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An epidemiological study of hepatitis virus infection in psychiatric patients in East China

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Abstract

Backgrounds Psychiatric patients have been the focus of social attention, and they may be more susceptible to hepatitis viruses. This study aims to investigate the prevalence and influencing factors of hepatitis virus infection among psychiatric patients in East China.

Methods A total of 6,5911 newly admitted psychiatric patients at Shandong Daizhuang Hospital from 2017 to 2023 were included in this study. Test results of serum biomarkers for HBV and HCV infection were collected from psychiatric patients. Background information such as sex, age, ethnicity, marital status, occupation, residence, region, and types of psychosis were collected. Results of serum markers for hepatitis B and C were also collected from 23,628 non-psychiatric individuals.

Results In the study area, the HBV infection rate in psychiatric patients was 3.75% (95% CI: 3.46–3.74%) and showed a decreasing trend by year (p for trend = 0.000). The HCV infection rate in psychiatric patients was 0.23% (95% CI: 0.19–0.27%). The HBV infection rates differed among sex, age, marital status, occupation, residence, region, severity, and psychosis types. The HCV infection rates differed among age, marital status, occupation, and psychosis types. The HBV infection rate in psychiatric patients was positively skewed with age, being lowest in the age group of 5–15 years old and the highest in the age group of 36–40 years old, similar to the distribution of HBV infection in non-psychiatric patients. The HCV infection rate in psychiatric patients increased with age (p for trend = 0.000) and was similar to non-psychiatric patients (p for trend = 0.000). Compared with non-psychiatric patients, the "Mental and behavioural disorders due to use of alcohol", "Schizophrenia", "Mental disorders due to epilepsy", "Behavioural and emotional disorders with onset usually occurring in childhood and adolescence", "Obsessive-compulsive disorder", "Somatoform disorders" and "Depressive episode" become influencing factors for HBV infection. Compared with non-psychiatric patients, the "Dementia in other diseases classified elsewhere", "Depressive episode" become influencing factors for HCV infection. Being male, jobless and living in rural were risk factors for HBV infection, and urban became a risk factor for HCV infection.

Discussion and conclusion The rate of HBV and HCV infection among psychiatric patients in this region have remained low. Gender, age, occupation, residence, and types of psychosis were identified as potential influencing factors for hepatitis virus infection.

Keywords HBV, HCV, Psychiatric patients, Psychosis

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Background

The prevalence of mental illness remains high around the world, with more than one-third of people in most countries meeting the criteria for at least one mental illness at some point in their lives [1]. In China, about 173 million people have mental illnesses. The latest epidemiological survey shows that the weighted prevalence of any disorder (excluding dementia) was 9.3% during the past 12 months and 16.6% (ranging from 13.0 to 20.2%) during the participants' entire lifetime [2].

Viral hepatitis is the main cause of hepatitis [3–5]. Among the various types of hepatitis viruses, hepatitis B virus (HBV) and hepatitis C virus (HCV) are the main causes of chronic liver inflammation and liver malignancy. They can be transmitted through blood, from mother to child, and through sexual contact [6, 7]. Approximately 350 million people worldwide are chronically infected with HBV, with 4.5 million new infections occurring every year [8, 9]. According to the 2015 WHO statistics, the global positive rate of HCV antibody is around 2%, with about 143 million people living with chronic hepatitis C, and about 3–4 million people were infected every year [10]. The pooled estimated rate of HBV infection in the general population in China from 2013 to 2017 was 6.89% (95% CI: 5.84–7.95%) [11]. The China Center for Disease Control and Prevention reported that the prevalence of anti-HCV indifferent region were ranged from 0.29 to 0.67%, and with 5.6 million people are infected with HCV in China [12, 13].

Over the past 30 years, the country has undertaken many initiatives to reduce HBV and HCV infection rates, such as expanding vaccination, especially for newborns, enhancing blood and medical safety, improving diagnosis and treatment rates, and strengthening health education and promotion. Although the disease burden of hepatitis B virus and hepatitis C virus infection has decreased in China, the incidence of hepatitis B virus remains high.

Although the disease burden of HBV and HCV infection has decreased in China over the past 30 years, the incidence of HBV remains high. There is still a need for effective management of HBV and HCV infection in high-risk populations [14]. Some studies suggest that HBV and HCV infection rates may be higher in psychiatric patients than in the general population [15, 16]. HBV infection can be complicated by chronic liver insufficiency, cirrhosis and hepatocellular carcinoma, and is common in psychiatric patients [17, 18]. This study aims to analyze the current status of HBV and HCV infection in patients with mental illness in the study area, provide a reference for research in the same field, offer assistance for the treatment of mental patients and help develop health care strategies.

Method

Study design and data collection

This study was a retrospective study and was approved by the hospital Ethics Committee. Since the data in this study were extracted from hospital medical records and all data information was anonymized, informed consent was not necessary. Patient names were concealed, and admission numbers were used as unique identification codes to gather medical records data. The hepatitis virus serum detection results and patient case information from the medical laboratory of Shandong Daizhuang Hospital were collected from 2017 to 2023 through the hospital's Laboratory Information System (LIS system) and medical record workstation.

The inclusion criteria included: (1) newly hospitalized patients, (2) diagnosed by a psychiatrist as mentally ill patients according to the *International Classification of Diseases, 10th Revision (ICD-10)*, (3) availability of HBV and HCV biomarker test results. Patient's medical record information, such as age, gender, ethnicity, diagnosis, marital status, region, and occupation, was extracted. A total of 65,911 cases that met the requirements were finally included.

Among the subjects included in the study, males accounted for 44.45% and females accounted for 55.55%. The average age of the 65,896 patients, excluding 15 social assistance patients with unknown ages, was 42.80 ± 17.52 years, ranging from 5 to 97. The participants were divided into fourteen age groups. The Han ethnicity constituted the vast majority, with other races comprising only 0.67%. Marital status was categorized into four groups: single, married, divorced, and widowed. The hospital caters to approximately 60 million people across 90,000 square kilometers in the region, making it one of the largest psychiatric hospitals in China. The majority of patients hailed from Shandong, Jiangsu, and Henan provinces, while others came from 30 other Chinese provinces such as Heilongjiang Province and Anhui. The top 10 cities with the highest number of patients were listed based on the cities of admission, with Jining accounting for 69.22%. Residential locations were classified into rural and urban categories. Work nature was divided into seven groups: jobless, farmers, workers, students, public servants, retirees, and others, with the jobless comprising 51.70% of the total.

The six severe mental disorders defined by the Mental Health Law of the People's Republic of China include: schizophrenia, bipolar disorder, persistent delusional disorder (paranoid mental disorder), mental retardation with associated mental disorders, mental disorders due to epilepsy, schizoaffective disorder. According to the severity of the disease, we divided the patients into two groups: general and severe. According to the *ICD-10* diagnostic criteria, we divided the disease into 22

categories for analysis, including schizophrenia, bipolar affective disorder, depressive episode, recurrent depressive disorder, dissociative [conversion] disorders, and so forth. The most frequently treated mental illnesses in this region are schizophrenia, bipolar affective disorder and depressive episodes (Table 1).

Meanwhile, the results of hepatitis B and hepatitis C tests in 23,628 non-psychiatric patients from 2017 to 2023 were collected at the Medical Laboratory of the Affiliated Hospital of Jining Medical College as a control group. The average age was 50.79 ± 21.27, ranging from 1 to 98 years old. Among them, 49.82% were males and 50.18% were females.

Laboratory testing

This study used hepatitis B surface antigen (HBs-Ag) as a biomarker for current HBV infection and hepatitis C antibody (Anti-HCV) as a biomarker for HCV infection. According to the admission requirements for psychiatric patients and expert advice [19], psychiatrists provided an application form for hepatitis virus tests to psychiatric patients to psychiatric patients requiring hospitalization. The patients then visited to the laboratory for testing. A 5 mL fasting venous blood sample was collected from the newly admitted patients, centrifuged 4000 rpm for 10 min, and the serum was separated for testing. Enzyme-linked immunosorbent assay (ELISA, Autobio PRODUCTS, INC., China) was used to detect HBs-Ag and anti-HCV. In case where the test results were positive, the samples underwent retesting using a colloidal gold dipstick (colloidal gold method, Intec PRODUCTS, INC.). Only samples that assessed positive upon retesting were reported as positive.

Statistical analysis

Statistical analysis was conducted using SPSS v22 software (IBM Inc., Chicago, USA). Demographic characteristics were analyzed through descriptive analysis. The analysis of categorical data involved the use of Pearson chi-square test, continuity correction, or Fisher's exact tests. The association between potential risk factors and each infectious biomarker was assessed using odds ratio (OR) with 95% confidence intervals (95% CIs) through logistic regression for both univariate and multivariate analyses. $P < 0.05$ was considered statistically significant. The multivariate logistic regression analysis employed the Enter Stepwise strategy.

Results

Positive rate of hepatitis virus infection in psychiatric patients and non-psychiatric patients

In this study population, the infection rate of hepatitis viruses (including HBV and HCV) in psychiatric patients was 3.82%. The infection rate of HBV was 3.60% (95% CI 3.46–3.74%) (2371/65911), while the infection rate of HCV was 0.23% (95%CI 0.19–0.27%) (150/65911), with four cases being infected with both HBV and HCV. The hepatitis virus infection rate in non-psychiatric patients was 3.89%. The infection rate of HBV was 3.55% (95% CI 3.31–3.79%) (838/23628), while the infection rate of HCV was 0.35% (95% CI 0.31–0.39%) (83/23628), with two cases being infected with both HBV and HCV.

There was no significant difference in the infection rate of HBV between psychiatric patients and non-psychiatric patients ($p = 0.719$), but there was a significant difference in the infection rate of HCV between psychiatric patients and non-psychiatric patients ($p = 0.001$).

HBV infection rates from 2017 to 2023 exhibited statistically significant variances in both patients with and without psychiatric disorders (p for $\chi 2$ value was 0.000 and 0.046, respectively) (Table 2), whereas HCV infection rates did not show statistical significance.

From 2017 to 2023, the infection rates of HBV showed a decreasing trend in psychiatric patients and non-psychiatric patients ($p = 0.000$ and $p = 0.042$, respectively). During the same period, there was no significant change in HCV positive rates in either psychiatric patients or non-psychiatric patients ($p = 0.200$ and $p = 0.604$, respectively) (Fig. 1).

The pattern of HBV infection rates with age was similar in psychiatric and non-psychiatric patients. In psychiatric patients, the HBV infection rate exhibited a positively skewed distribution with age, peaking in the 36–40 age group and lowest point in the 5–15 age group. Similarly, in non-psychiatric patients, the HBV infection rate displayed a positively skewed distribution with age, peaking in the 26–30 age group and the lowest in hitting its 5–15 age group (Fig. 2).

HCV infection rates in both psychiatric patients and non-psychiatric patients generally increased with age (p values of trend test were $p = 0.000$ and $p = 0.000$, respectively). The infection rate of HCV was higher among psychiatric patients in the 76–97 age group and among non-psychiatric patients in the 51–55 age group (Fig. 2).

Chi-square test analysis results

The chi-square test analysis showed that the HBV infection rate was significantly different among sex, age, marital status, occupation, residence, region, and severity. Various mental illnesses were classified and analyzed, revealing significant statistical differences in HBV infection rates among diverse types of psychosis (Table 3). Males exhibited a higher HBV infection rate than females ($p = 0.000$). Divorced individuals had the highest HBV infection rate compared to other marital statuses. Students had the lowest HBV infection rate compared to other occupations. Rural areas had a higher HBV infection rate than urban areas. Patients with severe mental

Table 1 Demographic characteristics of the psychiatric patients

Variables		Number	Percentage (%)
Sex	Female	36,612	55.55
	Male	29,299	44.45
Age(year)	5–15	3074	4.66
	16–20	5507	8.36
	21–25	4345	6.59
	26–30	5345	8.11
	31–35	6945	10.54
	36–40	5711	8.66
	41–45	4975	7.55
	46–50	5946	9.02
	51–55	6974	10.58
	56–60	5351	8.12
	61–65	4119	6.25
	66–70	3722	5.65
	71–75	2247	3.41
	76–97	1635	2.48
	Missing	15	0.02
Ethnicity	Han	65,384	99.20
	Others	441	0.67
	Missing	86	0.13
Marital status	Single	16,983	25.77
	Married	46,256	70.18
	Divorced	2104	3.19
	Widowed	322	0.49
	Missing	246	0.37
Occupation	Jobless	34,077	51.70
	Farmer	11,776	17.87
	Worker	4382	6.65
	Student	7715	11.71
	Public servant	1222	1.85
	Retired	3168	4.81
	Other	3205	4.86
	Missing	366	0.56
Residence	Urban	17,132	25.99
	Rural	48,397	73.43
	Missing	382	0.58
Region	Jining	45,624	69.22
	Heze	9111	13.82
	Zaozhuang	3318	5.03
	Taian	2881	4.37
	Linyi	1653	2.51
	Xuzhou	656	1.00
	Jinan	455	0.69
	Puyang	204	0.31
	Liaocheng	180	0.27
	Other	1598	2.42
	Missing	231	0.35
Severity	Severe	28,608	43.40
	General	37,303	56.60
Psychosis type	Schizophrenia	16,798	25.49
	Bipolar affective disorder	11,506	17.46
	Depressive episode	9751	14.79
	Recurrent depressive disorder	9809	14.88

Table 1 (continued)

Variables		Number	Percentage (%)
	Dissociative [conversion] disorders	3945	5.99
	Mental and behavioural disorders due to use of alcohol	2983	4.53
	Other mental disorders due to brain damage and dysfunction and to physical disease	2038	3.09
	Somatoform disorders	1380	2.09
	Anxiety disorder	1625	2.47
	Manic episode	707	1.07
	Mental retardation	615	0.93
	Obsessive-compulsive disorder	611	0.93
	Nonorganic sleep disorders	710	1.08
	Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1223	1.86
	Reaction to severe stress, and adjustment disorders	357	0.54
	Acute and transient psychotic disorders	242	0.37
	Mental and behavioural disorders due to use of methamphetamine	160	0.24
	Mental disorders due to epilepsy	231	0.35
	Dementia in Alzheimer's disease	187	0.28
	Dementia in other diseases classified elsewhere	85	0.13
	Others	842	1.28
	Missing	106	0.16

Table 2 Annual trends of HBV and HCV infection rates in psychiatric patients and non-psychiatric patients

Biomarkers		Years							*p* for χ2 value	*p* for trend
		2017	2018	2019	2020	2021	2022	2023		
HBsAg	Positive rate of psychiatric patients (%)	4.24	4.04	3.66	3.41	3.35	3.24	3.23	0.000	0.000
	Positive rate of non-psychiatric patients (%)	4.21	3.99	3.71	2.81	3.52	3.58	3.28	0.046	0.042
Anti-HCV	Positive rate of psychiatric patients (%)	0.28	0.28	0.26	0.14	0.17	0.19	0.25	0.242	0.200
	Positive rate of non-psychiatric patients (%)	0.22	0.48	0.46	0.31	0.34	0.43	0.17	0.290	0.504

illnesses had a higher HBV infection rate than those with general mental illnesses. Among several types of psychiatric disorders, "mental disorders due to epilepsy" had the highest HBV infection rate (Table 3).

HCV infection rates varied significantly among different age groups, marital status, occupations, and types of mental illnesses. The 76–97 age group exhibited the highest HCV infection rate compared to other age groups, while the married individuals had the highest HCV infection rate among different marital statuses. Student had the lowest HCV infection rate compared to other occupations. Compared to other types of mental illness, the "dementia in other diseases classified elsewhere" had the highest HCV infection rate (Table 3).

Logistic regression analysis results

The adjusted binary logistic regression multivariate analysis was used to analyze the relationship between hepatitis virus infection and potential risk factors. The results showed that the HBV infection rate in psychosis patients was associated with sex, age, occupation, residence, and region (Table 4).

[a] adjusted results by binary logistic regression multivariate analysis.

Compared with females, males become a risk factor for HBV infection (OR = 1.383, 95% CI: 1.261–1.517, $p = 0.000$). Age has also been identified as a risk factors for HBV infection in psychiatric patients, particularly in the 36–40 age group (OR = 9.837, 95%CI: 4.008–24.143, $p = 0.000$) compared to the 5–15 years old age group. Among various occupations, jobless individuals and students were associated with the hepatitis B infection rate in psychiatric patients. Students, in comparison to jobless individuals, were found to be a protective factor against HBV infection (OR = 0.381, 95% CI: 0.227–0.640, $p = 0.000$). Additionally, the rural population had a higher HBV infection rate compared to the urban population, making it a risk factor for HBV infection in psychiatric patients (OR = 1.228, 95% CI: 1.091–1.383, $p = 0.001$). Significant regional variations were observed in the infection rate of HBV among psychiatric patients, while no significant differences were found in different psychiatric types (Table 4).

The adjusted binary logistic regression multivariate analysis showed that HCV infection rates were associated with age, occupation, residence, and psychosis types (Table 4). Compared with the urban population, the HCV infection rate was lower in the rural population, and rural area became a protective factor for HCV infection

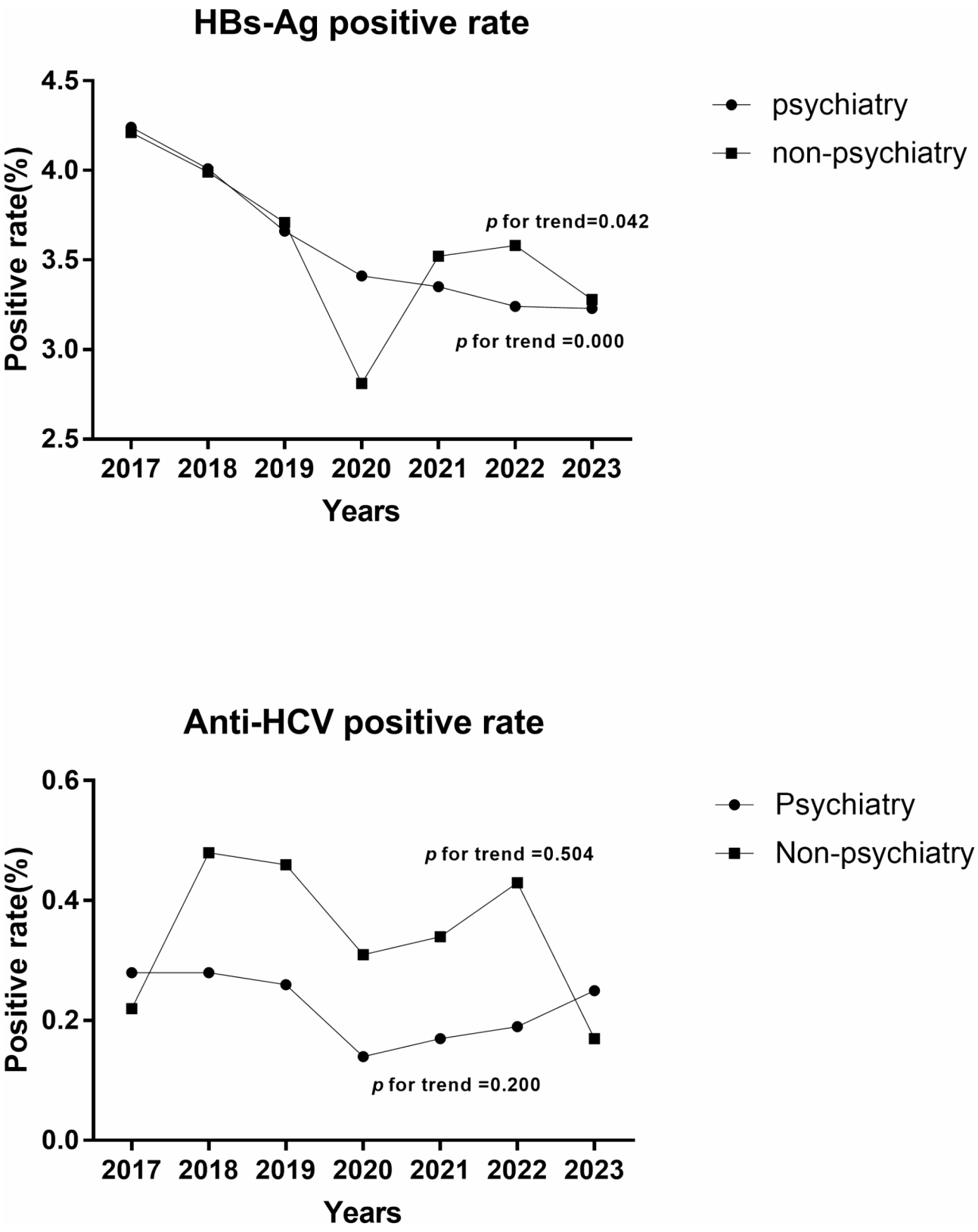

Fig. 1 Time trends in HBs-Ag positive rate and Anti-HCV positive rate in psychiatric patients and non-psychiatric patients

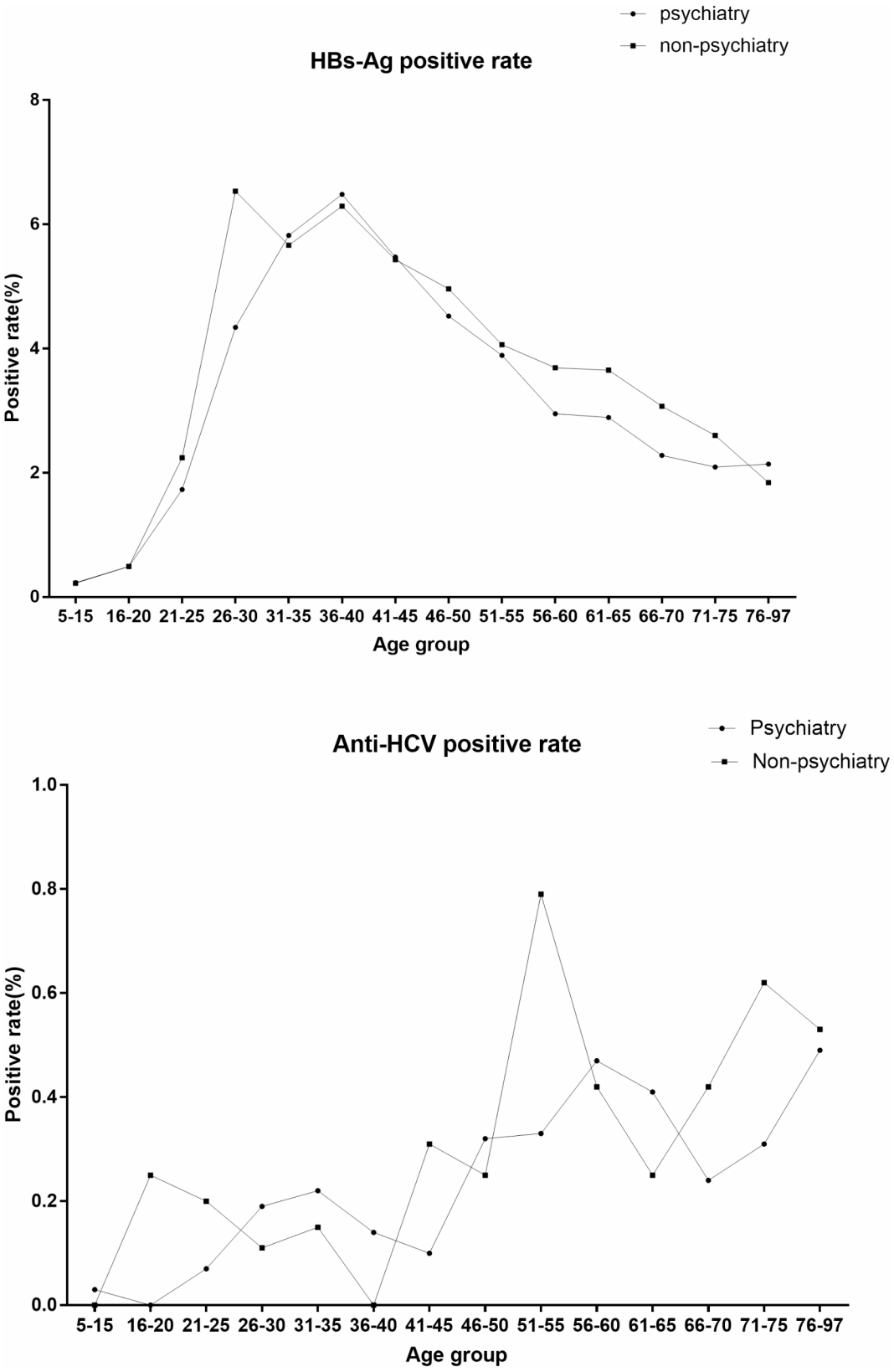

Fig. 2 Age trends in HBs-Ag positive rate and Anti-HCV positive rate in psychiatric patients and non-psychiatric patients

Table 3 Chi-square test analysis results

Variables		number	HBV				HCV			
			positive	Positive rate (%)	χ^2	*p*	positive	Positive rate (%)	χ^2	*p*
Sex	Female	36,612	1117	3.05	70.897[a]	**0.000**	84	0.23	0.012a	0.911
	Male	29,299	1254	4.28			66	0.23		
Age(year)	5–15	3074	7	0.23			1	0.03		
	16–20	5507	27	0.49			0	0.00		
	21–25	4345	75	1.73			3	0.07		
	26–30	5345	232	4.34			10	0.19		
	31–35	6945	404	5.82	663.75[a]	**0.000**	15	0.22	59.24a	**0.000**
	36–40	5711	370	6.48			8	0.14		
	41–45	4975	272	5.47			5	0.10		
	46–50	5946	269	4.52			19	0.32		
	51–55	6974	271	3.89			23	0.33		
	56–60	5351	158	2.95			25	0.47		
	61–65	4119	119	2.89			17	0.41		
	66–70	3722	85	2.28			9	0.24		
	71–75	2247	47	2.09			7	0.31		
	76–97	1635	35	2.14			8	0.49		
Ethnicity	Han	65,384	2349	3.59	0.087[a]	0.768	150	0.23	Fisher[c]	0.630
	Others	441	17	3.85			0	0.00		
Marital status	Single	16,983	375	2.21			14	0.08		
	Married	46,256	1857	4.01			130	0.28		
	Divorced	2104	119	5.66	145.57[a]	**0.000**	5	0.24	22.39[a]	**0.000**
	Widowed	322	7	2.17			0	0.00		
Occupation	Jobless	34,077	1373	4.03			83	0.24		
	Farmer	11,776	509	4.32			37	0.31		
	Worker	4382	183	4.18			11	0.25		
	Student	7715	26	0.34	292.13[a]	**0.000**	1	0.01	20.01[a]	**0.003**
	Public servant	1222	62	5.07			3	0.25		
	Retired	3168	86	2.71			7	0.22		
	Other	3205	115	3.59			8	0.25		
Residence	Urban	17,132	521	3.04	19.83[a]	**0.000**	46	0.27	1.87[a]	0.171
	Rural	48,397	1828	3.78			102	0.21		
Region	Jining	45,624	1706	3.74			113	0.25		
	Heze	9111	357	3.92			20	0.22		
	Zaozhuang	3318	65	1.96			3	0.09		
	Taian	2881	84	2.92			6	0.21		
	Linyi	1653	41	2.48			2	0.12		
	Xuzhou	656	26	3.96	44.63[a]	**0.000**	2	0.30	7.853[a]	0.549
	Jinan	455	11	2.42			0	0.00		
	Puyang	204	4	1.96			1	0.49		
	Liaocheng	180	7	3.89			1	0.56		
	Other	1598	57	3.57			2	0.13		
Severity	Severe	28,608	1158	4.05	29.59[a]	**0.000**	69	0.24	0.41[a]	0.521
	General	37,303	1213	3.25			81	0.22		
Psychosis types	Schizophrenia	16,798	693	4.13			38	0.23		
	Bipolar affective disorder	11,506	447	3.88			29	0.25		
	Depressive episode	9751	275	2.82			14	0.14		
	Recurrent depressive disorder	9809	338	3.45			22	0.22		
	Dissociative [conversion] disorders	3945	149	3.78			14	0.35		

Table 3 (continued)

Variables		number	HBV				HCV			
			positive	Positive rate (%)	χ^2	*p*	positive	Positive rate (%)	χ^2	*p*
	Mental and behavioural disorders due to use of alcohol	2983	157	5.26			11	0.37		
	Other mental disorders due to brain damage and dysfunction and to physical disease	2038	63	3.09			3	0.15		
	Somatoform disorders	1380	30	2.17			3	0.22		
	anxiety disorder	1625	61	3.75			1	0.06		
	Manic episode	707	20	2.83			2	0.28		
	Mental retardation	615	30	4.88			2	0.33		
	Obsessive-compulsive disorder	611	9	1.47			1	0.16		
	Nonorganic sleep disorders	710	24	3.38	143.97[a]	**0.000**	2	0.28	90.55[a]	**0.000**
	Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1223	1	0.08			1	0.08		
	Reaction to severe stress, and adjustment disorders	357	6	1.68			0	0.00		
	Acute and transient psychotic disorders	242	13	5.37			0	0.00		
	Mental and behavioural disorders due to use of methamphetamine	160	9	5.63			0	0.00		
	Mental disorders due to epilepsy	231	16	6.93			1	0.43		
	Dementia in Alzheimer's disease	187	4	2.14			0	0.00		
	Dementia in other diseases classified elsewhere	85	2	2.35			4	4.71		
	Others	842	20	2.38			2	0.24		

[a]Pearson chi-square test. [c]Fisher's exact probability method

in psychiatric patients (OR = 0.576, 95%CI: 0.378–0.880, $p = 0.011$). The "dementia in other diseases classified elsewhere" had the highest HCV infection rate. Compared with "dementia in other diseases classified elsewhere", the schizophrenia, bipolar affective disorder, depressive episode, recurrent depressive disorder, dissociative [conversion] disorders and so forth, become relative protective factors for HCV infection (Table 4).

Compared with non-psychiatric patients, the "Mental and behavioural disorders due to use of alcohol (OR = 1.510, 95% CI: 1.268–1.799, $p = 0.000$)", "Schizophrenia (OR = 1.170, 95% CI: 1.056–1.296, $p = 0.003$)" and "Mental disorders due to epilepsy (OR = 2.023, 95% CI: 1.212–3.378, $p = 0.007$)" become risk factors for HBV infection. The "Behavioural and emotional disorders with onset usually occurring in childhood and adolescence (OR = 0.022, 95% CI: 0.003–0.158, $p = 0.000$)", "Obsessive-compulsive disorder (OR = 0.406, 95% CI: 0.210–0.788, $p = 0.008$)", "Somatoform disorders (OR = 0.604, 95% CI: 0.418–0.873, $p = 0.007$)" and "Depressive episode (OR = 0.789, 95%CI: 0.687–0.906, $p = 0.001$)" become protective factors for HBV infection (Fig. 3a).

Compared with non-psychiatric patients, the "Dementia in other diseases classified elsewhere (OR = 14.072, 95% CI: 5.040-39.288, $p = 0.000$)" becomes a risk factor for HCV infection, while the "Depressive episode (OR = 0.410, 95%CI: 0.232–0.722, $p = 0.002$)" acts as a protective factor against HCV infection (Fig. 3b).

Discussion

Recent studies have shown that the prevalence of HBV infection in psychiatric patients varied from 1.64 to 66.0%, and the prevalence of HCV infection in patients with mental illnesses varied from 0.4-38.0% [20, 21]. In this study, the prevalence of HBV infection in psychiatric patients was 3.60%, indicating a lower infection rate of HBV among patients with mental illness in the region. The infection rate of HCV in psychiatric patients in the study area was 0.23%, which was lower compared to other studies in China. In summary, the prevalence rate of infectious disease among psychiatric patients in parts of eastern China remained at a low level, possibly due to effective health prevention and control strategies and the care provided to psychiatric patients in the region [22, 23].

There was no significant difference in HBV infection rate between psychiatric and non-psychiatric patients, which may benefit from China's hepatitis B prevention policies in recent decades. For example, in 1992, China's hepatitis B vaccine was officially included in the planned immunization management, and in 2005, hepatitis B vaccine was included in the national first-class vaccine, and all newborns were vaccinated free of

Table 4 Analysis results of HBV and HCV risk factors adjusted by multivariate logistic regression analysis

Factors		n	HBV			HCV		
			OR[a]	95%CIa	p	OR[a]	95%CI	p
Sex	Female	36,612	(Ref)			(Ref)		
	Male	29,299	1.383	1.261–1.517	0.000	1.087	0.751–1.574	0.658
Age(year)	5–15	3074	(Ref)		0.000	(Ref)		0.001
	16–20	5507	1.220	0.509–2.925	0.655	0.000		0.981
	21–25	4345	2.646	1.080–6.481	0.033	3.220	0.038-271.766	0.605
	26–30	5345	6.276	2.564–15.362	0.000	7.702	0.091-648.959	0.367
	31–35	6945	8.614	3.519–21.087	0.000	8.474	0.099-726.156	0.347
	36–40	5711	9.837	4.008–24.143	0.000	4.733	0.053-425.268	0.498
	41–45	4975	8.305	3.373–20.447	0.000	3.905	0.042-360.984	0.555
	46–50	5946	6.946	2.821–17.105	0.000	11.930	0.137-1037.366	0.277
	51–55	6974	5.851	2.376–14.409	0.000	14.385	0.166-1246.266	0.242
	56–60	5351	4.475	1.806–11.084	0.001	22.331	0.258-1932.827	0.172
	61–65	4119	4.195	1.683–10.457	0.002	20.940	0.239-1831.394	0.182
	66–70	3722	3.432	1.368–8.611	0.009	13.313	0.149-1191.577	0.259
	71–75	2247	3.173	1.238–8.132	0.016	17.633	0.193-1607.080	0.213
	76–97	1635	3.311	1.269–8.637	0.014	33.467	0.369-3032.676	0.127
Marital status	Single	16,983	(Ref)		0.699	(Ref)		0.993
	Married	46,256	0.941	0.813–1.088	0.411	1.057	0.524–2.131	0.878
	Divorced	2104	1.006	0.803–1.261	0.960	1.181	0.400-3.488	0.763
	Widowed	322	0.729	0.338–1.572	0.420	0.000		0.994
Occupation	Jobless	34,077	(Ref)		0.001	(Ref)		0.379
	Farmer	11,776	1.025	0.922–1.138	0.652	1.222	0.823–1.814	0.321
	Worker	4382	0.927	0.780–1.100	0.384	0.838	0.420–1.672	0.616
	Student	7715	0.381	0.227–0.640	0.000	0.274	0.012–6.484	0.422
	Public servant	1222	1.149	0.871–1.515	0.326	0.741	0.224–2.451	0.624
	Retired	3168	1.089	0.851–1.395	0.499	0.420	0.181–0.978	0.044
	Other	3205	0.787	0.640–0.968	0.024	0.931	0.424–2.042	0.858
Residence	Urban	17,132	(Ref)			(Ref)		
	Rural	48,397	1.228	1.091–1.383	0.001	0.576	0.378–0.880	0.011
Region	Jining	45,624	(Ref)		0.000	(Ref)		0.862
	Heze	9111	1.134	1.007–1.278	0.038	1.101	0.680–1.782	0.697
	Zaozhuang	3318	0.569	0.442–0.732	0.000	0.433	0.137–1.368	0.154
	Taian	2881	0.796	0.635–0.997	0.047	1.016	0.445–2.319	0.971
	Linyi	1653	0.691	0.502–0.952	0.024	0.594	0.146–2.413	0.466
	Xuzhou	656	1.106	0.742–1.647	0.622	1.408	0.345–5.744	0.634
	Jinan	455	0.743	0.406–1.359	0.335	0.000		0.993
	Puyang	204	0.518	0.191–1.401	0.195	0.000		0.996
	Liaocheng	180	0.980	0.457–2.102	0.958	2.973	0.409–21.612	0.282
	Other	1598	0.992	0.746–1.319	0.958	0.616	0.151–2.515	0.500
Severity	Severe	28,608	(Ref)			(Ref)		
	General	37,303	1.085	0.432–2.724	0.862	0.254	0.0272.353	0.228
Psychosis type	Schizophrenia	16,798	0.641	0.381–1.079	0.094	0.022	0.002–0.265	0.003
	Bipolar affective disorder	11,506	0.665	0.394–1.122	0.127	0.025	0.002–0.303	0.004
	Depressive episode	9751	0.609	0.220–1.688	0.341	0.055	0.017–0.175	0.000
	Recurrent depressive disorder	9809	0.639	0.231–1.769	0.389	0.061	0.020–0.186	0.000
	Dissociative [conversion] disorders	3945	0.636	0.228–1.773	0.387	0.112	0.035–0.361	0.000
	Mental and behavioural disorders due to use of alcohol	2983	0.608	0.218–1.696	0.342	0.099	0.029–0.336	0.000
	Other mental disorders due to brain damage and dysfunction and to physical disease	2038	0.611	0.215–1.738	0.356	0.030	0.007–0.140	0.000
	Somatoform disorders	1380	0.441	0.150–1.293	0.136	0.047	0.010–0.216	0.000
	anxiety disorder	1625	0.678	0.238–1.928	0.466	0.016	0.002–0.146	0.000
	Manic episode	707	0.531	0.176–1.607	0.263	0.129	0.023–0.736	0.021

Table 4 (continued)

Factors		n	HBV			HCV		
			OR[a]	95%CIa	p	OR[a]	95%CI	p
	Mental retardation	615	0.982	0.350–2.753	0.972	0.173	0.027–1.089	0.062
	Obsessive-compulsive disorder	611	0.331	0.099–1.109	0.073	0.101	0.011–0.939	0.044
	Nonorganic sleep disorders	710	0.645	0.216–1.924	0.432	0.064	0.011–0.358	0.002
	Behavioural and emotional disorders with onset usually occurring in childhood and adolescence	1223	0.135	0.014–1.308	0.084	0.891	0.019–40.963	0.953
	Reaction to severe stress, and adjustment disorders	357	0.277	0.076–1.013	0.052	0.000		0.993
	Acute and transient psychotic disorders	242	0.825	0.256–2.657	0.747	0.000		0.994
	Mental and behavioural disorders due to use of methamphetamine	160	0.353	0.076–1.644	0.185	0.000		0.996
	Others	842	0.440	0.154–1.258	0.126	0.060	0.010–0.374	0.003
	Dementia in Alzheimer's disease	187	0.501	0.121–2.075	0.341	0.000		0.995
	Dementia in other diseases classified elsewhere	85	0.499	0.088–2.825	0.432	(Ref)		0.003
	Mental disorders due to epilepsy	231	(Ref)		0.129	0.049	0.002–1.126	0.059

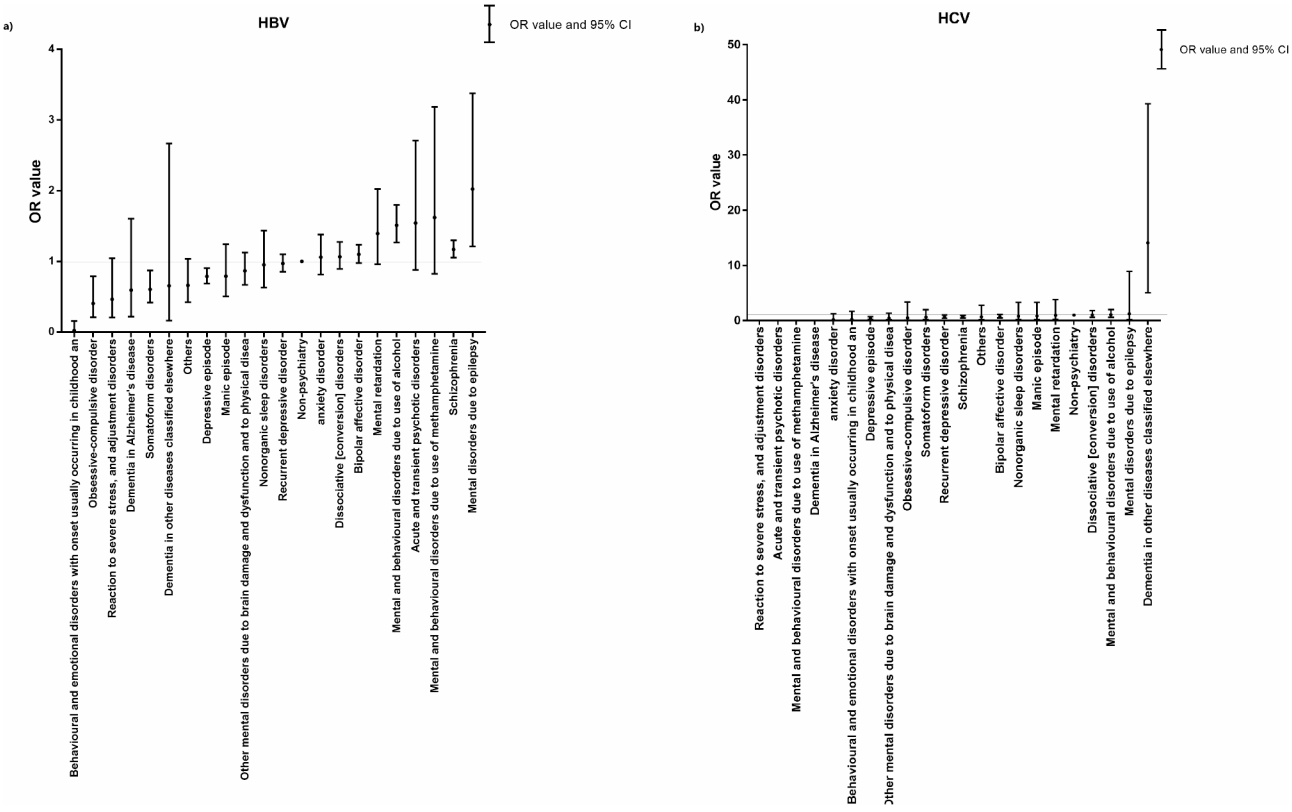

Fig. 3 (**a**) Logistic regression analysis of HBV positive rate in different psychiatric patients and non- psychiatric patients. (**b**) Logistic regression analysis of HCV positive rate in different psychiatric patients and non- psychiatric patients

charge. Optimization of the overall prevention and control strategy, progress in biomedical science and technology, consolidating the foundation of mass prevention and control and updating the prevention and control guidelines are also important factors in reducing HBV infection rate and hepatitis burden in the population. The lower HCV positive rate in psychiatric patients than in non-psychiatric patients is a surprising result that needs more research to clarify. The results of changes in HCV positive rates over time in both psychiatric and non-psychiatric patients also require further research to interpret this result. The positive rate of HBV in non-psychiatric patients decreased significantly in 2020 (in Fig. 1), but no possible explanation has been found.

Being male was identified as a risk factor for HBV infection in mental illness in the present study, which is consistent with other studies [14, 24]. This may be due to the fact that male psychiatric patients have more

opportunities for HBV infection. Possible mechanisms between men and HBV infection include sexual transmission, blood-borne transmission, mother-to-child vertical transmission, iatrogenic transmission, and close contact transmission. To prevent HBV infection, men are advised to pay attention to personal hygiene, avoid unprotected sexual contact, use safe medical devices and hygiene products. HBV detection should be intensified in male patients with mental disorders.

In this study, age emerged as a significant factor influencing HBV infection but not HCV infection in psychiatric patients. The 5–15 age group exhibited the lowest HBV infection rate, possibly due to the increased care provided to mentally ill adolescents by their families, reducing their exposure to pathogens [25]. In 2005, hepatitis B vaccine was officially included in China's national Class A vaccine, which means that all newborns can receive free hepatitis B vaccine , and students have a better effect of vaccination. This should be the result of a combination of age and vaccine policy.

A study in a central China on the prevalence of HBV infection in the general population under 15 years old reported a HBs-Ag prevalence of 0.8% [26], This finding may suggest a lower HBV infection rate among both psychiatric and non- psychiatric patients under 15 years old in the study area. Psychiatric patients aged from 36 to 40 years had the highest HBV infection rate, and the reasons need to be further studied. A study in a Brazil identified the age group of 18–29 years as a risk factor for HBV infection compared to the age group of ≥ 30 years (PRR = 2.23, 95% CI: 1.53–3.20) [27], a result that contrasts with this study and may be due to geographic or other differences factors. Some studies suggest that age is a crucial factor for HCV infection [28]. Although multivariate regression analysis in this study did not show an association between age and the risk of HCV infection, for both psychiatric and non-psychiatric patients in the region, the trend test of HCV infection rate with age revealed a significant difference. Screening for HCV infection should prioritize the elderly population.

In this study, rural living emerged as a risk factor for HBV infection among mental patients compared to urban areas. This could be attributed to the superior medical and health conditions as well as better HBV vaccination services in urban areas [26]. Surprisingly, rural living was found to be a protective factor for HCV infection in this study. The impact of residence on HBV and HCV infection in psychiatric patients, showed contrasting results, indicating the need for further studies to elucidate this phenomenon.

Some studies argue that compared with the general population, high-risk behaviors in patients with severe mental illness increase the risk of infectious diseases, such as HBV, HCV and other types of hepatitis viruses [29]. The prevalence of HBV infection in patients with severe mental illness ranges from approximately 0.53–9.7%, and the prevalence of HCV infection ranges from approximately 1.29–8.0%, tending to be higher than in the general population [16, 30, 31]. In this study, the HBV infection rate in patients with severe mental illness was consistent with existing studies, and the HCV infection rate was relatively low. Patients with severe mental illness had a higher HBV infection rate than patients with general mental illness, but adjusted regression analysis showed that severe mental illness was not a risk factor. Therefore, further studies are needed to shed light on this phenomenon.

Of particular concern is the fact that epidemiological studies conducted over the past 30 years have shown a higher risk of infection with blood-borne viruses (HIV, hepatitis B and C) [32]. These viruses pass through contaminated body fluids (blood and blood products; Contaminated instruments and needles; Semen and vaginal fluid). Transmission can also occur through unprotected sex (anal, vaginal, or oral), vertical mother-to-child transmission, and sharing drug injection equipment. There is evidence that people with mental illness are at higher risk of contracting HIV, hepatitis B and hepatitis C compared to the general population. In general, people with mental illness are less informed about the spread of infectious diseases and measures to protect against them. In addition, they have risky sexual behavior and substandard living or hospital conditions. These may be factors that increase the risk of these infections spreading in people with mental illness [33]. Mental patients have low awareness of infectious disease transmission and protective measures. Engaging in risky sexual behaviors, including not using condoms, having multiple partners, trading sex, and having unprotected sex with a partner infected with the blood-borne virus can all contribute to increased infection rates. In regions with low blood-borne virus prevalence, such as the United States and Europe, the prevalence of blood-borne virus infection is higher in people with severe mental illness than in the general population, and in regions with high blood-borne virus prevalence (HIV prevalence in Africa and hepatitis B and C virus prevalence in Southeast Asia), the prevalence is comparable to that of the general population. Epidemiological studies have shown that severe mental illness is a risk factor for blood-borne viral infection. Many people with serious mental health problems engage in behaviors that increase their risk of contracting the blood-borne virus, including having unprotected sex with multiple partners, sex work (or sex trafficking - trading sex for goods), and intravenous drug use (or having a sex partner who is an injecting drug user) [31]. Severe mental illness is unlikely to be the only risk factor, and the risk of blood-borne viral infection may be multifactorial and associated

with low socioeconomic status, drug and alcohol abuse, ethnic origin, and gender.

At present, the research on intravenous drug abuse and hepatitis virus infection mainly focuses on HCV. Of the most common routes of transmission of hepatitis C virus, intravenous drug use (IVDU) remains the most common route [34], with HCV occurring in up to 90% of people who inject drugs. Most new and existing cases of HCV are associated with injecting drug use, and the prevalence of mental illness is high in this population [35]. The incidence of hepatitis C virus infection among people with severe mental illness is reported to be 11 times higher than in the general population, and as high as 25% in some study samples of people with severe mental illness [36]. Psychiatric and substance use disorders are factors that make people susceptible to HCV [37]. Psychiatric and substance use disorders are common comorbidities of people infected with HCV, and 30 to 98% of people who inject drugs are infected with the hepatitis C virus [38]. Of these HCV-infected patients with combined psychiatric and substance use disorders, 85% were diagnosed with depression, 71% with anxiety, 43% with post-traumatic stress disorder, 42% with psychotic disorder, and 30% with bipolar disorder [39]. At the same time, people with hepatitis C have a higher risk of depression [40]. Follow-up studies should add factors such as intravenous drug abuse and substance use disorders.

The current research on the classification of mental illness and hepatitis virus infection mainly focuses on schizophrenia. The prevalence of HBV infection in Chinese schizophrenia patients ranges from 6.75–11% [15, 41, 42]. In contrast, the HBV infection rate of patients with schizophrenia in the study area was at a low level. Previous studies have shown that the HCV infection rate of schizophrenia patients was 1.9-2.1% [42, 43]. In comparison with existing studies, the HCV infection rate of schizophrenia patients in this study area was maintained at a low level. HCV positivity was found to be a potential risk factor for the development of schizophrenia in a population-based cohort study [44]. Therefore, HBV and HCV testing are essential in patients with mental illness.

Studies have reported higher HBV and HCV seroprevalence in individuals with alcohol use disorder [45]. This study found that HBV and HCV infection rates in people with "mental and behavioural disorders due to use of alcohol" were higher compared to various psychiatric disorders. When compared with "dementia in other diseases classified elsewhere", the "mental and behavioural disorders due to use of alcohol" associated with a higher HCV infection rate. Similarly, compared to the "non-psychiatry", the "mental and behavioural disorders due to use of alcohol" was associated with HBV infection rate. This suggests that alcohol use may primarily impact HBV or HCV infection in psychiatric patients.

For male patients with mental illness, patients with mental illness aged 30 to 45 years old, rural patients with mental illness, HBV testing should be increased for early detection, early diagnosis, early vaccination. HCV testing should be increased for urban patients with mental illness for early detection, early prevention, and hopefully the development of hepatitis C vaccine.

Limitations

This study conducted an epidemiological analysis of HBV and HCV infection rates in patients with mental illness. The analysis of causality was weak. Given the population and area of our country, it is essential to conduct a domestic multi-center study. The baseline data collected in this study were limited. Future research should gather more detailed background information on the population, such as income, education, and alcohol use, to achieve more scientific and meaningful research results. Studies have shown that patients hospitalized for mental illness often have risk factors for HCV infection. It is cost-effective to test all psychiatric patients in hospitals for HCV [46]. Therefore, it is necessary to test HBV and HCV in hospitalized patients with mental illness to enhance the health status of these patients and improve the effectiveness of hepatitis virus prevention and control.

Conclusion

The rate of HBV and HCV infection among psychiatric patients in this region have remained low. Gender, age, occupation, residence, and types of psychosis were identified as potential influencing factors for hepatitis virus infection.

Abbreviations

HBV	Hepatitis B virus
HCV	Hepatitis C virus
ICD-10	International Classification of Diseases, 10th Revision
HBs-Ag	Hepatitis B surface antigen
Anti-HCV	Hepatitis C antibody

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Author contributions

Heng Zhang and Zheng Shi collected the data, Taixiu Liu and Ruiui Chen wrote the main manuscript text and prepared tables, Deyun Bu prepared figures, Wu Li and Dong Liu designed the study. All authors reviewed the manuscript.

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Data availability

Further inquiries of data can be directed to the corresponding author.

Declarations

Ethics approval and consent to participate
This study was approved by the Ethics Committee of Shandong Daizhuang Hospital (Ethics number: 2023 Research No. 07 -202302KS-1), the need for consent to participate was waived by the Ethics Committee. All experiments were performed in accordance with the Declaration of Helsinki and relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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