, and 46.10% respectively. Almost half of the community residents were current drinkers, which was a considerably large number. The amount of ethanol intake in weekly drinkers was 37.18 ± 40.13 g/day, while among heavy drinkers, it reached 98.47 ± 51.77 g/day. The initial drinking age was 25.53 ± 9.47 years old. Alcohol consumption was much more frequent among men than women, and it was more frequent in rural areas than urban areas. Similar to other areas in China, men consumed more alcohol than women [22]. The reasons for high alcohol consumption in men may include more opportunities to participate in social activities and expose themselves to environments of alcohol abuse, and men don’t have a strong sense of self-protection due to traditional education, and thus increase their alcohol intake. In rural areas, people work very hard during the day, so they tend to drink more wine to relieve fatigue at night. The amount of ethanol intake in men and rural areas were also higher than in women and urban regions. Younger age, higher education level and more household income led to a higher proportion of alcohol consumption. These data reflect the relationship between alcohol consumption, geography, economics, and culture. The alcohol consumption varied among different areas and provinces. In a 2019 review [15], the percentage of regular alcohol drinkers, among general Chinese adults in different areas, was shown to be the lowest at 27% in Zhengjiang and the highest at 66.2% in Shanxi, Gansu, and Xinjiang. Compared to other cities in this review, we revealed that the alcohol consumption in Beijing was at an upper middle level. Strong spirit consumption among weekly drinkers was the highest. Strong spirit was commonly consumed by men, and their ethanol intake was also the highest. In contrast, beers were commonly consumed by women. Drinking strong spirit and more ethanol intake were more likely to lead to liver steatosis, but such correlation was not identified with liver fibrosis. Although people living in urban areas preferred strong spirits, their ethanol intake was lower than people living in rural areas. It was also found that the ethanol intake of Beijing residents in different wines (strong spirits, weak spirits, beer, rice wine and grape wine) were lower than ten other provinces in China [17].

In this study, we observed that the ALD prevalence was 1.30% among permanent residents and 7.16% among weekly drinkers. The ALD prevalence in Beijing was lower than other provinces, which was between 2.27–8.74% [8–14]. The proportion of men who consumed more than 40 g of ethanol per day or women who
consumed more than 20 g of ethanol per day to weekly drinkers was 36.28%, which meant that ethanol intake among most weekly drinkers was low, and not at an abusive level. This may be because the economy level in Beijing is high, and most people are able to detect illness in advance via physical examinations, therefore, tend to abstain from alcohol or drink less. The ALD prevalence in urban and rural areas was not statistically significant. The ALD prevalence in men was 2.75%, while in women it was 0.05%. The higher ALD prevalence in men is in accordance with other studies in China [8–14]. Meanwhile, the ALD prevalence was the highest among individuals aged between 50 and 60 years old. With rise in the participants’ age, the number of current drinks went down. However, the amount of ethanol intake increased, which may result in a higher ALD prevalence in the elderly. Such correlation is different from what was reported in foreign studies, in which the highest ALD prevalence was usually found in young residents aged between 18 and 34 years old [4]. In our study, with increasing age, the ethanol intake increased, which revealed that the young people in China typically drink alcoholic beverages containing low ethanol, such as beer. This led to a higher proportion of young people drinking alcohols, but with low ethanol intake, and therefore, failure to meet the ALD diagnostic criteria. In addition, the Chinese tradition does not encourage young people to consume alcohol. Hence, only middle-aged and older participants participate in social activities. These individuals likely have a stable family income, so they have more access to alcoholic beverages. All these factors contribute to the higher prevalence of ALD in China among individuals between 50 and 60 years old.

Several factors regulate ALD occurrence [23, 24]. In this study, gender (male), age (older than 35 years old), increased waist circumference, high blood pressure, high BMI, high blood sugar level, and being heavy drinkers were risk factors for ALD in Beijing. These risk factors for

### Table 5 Comparison of heavy drinkers versus non-heavy drinkers, according to ALD

|                  | Non-ALD | Heavy drinker | T      | Non-ALD | Heavy drinker | T      |
|------------------|---------|---------------|--------|---------|---------------|--------|
|                  | N = 10,604 | N = 2022 |       | N = 390 | N = 584 |       |
| Age              | 49.02 ± 13.64 | 53.00 ± 11.51 | t = 13.80 | P = 0.00 | 49.45 ± 11.06 | 49.45 ± 11.40 | t = 0.01 | P = 0.996 |
| Waist circumference (cm) | 89.86 ± 10.04 | 90.36 ± 9.10 | t = 2.21 | P = 0.03 | 97.43 ± 8.33 | 97.82 ± 8.13 | t = 0.73 | P = 0.46 |
| Hip circumference (cm)   | 99.49 ± 7.38 | 99.17 ± 6.73 | t = 1.99 | P = 0.047 | 103.52 ± 6.85 | 103.22 ± 6.60 | t = 0.68 | P = 0.49 |
| BMI               | 25.93 ± 3.69 | 25.63 ± 3.35 | t = 3.69 | P = 0.00 | 28.83 ± 3.05 | 28.64 ± 3.45 | t = 0.90 | P = 0.37 |
| Systolic BP (mmHg)  | 135.84 ± 20.22 | 141.17 ± 20.76 | t = 10.82 | P = 0.00 | 143.88 ± 20.83 | 143.40 ± 19.54 | t = 0.37 | P = 0.71 |
| Diastolic BP (mmHg) | 82.88 ± 12.98 | 84.58 ± 13.33 | t = 6.36 | P = 0.00 | 88.14 ± 13.48 | 88.30 ± 13.27 | t = 0.18 | P = 0.86 |
| Blood sugar (mmol/L) | 6.14 ± 1.87 | 6.32 ± 2.04 | t = 3.73 | P = 0.00 | 6.88 ± 2.32 | 6.72 ± 1.99 | t = 1.07 | P = 0.29 |
| Total cholesterol (mmol/L) | 5.14 ± 1.01 | 5.34 ± 1.07 | t = 7.89 | P = 0.00 | 5.60 ± 1.21 | 5.74 ± 1.31 | t = 1.76 | P = 0.08 |
| HDL (mmol/L)       | 1.37 ± 0.35 | 1.50 ± 0.41 | t = 13.08 | P = 0.00 | 1.31 ± 0.33 | 1.36 ± 0.37 | t = 2.49 | P = 0.01 |
| LDL (mmol/L)       | 3.05 ± 1.76 | 3.07 ± 1.91 | t = 0.42 | P = 0.67 | 3.12 ± 0.96 | 3.27 ± 0.99 | t = 2.22 | P = 0.03 |
| Triglyceride (mmol/L) | 12.20 ± 298.55 | 12.25 ± 270.17 | t = 0.01 | P = 0.995 | 3.60 ± 3.80 | 3.50 ± 3.65 | t = 0.39 | P = 0.70 |
| ALT (U/L)          | 24.80 ± 19.85 | 23.80 ± 21.84 | t = 1.90 | P = 0.06 | 39.05 ± 26.14 | 39.29 ± 28.18 | t = 0.13 | P = 0.89 |
| AST (U/L)          | 23.69 ± 13.76 | 25.89 ± 22.29 | t = 4.29 | P = 0.00 | 33.28 ± 26.09 | 34.19 ± 23.03 | t = 0.58 | P = 0.56 |
| DBM (db/m)         | 234.41 ± 37.38 | 228.75 ± 32.81 | t = 6.95 | P = 0.00 | 270.46 ± 25.99 | 270.06 ± 25.48 | t = 0.24 | P = 0.81 |
| LSM (Kpa)          | 6.86 ± 3.38 | 6.78 ± 2.97 | t = 1.08 | P = 0.28 | 8.08 ± 4.16 | 8.24 ± 4.32 | t = 0.58 | P = 0.56 |
ALD are the same as other studies [15, 23, 24]. Being a heavy drinker is a very serious risk factor for ALD and the OR is up to 7.90. For current drinkers who were not diagnosed with ALD, their liver function was impaired, heavy ethanol intake did not worsen their liver condition, which is in accordance with the ceiling effect. These evidence suggested that if alcohol intake cannot be avoided, drinking heavily should strictly be avoided.

Although this study fills the void in data on the ALD prevalence in Beijing, there are still some limitations that deserve further discussion. First, this study was only conducted in Beijing and does not cover other regions. Therefore, we can't infer the ALD prevalence in the whole country using this study. Second, this was a cross-sectional study and it lacks effective follow-ups to observe the health condition of residents. Causal relationship cannot be examined based on cross-sectional data. Third, a major limitation of all alcohol epidemiology is that the exposure is uncertain. The main reason is recall bias. Drinking patterns are variable, and intake may be substantially underperceived or underreported. Despite these limitations, the sample size of this study was considerably large, and could fill the void of alcohol usage and ALD prevalence in Beijing.

**Conclusions**

The level of alcohol consumption in Beijing was at an upper middle level compared with other cities or regions in China. There is a higher proportion of alcohol drinkers in male residents, people living in rural areas, younger people, people who have received higher education, and people with higher income. Strong spirits are commonly consumed by men, while beers are commonly consumed by women. Strong spirit and heavy ethanol intake are more likely to lead to liver steatosis. Although half of the residents are current drinkers, the prevalence of ALD is at a low level, because the amount of ethanol intake are not high in Beijing. There is a higher prevalence of ALD in men and in individuals aged from 50 to 60 years old. Being a heavy drinker is a major risk factor for ALD and should be avoided. If alcohol consumption is unavoidable, we caution against heavy drinking.

**Abbreviations**

AUD: Alcohol use disorder; ALD: Alcoholic liver disease; NAFLD: Nonalcoholic fatty liver disease; HBV: Hepatitis B virus; HCV: Hepatitis C virus; WHO: World Health Organization; DALY’s: Disability-adjusted life years; HIV: Human immunodeficiency virus; AIDS: Acquired Immune Deficiency Syndrome; HSR: Hospitalization summary report; OR: Odd ratios.

**Acknowledgements**

We acknowledge all the residents who took part in the study and all the personnel from the Beijing Center Disease Control and Prevention, District Center for Disease Control and Prevention who took part in collection of samples. We acknowledge Hui Li and Li Wang from Chinese Academy of Medical Sciences and Peking Union Medical College to give valuable advice to this paper.

**Authors’ contributions**

HW and JW had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. HW designed the study, performed data extraction and analysis, and drafted the manuscript. PG was responsible for Fibrotouch tests. WC was responsible for the hepatitis B and hepatitis C experiments. SB was responsible for liver function tests and routine blood tests. QY and ML participated in the data analysis and revision of the paper. JW critically reviewed and edited the manuscript. All the authors approved the final version of the manuscript.

**Funding**

This work was funded by Beijing Municipal Science & Technology Commission, D171100003117001. Beijing Municipal Science & Technology Commission supported sample collection, laboratory test and data analysis.

**Availability of data and materials**

The data sets used and/or analyzed for the current study are available from the corresponding author upon reasonable request.

**Declarations**

**Ethics approval and consent to participate**

The study was approved by the medical ethics committee in Beijing Centers for Disease Control and Prevention (CDC) in 2017. Written informed consent was obtained from each participant. The procedure of the study was in accordance with the Good Clinical Practice Guidelines and the ethical standards of the Helsinki Declaration.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

**Received: 17 August 2021   Accepted: 5 April 2022**

**Published online: 12 April 2022**

**References**

1. Wang H, Men P, Xiao Y, et al. Hepatitis B infection in the general population of China: a systematic review and meta-analysis. BMC Infect Dis. 2019;19:811.
2. Wong MCS, Huang JLW, George J, Huang J, Leung C, Eslam M, et al. The changing epidemiology of liver diseases in the Asia-Pacific region. Nat Rev Gastroenterol Hepatol. 2019;16:57–73.
3. Global status report on alcohol and health 2018. https://www.who.int/substance_abuse/publications/global_alcohol_report/gsr_2018/en/
4. Wang H, Ma L, Yin Q, Zhang X, Zhang C. Prevalence of alcoholic liver disease and its association with socioeconomic status in north-eastern China. Alcohol Clin Exp Res. 2014;38(4):1035–41.
5. Bao XY, Xu BB, Fang K, Li Y, Hu YH, Yu GP. Changing trends of hospitalization of liver cirrhosis in Beijing, China. BMJ Open Gastroenterol. 2015;2:e000051.
6. Huang A, Chang B, Sun Y, Lin H, Li B, Teng G, et al. Disease spectrum of alcoholic liver disease in Beijing 302 hospital from 2002 to 2013: a large tertiary referral hospital experience from 7422 patients. Medicine (Baltimore). 2017;96:e6163.
7. Liu Y, Zhou LY, Meng XW. Genetic polymorphism of two enzymes with alcoholic liver disease in Northeast China. Hepatogastroenterology. 2012;59:204–7.
8. Li YM, Chen WX, Yu CH, Yue M, Liu YS, Xu GY, et al. An epidemiological survey of alcoholic liver disease in Zhejiang province. Zhonghua Gan Zang Bing Za Zhi. 2003;3:647–9.
9. Lu XJTM, Luo JY, Zhao P, Zhao HL. Epidemiology of alcoholic liver diseases in Xi’an. World Chin J Dig. 2005;6:719–22.
10. Huang SL, Dai SQ, Zhang XH, Yu YJ, Tan ML, Yi CG. Epidemiological survey of alcoholic liver disease in Hui‘nan province. Zhongguo Yishi Zazhi. 2005;7:426–7.
11. Chen SL, Meng XD, Wang BY, Xiang GQ. An epidemiologic survey of alcoholic liver disease in some cities of Liaoning Province. Shiyong Gan-zangbing Zazhi. 2010;13:428–30.
12. Yan H, Lu X, Gao Y, Luo J. Epidemiological investigation of fatty liver disease in Northwest China. Zhonghua Gan Zang Bing Za Zhi. 2015;23:622–7.
13. Guo SQ, Liu T, Sun LX, Li L, Liu D, Zhou J. Research on status of alcohol consumption among adult residents in Guizhou Province. Xianda Yufang Yixue. 2016;43:653–62.
14. Chang G, Wand P, Jing LJ, Xin P, Wang M, Juan LJ, et al. Investigation of drinking status in residents (≥ 15 years old) of urban and rural areas in Tianjin. Zhongguo Manxingbing Yufang Yu Kongzhi. 2016;24:493–501.
15. Wang W, Xiao P, Hongqin X, Niu J, Gao Y. Growing burden of alcoholic liver disease in China: a review. World J Gastroenterol. 2019;25(12):1445–56.
16. Lee YH, Wang Z, Chiang TC, Liu CT. Beverage intake, smoking behavior, and alcohol consumption in contemporary China—a cross-sectional analysis from the 2011 China health and nutrition survey. Int J Environ Res Public Health. 2017;14:493.
17. Millwood IY, Li L, Smith M, Guo Y, Yang L, Bian Z, et al. Alcohol consumption in 0.5 million people from 10 diverse regions of China: prevalence, patterns and socio-demographic and health-related correlates. Int J Epidemiol. 2013;42:816–27.
18. Xiang Y, Ma X, Lu J, Cai Z, Li S, Xiang Y, et al. Alcohol-related disorders in Beijing, China: prevalence, socio-demographic correlates, and unmet need for treatment. Alcohol Clin Exp Res. 2009;33(6):1111–8.
19. Xiaolan L, Jiwen L, Ming T, Yan G, Ping Z, Hongli Z, et al. Risk factors for alcoholic liver disease in China. World J Gastroenterol. 2004;10(16):2423–6.
20. World Health Organization (WHO). International guide for monitoring alcohol consumption and related harm. Geneva: WHO; 2000. https://apps.who.int/iris/bitstream/handle/10665/66529/WHO_MSD_MSB_00.4.pdf;jsessionid=3B86658E54BF08103BAACC1366EA806D.
21. National Workshop on Fatty Liver and Alcoholic Liver Disease, Chinese Society of Hepatology Chinese Medical Association, Fatty Liver Expert Committee, Chinese medical Doctor Association. Guidelines of prevention and treatment for alcoholic liver disease: a 2018 update. 2018; 34(5):939–946.
22. Millwood IY, Walters RG, Mei XW, Guo Y, Yang L, Bian Z, et al. Conventional and genetic evidence on alcohol and vascular disease aetiology: a prospective study of 500 000 men and women in China. Lancet. 2019;393:1831–42.
23. Kamper-Jorgensen M, Gronbaek M, Tolstrup J, Becker U. Alcohol and cirrhosis: dose—response or threshold effect? J Hepatol. 2004;41:25–30.
24. Gao B, Bataller R. Alcoholic liver disease: pathogenesis and new therapeutic targets. Gastroenterology. 2011;141:572–85.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.