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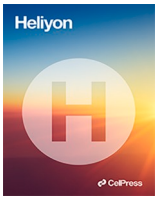

Research article

# Analysis of the prevalence and influencing factors of anxiety and depression in the Chinese population: A cross-sectional survey

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ABSTRACT

To explore the prevalence and influencing factors of anxiety and depression symptoms among Chinese people in 2021. Investigation teams were recruited in 120 cities across the country. Based on the data from "the Seventh National Population Census in 2021", quota sampling was conducted on the residents of these cities to obtain samples that conformed to population characteristics. Next, baseline information on research objects was collected, and the questionnaire survey was conducted through the online questionnaire Wenjuanxing platform. The Patient Health Questionnaire-9 (PHQ-9) rating scale was used to evaluate the mental state of the subjects. The correlation between baseline information and different PHQ-9 risk intervals was analyzed using the Chi-square test and Logit model. The impact of relevant risk factors on PHQ-9 scores was analyzed using the decision tree. The Chi-square test results revealed that place of residence ($p = 0.438$) and obesity ($p = 0.443$) was not significantly correlated with PHQ-9 risk intervals. According to Logit model analysis, age ($p = 0.001$, 95%CI 0.84–0.96), marital status ($p < 0.001$, 95%CI 0.71–0.89), drinking ($p < 0.001$, 95%CI 1.07–1.18), diabetes or hypertension ($p = 0.001$, 95%CI 1.11–1.47), health care ($p < 0.001$, 95%CI 0.53–0.66), economic welfare ($p = 0.022$, 95% CI 0.85–0.99), COVID-19 vaccine ($p < 0.001$, 95%CI 1.28–1.72), and HPV vaccine ($p < 0.001$, 95%CI 0.46–0.57) were potential influencing factors of PHQ-9 risk intervals. Decision tree analysis results showed that the grouping strategy in the PHQ-9 two-side groups had a better classification effect on the questionnaire population according to the PHQ-9 score characteristics. The prevalence rate of moderate to severe depression among Chinese people was about 8.29%. Age, marital status, drinking, diabetes or hypertension, health care, economic well, COVID-19 vaccine, and HPV vaccine were potential influencing factors of anxiety and depression symptoms in Chinese people.

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## 1. Introduction

Depression is a common mental disease endangering people's physical and mental health worldwide, which is also a serious health hazard, making great contributions to the increased suicide rate in the 21st century [1]. Clinically, depression is regarded as a heterogeneous disease with its unclear pathological mechanism, accompanied by different treatment effects [2]. Based on the degree of disease, depression can be defined as mild, moderate, and severe depression, and different countries and regions have different definitions. Severe depression, a clinical syndrome, is characterized by a depressed mood or the state of losing interest in activities that last for two weeks or more, accompanied by some other symptoms (such as sleep disorders, changes in eating habits, fatigue, suicidal thoughts, and difficulty in concentrating) [2,3].

Anxiety disorder is a common and debilitating mental health condition worldwide, with a global prevalence of 3.8%–25%, which will weaken daily function and happiness [4]. Anxiety disorder can be subdivided into a phobia, social anxiety disorder, agoraphobia, generalized anxiety disorder, and separation anxiety disorder; although all subtypes are characterized by anxiety, each subtype is accompanied by a series of other different symptoms, which seriously affects daily functioning and well-being [5]. Patients with anxiety disorders may be complicated with other mental health disorders (such as depression) and are plagued by a higher risk of cardiovascular disease and premature death [6].

Despite the rapid economic development and great social changes in China, the health and life expectancy of Chinese citizens have not increased significantly [7]. Rapid economic development leads to a remarkably increased incidence rate of mental diseases to a certain extent [8]. Nowadays, depression and anxiety have become common social phenomena. According to the national epidemiological survey of adult mental disorders published for the first time in China, depression had an ever-increasing prevalence rate from 2012 to 2015 in China, with a 12-month prevalence of 2.1% and a lifetime prevalence of 3.4% [9]. Another survey showed that the prevalence of anxiety disorder in China was 4.98% in 2017, which is dramatically higher than in the 1980s and 1990s [10]. Mental diseases (especially depression and anxiety) are often stigmatized in China; therefore, people with potential mental diseases are unwilling to disclose their mental status, which may result in a large number of unreported and untreated cases.

China is in the process of transforming its development mode, optimizing its economic structure and changing its growth momentum, facing many difficulties to be overcome and a series of foreseeable and unforeseeable risks and challenges. Like people in other countries and regions, Chinese people are plagued by a range of problems that manifest themselves in various ways (such as study, work, interpersonal relationships, and social adaptation). These problems are very likely to lead to depression and anxiety symptoms if not properly handled, which would negatively affect the mental health of Chinese people, and even induce some extreme behaviors (such as self-inflicted injury and suicide). Therefore, it is of great necessity to study the current situation and influencing factors of anxiety and depression symptoms in Chinese people in recent years, which may provide a scientific basis for the prevention and control of anxiety and depression symptoms.

## 2. Materials and methods

### 2.1. Research subjects

The multi-stage sampling method was used in this study. Firstly, the capital cities of 23 provinces and 5 autonomous regions, together with 4 municipalities under the central government (Beijing, Tianjin, Shanghai, and Chongqing) in China, were directly included. Next, 2–6 non-capital administrative regions on the prefecture-level were selected from each province/autonomous region with the random number table, and a total of 120 cities were finally determined (Supplementary materials, Appendix 1). Subsequently, investigators or investigation teams ($\leq$10 people) are openly recruited in these cities. Based on the data results of "the Seventh National Population Census in 2021", the questionnaire investigation was conducted on residents of these 120 cities by quota sampling, with sex, age, and place of residence as the control characteristics, while ensuring that these characteristics of these samples conform to the demographic characteristics (Supplementary materials, Appendix 2). At least one investigator or one investigation team shall be recruited in each city, and each investigator and investigation team shall be responsible for collecting 30–90 questionnaires and 100–200 questionnaires, respectively.

The inclusion and exclusion criteria of the research subjects were as follows.

Inclusion criteria: ① people aged $\geq$12 years old; ② people with the nationality of the People's Republic of China; ③ China's permanent population (migration time $\leq$1 month within one year); ④ people who volunteer to participate in the study with the informed consent form; ⑤ people who complete the questionnaire independently or with the help of the investigator; ⑥ people who understand the meaning of each item in the questionnaire.

Exclusion criteria: ① people with obnubilation or disoriented mental (according to self-report and relevant records from community health centers); ② people participating in other similar research projects; ③ people unwilling to cooperate.

### 2.2. Investigation method

From July 10, 2021, to September 15, 2021, the investigators, in their responsible areas, supervised the people one-for-one and face-to-face to finish the questionnaires through the online questionnaire Wenjuanxing platform (https://www.wjx.cn/). The questionnaire list is shown in Supplementary Table 1. The subjects completed the questionnaire by clicking on the link, and the informed consent of the subjects was obtained during the survey. The questionnaire was numbered and entered by the investigator following the numbering requirements (Supplementary materials, Appendix 3). For the respondents with thinking ability but insufficient action

ability to answer the questionnaire, the survey would be completed via a one-for-one inquiry by the investigator. During the questionnaire process, the staff in the community (from the neighborhood committee or health service center) acted as volunteers to help the investigators familiarize the basic condition of community residents.

### 2.3. Baseline information collection

The subject's baseline information was collected, such as sex, age, obesity (height and weight), vaccination [novel coronavirus (COVID-19) vaccine and human papillomavirus (HPV) vaccine], smoking status, drinking, diabetes or hypertension, health care, place of residence, economic welfare, household register, degree level, and marital status.

### 2.4. Patient Health Questionnaire-9 (PHQ-9) rating scale and reference risk interval

PHQ-9 is a self-assessment scale developed by Columbia University in the mid-1990s, which has been widely used in primary healthcare institutions for the specific screening of mental disorders with its more concise items than other scales. PHQ-9 contains nine questions that assess the presence of depressive symptoms. The Chinese version of PHQ-9 has been well-validated in multiple studies [11,12] and demonstrated good internal consistency. The total score ranges from 0 to 27, with 5, 10, 15, and 20 representing cut points for mild, moderate, moderately severe, and severe depression, respectively. Studies on the scoring method of PHQ-9 indicated that cut-off scores between 8 and 11 have been recommended for identifying possible depression [13,14]. Additionally, PHQ-9, characterized by high sensitivity, simplicity, and easy operation, can be completed by most patients within 5 min, even without any help. The reference risk interval is shown in Supplementary Table 2.

### 2.5. Analysis process

The design and analysis process of this study are displayed in Fig. 1.

### 2.6. Logit model analysis

The logit model, as a generalized linear model, was used to analyze the effect of each variable on the PHQ-9 score from the perspective of probability. The principle of the logit model was as follows:

$$ln\left[\frac{P(Y=0)}{P(Y=1)}\right] = \propto_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \mu$$

β1～βn is the regression coefficient; μ represents a random error term; the conditional probability of Y is

$$\frac{exp(\propto_0 + \beta_1 x_1 + \ldots \beta_n x_n)}{1 + exp(\propto_0 + \beta_1 x_1 + \ldots \beta_n x_n)}$$

In the above formula, the changes in the probability of Y caused by the change of x indicated the influence of the factors studied in this paper on the PHQ-9 score.

### 2.7. Decision tree

As an integrated learning method, Random forest is one of the most widely used machine learning models. There are many decision trees in a random forest that are not correlated with each other. While using random forest, multiple decision trees were constructed based on different characteristics of multiple sub-samples to predict each sample. In this study, decision trees were generated by the

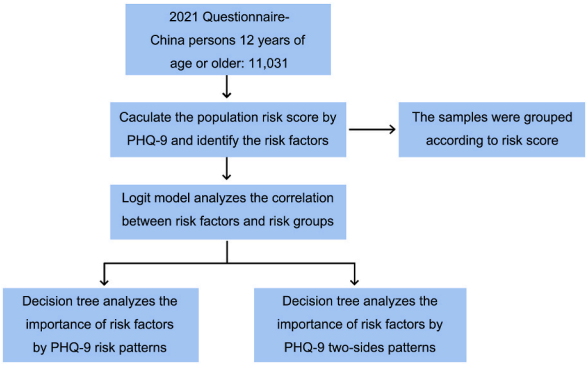


**Fig. 1.** Analysis process.

common Python (version 3.7.4) programming language with the CART algorithm. We implement decision trees using Scikit-Learn (https://scikit-learn.org/) [15,16]. A total of 11,031 subjects were randomly allocated into the training set (n = 7721, 70%) and the verification set (n = 3310, 30%). With the 8 risk factors as the Feature of the decision tree, the PHQ-9 risk groups and PHQ-9 two-side groups served as the evaluation criteria for subsequent analysis.

### 2.8. Ethical review

Following the ethical principles of *The Regulations on Ethical Reviews of Biomedical Researches Involving Human Beings (Trial)* issued by the Ministry of Health, *Good Clinical Practice* (2003) by State Drug Administration, *Provisions for Clinical Trials of Medical Devices* (2004), *the Helsinki Declaration* of the World Medical Association, and the *International Ethical Guidelines for Biomedical Research Involving Human Subjects*, this study passed the ethical review of IRB of Jinan University (JNUKY-2021-018).

### 2.9. Statistical analysis

All data were statistically analyzed using SPSS 25.0. Measurement data with normal distribution were expressed as mean ± standard deviation (x ± s). The influencing factors were analyzed using $\chi$ 2 test, independent sample *t*-test, Pearson's correlation test, and ordered logistic regression analysis. A p-value of less than 0.05 is indicative of a statistically significant difference. The validity of the PHQ-9 scale was analyzed using AMOS software. The logit model was analyzed using Biogeme software. The decision tree model was completed using R and R Studio.

## 3. Results

### 3.1. PHQ-9 score distribution of questionnaire subjects was analyzed

After questionnaire collection (quality control in Supplementary materials), the PHQ-9 score distribution of the subjects was analyzed. The results revealed that the PHQ-9 scores of questionnaire subjects were primarily 0–9 points (no depression or mild depression), and the highest PHQ-9 score was 18 (moderate to severe depression) (Fig. 2).

### 3.2. The distribution characteristics of baseline information of questionnaire subjects were analyzed

The baseline information of the questionnaire subjects was displayed in Supplementary Table 3. Specifically, detailed distribution characteristics of age (12–18, 19–25, 26–45, 46–65, and >65 years old), place of residence (rural and urban), household register (agriculture and non-agriculture), degree level (none, primary, intermediate, advanced, and Master/Doctor), marital status (unmarried, married, divorced, and widowed), drinking (never, rarely, often, and intemperance), diabetes or hypertension (none, hypertension, diabetes, and both), and economic welfare (unclear, no allowance, and have allowance) were shown. For other baseline information (obesity, smoking status, health care, COVID-19 vaccine, and HPV vaccine), the questionnaire subjects should fill in "yes" or "no" according to the actual situation.

### 3.3. The correlation between baseline information and different PHQ-9 risk intervals was analyzed using the chi-square test

The Chi-square test was used to analyze the correlation between the baseline information of the questionnaire subjects and different PHQ-9 risk intervals (Table 1). Considering that the highest PHQ-9 score in this study was 18 points, two intervals (15–19) and (20–27) were integrated into one interval (15–27). According to the chi-square test results, there was no significant correlation between the

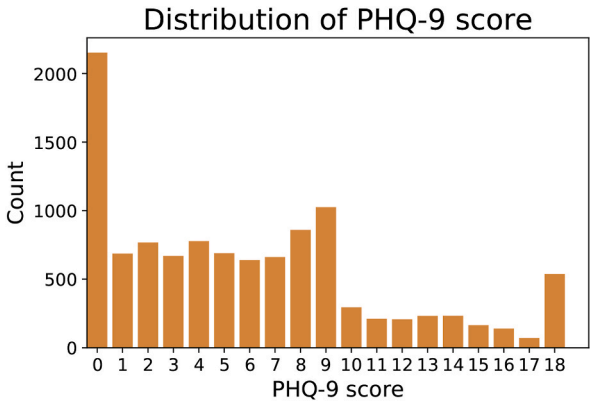


**Fig. 2.** PHQ-9 score distribution of questionnaire subjects.

**Table 1**
The correlation between baseline information and different PHQ-9 risk intervals.

| Characteristics | PHQ-9 score | | | | | | | | P value |
|---|---|---|---|---|---|---|---|---|---|
| | 0–4 | | 5–9 | | 10–14 | | 15–27 | | |
| Sample size | 5056 | 45.83% | 3878 | 35.16% | 1183 | 10.72% | 914 | 8.29% | |
| Age (years) | | | | | | | | | |
| 12–18 | 489 | 9.67% | 375 | 9.67% | 129 | 10.90% | 72 | 7.88% | <0.001 |
| 19–25 | 756 | 14.95% | 769 | 19.83% | 252 | 21.30% | 245 | 26.81% | |
| 26–45 | 2077 | 41.08% | 1585 | 40.87% | 512 | 43.28% | 405 | 44.31% | |
| 46–65 | 1289 | 25.49% | 865 | 22.31% | 194 | 16.40% | 142 | 15.54% | |
| >65 | 445 | 8.80% | 284 | 7.32% | 96 | 8.11% | 50 | 5.47% | |
| Sex | | | | | | | | | |
| Female | 2673 | 52.87% | 2242 | 57.81% | 650 | 54.95% | 433 | 47.37% | <0.001 |
| Male | 2383 | 47.13% | 1636 | 42.19% | 533 | 45.05% | 481 | 52.63% | |
| Place of residence | | | | | | | | | |
| Rural | 1368 | 27.06% | 1051 | 27.10% | 363 | 30.68% | 241 | 26.37% | 0.061 |
| Urban | 3688 | 72.94% | 2827 | 72.90% | 820 | 69.32% | 673 | 73.63% | |
| Household register | | | | | | | | | |
| Non-agriculture | 3007 | 59.47% | 2205 | 56.86% | 640 | 54.10% | 508 | 55.58% | 0.001 |
| Agriculture | 2049 | 40.53% | 1673 | 43.14% | 543 | 45.90% | 406 | 44.42% | |
| Degree level | | | | | | | | | |
| None | 164 | 3.24% | 117 | 3.02% | 54 | 4.56% | 43 | 4.70% | <0.001 |
| Primary | 1064 | 21.04% | 810 | 20.89% | 206 | 17.41% | 108 | 11.82% | |
| Intermediate | 929 | 18.37% | 681 | 17.56% | 229 | 19.36% | 139 | 15.21% | |
| Advanced | 2553 | 50.49% | 2055 | 52.99% | 606 | 51.23% | 536 | 58.64% | |
| Master/Doctor | 346 | 6.84% | 215 | 5.54% | 88 | 7.44% | 88 | 9.63% | |
| Marital status | | | | | | | | | |
| Unmarried | 1762 | 34.85% | 1566 | 40.38% | 552 | 46.66% | 483 | 52.84% | <0.001 |
| Married | 3130 | 61.91% | 2136 | 55.08% | 567 | 47.93% | 393 | 43.00% | |
| Divorced | 70 | 1.38% | 78 | 2.01% | 36 | 3.04% | 23 | 2.52% | |
| Widowed | 94 | 1.86% | 98 | 2.53% | 28 | 2.37% | 15 | 1.64% | |
| Obesity | | | | | | | | | |
| No | 4861 | 96.14% | 3739 | 96.42% | 1137 | 96.11% | 871 | 95.30% | 0.466 |
| Yes | 195 | 3.86% | 139 | 3.58% | 46 | 3.89% | 43 | 4.70% | |
| Smoking status | | | | | | | | | |
| No-smoking | 4425 | 87.52% | 3425 | 88.32% | 1014 | 85.71% | 768 | 84.03% | 0.002 |
| Smoking | 631 | 12.48% | 453 | 11.68% | 169 | 14.29% | 146 | 15.97% | |
| Drinking | | | | | | | | | |
| Never | 3178 | 62.86% | 2282 | 58.84% | 653 | 55.20% | 465 | 50.88% | <0.001 |
| Rarely | 688 | 13.61% | 696 | 17.95% | 210 | 17.75% | 183 | 20.02% | |
| Often | 493 | 9.75% | 379 | 9.77% | 122 | 10.31% | 86 | 9.41% | |
| Intemperance | 697 | 13.79% | 521 | 13.43% | 198 | 16.74% | 180 | 19.69% | |
| Diabetes or hypertension | | | | | | | | | |
| None | 4520 | 89.40% | 3422 | 88.24% | 1040 | 87.91% | 829 | 90.70% | 0.015 |
| Hypertension | 436 | 8.62% | 358 | 9.23% | 99 | 8.37% | 61 | 6.67% | |
| Diabetes | 43 | 0.85% | 43 | 1.11% | 16 | 1.35% | 11 | 1.20% | |
| Both | 57 | 1.13% | 55 | 1.42% | 28 | 2.37% | 13 | 1.42% | |
| Health care | | | | | | | | | |
| No | 835 | 16.52% | 852 | 21.97% | 333 | 28.15% | 279 | 30.53% | <0.001 |
| Yes | 4221 | 83.48% | 3026 | 78.03% | 850 | 71.85% | 635 | 69.47% | |
| Economic welfare | | | | | | | | | |
| Unclear | 1189 | 23.52% | 1048 | 27.02% | 375 | 31.70% | 309 | 33.81% | <0.001 |
| Not allowance | 3176 | 62.82% | 2294 | 59.15% | 602 | 50.89% | 432 | 47.26% | |
| Have allowance | 691 | 13.67% | 536 | 13.82% | 206 | 17.41% | 173 | 18.93% | |
| COVID-19 vaccine | | | | | | | | | |
| No | 517 | 10.23% | 423 | 10.91% | 145 | 12.26% | 149 | 16.30% | <0.001 |
| Yes | 4539 | 89.77% | 3455 | 89.09% | 1038 | 87.74% | 765 | 83.70% | |
| HPV vaccine | | | | | | | | | |
| No | 4070 | 80.50% | 3108 | 80.14% | 870 | 73.54% | 588 | 64.33% | <0.001 |
| Yes | 986 | 19.50% | 770 | 19.86% | 313 | 26.46% | 326 | 35.67% | |

place of residence/obesity and PHQ-9 score (both $p > 0.05$). Other baseline information (age, sex, household register, degree level, marital status, smoking status, drinking, diabetes or hypertension, health care, economic welfare, and vaccination (COVID-19 vaccine and HPV vaccine) showed notable correlations with PHQ-9 scores, which may be risk factors of anxiety and depression.

Furthermore, considering that the majority of questionnaire subjects had a PHQ-9 score of 0–9 points (no depression or mild depression), with the highest PHQ-9 score of 18 points, we allocated the questionnaire population into the low-risk interval (0–9 points; no depression or mild depression) and high-risk interval (10–18 points; moderate depression/moderate to severe depression) for further analysis. The results demonstrated that two factors (place of residence and obesity) had no significant correlation with the PHQ-9 risk interval ($p > 0.05$, Supplementary Table 4), which was consistent with the previous results.

### 3.4. The correlation between baseline information and different PHQ-9 risk intervals was analyzed using the logit model

Subsequently, the Logit model was applied to analyze the correlation between baseline information and different PHQ-9 risk intervals. Six factors (sex, place of residence, household register, degree level, obesity, and smoking status) were found to have no significant correlation with the PHQ-9 risk interval ($p > 0.05$, Table 2). Meanwhile, 8 factors (age, marital status, drinking, diabetes or hypertension, health care, economic welfare, COVID-19 vaccine, and HPV vaccine) were notably correlated with PHQ-9 risk interval ($p < 0.05$, Table 2), which were subjected to subsequent analysis.

### 3.5. The impact of 8 risk factors on PHQ-9 scores was analyzed using the decision tree

Through machine learning, a total of 11,031 questionnaire subjects were randomly allocated into the train set (n = 7721, 70%) and verification set (n = 3310, 30%). With the 8 risk factors as the decision tree Feature, analysis was performed with different evaluation criteria (PHQ-9 risk groups and PHQ-9 two-side groups). The analysis results showed that the accuracy rate of the train set and verification set in the PHQ-9 risk groups was 53.94% and 45.74%, respectively (Fig. 3A), while that in the PHQ-9 two-side groups was 83.65% and 79.37%, respectively (Fig. 3B). Therefore, PHQ-9 two-side patterns had a better classification effect on grouping the questionnaire subjects according to PHQ-9 scores. The influencing importance of 8 risk factors from high to low were age, drinking, economic welfare, marital status, diabetes or hypertension, health care, covid-19 vaccine, and HPV vaccine (Supplementary Table 5).

### 3.6. Distribution characteristics of 8 risk factors in questionnaire subjects were analyzed by PHQ-9 two-side patterns

The distribution characteristics of the 8 risk factors in the population were analyzed by PHQ-9 two-sided patterns (Table 3). Specifically, people aged 19–25 accounted for 6.67% higher in the high-risk interval (10–18) than in the low-risk interval (0–9), while people aged 46–65 accounted for 8.09% lower in the high-risk interval (10–18) than in the low-risk interval (0–9). The proportion of unmarried people in the high-risk interval (10–18) was 12.11% higher than those in the low-risk interval (0–9), while the proportion of married people in the high-risk interval (10–18) was 13.16% lower than those in the low-risk interval (0–9). People who never drunk accounted for 7.8% lower in the high-risk interval (10–18) than in the low-risk interval (0–9). While people who rarely, often, or intemperance drunk all accounted higher in the high-risk interval (10–18) than those in the low-risk interval (0–9). People with health care accounted for 10.3% lower in the high-risk interval (10–18) than that in the low-risk interval (0–9). For economic welfare, the proportion of people without allowance in the high-risk interval (10–18) was 11.92% lower than that in the low-risk interval (0–9). People vaccinated with the HPV vaccine accounted for 10.81% higher in the high-risk interval (10–18) than in the low-risk interval (0–9).

Moreover, the distribution characteristics of 8 risk factors in different gender populations were further analyzed (Table 4). Similar to the whole population distribution in the 8 risk factors, both females and males aged 19–25 accounted higher in the high-risk interval (10–18) than in the low-risk interval (0–9), while both females and males aged 46–65 accounted lower in the high-risk interval (10–18) than in the low-risk interval (0–9). The female and male respective distribution in marital status, health care, economic welfare, Covid-19 vaccine, and HPV vaccine were also similar to the whole population distribution. Interestingly, different from the whole population distribution, among the people who often drink, the proportion of males in the high-risk interval (10–18) is lower than that in the low-risk interval (0–9).

## 4. Discussion

According to the research report published by *Global Burden of Diseases* in 2019, depression ranks first in mental disorders regarding the disease burden, whether in the world or China; among the disease burden of all diseases, depression ranks 13th in the world and

**Table 2**
The correlation between baseline information and different PHQ-9 risk intervals.

| Variable | Depression | | |
|---|---|---|---|
| | OR | 95%CI | P value |
| Age | 0.9 | (0.84–0.96) | 0.001 |
| Sex | 0.94 | (0.84–1.04) | 0.216 |
| Place of residence | 1.05 | (0.92–1.20) | 0.438 |
| Household register | 1.04 | (0.93–1.17) | 0.466 |
| Degree level | 1 | (0.96–1.04) | 0.903 |
| Marital status | 0.79 | (0.71–0.89) | <0.001 |
| Obesity | 1.1 | (0.86–1.41) | 0.443 |
| Smoking status | 1.13 | (0.97–1.33) | 0.124 |
| Drinking | 1.12 | (1.07–1.18) | <0.001 |
| Diabetes or hypertension | 1.28 | (1.11–1.47) | 0.001 |
| Health care | 0.59 | (0.53–0.66) | <0.001 |
| Economic welfare | 0.92 | (0.85–0.99) | 0.022 |
| COVID-19 vaccine | 1.48 | (1.28–1.72) | <0.001 |
| HPV vaccine | 0.51 | (0.46–0.57) | <0.001 |

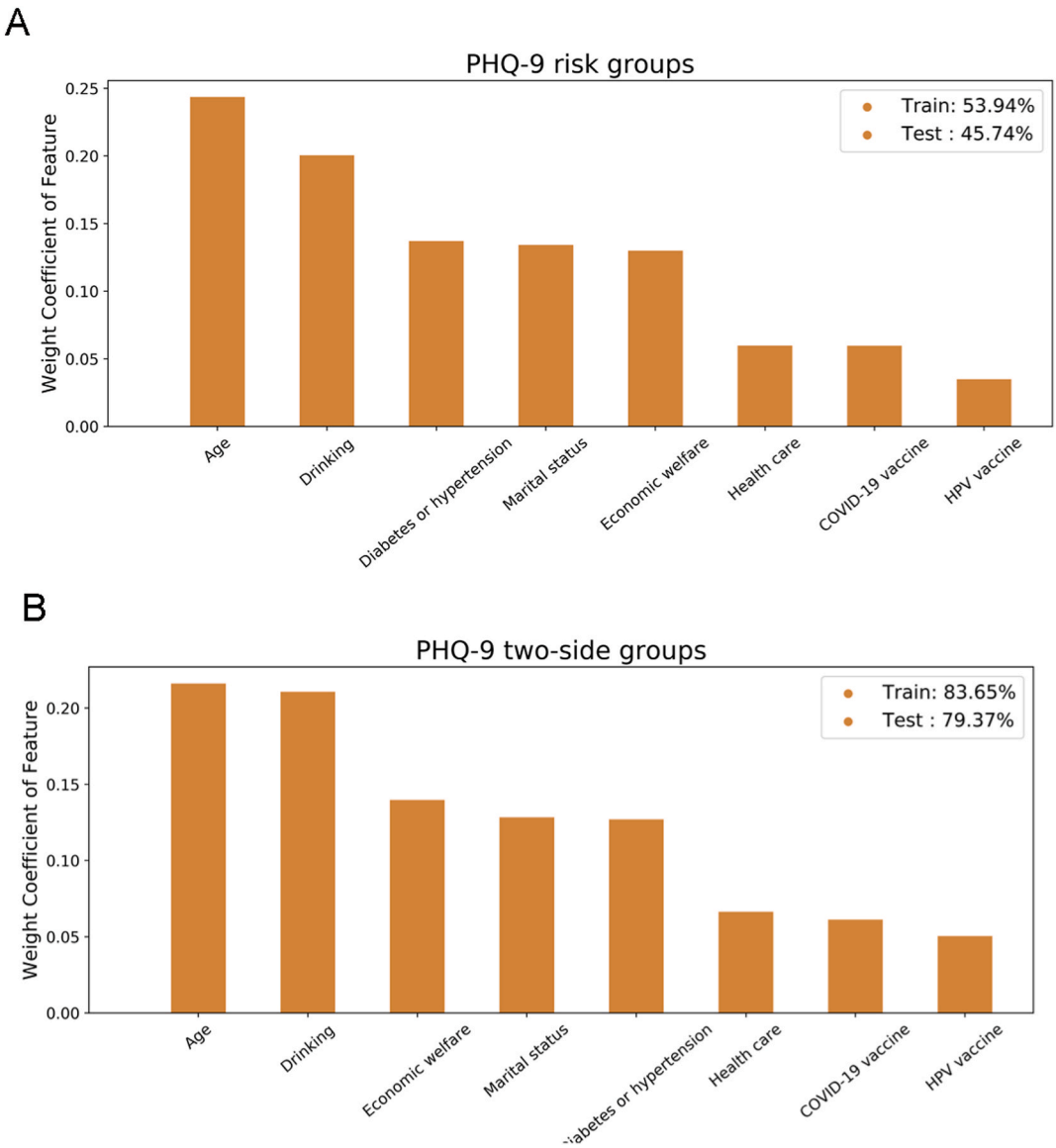


**Fig. 3.** The effects of two models on PHQ-9 scores.

11th in China [17]. More surprisingly, the majority of patients with mental disorders in China are unwilling to seek medical advice; instead, they choose to endure alone, which not only significantly reduces the quality of life but also induces tension in family relations and interpersonal relationships. Eventually, the low diagnosis and treatment rate of mental disorders leads to an increase in the overall disease burden. Recently, anxiety and depression symptoms of people in China are gaining attention. For example, accumulating studies have explored the detection rate of anxiety and depression among college students and the related influencing factors [18–21]. On the other hand, the impact of various diseases (such as functional dyspepsia [22], breast cancer [23], and COVID-19 [24]) on patients' anxiety and depression has been clinically investigated. At present, there are many scales for depression evaluation, such as Beck Depression Inventory (BDI II), the Center for Epidemiology Studies Depression Scale (CES-D), Hospital Anxiety and Depression Scale (HADS), General Health Questionnaire (GHQ12), and PHQ-9. Among them, PHQ-9 is considered the most reliable screening tool [25], characterized by multiple advantages, such as concise items, convenient operation, and easy acceptance by all kinds of people. In this study, the highest PHQ-9 score of the questionnaire subjects was 18 points, and the prevalence rate of moderate to severe depression among Chinese people was about 8.29%, consistent with the previous research results [9,26].

After a series of investigations of influencing factors of anxiety and depression symptoms, 8 factors (age, marital status, drinking, diabetes or hypertension, health care, economic welfare, COVID-19 vaccine, and HPV vaccine) were proposed to be influencing factors of anxiety and depression symptoms in Chinese people. In terms of age, people with high PHQ-9 scores were concentrated in the age group of 26–45, followed by 19–25 and 46–65, which may be associated with many of their pressures (in the study, employment, or

**Table 3**
Distribution characteristics of 8 risk factors in questionnaire subjects in the PHQ-9 two-side groups.

| Characteristics | PHQ-9 score | | | | P value |
|---|---|---|---|---|---|
| | 0–9 | | 10–18 | | |
| Sample size | 8934 | 80.99% | 2097 | 19.01% | |
| Age (years) | | | | | |
| 12–18 | 864 | 9.67% | 201 | 9.59% | <0.001 |
| 19–25 | 1525 | 17.07% | 497 | 23.70% | |
| 26–45 | 3662 | 40.99% | 917 | 43.73% | |
| 46–65 | 2154 | 24.11% | 336 | 16.02% | |
| >65 | 729 | 8.16% | 146 | 6.96% | |
| Marital status | | | | | |
| Unmarried | 3328 | 37.25% | 1035 | 49.36% | <0.001 |
| Married | 5266 | 58.94% | 960 | 45.78% | |
| Divorced | 148 | 1.66% | 59 | 2.81% | |
| Widowed | 192 | 2.15% | 43 | 2.05% | |
| Drinking | | | | | |
| Never | 5460 | 61.11% | 1118 | 53.31% | <0.001 |
| Rarely | 1384 | 15.49% | 393 | 18.74% | |
| Often | 872 | 9.76% | 208 | 9.92% | |
| Intemperance | 1218 | 13.63% | 378 | 18.03% | |
| Diabetes or hypertension | | | | | |
| None | 7942 | 88.90% | 1869 | 89.13% | 0.012 |
| Hypertension | 794 | 8.89% | 160 | 7.63% | |
| Diabetes | 86 | 0.96% | 27 | 1.29% | |
| Both | 112 | 1.25% | 41 | 1.96% | |
| Health care | | | | | |
| No | 1687 | 18.88% | 612 | 29.18% | <0.001 |
| Yes | 7247 | 81.12% | 1485 | 70.82% | |
| Economic welfare | | | | | |
| Unclear | 2237 | 25.04% | 684 | 32.62% | <0.001 |
| Not allowance | 5470 | 61.23% | 1034 | 49.31% | |
| Have allowance | 1227 | 13.73% | 379 | 18.07% | |
| COVID-19 vaccine | | | | | |
| No | 940 | 10.52% | 294 | 14.02% | <0.001 |
| Yes | 7994 | 89.48% | 1803 | 85.98% | |
| HPV vaccine | | | | | |
| No | 7178 | 80.34% | 1458 | 69.53% | <0.001 |
| Yes | 1756 | 19.66% | 639 | 30.47% | |

interpersonal communication). Previous studies have evidenced that marital status is closely related to anxiety and depression [27–29]. In this study, it was found that unmarried people in the high-risk interval were 12.11% higher than those in the low-risk interval, while married people in the high-risk interval were 13.16% lower than those in the low-risk interval. In supporting these results, previous results have shown that marriage may alleviate some anxiety and depression symptoms, which may be attributed to the company and care of partners. Clinically, it has been evidenced that alcohol may play a role in people with elevated social anxiety [30]. Researchers have found that people with social anxiety generally drink in social situations because drinking can reduce not only their negative affect (NA) but also increase their positive affect (PA) [31]. Consistently, the present study revealed that the proportion of people who have never drunk in the high-risk interval was 7.8% lower than that in the low-risk interval. Namely, people in high-risk intervals may drink to alleviate anxiety. Accumulating studies have shown that people with diabetes may exhibit clinical and subclinical symptoms of depression and anxiety more frequently than those without diabetes, which may be attributed to their poor metabolic outcomes and increased medical complications [32,33]. Moreover, depression [34] and anxiety [35] also exert negative impacts on hypertension procession; there is a mutually promoting and cause-effect relationship between depression/anxiety and diabetes/hypertension. Furthermore, health care and economic welfare have been proven to play crucial roles in anxiety and depression [36–38]. Accordingly, in the present study, people with health care accounted for 10.3% lower in the high-risk interval than in the low-risk interval, and people without economic welfare accounted for 11.92% lower in the high-risk interval than in the low-risk interval. A previous study has pointed out that patients with COVID-19 have a significantly increased risk of mental disorders [39]. For example, the comprehensive prevalence of depression, anxiety, and sleep disorders is 45% (95% CI: 37–54%, $I^2 = 96\%$), 47% (95% CI: 37–57%, $I^2 = 97\%$), and 34% (95% CI: 19–50%, $I^2 = 98\%$), respectively [40]. In this study, the proportion of people vaccinated with the COVID-19 vaccine in the high-risk interval was 3.5% lower than that in the low-risk interval. HPV infection is the most common sexually transmitted disease among human beings. HPV, as a DNA virus, can lead to benign skin and mucosal tumors on different organs (genital, anal, or oral warts), intraepithelial neoplasia and/or malignant tumors; women are more vulnerable to HPV carcinogenesis, mainly in the genital tract in the cervix. It has been shown that the relapse of HPV infection positively correlates with depression and anxiety among women [41]. However, little is known about the impact of the HPV vaccine on the depression and anxiety symptoms of vaccinated people. The results of this study revealed that the proportion of people vaccinated with the HPV vaccine in the high-risk interval was 10.81% higher than that in the low-risk interval. These findings may be related to the high

**Table 4**
Distribution characteristics of 8 risk factors in female and male in the PHQ-9 two-side groups.

| Gender | Female | | | | Male | | | | P.value |
|---|---|---|---|---|---|---|---|---|---|
| PHQ-9 | 0–9 | | 10–18 | | 0–9 | | 10–18 | | |
| Sample size | 4915 | 81.94% | 1083 | 18.06% | 4019 | 79.85% | 1014 | 20.15% | |
| Age (years) | | | | | | | | | |
| 12–18 | 499 | 10.15% | 124 | 11.45% | 365 | 9.08% | 77 | 7.59% | <0.001 |
| 19–25 | 893 | 18.17% | 268 | 24.75% | 632 | 15.73% | 229 | 22.58% | |
| 26–45 | 2117 | 43.07% | 480 | 44.32% | 1545 | 38.44% | 437 | 43.10% | |
| 46–65 | 1037 | 21.10% | 146 | 13.48% | 1117 | 27.79% | 190 | 18.74% | |
| >65 | 369 | 7.51% | 65 | 6.00% | 360 | 8.96% | 81 | 7.99% | |
| Marital status | | | | | | | | | |
| Unmarried | 1900 | 38.66% | 549 | 50.69% | 1428 | 35.53% | 486 | 47.93% | <0.001 |
| Married | 2790 | 56.77% | 473 | 43.67% | 2476 | 61.61% | 487 | 48.03% | |
| Divorced | 98 | 1.99% | 31 | 2.86% | 50 | 1.24% | 28 | 2.76% | |
| Widowed | 127 | 2.58% | 30 | 2.77% | 65 | 1.62% | 13 | 1.28% | |
| Drinking | | | | | | | | | |
| Never | 3780 | 76.91% | 717 | 66.20% | 1680 | 41.80% | 401 | 39.55% | <0.001 |
| Rarely | 705 | 14.34% | 189 | 17.45% | 679 | 16.89% | 204 | 20.12% | |
| Often | 252 | 5.13% | 79 | 7.29% | 620 | 15.43% | 129 | 12.72% | |
| Intemperance | 178 | 3.62% | 98 | 9.05% | 1040 | 25.88% | 280 | 27.61% | |
| Diabetes or hypertension | | | | | | | | | |
| None | 4495 | 91.45% | 974 | 89.94% | 3447 | 85.77% | 895 | 88.26% | 0.031 |
| Hypertension | 327 | 6.65% | 73 | 6.74% | 467 | 11.62% | 87 | 8.58% | |
| Diabetes | 38 | 0.77% | 16 | 1.48% | 48 | 1.19% | 11 | 1.08% | |
| Both | 55 | 1.12% | 20 | 1.85% | 57 | 1.42% | 21 | 2.07% | |
| Health care | | | | | | | | | |
| No | 982 | 19.98% | 337 | 31.12% | 705 | 17.54% | 275 | 27.12% | <0.001 |
| Yes | 3933 | 80.02% | 746 | 68.88% | 3314 | 82.46% | 739 | 72.88% | |
| Economic welfare | | | | | | | | | |
| Unclear | 1198 | 24.37% | 343 | 31.67% | 1039 | 25.85% | 341 | 33.63% | <0.001 |
| Not allowance | 3101 | 63.09% | 553 | 51.06% | 2369 | 58.95% | 481 | 47.44% | |
| Have allowance | 616 | 12.53% | 187 | 17.27% | 611 | 15.20% | 192 | 18.93% | |
| COVID-19 vaccine | | | | | | | | | |
| No | 535 | 10.89% | 145 | 13.39% | 405 | 10.08% | 149 | 14.69% | 0.021 |
| Yes | 4380 | 89.11% | 938 | 86.61% | 3614 | 89.92% | 865 | 85.31% | |
| HPV vaccine | | | | | | | | | |
| No | 3902 | 79.39% | 782 | 72.21% | 3276 | 81.51% | 676 | 66.67% | <0.001 |
| Yes | 1013 | 20.61% | 301 | 27.79% | 743 | 18.49% | 338 | 33.33% | |

willingness to vaccination among people with previous sexual behavior [42] and the reduced vaccine effectiveness in women with sexual behavior [43].

This study has some limitations. Most of the data were based on the subjective self-report of the questionnaire subjects, and there may be some recall bias during information collection. Anxiety and depression are prevalent during pregnancy and post-partum [44]; in the present study, we had no information on whether the respondents were pregnant or post-partum. Failure to exclude these individuals may affect the validity of the statistics to some extent. In addition, we omitted other types of highly possible variables from the analyses, including exercise and physical activity.

In conclusion, most Chinese people are suffering from anxiety and depression, and the clinical symptoms have affected individual study and work. Meanwhile, there are many influencing factors of anxiety and depression involving multiple aspects of learning and life. Therefore, it is of great significance to investigate how to intervene in anxiety and depression effectively. The present study revealed the prevalence and influencing factors of anxiety and depression among the Chinese population, aiming to provide a reference for individuals, clinical workers, and even policymakers.

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## Author contribution statement

Xinyi Kong: Conceived and designed the experiments; Wrote the paper.

Yibo Wu; Xinpei Wang; Yike Sun; Ke Chen: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Qiyu Li; Jie Li: Conceived and designed the experiments.

## Data availability statement

No data was used for the research described in the article.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e15889.

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