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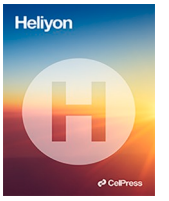

Research article

Impacts of alcohol consumption on farmers' mental health: Insights from rural China

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ABSTRACT

The global mental health crisis presents a significant challenge to sustainable development, and this crisis is more pronounced in China's rural areas versus urban areas. Alcohol consumption has increased in rural areas with China's economic growth, but the number of studies on the relationship between farmers' alcohol consumption and their mental health is limited. Based on data from the China Labor Force Dynamics Survey (CLDS), this study uses the endogenous switching regression model (ESR) to analyze the influence of alcohol consumption on farmers' mental health. On this basis, the study further conducts a counterfactual analysis to estimate the average treatment effect of alcohol consumption on farmers' mental health. The results show that: (1) There is a significant positive relationship between alcohol consumption and farmers' mental health. Specifically, the mental health index of drinking farmers increases by 19.7 % compared to non-drinking farmers. (2) Heterogeneity analysis shows that alcohol consumption is more beneficial for improving the mental health of male farmers, elderly farmers, and employed farmers. Furthermore, drinking alcohol almost every day, consuming Baijiu, and each drinking consumption ranging from 0 to 100 mL per occasion are more conducive to improving farmers' mental health. These findings have implications for relieving depressive symptomology and improving farmers' mental health in developing countries. The results of this study also provide guidance for addressing the global mental health crisis.

1. Introduction

The global mental health crisis presents a challenge to sustainable development [1]. During the COVID-19 pandemic, the world has experienced varying degrees of fear, anxiety, and depression, significantly impacting people's mental health [2]. In the context of the global COVID-19 pandemic, more than 70 million people have been newly diagnosed with depression and 90 million with anxiety [3]. The World Mental Health Report, released by the World Health Organization in 2022, indicates that nearly 1 billion individuals globally are affected by mental disorders, with depression (280 million) and anxiety disorders (301 million) comprising the largest groups [4]. It is estimated that by 2030, depression will surpass all other diseases and become the leading contributor to the global burden of disease [5]. However, 71 % of people with mental illness worldwide lack access to mental health services, with only 12 % of those residing in low-income countries having access to mental health care services [4]. The presence of mental illness can significantly

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impact an individual's physical health and longevity. Compared to the general population, people with depression have nearly twice the risk of death [6]. Research indicates that individuals with severe mental health disorders die, on average, 15–20 years earlier than the general population [7]. Simultaneously, the presence of mental illnesses, such as depression and anxiety, profoundly affects individuals' functioning and quality of life. Corrigan and Watson [8] highlight the social stigma faced by people with mental illness, while Corbiere et al. [9] suggest that individuals with mental illness are more likely to experience physical and emotional abuse, as well as limited access to education and employment opportunities. Moreover, Jacquet et al. [10] observe that disparities in healthcare and treatment persist among individuals with mental illness. Unfortunately, the existence of mental health issues has resulted in increased economic and social costs, impeding development in numerous countries [11]. According to the World Mental Health Report (2022), depression and anxiety have caused approximately US $1 trillion in losses to the global economy [4]. Therefore, mitigating the burden of mental illness has become a crucial inquiry for scholars worldwide.

Alcohol consumption occurs globally. Alcohol plays an important role as a social lubricant and is closely associated with various celebrational, commercial, social, and sporting events [12]. People consume alcohol in moments of joy and sorrow, as well as during ceremonial events like coming-of-age ceremonies, weddings, and in remembrance of their ancestors. Consequently, individuals' alcohol consumption reflects the historical, cultural, religious, lifestyle, and ethnic attributes of their respective countries [13]. Alcohol, as a tangible medium, is intricately linked with people's lives, emotions, and spirits. Numerous countries have cultivated distinctive characteristics of alcohol and drinking cultures [14,15]. For example, France is a world-famous wine-producing country, and its history of wine production can be traced back to approximately 600 BCE [16]. Wine culture not only reflects the French people's pursuit of an enhanced quality of life but is also an inseparable part of French civilization and culture [17]. Germans rank as the world's foremost beer consumer, with the country additionally holding the position of the second-largest beer producer globally [18]. Germany's extensive beer history, alongside its diverse beer-brewing methods, has cultivated its distinctive beer culture [19]. Vodka production dates back to the 15th century, accompanying the Russian people through the reign of the Tsar, the October Revolution, the Great Patriotic War, and the collapse of the Soviet Union, essentially witnessing Russian history unfold. For thousands of years, vodka has been integral to Russian culture, shaping its societal development and history [20]. As the birthplace of alcohol, China has a long history. Baijiu, commonly referred to as China's national liquor, is a renowned distilled spirit with a production history spanning over 2000 years [21]. As a unique product of China, Baijiu aligns with the trajectory of Chinese civilization and, thus, has a lofty status in the country [14]. It can be seen that, whether in the West or the East, alcohol is beloved by people worldwide and has gradually become a medium of material, spiritual and cultural exchange between countries.

Previous research has investigated the health effects of alcohol consumption [22,23]. Currently, there is a consensus on the relationship between alcohol consumption and physical health. Studies have indicated that heavy alcohol consumption and binge drinking are significant contributors to global mortality [24]. Heavy alcohol consumption is causally associated with various cancers, including oral cancer, esophageal cancer, colon cancer, and liver cancer, contributing to a total of 6.3 million cases and 3.3 million deaths worldwide in 2020 [25]. In addition, drinking heavily is associated with cardiovascular disease [26], hypertension [27], cirrhosis [28], kidney failure [29], and various other adverse health outcomes. Although the adverse effects of heavy drinking on health are well-documented, the findings linking moderate alcohol consumption to health benefits still exist. Some studies have demonstrated that moderate alcohol consumption, typically defined as one to two drinks per day, is associated with a reduced risk of coronary artery disease [30]. Regular light to moderate alcohol consumption has been associated with a significant 30 %–40 % reduction in the risk of type 2 diabetes mellitus (T2D) [31]. Moderate alcohol consumption has been linked with a 10 %–20 % decrease in the risk of heart failure (HF) [32]. Moreover, moderate drinking is related to reducing the risk of stroke and mortality rate [33].

However, there is no consensus on the relationship between alcohol consumption and mental health [34]. On the one hand, some studies have shown that heavy drinking can impair the nervous system, resulting in cognitive dysfunction, including memory and attention deficits [35,36]. Simultaneously, alcohol consumption is closely associated with the prevalence of depression [37]. In particular, long-term heavy drinking can have serious emotional impacts and adverse consequences, including intentional self-harm and even suicide [38]. On the other hand, studies have also found that alcohol consumption may alleviate stress [39], and moderate drinking could mitigate the risk of mental health disorders [40]. Compared with non-drinkers, drinkers exhibit fewer symptoms of depression and report higher subjective happiness levels [41].

The divergences in the above-mentioned research stem from differences in research areas, groups, and methods. First, in terms of research on the relationship between alcohol consumption and mental health, Yörük and Yörük [42] examine this relationship in the United States, Sourander et al. [43] explore it in Finland, and Stanton et al. [44] focus on Australia, all of which are economically developed countries. Second, concerning research groups, most of the available literature targets specific groups, including college students [45], the elderly [46], urban residents [47], and civil servants [23], when investigating the association between alcohol consumption and mental health. Third, regarding research methodologies employed in examining this relationship, Jacob et al. [48] use the logit model; Zhu et al. [49] adopt two-stage least squares (2SLS); Petrie et al. [50] use the ordered probit model; and St. John et al. [51] employ the difference test.

In summary, compared to existing studies, this study's marginal contribution is reflected in the following three aspects: (1) The research area is the first, as previous studies [48,52] have mainly focused on developed countries such as the United States, the United Kingdom, and Australia, with few focusing on developing countries. More than 80 % of people with mental disorders in the world live in developing countries [53], and developing countries are suffering from serious mental illness challenges due to a lack of mental health facilities [54]. Therefore, China, the largest developing country in the world, is chosen as the research area for the current study. (2) The research group constitutes the second, where existing studies [55] have predominantly focused on the mental health of teenagers, the elderly, urban residents, and other demographic groups. Only a limited number of studies have investigated the mental health of rural residents. Over the past 20 years, suicide rates in rural areas have surpassed those in urban areas. Hirsch and Cukrowicz

[56] show that the incidence of suicide in rural versus urban areas is much higher, especially in China, where the suicide rate in rural areas was nearly three times higher than that in the country's urban areas. Therefore, this study focuses on the mental health of rural residents, given the pronounced mental health challenges faced by rural communities. (3) For research methods, existing studies have predominantly selected logit, probit, and different tests to discuss the relationship between individuals' alcohol consumption and their mental health. However, farmers' alcohol consumption behavior is the result of self-selection, and the methods mentioned above fail to consider the impact of selection bias on the estimation results, leading to a deviation from the real-life situation [57]. Therefore, the current study introduces the endogenous switching regression model to eliminate selection bias about alcohol consumption.

The remainder of this paper is structured as follows: Section 2 describes the data sources, models, and variable settings used in the study; Section 3, titled "Results Analysis," presents and analyzes the empirical findings; Section 4 is a "Discussion" section that further discusses the results and limitations of this paper; Section 5 is devoted to "Conclusions and recommendations."

2. Materials, methods, and variables

2.1. Materials

The data used in this study was collected from the 2016 China Labor Force Dynamic Survey (http://css.sysu.edu.cn/), a large-scale and nationally representative labor force dynamic tracking survey designed and implemented by the Social Science Survey Center of Sun Yat-sen University. It includes questionnaires at three levels, individual, family, and community, and covers population, the economy, social and psychological factors, health, and other areas. The survey adopted a multi-stage and multi-level probability sampling method proportional to the size of the labor force, covering 29 provinces and cities in China (except Hong Kong, Macao, Taiwan, Tibet, and Hainan), with a total of 401 village community questionnaires, 14,226 family questionnaires, and 21,086 questionnaires for individual labor force aged 15 to 64. The sample has strong representability and applicability. During the data analysis, the original data underwent the following processes: (1) Merging data from individuals, families, and villages; (2) Focusing on the rural population, only samples of rural residents are retained; (3) Since the legal drinking age in China is 18 years old, only sample data of individuals over 18 years old are kept; (4) Excluding individuals with missing values and abnormalities. After implementing these screening measures, 12,236 valid samples were obtained.

2.2. Methods

This study explores the impact of alcohol consumption on farmers' mental health, particularly given farmers' decision to drink or not is a self-selection problem rather than a random one [58]. Ma and Abdulai [59], Dhakal et al. [60], and Jena et al. [61] have illustrated that failure to account for selection bias when evaluating behavioral outcomes may result in erroneous estimates. Essentially, accurately estimating the impact of alcohol consumption on farmers' mental health is unattainable without accounting for farmers' voluntary choice in drinking behavior. Moreover, studies by Shahzad and Abdulai [62] and Xiao et al. [58] suggest that selection bias may stem from both observable and unobservable factors, including farmers' personal preferences, personality traits, social environment, and other variables. These selection outcomes and unobservable variables may introduce bias issues, and failure to address this selection bias could result in inconsistent estimated results [63]. To address this problem, existing studies often employ the propensity score matching method (PSM) [64], instrumental variable method (IV) [65], two-part model [66], and Heckman selection model [67] to mitigate such biases. However, each of these methods has limitations. While the PSM model can mitigate self-selection bias resulting from observable variables, it is unable to address the endogeneity issue stemming from unobservable factors [68]. Similarly, while the IV method can reduce estimation bias caused by missing variables, it fails to consider the heterogeneity of treatment effects between experimental and control groups [69]. Furthermore, although the two-part model addresses the selection bias problem, it assumes no correlation between the selection and outcome equations, thereby disregarding the underlying endogeneity relationship and potentially yielding biased estimates [70]. The Heckman model tends to impose a functional form assumption, assuming only the intercept shifts and not the slope in the outcome variable after the farmer chooses to consume alcohol [71]. The endogenous switching regression (ESR) model, initially proposed by Lee [72], extends the Heckman treatment model to correct selection bias and is commonly employed to mitigate self-selection bias in empirical analysis [73]. To avoid this problem, the current study uses the ESR model to analyze the impact of alcohol consumption on farmers' mental health. Additionally, a counterfactual analysis is conducted to estimate the average treatment effect of alcohol consumption on farmers' mental health. This research method offers several advantages: (1) It considers the influence of both observable and unobservable factors when addressing self-selection and endogeneity issues in farmers' drinking decision-making; (2) It enables the estimation of the influencing factors' equations for the mental health status of both drinking and non-drinking farmers groups separately, facilitating a more comprehensive analysis of various factors' effects; (3) It employs the full information maximum likelihood estimation method to better avoid the problem of omitting effective information; (4) It enables counterfactual analysis.

The ESR model is estimated in two stages, and the specific implementation process is outlined as follows.

In the first stage, the decision equation regarding whether farmers consume alcohol is as follows:

$$Drinking_i^* = \eta Z_i + \mu_i, Drinking_i = \begin{cases} 1, Drinking_i^* > 0 \\ 0, Drinking_i^* \leq 0 \end{cases} \quad (1)$$

Where $Drinking_i^*$ denotes the probability of drinking by farmers, which is equivalent to the latent variable of the dummy variable

$Drinking_i$, where "$Drinking_i = 1$" indicates that farmers consume alcohol, and "$Drinking_i = 0$" indicates that farmers do not consume alcohol. Z_i represents the feature vector influencing farmers' alcohol consumption, and η is the parameter vector to be estimated. Additionally, μ_i is the random error term.

To further assess the impact of alcohol consumption on farmers' mental health, this study formulates the effect model of alcohol consumption on mental health among farmers, as presented in Equation (2):

$$Mental_i = \beta_i X_i + \delta_i Drinking_i + \varepsilon_i \tag{2}$$

Where $Mental_i$ represents the effect of farmers' mental health. X_i presents the control variables affecting the mental health status of farmers, such as their age, gender, and education level (among others). β_i and δ_i represent the coefficient to be estimated of the corresponding variable. ε_i is a random error term. Considering that farmers' decision to drink or not is influenced by unobservable factors that are related to the outcome variable, there may exist a correlation between alcohol consumption ($Drinking_i$) and the outcome variable ($Mental_i$) in Equation (2). Therefore, directly estimating Equation (2) may introduce estimation bias due to the issue of sample self-selection.

The model expressions for the health effects of farmers who consume alcohol and those who do not are as follows:

$$Mental_{ia} = \beta_a X_a + \sigma_{\mu a}\lambda_{ia} + \varepsilon_{ia}, \quad if \quad Drinking_i = 1 \tag{3}$$

$$Mental_{in} = \beta_n X_{in} + \sigma_{\mu n}\lambda_{in} + \varepsilon_{in}, \quad if \quad Drinking_i = 0 \tag{4}$$

Where $Mental_{ia}$ and $Mental_{in}$ represent the mental health status of farmers with and without alcohol consumption, respectively. X_i represents the control variables affecting the mental health status of farmers, such as their age, gender, and education level (among others). ε_i is the random error term. To address the issue of sample selectivity bias caused by unobservable factors, this study introduces the inverse Mills ratio (IMR), denoted as λ_{ia} and λ_{in}, along with their covariances $\sigma_{\mu a} = \mathrm{cov}(\mu_i, \varepsilon_{ia})$ and $\sigma_{\mu n} = \mathrm{cov}(\mu_i, \varepsilon_{in})$. Equations (1), (3) and (4) are estimated simultaneously, incorporating these variables. It is worth noting that the explanatory variables in Z_i can overlap with X_i to some extent, but for effective identification, there should be at least one instrumental variable in Z_i that is not included in X_i. This variable should directly impact farmers' alcohol consumption but not their mental health status. According to the peer effect theory, peer behavior plays an important role in individual behavior [74]. Therefore, referring to the studies of Deng et al. [75] and Ma et al. [76], the instrumental variable of regular alcohol consumption can be defined as the proportion of other family members' alcohol consumption, excluding the individual under consideration ($n-1$). The expression is shown in equation (5).

$$Peer'habit = \frac{Number}{Total - 1} \tag{5}$$

$Peer'habit$ is the instrumental variable. Here, "number" represents the count of individuals in the same family who drink regularly, while "total" represents the total number of people in the family.

Finally, based on the estimation results of the ESR model, the Average Treatment Effect on the Treated (ATT) of alcohol consumption on farmers' mental health can be shown in equation (6).

$$ATT = E(Mental_{ia}|Drinking_i = 1) - E(Mental_{in} \mid Drinking_i = 1) = X_{ia}(\beta_a - \beta_n) + \lambda_{ia}(\sigma_{\mu a} - \sigma_{\mu n}) \tag{6}$$

Table 1
Evaluation index system of the mental health status of rural residents.

Indicators	Definition	Attributes	Mean	S.D.	Weights
index1	I was bothered by things that usually don't bother me.	-	1.557	0.748	0.053
index2	I did not feel like eating; my appetite was poor.	-	1.542	0.760	0.053
index3	I felt that I could not shake off the blues, even with help from my family or friends.	-	1.364	0.637	0.049
index4	I felt I was just as good as other people.	-	1.482	0.748	0.053
index5	I had trouble keeping my mind on what I was doing.	-	1.415	0.666	0.049
index6	I felt depressed.	-	1.496	0.704	0.051
index7	I felt it hard to do anything.	-	1.544	0.791	0.055
index8	I felt hopeless about the future.	-	1.378	0.704	0.051
index9	I thought my life had been a failure.	-	1.345	0.669	0.050
index10	I felt fearful.	-	1.261	0.568	0.047
index11	My sleep was restless.	-	1.651	0.885	0.060
index12	I was unhappy.	-	1.490	0.705	0.051
index13	I talked less than usual.	-	1.385	0.655	0.049
index14	I felt lonely.	-	1.328	0.649	0.049
index15	People were unfriendly.	-	1.271	0.560	0.047
index16	I thought life was not interesting.	-	1.274	0.598	0.048
index17	I had crying spells.	-	1.216	0.506	0.045
index18	I felt sad.	-	1.416	0.690	0.050
index19	I felt that people disliked me.	-	1.237	0.531	0.046
index20	I could not get going.	-	1.196	0.509	0.046

2.3. Variables

2.3.1. Dependent variable

The explanatory variable in the current study is farmers' mental health. It is assessed using the 20-item CES-D scale. In the individual questionnaire, respondents are asked about the frequency of experiencing certain emotions in the past week (see Table 1). The response categories range from 1 to 4, including "almost none" (1), "rarely" (2), "often" (3), and "all the time" (4). To comprehensively measure the mental health of rural residents, the entropy weight method, as described in equations (6)–(12) in Appendix A and based on the studies by He et al. [77], is utilized to calculate a mental health index ranging from 0 to 10. A higher calculated value indicates a better mental health status among farmers. The definitions and weights of the indicators are provided in Table 1.

2.3.2. Focus variables

The current study primarily investigates whether alcohol consumption has a positive impact on farmers' mental health. Therefore, whether farmers consume alcohol is the main explanatory variable in this study. The study used the following question from the CLDS (2016) survey: "Do you have a drinking habit (at least once a week)?" to determine whether farmers consume alcohol. Responses indicating "yes" were coded as "1″, while those indicating "no" were coded as "0". Those who answered in the affirmative were then asked about the frequency of their consumption, the type of alcohol, and the amount of drinking.

2.3.3. Control variables

Existing studies have shown that many factors influence farmers' mental health. To eliminate the estimation bias caused by variable omission, this article consulted the existing literature [42,48], combined it with the actual situation in rural China, and controlled the relevant variables from three perspectives: farmers' individual characteristics, family characteristics, and the external environment. Specifically, drawing upon the research of Wang et al. [78] and Ji et al. [79], this study controlled for farmers' personal characteristics, including age, gender, education level, marital status, employment status, insurance coverage, and physical health status. Based on the research of Liu et al. [80], Zhang et al. [81], and Qin et al. [82], household characteristic variables were controlled, including household income, participation in agricultural production, presence of an indoor toilet, availability of kitchen ventilation, and use of clean energy for cooking. At the same time, community environment variables include indicators such as the presence of a village hospital, village facilities, and the geographical terrain of the respondent's village [83]. Definitions and descriptive statistics for each variable are detailed in Table 2.

3. Results analysis

3.1. Mean difference between drinking and non-drinking farmers

The mean difference between drinking and non-drinking farmers allows for the identification in this study of systematic differences between farmers in terms of their alcohol consumption. Table 3 shows the mean difference of each variable between drinking and non-drinking farmers (1 = drinking habit; 0 = otherwise). Specifically, in terms of personal characteristics, farmers who consumed alcohol exhibited higher average age (significant at the 1 % level), a higher proportion of males (significant at the 1 % level), a higher proportion of those who were employed (significant at the 1 % level), a higher proportion of those who were married (significant at the 1 % level), and a higher proportion of farmers in good health (significant at the 1 % level) compared to non-drinking farmers. From the perspective of household characteristics, compared with non-drinking farmers, the household income of drinking farmers was higher

Table 2
Definitions and data description of the variables in the model.

Variables	Definition	Mean	S.D.
Mental health	The score of farmers' mental health index calculated by entropy weight method (0-10)	8.654	1.606
Drinking habit	1 If the individual farmer has a drinking habit; 0 otherwise	0.205	0.404
Individual age	The age of individual farmer	46.749	14.520
Individual gender	1 If the gender of the individual farmer is male; 0 otherwise	0.481	0.500
Individual education	1 If the individual farmer has a high school diploma or above; 0 otherwise	0.171	0.376
Individual marriage	1 If the individual farmer is already married; 0 otherwise	0.854	0.354
Individual insurance	1 If the individual farmer has medical insurance; 0 otherwise	0.146	0.353
Individual job	1 If the individual farmer has a job; 0 otherwise	0.687	0.464
Individual Health	1 If the individual farmer has good physical health; 0 otherwise	0.537	0.499
Household income	The total income of a farmer household (10^4 Yuan)	4.758	7.144
Household agriculture	1 If the farmer household is engaged in agriculture; 0 otherwise	0.650	0.477
Household toilet	1 If the farmer's household has an indoor toilet; 0 otherwise	0.459	0.498
Household ventilator	1 If the farmer's household has the ventilator in the kitchen; 0 otherwise	0.315	0.465
Household energy	1 If the farmer household uses clean energy in cooking; 0 otherwise	0.415	0.493
Village hospital	1 If there is a hospital in the village; 0 otherwise	0.808	0.394
Village facility	1 If there are sports facilities in the village; 0 otherwise	0.489	0.500
Village terrain1	1 If the village is located on the plain; 0 otherwise	0.478	0.500
Village terrain2	1 If the village is located on the hill; 0 otherwise	0.251	0.434
Village terrain3	1 If the village is located in a mountainous area; 0 otherwise	0.265	0.441

Table 3
The mean difference between the not drinking habit group and the drinking habit group.

Variables	Not drinking habit group (Observations = 9748)	Drinking habit group (Observations = 2515)	Mean Diff.
Mental health	8.609	8.830	−0.221***
Individual age	45.973	49.754	−3.781***
Individual gender	0.372	0.901	−0.529***
Individual education	0.170	0.174	−0.004
Individual marriage	0.847	0.880	−0.033***
Individual insurance	0.143	0.154	−0.011
Individual job	0.651	0.824	−0.173***
Individual health	0.530	0.563	−0.033***
Household income	4.685	5.011	−0.326**
Household agriculture	0.642	0.679	−0.036***
Household toilet	0.450	0.496	−0.047***
Household ventilator	0.313	0.323	−0.010
Household energy	0.415	0.413	0.003
Village hospital	0.812	0.794	0.018**
Village facility	0.487	0.495	−0.008

Note: t statistics in parentheses; *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

(significant at the 5 % level), the proportion of household participation in agricultural production was larger (significant at the 1 % level), and the proportion of households with an indoor toilet was larger (significant at the 1 % level). Particularly, based on the measured mental health scores, drinking farmers exhibited a comprehensive mental health score of 8.830, which was 22.1 % higher than that of non-drinking farmers (8.609) (significant at the 1 % level). Therefore, consuming alcohol may potentially be beneficial for improving farmers' mental health.

3.2. Determinants of farmers' alcohol consumption and mental health

Column (2) of Table 4 shows the results of the estimating factors affecting farmers' alcohol consumption, and Column (3) and Column (4), respectively, correspond with the estimation results of the influencing factors of mental health among drinking farmers and non-drinking farmers. The Wald test rejects the null hypothesis of independence between the selection equation and outcome equation at the statistical level of 1 %. The values of rho1 and rho0 are significant at the statistical level of 10 % and 5 %, respectively, exhibiting negative coefficients. This indicates the presence of negative selection bias, suggesting that disregarding the selection bias in sampled farmers may result in an underestimation of the impact of alcohol consumption on their mental health [84].

(1) Determinants of farmers' alcohol consumption behavior

According to column (2) of Tables 4 and it can be observed that farmers' age, gender, marital status, employment status, physical health condition, and household income significantly influence farmers' alcohol consumption behavior. Specifically, farmers' age exhibits a positive and significant effect on alcohol consumption at the 1 % significance level, suggesting an increased propensity for alcohol consumption with age. The reason is that with the increase in age, farmers may face more life pressures such as retirement, financial issues, family problems, etc., and they may resort to alcohol consumption to alleviate these pressures and anxieties [85]. Gender also significantly affects alcohol consumption behavior at the 1 % significance level, with males tending to consume more alcohol compared to females, which is consistent with the existing research results [86]. This inclination may stem from traditional gender norms that generally perceive women as less accepting of alcohol than men, viewing alcohol use and alcoholism as conflicting with traditional feminine ideals [87]. Marital status is significant at the 1 % level with a positive coefficient, suggesting that married farmers are more likely to consume alcohol than unmarried farmers, contradicting the findings of Single et al. [88], Horwitz and White [89]. This trend may be attributed to the increased social responsibilities and pressures experienced by married individuals, including family obligations, household division of labor, and potential family conflicts. Drinking alcohol can relieve stress and negative emotions, thereby increasing the tendency of married farmers to drink alcohol compared to unmarried farmers. Employment status significantly influences alcohol consumption among farmers at the 1 % significance level, indicating that employed farmers are more likely to consume alcohol. This finding contrasts with some existing results [90]. Potential explanations include the higher disposable incomes of employed farmers, enabling them to afford more alcohol compared to their unemployed counterparts. Additionally, employed farmers may experience more significant work-related stress, leading to a heightened need to alleviate such stress through alcohol consumption. Farmers' health status is significant at the 10 % level, with a positive coefficient, suggesting that farmers with good health status tend to consume more alcohol than those with poor health status, contradicting previous research by Brennan et al. [91], Moos and Moos [92]. One possible explanation is that farmers in good health are more socially active within their rural communities, leading to increased participation in alcohol consumption. Conversely, farmers in poor health may be constrained by medical advice or their health conditions, resulting in lower levels of alcohol consumption. Furthermore, household income status positively influences farmers' alcohol consumption behavior at the 10 % significance level. In other words, higher household incomes are associated with a higher probability of alcohol consumption among farmers. This may be attributed to individuals with higher incomes being more engaged in social activities, where drinking is often considered a socializing component.

Table 4
The estimates for determinants of drinking habit and mental health.

		Mental health	
	Drinking habit	Drinking habit = 0	Drinking habit = 1
Individual age	0.006***	−0.003*	0.005*
	(3.572)	(-2.005)	(2.141)
Individual gender	2.281***	0.197***	0.257*
	(39.124)	(5.385)	(2.197)
Individual education	−0.021	0.098*	0.080
	(-0.388)	(2.010)	(1.044)
Individual marriage	0.360***	0.209***	0.104
	(5.591)	(4.011)	(1.157)
Individual insurance	−0.061	0.116*	−0.070
	(-1.106)	(2.422)	(-0.888)
Individual job	0.276***	0.156***	0.257**
	(5.658)	(4.294)	(3.014)
Individual health	0.085*	0.913***	0.257***
	(2.102)	(26.677)	(11.990)
Household income	0.005*	0.008**	0.002
	(2.063)	(3.179)	(0.535)
Household agriculture	0.022	0.021	0.010
	(0.481)	(0.566)	(0.151)
Household toilet	0.037	0.194***	0.188*
	(0.694)	(4.226)	(2.474)
Household ventilator	0.020	0.142***	0.119
	(0.437)	(3.629)	(1.765)
Household energy	−0.016	0.105**	0.123
	(-0.351)	(2.829)	(1.918)
Village hospital	−0.094	0.002	−0.110
	(-1.858)	(0.039)	(-1.536)
Village facility	−0.001	−0.146***	−0.155*
	(-0.032)	(-3.893)	(-2.439)
Village terrain2	0.018	0.080	−0.031
	(0.362)	(1.934)	(-0.437)
Village terrain3	−0.028	−0.022	−0.135
	(-0.491)	(-0.461)	(-1.643)
Peer habit	4.525***		
	(48.358)		
Constant	−5.070***	7.823***	8.087***
	(-19.385)	(57.085)	(17.027)
Province dummies	Yes	Yes	Yes
lns0		0.432***	
		(60.131)	
rho0		−0.102**	
		(-2.727)	
lns1			0.289***
			(20.320)
rho1			−0.096*
			(-1.969)
Wald chi2(42)	1372.688		
Log pseudolikelihood	−53430.161		
Observations	12,263		

Note: t statistics in parentheses; *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

(2) Determinants of farmers' mental health

From the results presented in Table 4 (3) and (4), it is evident that farmers' age, gender, employment status, physical health condition, installation of indoor toilets, and village facilities significantly influence the mental health status of both non-drinking and drinking farmers. Specifically, farmers' age significantly impacts the mental health of both non-drinking and drinking farmers at a 10 % significance level. The coefficients are −0.003 and 0.005, respectively, indicating a 0.3 % decrease in the mental health index of non-drinking farmers with age, while for drinking farmers, the mental health index increases with age. This finding is consistent with existing research [93], suggesting that alcohol consumption among the elderly may enhance cognitive levels and well-being [36]. Gender significantly influences the mental health status of both non-drinking farmers (significant at the 1 % statistical level) and drinking farmers (significant at the 10 % statistical level). The coefficients are 0.197 and 0.257 for non-drinking and drinking farmers, respectively, indicating a 25.7 % increase in the mental health index of male farmers after drinking, surpassing that of non-drinking farmers. This could be attributed to traditional Chinese culture, where men face greater social pressure and role expectations. Alcohol consumption is often viewed as a means of stress relief, reducing tension and anxiety, and potentially improving mental health. The

employment situation significantly and positively affects the mental health status of both non-drinking (significant at the 1 % statistical level) and drinking (significant at the 5 % statistical level) farmers, with coefficients of 0.156 and 0.257, respectively. Employed farmers exhibit better mental health post-drinking, possibly due to reduced financial stress, resulting in lower levels of depression and anxiety. Moreover, drinking alcohol may provide employed farmers with timely stress relief from work-related pressures, contributing to overall improved mental health. Farmers' physical health status positively influences the mental health status of both non-drinking (significant at the 1 % statistical level) and drinking farmers (significant at the 1 % statistical level). Physically fit individuals tend to adopt healthier lifestyles, such as regular eating habits, sufficient sleep, and moderate exercise, which can improve mental health and reduce the risk of depression and anxiety. Regarding household characteristics, the installation of indoor toilets significantly enhances the mental health status of both non-drinking (significant at the 1 % statistical level) and drinking farmers (significant at the 10 % statistical level). Indoor toilets can mitigate the risk of household members being exposed to germs and diseases, thus alleviating psychological stress related to physical health problems [81]. Concerning village characteristics, the condition of village sports facilities significantly impacts the mental health of both non-drinking farmers and those who consume alcohol. However, the coefficients are negative, which contradicts previous findings [94]. This discrepancy may stem from the inequitable distribution of resources, where not all farmers can fully utilize village facilities, potentially leading to feelings of unfairness or anger that may impact their mental health.

3.3. Estimating a treatment effect

As can be seen from Table 5, under the counterfactual assumption, the average treatment effect of alcohol consumption on farmers' mental health has a significant positive impact at the 1 % statistical level, and the ATT value is 0.197. This indicates that if the same farmer changes from drinking to not drinking, their mental health index will decrease by 19.7 %. These findings suggest that alcohol consumption may have a positive influence on farmers' mental health. However, the findings of this study diverge from those of existing literature [48,95]. The following reasons may explain the difference: First, China has a long history of alcohol culture [96], and the unique alcohol culture makes people love drinking. When people drink alcohol, it can enhance communication between individuals and create a greater sense of intimacy compared to when they do not drink. Alcohol consumption also facilitates the expression and communication of emotions, leading to a reduced likelihood of experiencing depression or anxiety. Second, alcohol consumption has been found to elevate dopamine levels in the body while simultaneously inhibiting excitatory neurotransmitters and slowing down brain function [97]. This mechanism allows individuals to temporarily escape from life's difficulties, providing relief from depression and anxiety. Lastly, this study primarily focuses on rural residents, but there have been few studies investigating the impact of alcohol consumption on farmers' mental health. In developing countries like China, farmers often have a low education level. Consequently, most rural residents are involved in physically demanding work. After a busy day's work, people prefer to have a drink to alleviate physical fatigue and reduce stress, thereby enhancing their mental well-being to some extent.

3.4. Heterogeneity analysis

Although the impact of farmers' alcohol consumption on their mental health has been investigated, the results outlined above only reflect the average effect at the whole sample level. They cannot reflect differences among different groups. To further investigate the relationship between farmers' alcohol consumption and their mental health, and to analyze the characteristics of this relationship, this study divided farmers into groups according to gender, age, employment conditions, drinking frequency, drinking categories, and drinking volume. It then approached a discussion on the heterogeneous effects of alcohol consumption on farmers' mental health.

As can be seen from Table 6, when grouped by gender, alcohol consumption has a significant positive effect on the mental health status of both male and female farmers, and the coefficients are 0.201 and 0.162, respectively. This indicates that if the male drinker changes from drinking to not drinking, his mental health index will decrease by 20.1 %. On the other hand, if the female drinker changes from drinking to not drinking, her mental health index will decrease by 16.2 %. It can be seen, therefore, that drinking has a more substantial effect on the mental health of male farmers. One possible explanation for this is that men may be more inclined to view alcohol consumption as a means of stress relief or social interaction, while women may prefer alternative methods to alleviate stress or enhance their mental well-being. Consequently, the impact of alcohol consumption on improving mental health may be more prominent in men.

Table 7 reports the results of the age heterogeneity estimates of the effect of alcohol consumption on mental health. Heterogeneous estimation by age group shows that alcohol consumption has a significant positive impact on the mental health of young people (ATT = 0.054), middle-aged people (ATT = 0.205), and elderly people (ATT = 0.345). It can be observed that alcohol consumption has a more significant positive effect on the mental health of older individuals, while its impact on the mental health of young people is less apparent. One primary reason for this phenomenon could be the significant population of elderly individuals residing in rural areas of

Table 5
The ATT for impacts of drinking habit on mental health.

Observation	ATT	S.E.	t-value
2515	0.197	0.015	12.872[a]

Note.
[a] Represents significance at the 1 % statistical level.

Table 6
The ATT for impacts of drinking habit on mental health by gender.

	Observation	ATT	S.E.	t-value
Male	2266	0.201	0.015	12.966[a]
Female	249	0.162	0.047	3.461[a]

Note.
[a] Represents significance at the 1 % statistical level.

China, who are especially susceptible to mental challenges like loneliness and depression. However, moderate alcohol consumption may alleviate these negative emotions, thus reducing the likelihood of developing psychological issues.

Table 8 groups farmers according to whether they have jobs or not. According to ATT estimates, it finds that for employed farmers who usually drink and then do not drink for some time, their mental health index would decrease by 20.6 % (significant at the 1 % level). Similarly, for unemployed farmers, their mental health index would decrease by 15.3 % (significant at the 1 % level) if they do not consume alcohol. Therefore, it is evident that alcohol consumption is more beneficial in improving the mental health status of employed farmers. Employed farmers may have greater access to social support and networks, participating in work-related social gatherings that involve alcohol consumption. By engaging in these social activities, they can gain emotional support and a sense of belonging, which may enhance mental health.

When grouped according to drinking frequency, the results in Table 9 show that drinking almost every day, drinking 3–4 times a week, and drinking 1–2 times a week have a significant positive impact on farmers' mental health (significant at 1 % statistical level). For farmers who drink almost every day and then do not drink for some time, their mental health index will decrease by 24.6 %. For farmers who drink alcohol 3–4 times a week and then do not drink for some time, their mental health index will decrease by 15.1 %. And for farmers who drink alcohol 1–2 times a week and then do not drink for some time, their mental health index will decrease by 16.3 %. It can be said, therefore, that drinking alcohol almost every day is more conducive to improving farmers' mental health. This may be because farmers develop a psychological expectation that daily alcohol consumption is an effective method for stress relief and relaxation, contributing to their psychological well-being.

The intake of different types of alcoholic beverages will also have different effects on farmers' mental health status. The results presented in Table 10 show that Baijiu, red wine, and beer all significantly positively impact the incidence of mental health among farmers (significant at the 1 % level). Among them, it finds that for farmers who usually drink Baijiu and then do not drink for some time, their mental health index will decrease by 23.7 %. For farmers who usually drink red wine and then do not drink it for some time, their mental health index will decrease by 18.3 %. At the same time, for farmers who usually drink beer and then do not drink for some time, their mental health index will decrease by 12.3 %.Therefore, it can be argued that drinking Baijiu regularly is more conducive to improving farmers' mental health, contradicting previous research suggesting that red wine may alleviate depressive feelings [98]. One possible explanation lies in China's unique alcohol culture, where Baijiu has been highly valued since ancient times, creating a distinct image in people's minds. Particularly among the vast rural population, Baijiu culture is deeply ingrained, and farmers prefer to enjoy a drink to relieve stress after strenuous labor. Therefore, consuming Baijiu appears to be more effective for rural residents in improving their mental well-being.

Table 11 is grouped based on the amount of alcohol consumption to explore the impact of alcohol intensity on mental health among farmers. It finds that different degrees of alcohol consumption significantly affect farmers' mental health (significant at the 1 % level). The result shows that consuming alcohol at 0–100 ml is most beneficial in improving farmers' mental health. For farmers who usually drink 0~100 ml alcohol each time and then do not drink for some time, their mental health index will decrease by 20.2 %. Moderate alcohol consumption has been shown in numerous studies to have certain health benefits, such as promoting relaxation, reducing anxiety, and easing tension. Drinking within the range of 0–100 mL of alcohol per occasion falls within this moderate drinking range [99], leading to mental health benefits.

4. Conclusions and recommendations

Utilizing data from the 2016 China Labor Force Dynamics Survey (CLDS), the study compares the mental health of drinking and non-drinking farmers. The primary conclusions drawn from this study are as follows: Firstly, alcohol consumption helps reduce mental

Table 7
The ATT for impacts of drinking habit on mental health by age.

	Observation	ATT	S.E.	t-value
Young people[b]	744	0.054	0.026	2.081[a]
Middle-aged people[c]	1050	0.205	0.024	8.475[a]
Elderly people[d]	701	0.345	0.028	12.285[a]

Note.
[a] Represents significance at the 1 % statistical level.
[b] Young people: between 18 and 44 years old.
[c] Middle-aged people: between 45 and 59 years old.
[d] Elderly people are: over 60 years old.

Table 8
The ATT for impacts of drinking habit on mental health by job.

	Observation	ATT	S.E.	t-value
Job = 1	2073	0.206	0.016	12.582[a]
Job = 0	442	0.153	0.037	4.130[a]

Note.
[a] Represents significance at the 1 % statistical level.

Table 9
The ATT for impacts of drinking habit on mental health by drinking frequency.

	Observation	ATT	S.E.	t-value
Almost every day	1086	0.246	0.023	10.633[a]
Three or four times a week	392	0.151	0.039	3.910[a]
Once or twice a week	1036	0.163	0.024	6.821[a]

Note.
[a] Represents significance at the 1 % statistical level.

Table 10
The ATT for impacts of drinking habit on mental health by types.

	Observation	ATT	S.E.	t-value
Baijiu	1616	0.237	0.191	12.368[a]
Red wine	36	0.183	0.112	1.639[a]
Beer	861	0.123	0.026	4.781[a]

Note.
[a] Represents significance at the 1 % statistical level.

Table 11
The ATT for impacts of drinking habit on mental health by the number of drinking.

	Observation	ATT	S.E.	t-value
0~100 ml	2225	0.202	0.016	12.384[a]
100–500 ml	252	0.154	0.048	3.205[a]
500 ~	33	0.201	0.137	1.467[a]

Note.
[a] represents significance at the 1 % statistical level.

illness (i.e., depression and anxiety) among farmers. Counterfactual estimates suggest that if farmers who regularly consume alcohol abstain for some time, their mental health index would decrease by 19.7 %. Secondly, concerning the reduction of mental illness likelihood, the impact of alcohol consumption behavior on the mental health of male farmers, elderly farmers, and employed farmers is particularly significant. In addition, drinking alcohol almost every day, consuming Baijiu, and drinking between 0 and 100 mL of alcohol at a time are more conducive to improving farmers' mental health.

Alongside the findings outlined above, this study has several important implications: (1) Firstly, the findings show that moderate alcohol consumption is beneficial for improving farmers' mental health, but excessive drinking may harm health. Therefore, the grass-roots governments in developing countries should strengthen the publicity and education of moderate drinking, so that the concept of civilized drinking can be further rooted in the people's hearts. (2) Secondly, the variety of alcohol consumption in rural areas should be enriched. In many developing countries, spirits are the preferred choice of most drinkers; however, spirits have a high alcohol content, making it challenging to control consumption. This study finds that red wine has a mental health improvement effect second only to Baijiu, but the number of red wine consumers is relatively small. This suggests that in the future, governments of developing countries should promote the development of the red wine industry through government subsidies and tax incentives, and educate more rural residents about red wine and its consumption. (3) Thirdly, the study finds that alcohol consumption has the greatest impact on the mental health of the elderly, with regular alcohol consumption increasing their mental health index by 34.5 %. In developing countries, rural families not only face serious empty-nest issues, but the phenomenon of rural elderly isolation is also increasingly common. The elderly in rural areas have limited access to entertainment and stress-relief activities, and their spiritual and cultural life is often lacking. In the future, efforts should be made to strengthen the development of spiritual civilization in rural areas, organize various cultural activities for the community, and consistently enrich the spiritual and cultural life of rural residents.

Along with the findings mentioned above, there are several problems worth mentioning: (1) This study primarily relies on self-reported measures of mental health from farmers, which may be subject to memory bias. (2) This paper mainly uses cross-sectional data, which does not allow for further tracking and investigating farmers' mental health. Therefore, future research could utilize

panel data to more comprehensively assess the impact of alcohol consumption on farmers' mental health. (3) This study focuses on the quantitative relationship between alcohol consumption behavior and farmers' mental health. Future research could investigate the implementation mechanisms and methodologies underlying this quantitative relationship. (4) As this study is based on data collected from farmers in rural China, its generalizability to other developing countries remains uncertain. Therefore, future studies could explore whether this study's findings are applicable to other developing nations.

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Data availability statement

The dataset supporting the conclusions of this article is included within the article.

CRediT authorship contribution statement

Jialan Zhang: Writing – review & editing, Writing – original draft, Visualization, Data curation, Conceptualization. **Ruohan Zhang:** Writing – original draft, Visualization. **Qiang He:** Writing – original draft, Visualization. **Kuan Zhang:** Writing – review & editing, Writing – original draft. **Dingde Xu:** Writing – review & editing, Writing – original draft. **Yanbin Qi:** Writing – review & editing, Writing – original draft. **Xin Deng:** Writing – review & editing, Writing – original draft, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:The corresponding author, Xin Deng is an AE of Heliyon journal(Society & Politics section). There are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

The questionnaire investigates the mental health status of farmers according to 20 items of the CES-D scale. Farmers' responses include "almost none," "rarely," "often," and "all the time." This paper calculates the mental health state of farmers according to the entropy value method. The specific steps are outlined below.

Step 1. To avoid the impact caused by the dimension, the first thing is to standardize the indicators. All indicators in this study are negative, and they are normalized using the following formula:

$$X_{ij} = \frac{\max\left(X_{1j}, X_{2j}, X_{3j}, \ldots, X_{nj}\right) - X_{ij}}{\max\left(X_{1j}, X_{2j}, X_{3j}, \ldots, X_{nj}\right) - \min\left(X_{1j}, X_{2j}, X_{3j}, \ldots, X_{nj}\right)} \tag{7}$$

where subscript *i*, *j*, and *n* correspond to the farmer, relevant indicators, and the number of farmers, respectively.

Step 2. Calculate the proportion of the *i-th* sample under the *j-th* index. The specific formula is as follows:

$$y_{ij} = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \tag{8}$$

Step 3. Calculate the entropy value of the index j:

$$e_j = -K\sum_{i=1}^{n} y_{ij}\ln\left(y_{ij}\right)$$
$$K = 1/\ln(n) \quad , \quad e_j \geq 0 \tag{9}$$

Step 4. Calculate the redundancy of information entropy D_j:

$$D_j = 1 - e_j \tag{10}$$

Step 5. Determine the weight of each indicator:

$$w_j = \frac{D_j}{\sum_{j=1}^{n} D_j} \tag{11}$$

Step 6. Calculate the composite score.

$$S_i = \sum_{j=1}^{n} y_{ij} w_j \tag{12}$$

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