

Knowledge, Attitudes, and Practices Regarding Hepatitis B and Liver Cancer Among Liver Cancer Patients and Their Families in China

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Purpose: This study aims to assess the knowledge, attitudes, and practices (KAP) of liver cancer patients and their family members regarding hepatitis B and liver cancer in hospitals in central and western China.

Patients and Methods: A multicenter cross-sectional survey was conducted on liver cancer patients and their families between February 2023 and August 2024. Data were collected using a validated, self-developed questionnaire.

Results: A total of 810 valid questionnaires were analyzed, with 432 (53.33%) respondents being family members. The mean scores for knowledge, attitude, and practice were 7.19 ± 3.68 , 43.71 ± 4.30 , and 39.93 ± 6.06 , respectively. Multivariate logistic regression identified education (OR = 3.009 for high school/technical school; OR = 6.771 for associate degree or above), hepatitis B diagnosis (OR = 1.530), and duration of liver cancer diagnosis (OR=1.690) as significant predictors of knowledge scores. Positive attitudes were linked to higher knowledge scores (OR=1.212), high school/technical school education (OR=1.831), and a monthly per capita income of 10,000–20,000 Yuan (OR=2.964). For practices, predictors included higher knowledge scores (OR=1.067), higher attitude scores (OR=1.241), non-disclosure of income (OR=3.311), current alcohol consumption (OR=0.303), and diabetes (OR=2.175).

Conclusion: Liver cancer patients and their family members demonstrated inadequate knowledge but relatively positive attitudes and proactive practices regarding hepatitis B and liver cancer in hospitals in central and western China. This knowledge–practice gap may reflect cultural norms, family support, or public health campaigns, yet improving knowledge remains essential to sustain positive behaviors. Targeted educational interventions should therefore be integrated into clinical and community care. In particular, future interventions should be tailored to address urban–rural disparities and to actively involve family members in supporting patients. These findings provide practical implications for enhancing health literacy, guiding policymaking, and improving counseling strategies to strengthen disease management and prevention.

Keywords: hepatocellular carcinoma, hepatitis B, liver neoplasms, cross-sectional study, patient education

Introduction

Hepatitis B virus (HBV) remains a significant global public health challenge. The global seroprevalence of hepatitis B surface antigen (HBsAg) was estimated to be 3.9% in 2016, reflecting widespread chronic infection rates worldwide.¹ In China, the burden is even greater, with an estimated HBsAg prevalence of 6.1% and over 80 million people living with chronic hepatitis B virus (CHB) infections as of 2018.^{1–3} According to the World Health Organization (WHO), an estimated 254 million people were living with chronic hepatitis B infection globally in 2022, with 1.2 million new infections occurring each year. The same year, hepatitis B accounted for approximately 1.1 million deaths, predominantly due to complications such as cirrhosis and hepatocellular carcinoma (HCC), a major form of primary liver cancer.⁴

Patients with chronic hepatitis B often face severe complications, including cirrhosis and HCC, which is the third leading cause of cancer-related deaths globally.⁵ In China, the association between hepatitis B and liver cancer is particularly striking, with approximately 80% of all HCC cases attributed to HBV infections.⁶ Recent national reports have highlighted continuing increases in liver cancer rehabilitation needs and disparities in disease outcomes across regions.⁷

Addressing these challenges requires not only clinical interventions but also a deep understanding of public knowledge, attitudes, and practices (KAP) regarding hepatitis B and liver cancer. KAP surveys serve as essential diagnostic tools to assess a population's comprehension, beliefs, and behaviors surrounding specific health issues. Based on the premise that knowledge positively influences attitudes, which subsequently shape behaviors, KAP studies provide a framework to identify deficiencies and inform targeted interventions in health literacy and behavior change.^{8,9} Recent KAP research in China has further emphasized gaps in screening awareness and prevention behaviors among high-risk groups.¹⁰

Given the significant public health burden of hepatitis B and liver cancer in China, this study investigates the Knowledge, Attitudes, and Practices (KAP) of hepatobiliary surgery liver cancer patients and their family members. The survey questions were designed to evaluate essential aspects of awareness, beliefs, and behaviors related to hepatitis B and liver cancer. Specifically, the study examines gaps in knowledge about the disease's risk factors, transmission pathways, prevention methods, and management strategies. Additionally, it explores attitudes toward disease disclosure, stigma, and psychological burdens, as well as practical barriers to treatment adherence, such as cost and accessibility of healthcare services.

These insights are crucial because hepatobiliary surgery patients and their families are at the center of care and decision-making processes, influencing disease outcomes through their understanding and behaviors. By identifying deficiencies in KAP, this study highlights areas requiring targeted interventions, such as public education campaigns, counseling support, and policy reforms to improve affordability and accessibility of care. Recent analyses in China have shown that the liver cancer burden and disease mortality have significant urban-rural disparities, with rural populations consistently demonstrating worse outcomes.¹¹ Several recent KAP studies among high-risk Chinese populations, including screening behavior, reinforce the observed gaps in knowledge and practice.¹⁰ The findings also provide a foundation for developing tailored health promotion strategies and clinical education programs to enhance early detection, treatment compliance, and disease management outcomes for both patients and their families. Furthermore, rising rehabilitation needs among liver cancer patients and increasing attributable risk factors, including demographic aging and regional inequality, have been documented in recent years.⁷

Materials and Methods

Study Design and Participants

This cross-sectional study was conducted between February 15, 2023, and August 31, 2024, at four institutions: the First Affiliated Hospital of Army Medical University, the Second Affiliated Hospital of Chongqing Medical University, the First Affiliated Hospital of Zhengzhou University, and Xuanhan County People's Hospital. The study population included inpatients with liver cancer in hepatobiliary surgery departments and their family members. Ethical approval was obtained from Ethics Committee the First Affiliated Hospital of Army Medical University (Approval No.: (A) KY2023025). This study was registered on the website of Chinese Clinical Trial Registry (registration number: ChiCTR2300068582), and informed consent was secured from all participants. Inclusion Criteria: 1) Patients diagnosed with primary liver cancer and their family members (including informed family members or immediate relatives), with no restrictions on age, gender, or treatment status (initial or repeat treatment). 2) Individuals who were aware of the patient's condition and voluntarily agreed to participate in the study. 3) In cases where the patient was unaware of their condition, the patient was excluded from the questionnaire survey, but their family members could still participate. Exclusion Criteria: 1) Patients with severe liver failure, such as hepatic coma, mental confusion, or other conditions that would impede the completion of the questionnaire. 2) Patients or their family members who declined to participate in the study. This study protocol has been approved by the Ethics Committee of the First Affiliated Hospital of Army Medical University Hospital and obtained the written consent of all participants.

Questionnaire Design

The questionnaire was designed and refined based on feedback from four experts, including one professor of statistics, one professor of epidemiology, and two professors of surgery. A pilot test was conducted with a sample of 39 participants, yielding a reliability score of 0.886, indicating strong internal consistency.

The final version of the questionnaire, written in Chinese, consists of 56 items divided into four dimensions (Figures S1 and S2). The demographic characteristics section includes 18 items, the knowledge dimension comprises 13 items, the attitude dimension includes 14 items, and the practice dimension contains 11 items (Figure S2). Scoring was tailored to the specific format of each dimension. In the knowledge dimension, correct answers were awarded 1 point, while incorrect or “unsure” answers were assigned 0 points. The attitude and practice dimensions were assessed using a 5-point Likert scale. For the attitude dimension, items 1–3, 5–7, 10, and 12 were scored on a scale from 5 to 1 for response options a to e, while items 4, 8, 9, and 11 were reverse-scored from 1 to 5. Items 13 and 14 were excluded from scoring, resulting in a total possible score range of 12–60. Attitude scores were categorized as follows: 12–30 indicated a negative attitude, 31–42 indicated a neutral attitude, and 43–60 indicated a positive attitude. In the practice dimension, items 1 and 3–10 were scored from 5 to 1 for options a to e, while item 2 was reverse-scored from 1 to 5. Item 11 was not scored, yielding a total possible score range of 10–50. Practice scores were similarly categorized: scores of 10–25 indicated negative practices, 26–35 indicated neutral practices, and 36–50 indicated positive practices. The scoring criteria were based on prior research, where a score below 50% was defined as poor, while a score above 70% was regarded as good.¹² These thresholds were adapted for pragmatic classification in this study, but we acknowledge that they may not be universally accepted and should be interpreted with caution.

Data Collection and Quality Control

Six well-trained research assistants conducted regular reviews of hepatobiliary surgery inpatients to identify and enroll eligible participants. For patients and family members who met the inclusion criteria, the research assistants provided on-site guidance to access and complete the questionnaire online via *SoJump* (<https://www.wjx.cn/>) platform by scanning a QR code. Although *SoJump* is widely used in China, we acknowledge that relying on an online self-administered platform may introduce potential digital literacy or access bias, particularly among older or rural participants. To mitigate this, trained research assistants were present to provide technical support and ensure that participants could complete the questionnaire without undue difficulty. While assistants addressed any questions regarding unclear items, they ensured that their explanations did not influence the participants’ responses. The hospital centers involved in this study were recruited through the researchers’ personal networks, engaging collaborators who expressed interest in participating in the study.

Sample Size Calculation

The sample size for this cross-sectional study was calculated using the standard formula:¹³ $n = Z^2 \times P \times (1 - P)/d^2$, where n represents the required sample size, Z is the Z -score corresponding to the desired confidence level (1.96 for 95% confidence), p is the estimated prevalence of the outcome in the target population, and d denotes the margin of error or precision (commonly set at 0.05 for $\pm 5\%$). In this study, a conservative prevalence estimates of $p=0.5$ was used to maximize the required sample size, ensuring sufficient power for detecting statistically significant results. Substituting these values into the formula, the calculation yielded $n=384$, which represents the minimum number of participants required to achieve reliable and valid results. Considering a potential 20% non-response rate, the final adjusted sample size was increased to $n=480$, ensuring adequate participation to account for incomplete or missing data.

Statistical Analysis

Statistical analyses were conducted using SPSS version 27 (IBM, Armonk, NY, USA) and AMOS version 26 (IBM, Armonk, NY, USA). The overall reliability of the questionnaire was confirmed with a Cronbach’s α of 0.886 based on a pilot test of 39 participants. Normality of data was assessed prior to analysis. For normally distributed data, results are presented as means and standard deviations (SD), and for non-normally distributed data, as medians and interquartile ranges (IQR; 25th and 75th percentiles). Categorical data are expressed as n (%). Group comparisons were performed using t -tests or Wilcoxon-Mann-Whitney tests for two groups and ANOVA or Kruskal-Wallis tests for three or more

groups, depending on the distribution and homogeneity of variance. Correlations between dimension scores were assessed using Pearson's or Spearman correlation coefficients, as appropriate. Univariate and multivariate logistic regression analyses were conducted to examine the associations between demographic characteristics and dimension scores, with variables meeting $p < 0.1$ in univariate analysis included in the multivariate model. Multicollinearity was assessed using variance inflation factors (VIFs) and tolerance values for all covariates. Tolerance ranged from 0.574 to 0.971 and VIF from 1.029 to 1.743, indicating no significant multicollinearity. A two-sided p -value < 0.05 was considered statistically significant. Structural equation modeling (SEM) was used to evaluate the mediating effect of attitudes on the relationship between knowledge and practice, with model fit indices set as RMSEA < 0.08 , SRMR < 0.08 , TLI > 0.8 , and CFI > 0.8 . If the model fit was inadequate, path analysis was conducted.

Results

After collecting the questionnaires, the following cases were excluded: 2 cases where the age was incorrectly filled or the participant was under 18 years old; 4 cases where the response to Question 13 was non-standardized; 9 cases with logical errors in responses to Question 16 of the basic questions; and 3 cases where all three dimensions of the KAP responses were "A". These resulted in 810 valid questionnaires.

Demographic Characteristics

Among the 810 respondents, 722 (89.14%) were from the Southwest Hospital Center, 432 (53.33%) were family members of patients, and 510 (62.96%) were male, with a mean age of 45.00 ± 13.19 years. A total of 98 (12.10%) participants were still consuming alcohol, while 564 (69.63%) were either patients or family members diagnosed with hepatitis B. Additionally, 529 (65.31%) had been diagnosed for more than one year, and 257 (31.73%) had a history of surgery for liver cancer. The mean scores for knowledge, attitude, and practice were 7.19 ± 3.68 (possible range: 0–18), 43.71 ± 4.30 (possible range: 12–60), and 39.93 ± 6.06 (possible range: 10–50), respectively. Moreover, knowledge scores varied significantly based on group ($P < 0.001$), residence ($P < 0.001$), education level ($P < 0.001$), employment status ($P < 0.001$), monthly per capita income ($P < 0.001$), smoking status ($P = 0.019$), health insurance coverage ($P = 0.002$), hepatitis B diagnosis ($P < 0.001$), duration of hepatitis B virus infection ($P < 0.001$), HCC status ($P < 0.001$), duration of liver cancer diagnosis ($P < 0.001$), diabetes status ($P < 0.001$), and history of liver cancer surgery ($P < 0.001$). Similarly, attitude scores were significantly influenced by group ($P < 0.001$), relationship with the patient ($P = 0.003$), residence ($P = 0.001$), education level ($P < 0.001$), employment status ($P < 0.001$), monthly per capita income ($P < 0.001$), health insurance ($P = 0.003$), hyperlipidemia ($P = 0.010$), diabetes ($P < 0.001$), and history of liver cancer surgery ($P = 0.001$). Practice scores also varied significantly by group ($P < 0.001$), relationship with the patient ($P < 0.001$), gender ($P < 0.001$), residence ($P < 0.001$), education level ($P < 0.001$), employment status ($P < 0.001$), monthly per capita income ($P < 0.001$), smoking status ($P < 0.001$), alcohol consumption status ($P = 0.013$), health insurance ($P < 0.001$), hepatitis B diagnosis ($P = 0.049$), presence of other chronic conditions ($P = 0.002$), hyperlipidemia ($P = 0.002$), and diabetes ($P < 0.001$) (Table 1).

Distribution of Responses to Knowledge, Attitude, and Practice

Within the knowledge domain, the items with the lowest correctness rates were: "Hepatitis B 'big three positive' is more harmful than 'small three positive'" (K4) at 5.80%, "All primary liver cancers originate from chronic hepatitis B" (K9) at 11.23%, and "Liver function tests cannot indicate liver damage" (K10) at 28.52%. Regarding attitudes, 35.93% of respondents felt depressed, tense, or anxious about liver cancer and its treatment (A8), 31.11% were embarrassed to disclose their diagnosis publicly (A11), and 24.32% believed hepatitis B carriers only needed regular blood tests (A2). For practices, 8.64% of respondents always and 27.28% often forwent treatment due to high costs (P2). Additionally, 7.90% reported never avoiding shared tableware after a hepatitis B diagnosis (P9). Among reasons for not performing regular screening before liver cancer diagnosis (P11), 42.96% were unaware of HCC screening, 43.83% cited lack of symptoms, and 13.21% attributed it to insufficient advice from doctors (Table S1).

Table 1 Demographic Characteristics and KAP Scores

	N (%)	Knowledge		Attitude		Practice	
		Mean ± SD	P	Mean ± SD	P	Mean ± SD	P
Total	810	7.19±3.68		43.71±4.30		39.93±6.06	
Groups			<0.001		<0.001		<0.001
Second Affiliated Hospital of Chongqing Medical University	31 (3.83)	7.90±3.14		43.97±3.70		40.45±5.13	
Southwest Hospital Center	722 (89.14)	7.38±3.57		43.87±4.30		40.23±5.90	
Xuanhan County People's Hospital	38 (4.69)	2.61±2.82		40.74±4.00		33.71±7.21	
First Affiliated Hospital of Zhengzhou University	19 (2.35)	8.21±4.02		43.42±3.55		40.47±4.50	
Relationship with patient			0.904		0.003		<0.001
Patient	378 (46.67)	7.18±3.71		43.24±4.30		39.09±5.80	
Family member	432 (53.33)	7.21±3.64		44.13±4.26		40.67±6.19	
Gender			0.261		0.159		<0.001
Male	510 (62.96)	7.08±3.70		43.55±4.20		39.39±6.21	
Female	300 (37.04)	7.38±3.63		43.99±4.46		40.86±5.69	
Age (years old)	45.00±13.19						
Residence			<0.001		0.001		<0.001
Rural	385 (47.53)	6.51±3.75		43.16±4.45		39.08±5.94	
Urban	382 (47.16)	7.92±3.44		44.30±4.05		40.72±6.06	
Suburban/urban-rural area	43 (5.31)	6.91±3.86		43.47±4.50		40.63±6.16	
Education			<0.001		<0.001		<0.001
Primary school or below	131 (16.17)	4.66±3.93		41.60±4.80		36.94±6.89	
Middle school	233 (28.77)	6.35±3.36		42.94±4.27		39.15±5.89	
High school/technical school	175 (21.60)	7.45±3.53		44.31±4.26		40.59±5.71	
Associate degree or above	271 (33.46)	8.98±2.89		45.01±3.50		41.63±5.31	
Employment status			<0.001		<0.001		<0.001
Employed	267 (32.96)	8.27±3.27		44.53±3.75		41.09±5.68	
Unemployed	132 (16.30)	6.60±3.71		43.04±4.31		38.16±6.17	
Retired	108 (13.33)	8.03±3.25		43.92±4.14		40.40±5.27	
Self-employed	65 (8.02)	7.14±3.37		44.63±4.44		41.12±6.54	
Housewife	66 (8.15)	5.50±4.05		41.83±4.80		39.61±5.25	
Other	172 (21.23)	6.13±3.85		43.21±4.58		38.88±6.64	
Monthly income per capita			<0.001		<0.001		<0.001
<2000	244 (30.12)	6.16±3.95		42.64±4.05		38.28±6.11	
2000-5000	265 (32.72)	7.31±3.45		43.78±4.29		39.89±5.80	
5000-10,000	155 (19.14)	7.99±3.33		44.45±3.95		41.45±6.08	
10,000-20,000	39 (4.81)	9.05±2.85		45.72±3.44		41.23±5.09	
>20,000	17 (2.10)	9.59±2.55		43.71±5.31		43.41±4.56	
Prefer not to disclose	90 (11.11)	7.03±3.79		44.28±5.01		40.72±6.19	

(Continued)

Table I (Continued).

	N (%)	Knowledge		Attitude		Practice	
		Mean ± SD	P	Mean ± SD	P	Mean ± SD	P
Marital status			0.301		0.065		0.336
Married	667 (82.35)	7.13±3.66		43.58±4.31		39.84±5.98	
Divorced/single/widowed	143 (17.65)	7.48±3.72		44.31±4.21		40.38±6.40	
Smoking status			0.019		0.526		<0.001
Never smoked	457 (56.42)	7.47±3.62		43.86±4.40		40.61±6.01	
Used to smoke	217 (26.79)	7.05±3.59		43.56±4.15		39.44±5.61	
Currently smoke	136 (16.79)	6.49±3.91		43.46±4.18		38.43±6.60	
Alcohol status			0.162		0.364		0.013
Never drink	412 (50.86)	7.27±3.69		43.55±4.53		40.54±5.89	
Used to drink	300 (37.04)	7.30±3.54		43.77±4.10		39.39±6.04	
Currently drink	98 (12.10)	6.53±3.99		44.22±3.83		39.04±6.58	
Health insurance			0.002		0.003		<0.001
Social health insurance only	682 (84.20)	7.12±3.69		43.62±4.32		39.73±5.97	
Commercial health insurance only	11 (1.36)	6.27±3.47		43.27±4.50		40.91±7.01	
Both	94 (11.60)	8.30±3.13		44.98±3.69		42.11±5.74	
No insurance	23 (2.84)	5.43±4.44		41.61±4.76		36.70±7.29	
Diagnosed with hepatitis B			<0.001		0.787		0.049
Yes	564 (69.63)	7.54±3.48		43.74±4.21		39.66±6.11	
No	246 (30.37)	6.40±3.99		43.65±4.49		40.57±5.92	
Duration of hepatitis B virus infection/years			<0.001		0.634		0.215
No idea	17 (2.10)	6.06±4.16		42.71±3.70		37.35±7.13	
0	135 (16.67)	6.47±4.01		43.65±4.62		40.70±6.19	
Less than 1 year	99 (12.22)	5.34±3.85		43.60±4.22		40.16±6.44	
1~20	384 (47.41)	7.40±3.50		43.63±4.21		39.74±5.95	
More than 20 years	175 (21.60)	8.46±3.05		44.10±4.33		39.88±5.83	
HCC status			<0.001		0.839		0.653
Initial treatment	511 (63.09)	6.80±3.82		43.74±4.28		40.01±6.35	
Retreatment	299 (36.91)	7.87±3.32		43.67±4.34		39.81±5.54	
Duration of liver cancer diagnosis/years			<0.001		0.897		0.715
Less than 1 year	529 (65.31)	6.78±3.81		43.74±4.13		40.10±6.23	
1-3 years	148 (18.27)	7.82±3.58		43.49±4.31		39.59±5.85	
3-5 years	45 (5.56)	7.96±2.70		43.98±4.94		40.00±5.74	
More tha 5 years	88 (10.86)	8.22±3.02		43.77±4.91		39.49±5.52	
Other underlying or chronic diseases			0.112		0.065		0.002
Hypertension							
Yes	189 (23.33)	7.57±3.71		44.22±4.51		41.10±5.80	
No	621 (76.67)	7.08±3.66		43.56±4.22		39.58±6.10	



Hyperlipidemia			0.062		0.010		0.002
Yes	35 (4.32)	8.31±2.68		45.54±4.34		43.06±4.3	
No	775 (95.68)	7.14±3.71		43.63±4.28		39.79±6.09	
Diabetes			<0.001		<0.001		<0.001
Yes	115 (14.20)	8.25±3.04		45.00±4.27		41.95±5.16	
No	695 (85.80)	7.02±3.74		43.50±4.27		39.600±6.14	
History of liver cancer surgery			<0.001		0.001		0.796
Yes	257 (31.73)	8.16±3.15		44.42±4.35		40.02±5.82	
No	553 (68.27)	6.75±3.82		43.39±4.24		39.90±6.17	
Family history of liver cancer			0.114		0.952		0.138
Yes	149 (18.40)	7.62±3.28		43.73±3.94		39.27±5.75	
No	661 (81.60)	7.10±3.75		43.71±4.38		40.08±6.12	

Correlations Between KAP

Correlation analysis showed significant positive relationships between knowledge and attitude ($r = 0.445$, $P < 0.001$), knowledge and practice ($r = 0.342$, $P < 0.001$), and attitude and practice ($r = 0.477$, $P < 0.001$) (Table S2).

Univariate and Multivariate Analysis

Using the top 70% of scores as the cut-off for each dimension, the number of participants above the cut-off was 298 (36.79%) for knowledge, 489 (60.37%) for attitude, and 629 (77.65%) for practice (Table S3). Multivariate logistic regression showed that with high school/technical school education (OR = 3.009, 95% CI: [1.577, 5.741], $P = 0.001$), with associate degree or above (OR = 6.771, 95% CI: [3.46, 13.251], $P < 0.001$), diagnosed with hepatitis B (OR = 1.530, 95% CI: [1.074, 2.178], $P = 0.018$), and suffered from liver cancer for 1–3 years (OR = 1.690, 95% CI: [1.072, 2.665], $P = 0.024$) were independently associated with good knowledge (Table 2). Concurrently, knowledge score (OR = 1.212, 95% CI: [1.154, 1.273], $P < 0.001$), with high school/technical school education (OR = 1.831, 95% CI: [1.005, 3.336], $P = 0.048$), with monthly per capita income of 10000–20000 yuan (OR = 2.964, 95% CI: [1.005, 8.737], $P = 0.049$), and with diabetes (OR = 2.031, 95% CI: [1.215, 3.395], $P = 0.007$) were independently associated with positive attitude (Table 3). In this analysis, “positive attitude” was defined according to the cutoff score range of 43–60 points, as specified in the Methods section. Moreover, knowledge score (OR = 1.067, 95% CI: [1.008, 1.131], $P = 0.026$), attitude score (OR = 1.241, 95% CI: [1.171, 1.314], $P < 0.001$), non-disclosure of monthly per capita income (OR = 3.311, 95% CI: [1.481,

Table 2 Multivariate Logistic Regression Analysis for Knowledge

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Relationship with patient				
Patient	Ref.			
Family member	0.920 (0.691, 1.224)	0.566		
Gender				
Male	Ref.			
Female	1.136 (0.846, 1.525)	0.396		
Age (years old)	0.989 (0.978, 0.999)	0.038	0.991 (0.976, 1.006)	0.252
Residence				
Rural	Ref.		Ref.	
Urban	1.866 (1.386, 2.514)	<0.001	0.947 (0.635, 1.412)	0.788
Suburban/urban-rural area	1.409 (0.731, 2.714)	0.306	1.005 (0.490, 2.061)	0.989
Education				
Primary school or below	Ref.		Ref.	
Middle school	1.642 (0.951, 2.835)	0.075	1.635 (0.915, 2.923)	0.097
High school/technical school	2.857 (1.645, 4.960)	<0.001	3.009 (1.577, 5.741)	0.001
Associate degree or above	6.521 (3.887, 10.940)	<0.001	6.771 (3.46, 13.251)	<0.001
Employment status				
Employed	Ref.		Ref.	
Unemployed	0.560 (0.362, 0.864)	0.009	1.268 (0.746, 2.153)	0.380
Retired	1.001 (0.640, 1.567)	0.996	1.667 (0.931, 2.982)	0.085
Self-employed	0.534 (0.301, 0.947)	0.032	0.956 (0.509, 1.795)	0.888
Housewife	0.274 (0.143, 0.527)	<0.001	0.634 (0.302, 1.333)	0.230
Other	0.373 (0.245, 0.568)	<0.001	0.669 (0.413, 1.084)	0.103

(Continued)



Table 2 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Monthly income per capita				
<2000	Ref.		Ref.	
2000-5000	1.225 (0.843, 1.780)	0.001	0.691 (0.439, 1.087)	0.110
5000-10,000	1.980 (1.303, 3.008)	0.002	0.787 (0.456, 1.359)	0.391
10,000-20,000	3.031 (1.521, 6.042)	0.002	1.241 (0.546, 2.819)	0.606
>20,000	5.622 (1.912, 16.533)	0.685	2.175 (0.637, 7.425)	0.215
Prefer not to disclose	1.114 (0.662, 1.873)	0.001	0.544 (0.290, 1.020)	0.058
Marital status				
Married	0.715 (0.496, 1.032)	0.074		
Divorced/single/widowed	Ref.			
Smoking status				
Never smoked	Ref.			
Used to smoke	0.757 (0.539, 1.063)	0.108		
Currently smoke	0.754 (0.504, 1.129)	0.170		
Alcohol status				
Never drink	Ref.			
Used to drink	0.904 (0.664, 1.231)	0.522		
Currently drink	0.779 (0.489, 1.243)	0.295		
Health insurance				
Social health insurance only	2.732 (0.919, 8.120)	0.071	2.383 (0.726, 7.822)	0.152
Commercial health insurance only	1.056 (0.162, 6.873)	0.955	1.174 (0.158, 8.707)	0.875
Both	4.005 (1.266, 12.674)	0.018	2.382 (0.675, 8.407)	0.177
No insurance	Ref.		Ref.	
Diagnosed with hepatitis B				
Yes	1.491 (1.083, 2.053)	0.014	1.530 (1.074, 2.178)	0.018
No	Ref.		Ref.	
Duration of hepatitis B virus infection/years				
No idea	Ref.			
0	1.047 (0.346, 3.163)	0.935		
Less than 1 year	0.768 (0.246, 2.401)	0.650		
1-20	1.393 (0.481, 4.034)	0.542		
More than 20 years	2.373 (0.802, 7.019)	0.118		
HCC status				
Initial treatment	Ref.		Ref.	
Retreatment	1.404 (1.046, 1.883)	0.024	1.027 (0.677, 1.558)	0.902
Duration of liver cancer diagnosis/years				
Less than 1 year	Ref.		Ref.	
1-3 years	1.764 (1.217, 2.557)	0.003	1.690 (1.072, 2.665)	0.024
3-5 years	1.145 (0.606, 2.165)	0.677	0.960 (0.452, 2.039)	0.915
More tha 5 years	1.895 (1.201, 2.99)	0.006	1.743 (0.976, 3.112)	0.061

(Continued)

Table 2 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Other underlying or chronic diseases				
Hypertension				
Yes	1.281 (0.918, 1.787)	0.145		
No	Ref.			
Hyperlipidemia				
Yes	1.472 (0.745, 2.909)	0.266		
No	Ref.			
Diabetes				
Yes	1.330 (0.891, 1.985)	0.163		
No	Ref.			
History of liver cancer surgery				
Yes	1.488 (1.099, 2.015)	0.010	0.969 (0.649, 1.447)	0.879
No	Ref.		Ref.	
Family history of liver cancer				
Yes	1.158 (0.804, 1.667)	0.432		
No	Ref.			

Table 3 Multivariate Logistic Regression Analysis for Attitude

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Knowledge score	1.244 (1.192, 1.299)	<0.001	1.212 (1.154, 1.273)	<0.001
Relationship with patient				
Patient	Ref.		Ref.	
Family member	1.619 (1.220, 2.150)	<0.001	1.227 (0.820, 1.837)	0.319
Gender				
Male	Ref.			
Female	1.275 (0.950, 1.711)	0.106		
Age (years old)	0.979 (0.969, 0.990)	<0.001	0.990 (0.973, 1.008)	0.282
Residence				
Rural	Ref.		Ref.	
Urban	2.157 (1.606, 2.898)	<0.001	1.238 (0.825, 1.859)	0.302
Suburban/urban-rural area	1.997 (1.024, 3.897)	0.042	1.721 (0.808, 3.664)	0.159
Education				
Primary school or below	Ref.		Ref.	
Middle school	1.712 (1.103, 2.658)	0.017	1.082 (0.657, 1.783)	0.757
High school/technical school	4.227 (2.610, 6.847)	<0.001	1.831 (1.005, 3.336)	0.048
Associate degree or above	5.551 (3.532, 8.725)	<0.001	1.551 (0.812, 2.962)	0.184

(Continued)



Table 3 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Employment status				
Employed	Ref.		Ref.	
Unemployed	0.372 (0.241, 0.574)	<0.001	0.858 (0.499, 1.474)	0.579
Retired	0.652 (0.406, 1.047)	0.077	0.921 (0.492, 1.721)	0.795
Self-employed	0.655 (0.370, 1.159)	0.146	1.031 (0.536, 1.985)	0.926
Housewife	0.283 (0.162, 0.493)	<0.001	0.726 (0.366, 1.440)	0.359
Other	0.462 (0.309, 0.691)	<0.001	1.031 (0.632, 1.681)	0.903
Monthly income per capita				
<2000	Ref.		Ref.	
2000-5000	2.044 (1.434, 2.912)	<0.001	1.194 (0.780, 1.828)	0.413
5000-10,000	2.761 (1.807, 4.218)	<0.001	1.126 (0.651, 1.946)	0.671
10,000-20,000	8.422 (3.186, 22.263)	<0.001	2.964 (1.005, 8.737)	0.049
>20,000	2.271 (0.814, 6.336)	0.117	0.594 (0.186, 1.901)	0.38
Prefer not to disclose	2.890 (1.724, 4.845)	<0.001	1.809 (0.977, 3.349)	0.059
Marital status				
Married	0.702 (0.479, 1.028)	0.069		
Divorced/single/widowed	Ref.			
Smoking status				
Never smoked	Ref.			
Used to smoke	0.876 (0.630, 1.217)	0.430		
Currently smoke	0.887 (0.600, 1.310)	0.545		
Alcohol status				
Never drink	Ref.		Ref.	
Used to drink	1.064 (0.786, 1.441)	0.687	1.184 (0.826, 1.699)	0.357
Currently drink	1.608 (1.003, 2.579)	0.049	1.560 (0.887, 2.743)	0.123
Health insurance				
Social health insurance only	2.247 (0.959, 5.263)	0.062	2.274 (0.836, 6.187)	0.108
Commercial health insurance only	2.722 (0.616, 12.039)	0.187	3.252 (0.609, 17.359)	0.167
Both	4.537 (1.742, 11.816)	0.002	2.623 (0.859, 8.008)	0.090
No insurance	Ref.		Ref.	
Diagnosed with hepatitis B				
Yes	1.116 (0.823, 1.514)	0.481		
No	Ref.			
Duration of hepatitis B virus infection/years				
No idea	Ref.			
0	1.180 (0.429, 3.245)	0.748		
Less than 1 year	1.489 (0.529, 4.196)	0.451		
1~20	1.387 (0.523, 3.673)	0.511		
More than 20 years	1.399 (0.515, 3.801)	0.511		

(Continued)

Table 3 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
HCC status				
Initial treatment	Ref.			
Retreatment	0.847 (0.633, 1.133)	0.264		
Duration of liver cancer diagnosis/years				
Less than 1 year	Ref.			
1-3 years	0.820 (0.566, 1.188)	0.294		
3-5 years	0.832 (0.449, 1.542)	0.559		
More tha 5 years	0.764 (0.484, 1.205)	0.247		
Other underlying or chronic diseases				
Hypertension				
Yes	1.379 (0.981, 1.939)	0.065		
No	Ref.			
Hyperlipidemia				
Yes	2.287 (1.025, 5.098)	0.043		
No	Ref.			
Diabetes				
Yes	2.525 (1.590, 4.007)	<0.001	2.031 (1.215, 3.395)	0.007
No	Ref.		Ref.	
History of liver cancer surgery				
Yes	1.331 (0.979, 1.809)	0.068		
No	Ref.			
Family history of liver cancer				
Yes	0.968 (0.673, 1.391)	0.860		
No	Ref.			

7.404], P = 0.004), currently drink (OR = 0.303, 95% CI: [0.156, 0.590], P < 0.001), and with diabetes (OR = 2.175, 95% CI: [1.035, 4.568], P = 0.040) were independently associated with practice (Table 4). Diagnostic checks indicated no concerning multicollinearity across models (tolerance 0.574–0.971; VIF 1.029–1.743).

SEM Analysis

The SEM model demonstrated good fit indices (CMIN/DF = 2.585, RMSEA = 0.044; IFI = 0.917; TLI = 0.909; CFI = 0.917) (Table S4). Results indicated that knowledge had a direct effect on attitude ($\beta = 1.136$, P < 0.001), while attitude directly influenced practice ($\beta = 0.816$, P < 0.001) (Table S5 and Figure 1).

Discussion

Liver cancer patients and their family members demonstrated inadequate knowledge but relatively positive attitudes and proactive practices regarding hepatitis B and liver cancer in Chinese hospitals. Targeted educational interventions focusing on improving knowledge about hepatitis B and liver cancer are essential to strengthen attitudes and practices, which may enhance prevention, early detection, and management of these conditions. This apparent contradiction, where practices seem relatively proactive despite limited knowledge, may be explained by cultural and social factors. In China’s

**Table 4** Multivariate Logistic Regression Analysis for Practice

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Knowledge score	1.206 (1.152, 1.262)	<0.001	1.067 (1.008, 1.131)	0.026
Attitude score	1.269 (1.208, 1.333)	<0.001	1.241 (1.171, 1.314)	<0.001
Relationship with patient				
Patient	Ref.			
Family member	1.276 (0.916, 1.776)	0.150		
Gender				
Male	Ref.		Ref.	
Female	1.511 (1.058, 2.157)	0.023	0.824 (0.479, 1.417)	0.484
Age (years old)	0.990 (0.978, 1.003)	0.124		
Residence				
Rural	Ref.			
Urban	1.394 (0.992, 1.957)	0.055		
Suburban/urban-rural area	2.135 (0.875, 5.210)	0.096		
Education				
Primary school or below	Ref.		Ref.	
Middle school	1.986 (1.255, 3.143)	0.003	1.465 (0.858, 2.504)	0.162
High school/technical school	3.181 (1.879, 5.385)	<0.001	1.539 (0.796, 2.978)	0.200
Associate degree or above	3.692 (2.279, 5.983)	<0.001	1.318 (0.669, 2.596)	0.424
Employment status				
Employed	Ref.		Ref.	
Unemployed	0.520 (0.317, 0.855)	0.010	1.022 (0.541, 1.932)	0.946
Retired	1.257 (0.668, 2.366)	0.479	1.289 (0.620, 2.681)	0.497
Self-employed	0.621 (0.324, 1.188)	0.150	0.724 (0.329, 1.592)	0.421
Housewife	0.753 (0.385, 1.474)	0.407	2.218 (0.895, 5.494)	0.085
Other	0.443 (0.281, 0.698)	<0.001	0.800 (0.450, 1.420)	0.445
Monthly income per capita				
<2000	Ref.		Ref.	
2000-5000	1.677 (1.128, 2.493)	0.011	1.443 (0.874, 2.382)	0.152
5000-10,000	2.131 (1.306, 3.478)	0.002	1.605 (0.842, 3.061)	0.151
10,000-20,000	4.111 (1.412, 11.973)	0.010	2.542 (0.752, 8.592)	0.133
>20,000	3.524 (0.787, 15.790)	0.100	4.943 (0.704, 34.695)	0.108
Prefer not to disclose	3.375 (1.700, 6.699)	0.001	3.311 (1.481, 7.404)	0.004
Marital status				
Married	1.103 (0.720, 1.690)	0.651		
Divorced/single/widowed	Ref.			
Smoking status				
Never smoked	Ref.		Ref.	
Used to smoke	0.785 (0.530, 1.163)	0.228	1.070 (0.592, 1.934)	0.823
Currently smoke	0.492 (0.320, 0.755)	0.001	0.827 (0.445, 1.539)	0.550

(Continued)

Table 4 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
Alcohol status				
Never drink	Ref.		Ref.	
Used to drink	0.730 (0.507, 1.050)	0.090	0.639 (0.386, 1.060)	0.083
Currently drink	0.426 (0.262, 0.691)	0.001	0.303 (0.156, 0.590)	<0.001
Health insurance				
Social health insurance only	3.117 (1.349, 7.201)	0.008	2.277 (0.861, 6.025)	0.097
Commercial health insurance only	4.125 (0.726, 23.429)	0.110	4.169 (0.547, 31.778)	0.168
Both	5.712 (2.088, 15.621)	0.001	2.492 (0.782, 7.943)	0.123
No insurance	Ref.		Ref.	
Diagnosed with hepatitis B				
Yes	0.904 (0.628, 1.300)	0.586		
No	Ref.			
Duration of hepatitis B virus infection/years				
No idea	Ref.			
0	1.830 (0.626, 5.348)	0.269		
Less than 1 year	2.155 (0.711, 6.532)	0.175		
1~20	1.978 (0.710, 5.507)	0.192		
More than 20 years	1.783 (0.621, 5.117)	0.283		
HCC status				
Initial treatment	Ref.			
Retreatment	1.160 (0.820, 1.641)	0.400		
Duration of liver cancer diagnosis/years				
Less than 1 year	Ref.			
1-3 years	1.075 (0.692, 1.671)	0.748		
3-5 years	1.186 (0.556, 2.532)	0.659		
More tha 5 years	1.077 (0.623, 1.861)	0.790		
Other underlying or chronic diseases				
Hypertension				
Yes	1.703 (1.106, 2.620)	0.016	1.299 (0.780, 2.164)	0.315
No	Ref.		Ref.	
Hyperlipidemia				
Yes	3.180 (0.962, 10.509)	0.058		
No	Ref.			
Diabetes				
Yes	3.061 (1.606, 5.835)	<0.001	2.175 (1.035, 4.568)	0.040
No	Ref.		Ref.	

(Continued)

Table 4 (Continued).

	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	P	OR (95% CI)	P
History of liver cancer surgery				
Yes	1.241 (0.862, 1.787)	0.245		
No	Ref.			
Family history of liver cancer				
Yes	0.772 (0.512, 1.162)	0.215		
No	Ref.			

collectivist family structures, caregivers often enforce preventive and treatment behaviors on behalf of patients, and long-standing public health campaigns around hepatitis B and liver cancer may further encourage action even in the absence of deep understanding.

These findings are consistent with prior studies that have identified inadequate knowledge as a persistent issue that limits preventive efforts and contributes to poor health outcomes, such as delayed diagnoses and suboptimal compliance with medical recommendations.^{14,15} For instance, misconceptions surrounding hepatitis B transmission, progression to

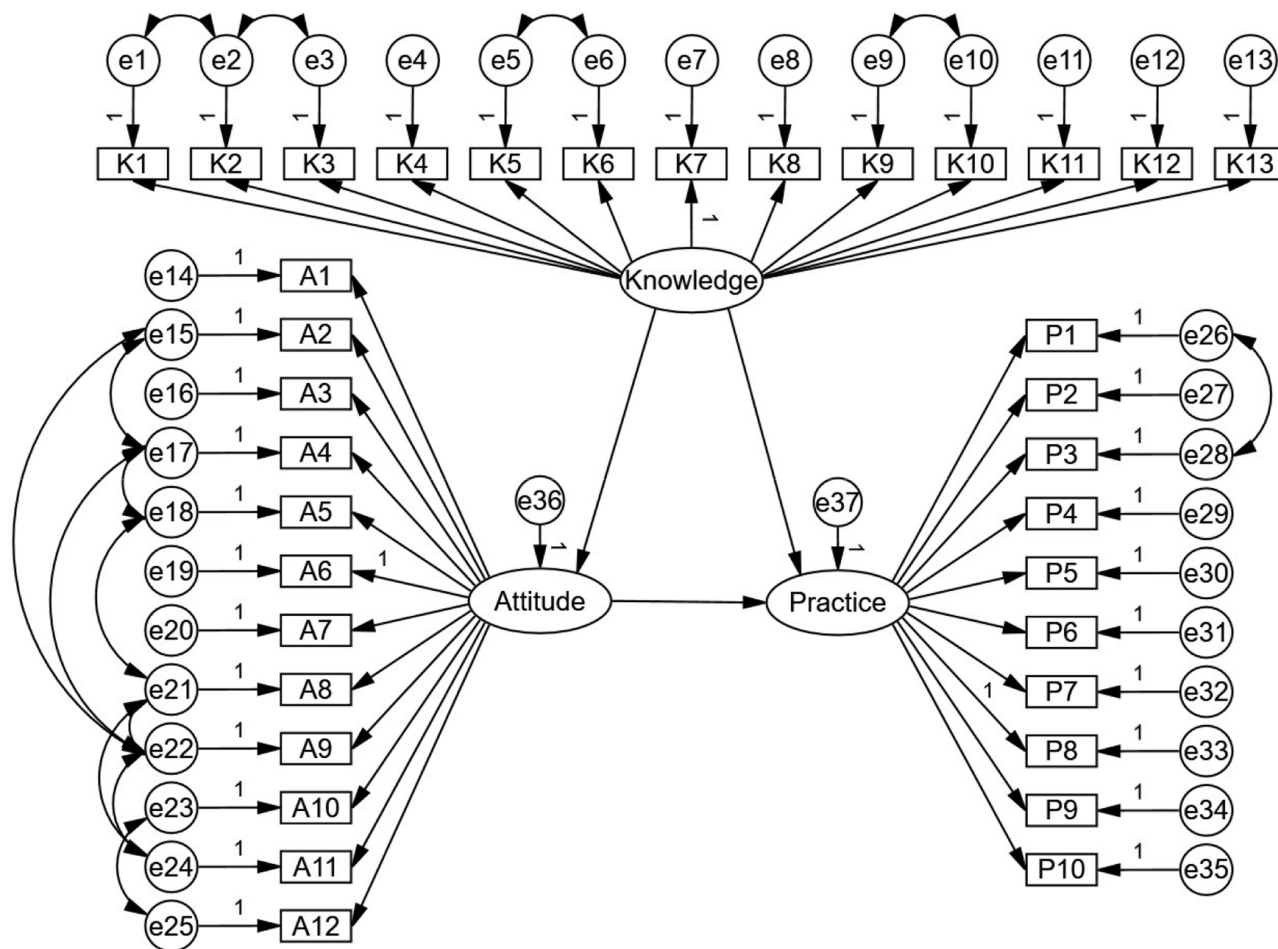


Figure 1 SEM Path.

liver cancer, and the utility of liver function tests are prevalent globally and have been linked to inadequate screening and late-stage detection of liver cancer.^{16,17} The inadequate knowledge observed in this study underscores the need for tailored educational interventions to address these specific misconceptions, which likely hinder effective disease prevention and management. At the same time, the relatively positive attitudes and proactive practices suggest that, when knowledge gaps are addressed, there is a strong foundation upon which to build more effective health behaviors.

The relationships among the KAP dimensions were further clarified through correlation analyses and SEM, which showed that knowledge significantly influenced attitudes, and attitudes, in turn, had a direct and substantial impact on practices. This finding aligns with established health behavior models, which posit that knowledge serves as the foundation for shaping attitudes and motivating positive behaviors.^{18,19} However, the SEM results also revealed that knowledge alone did not have a direct effect on practices, emphasizing the critical mediating role of attitudes in transforming knowledge into action. This suggests that educational programs must go beyond simply disseminating information and instead focus on fostering supportive attitudes to drive meaningful behavioral changes. Similar conclusions have been drawn in studies of other chronic diseases, where interventions targeting attitudes—such as counseling and peer support—have been shown to significantly enhance adherence to preventive and treatment practices.^{20,21} The SEM fit indices (TLI and CFI > 0.80) are interpreted as acceptable given the model complexity, although stricter thresholds (≥ 0.90) are typically recommended, this discrepancy is acknowledged as a limitation.

Significant differences in KAP scores were observed across demographic and clinical variables, shedding light on factors influencing health behaviors in this population. Higher education levels were consistently associated with better knowledge and attitudes, as reflected in both the descriptive and multivariate analyses. For instance, participants with an associate degree or higher had markedly higher knowledge scores, a finding consistent with prior research that links higher education to greater health literacy and better access to health-related resources.^{22,23} Similarly, urban residents outperformed rural residents in both knowledge and practices, reflecting disparities in access to healthcare services and information. These results echo findings from other studies highlighting the urban-rural divide in health behaviors and outcomes,^{24,25} underscoring the urgent need for targeted interventions in underserved rural areas. Clinical factors such as a diagnosis of hepatitis B and liver cancer duration also significantly influenced knowledge, with those diagnosed with hepatitis B (OR = 1.530, P = 0.018) and those diagnosed with liver cancer for 1–3 years (OR = 1.690, P = 0.024) exhibiting higher scores. These findings suggest that direct exposure to healthcare systems and disease-specific information plays a key role in improving knowledge, although such benefits may not extend equally to attitudes and practices without additional support.

The distribution of responses in the knowledge dimension revealed specific areas of concern. Participants showed poor understanding of key concepts, such as the relative harm of “big three positive” versus “small three positive” hepatitis B statuses and the limitations of liver function tests. These gaps mirror findings in other studies that identified similar misconceptions as barriers to early diagnosis and treatment adherence.^{26,27} The attitude dimension also revealed notable challenges, including significant proportions of participants who reported anxiety, stigma, or embarrassment about their diagnosis. Such emotional barriers have been shown to hinder open communication and reduce engagement with healthcare services.^{28,29} In terms of practices, cost emerged as a significant barrier, with many participants forgoing treatments due to financial constraints. This finding aligns with evidence from other settings where high out-of-pocket expenses for liver cancer treatments were associated with lower adherence to medical recommendations.^{30,31} Interestingly, non-disclosure of income was positively associated with better practice scores in this study. This unexpected finding may reflect privacy concerns or cultural attitudes toward discussing finances, rather than a true socio-economic effect. Such associations warrant further qualitative research to clarify underlying motivations.

These findings highlight several areas for intervention. Targeted educational programs should focus on addressing the most misunderstood aspects of hepatitis B and liver cancer, using culturally tailored approaches to reach both urban and rural populations. Community-based health promotion campaigns, delivered through local health workers and community leaders, could help bridge the urban-rural divide. Financial assistance mechanisms, such as expanded health insurance coverage and subsidies for screening and treatment, are critical to reducing cost barriers, particularly for lower-income groups. Psychological support services should be integrated into routine care to address anxiety and stigma, with peer support groups and counseling services playing a pivotal role in fostering positive attitudes.

Interventions addressing substance use, including alcohol and smoking cessation programs, could further improve adherence to preventive and treatment practices. It should be noted that the observed negative association between alcohol consumption and practice scores should not be overinterpreted as causal. Rather, it may reflect broader lifestyle patterns or comorbid risk factors, and should be considered cautiously when informing intervention strategies. For family members, tailored workshops emphasizing their role in supporting patients and promoting regular follow-ups should be developed to strengthen family involvement. Ongoing monitoring and feedback systems, potentially leveraging digital tools such as mobile health apps, could provide patients and families with real-time reminders and educational resources, ensuring sustained improvements in health behaviors.^{32,33} Recent research among high-risk populations in China confirms that liver cancer screening practices remain low despite relatively positive attitudes, indicating that knowledge deficits are a persistent barrier.¹⁰ Moreover, trend analyses show that although age-standardized rates of liver cancer incidence and mortality have declined over time, the absolute numbers and burden remain high, particularly among males and rural populations, suggesting that socioeconomic and structural factors still exert a strong influence.³⁴

This study has several limitations. First, as a cross-sectional survey, it cannot establish causal relationships between knowledge, attitudes, and practices, nor can it assess changes over time. Second, the study relied on self-reported data, which may be subject to social desirability bias, potentially overestimating positive attitudes and practices. Third, the study employed purposive sampling, relying on cooperative hospitals and personal networks for recruitment. This approach may limit the generalizability of the findings, as the participating hospitals could be relatively resource-rich or urban. Nevertheless, purposive sampling was deemed appropriate to ensure feasibility and secure multicenter participation across hepatobiliary surgery departments. Fourth, patients unaware of their diagnosis were excluded, whereas their family members were allowed to participate. This created a partial asymmetry in the dataset, as some family responses may reflect caregiving dynamics without corresponding patient data. However, this approach was ethically necessary to avoid breaching patient confidentiality. Analytically, family member data were treated as an independent but complementary perspective, and subgroup analyses of patients and family members were conducted separately to reduce potential bias from this asymmetry. Finally, the sampling was limited to hospitals in central and western China, which may affect the generalizability of the findings to other regions or healthcare settings. These limitations should be considered when interpreting the results.

Conclusions

In conclusion, liver cancer patients and their family members demonstrated inadequate knowledge but relatively positive attitudes and proactive practices regarding hepatitis B and liver cancer in hospitals in central and western China. This apparent knowledge–practice gap may reflect cultural norms, family involvement, or the influence of large-scale public health campaigns, suggesting that behavior change does not always require comprehensive understanding. Nevertheless, enhancing knowledge remains crucial, as it can consolidate positive attitudes and further reinforce sustainable practices. Targeted educational interventions should therefore be implemented in clinical and community settings to strengthen health literacy and reduce misconceptions, ultimately supporting more effective disease management and prevention. In particular, future interventions should be tailored to address urban–rural disparities and to actively involve family members in supporting patients with liver cancer. These findings also provide practical implications for policymakers and clinicians, including integrating health literacy promotion into routine care, prioritizing caregiver education, and designing programs that link counseling with affordable access to screening and treatment.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

Ethics Approval and Consent to Participate

The study was approved by Ethic Committee of the First Affiliated Hospital of Army Medical University[(A) KY2023025]. All participants were informed about the study protocol and provided written informed consent to participate in the study. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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