

Hepatitis B Vaccination Intention and Influencing Factors among College Students in Huanggang, Hubei, China: A Protection Motivation Theory–Based Cross–Sectional Study

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Abstract:

Objective: This study assessed the intention to receive the hepatitis B vaccine and identified influencing factors among college students in Huanggang, China, using the Protection Motivation Theory (PMT).

Material and Methods: A cross-sectional study was conducted between April and May 2025. Data were collected via PMT-based questionnaire measuring knowledge, preventive behaviors, perceived severity, perceived susceptibility, response efficacy, self-efficacy, and response cost. Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) v27.0 to examine associations between variables and vaccination intention.

Results: Among the 1,130 participants, 58.9% intended to receive the hepatitis B vaccine. In bivariate analyses, higher hepatitis B knowledge, vaccine knowledge, preventive behaviors, and favorable PMT constructs were positively associated with intention. Multivariate logistic regression confirmed independent associations: hepatitis B knowledge (odds ratio [OR]=1.41, 95% confidence interval [CI]: 1.02–1.95), vaccine knowledge (OR=1.49, 95% CI: 1.11–2.00), preventive behaviors (OR=1.60, 95% CI: 1.15–2.23), perceived severity (OR=1.05, 95% CI: 1.01–1.10), self-efficacy (OR=1.10, 95% CI: 1.02–1.18), and response efficacy (OR=1.16, 95% CI: 1.04–1.29) were positive predictors, whereas perceived response cost (OR=0.85, 95% CI: 0.79–0.91) was a negative predictor. Sociodemographic factors were not significant after adjustment.

Conclusion: The findings offer insights into hepatitis B vaccination behavior among college students. This evidence-based information could inform the future direction for improving hepatitis B vaccination rates in university settings by

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focusing health education on the severity of the hepatitis B consequences and the efficacy and safety of the vaccination, all of which could reduce the psychological and practical barriers.

Keywords: college students, hepatitis B, predictors, protection motivation theory, vaccination intention

Introduction

Chronic hepatitis B virus (HBV) infection remains a major global public health challenge, contributing to 1.1 million deaths annually from cirrhosis and hepatocellular carcinoma (HCC)¹, and imposing a substantial economic burden on healthcare systems². China continues to carry one of the largest HBV burdens worldwide. According to recent national statistics, serosurvey, the prevalence of hepatitis B surface antigen (HBsAg) in the general population has declined to 5.86%, corresponding to approximately 75 million people living with chronic HBV infection³. Despite improvements in prevention and disease management, HBV-related liver cancer remains a major concern, accounting for nearly 80% of HCC cases and continuing to rank among the leading causes of cancer incidence and mortality in China⁴⁻⁷.

China launched a nationwide HBV vaccination program for newborns in 1992 and gradually expanded coverage through strong policy and financial support⁸. Since 2002, the HBV vaccine has been fully subsidized by the central government as part of the National Immunization Program, eliminating out-of-pocket costs for infants⁹. Local governments have also supported free or low-cost catch-up vaccination campaigns for children and adolescents, and many universities offer on-campus HBV vaccination at reduced prices through school medical centers or student health insurance programs. These initiatives have contributed to substantial declines in HBV prevalence among younger generations.

With high full-series vaccination coverage and timely birth dose administration, the prevalence of HBsAg among

children under five decreased from 9.7% in 1992 to below 0.3% in 2020, representing one of the most successful HBV control efforts worldwide¹⁰. However, coverage gaps remain in older populations. Individuals born before the inclusion of the HBV vaccine in the national immunization schedule did not benefit universally from childhood vaccination, which contributes to a persistently higher prevalence among adults aged 15 and above¹¹. Antibody waning over time and increased social or occupational exposure during adolescence and adulthood further increase susceptibility to infection⁸.

Despite the demonstrated effectiveness of vaccination, HBV vaccine uptake among Chinese adults remains low. A recent national review reported an average adult vaccination rate of only about 26%, much lower than that achieved in children¹². Barriers to adult vaccination include limited knowledge of HBV risks, low perceived susceptibility, lack of routine recommendations during medical visits, inadequate workplace vaccination policies, and concerns about cost or vaccine necessity¹³. University students are a subgroup with a rising exposure risk. For female students, there are potential implications for future mother-to-child transmission. Studies have also indicated that a considerable proportion of students have insufficient protective antibody levels decades after childhood immunization¹⁴.

Therefore, promoting HBV vaccination among university students may be a critical strategy to reduce future incidence and improve population-level disease control. Understanding their willingness to be vaccinated and the psychological and contextual factors influencing their

decisions is essential for designing targeted interventions. Guided by the Protection Motivation Theory (PMT), protective health behaviors arise from threat appraisal (perceived severity and susceptibility) and coping appraisal (response efficacy, self-efficacy, and response cost). Extensive theoretical and empirical evidence supports the robustness of PMT, with meta-analyses demonstrating consistent associations between PMT constructs and health-related behavioral intentions across diverse contexts^{29,30}. In vaccination research, PMT has been increasingly applied to explain vaccination intention, including for seasonal influenza and COVID-19 vaccines, particularly among young adults and university students^{18,19}. Compared with other models, such as the Health Belief Model (HBM) and the Theory of Planned Behavior, PMT integrates perceived risk, individual confidence, and perceived barriers, making it well-suited to examine hepatitis B vaccination intention among university students in Huanggang, China.

Material and Methods

Study design, setting, and population

A cross-sectional survey was conducted to investigate HBV vaccination intention and associated factors among the study population. Eligible participants were college students aged 18–26 who were enrolled at one of three universities in Huanggang, represented different academic years and majors, and agreed to participate in the survey. Students who declined to complete the questionnaire or submitted incomplete responses were excluded from the study.

The sample size was calculated using Cochran's formula¹⁵ as follows:

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 \times p \times (1 - p)$$

where $Z_{1-\alpha/2} = 1.96$; $P = 0.612$ (previously reported HBV vaccination coverage among college students¹⁶); $\delta = 0.03$ (maximum allowable error).

$$n = (1.96 \div 0.03)^2 \times 0.612 \times 0.388 = 1,014$$

Considering a 10% non-response rate, the adjusted sample size was calculated as follows:

$$N1 = n / (1 - d)$$

where $N1$ = the adjusted sample size; n = the sample size required as per formula; d = the dropout rate (10%)

$$N1 = 1014 / (1 - 0.1) = 1,127$$

Thus, at least 1,127 students were required to ensure adequate power for prevalence estimation and multivariable analysis.

A multistage, proportional stratified sampling strategy was applied to select participants. First, sample sizes were allocated to each university according to their enrollment numbers (Table 1). Within each university, students were stratified by academic year. Finally, a complete sampling frame was constructed for each stratum, and participants were randomly selected until the predetermined number for each stratum was reached.

Table 1 Proportion of sample by college

College	Number of students	Number of sample
Huanggang vocational and technical college	10,400	393
Huanggang emergency management vocational and technical college	6,600	250
Huanggang normal college	12,800	484
Total	29,800	1,127

Data collection

Data were collected using a structured questionnaire distributed through QR code. Participation was voluntary, and informed consent was obtained before survey access. A pilot test with 30 students of similar characteristics ensured the clarity and reliability of the instrument. A total of 1500 questionnaires were distributed, and 1130 valid responses were received (response rate=75.3%). Because the sample

was drawn from university students, a relatively large proportion of participants majored in health-related fields, which may have resulted in higher baseline knowledge and vaccination intention.

The questionnaire was developed based on a literature review and comprised five domains. Domain 1: demographics (age [continuous], sex, residence, ethnicity, academic year, parental education, household income, HBsAg screening and vaccination status); Domain 2: hepatitis B knowledge (16 items, one point per correct answer, total score 0–16; Cronbach's $\alpha=0.864$); Domain 3: HBV prevention cognition—two true/false subscales: prevention behaviors (8 items) and vaccine knowledge (5 items), subscale $\alpha=0.736/0.836$, overall $\alpha=0.804$; Domain 4: vaccination intention—single item scored 1–10; Domain 5: PMT constructs—five subscales (perceived severity, susceptibility, response efficacy, self-efficacy, response cost) rated on 5-point Likert scales¹⁷; higher scores indicate stronger endorsement. Cronbach's α for PMT subscales ranged from 0.759 to 0.939. PMT measures were adapted from previously validated instruments^{18,19}.

Ethical considerations

This study was approved by the Human Research Ethics Committee of Mahasarakham University (Ref. No. 037–749/2025). Informed consent was obtained from all the participants prior to data collection.

Data analysis

Vaccination intention was assessed using a single 10-point item, with higher scores indicating stronger intention. For regression analysis, scores were dichotomized into low (1–6) and high (7–10) intention categories. All data were entered independently by two researchers using DataEasy v3.3 to establish a parallel double-entry database. Univariate analyses, including chi-square tests for categorical variables and independent-sample t-tests for

continuous variables, were conducted to examine preliminary associations. Variables with $p\text{-value}<0.25$ in univariate analysis, along with theoretically important variables based on prior research and professional judgment, were included in the multivariate logistic regression model²⁰. Binary logistic regression analysis was used to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs).

A stepwise modeling approach was adopted, following previous literature²¹. In Model 1, three variables related to knowledge and awareness were entered to assess their independent effects on vaccination intention. Model 2 added PMT-related factors to evaluate the incremental contribution of psychological constructs. In Model 3, eligible sociodemographic variables were further included to examine the integrated impact of all predictors. Statistical significance was defined as a two-sided $p\text{-value}<0.05$.

Results

Participant Characteristics and Overall Patterns of HBV Knowledge, Behaviors, and Vaccination Intention

A total of 1,130 college students from Huanggang, Hubei Province, were included in the study, with an average age of 19.7 years. The sample was predominantly female (75.1%), of Han ethnicity (92.7%), and from rural areas (65.8%). Most were in lower academic years (79.4%) and came from families with relatively low parental education levels, as nearly two-thirds of fathers and over 70% of mothers had only completed junior high school or below. Despite this, more than half of the households reported an annual income above 50,000 CNY (7,013 USD). With respect to HBV-related health history, only a minority had undergone HBsAg screening (38.7%) or completed vaccination within the past four years (31.5%).

When examining knowledge and prevention behaviors, just over half of the participants demonstrated high hepatitis B knowledge (58.2%), vaccine knowledge (60.1%), and prevention behavior scores (59.2%). While

a majority of students had adequate awareness, a considerable proportion still lacked sufficient understanding. Mean scores for the PMT constructs revealed that students generally perceived hepatitis B as a serious condition (severity mean=19.9), reported moderate self-efficacy in seeking vaccination (mean=14.8), and showed positive beliefs about vaccine effectiveness (response efficacy mean=10.9). However, susceptibility scores were relatively low (mean=6.3), suggesting that students may underestimate their personal risk of HBV infection. At the same time, perceived response costs (mean=11.6) were not negligible, reflecting concerns about barriers, such as vaccine side effects, costs, or accessibility. Overall, 58.9% of students expressed a high intention to receive the HBV vaccination, showing that while willingness was present in more than half of the population, a significant proportion still remained hesitant (Table 2).

Determinants of HBV vaccination intention among college students

Further analysis revealed several important predictors of vaccination intention. Female students were

significantly more likely to express intention than male students (60.8% vs 53.4%). Students in higher academic years demonstrated stronger vaccination intention (66.1% vs 57.1%), which may reflect increased maturity, greater health awareness, or exposure to health education during their studies. Prior HBsAg screening was also associated with higher vaccination intention (63.6% vs 56.0%), indicating that personal experience with HBV testing may enhance risk perception and motivation to take preventive action. Knowledge-related variables showed consistent and robust associations: students with higher hepatitis B knowledge, stronger vaccine-related knowledge, and better preventive behaviors were substantially more likely to report high vaccination intention (all p -values<0.001). The PMT constructs further supported these patterns: students in the high-intention group perceived hepatitis B as more severe, believed more strongly in their own ability to get vaccinated (self-efficacy), and expressed higher confidence in the vaccine's effectiveness (response efficacy). Conversely, they reported lower response costs, indicating that reducing perceived barriers is critical to enhancing vaccine uptake (Table 3).

Table 2 Participant characteristics and predictors related to vaccination intention (n=1130)

Factors	Value	Participants n(%)
Knowledge of Hepatitis B n (%)	low knowledge group	472 (41.7)
	high knowledge group	658 (58.2)
Knowledge of HBV vaccine n (%)	low knowledge group	450 (39.8)
	high knowledge group	680 (60.1)
HBV infection prevention behaviors n (%)	low behaviors group	460 (40.7)
	high behaviors group	670 (59.2)
PMT-related factors (mean±S.D.)	Perceived severity	19.9±4.6
	Perceived self-efficacy	14.8±2.9
	Perceived response efficacy	10.9±2.2
	Perceived susceptibility	6.3±1.4
	Perceived reaction cost	11.6±2.6
Hepatitis B vaccination intention n (%)	Low intention	464 (41.1)
	High intention	666 (58.9)

Values are presented as n (%) or mean±S.D., CNY=Chinese Yuan, PMT=Protection Motivation Theory, S.D.=standard deviation, HBV=chronic hepatitis B virus

Table 3 Determinants of hepatitis B vaccination intention among college students

Variable	High intention (n=666) n (%)	Low intention (n=464) n (%)	p-value
Sociodemographic factors			
Age (years)	19.7±1.2	19.8±3.4	0.297
Gender (ref.: Female)			0.029*
Male	150 (53.4)	131 (46.6)	
Female	516 (60.8)	333 (39.2)	
Place of residence (ref.: no)			0.618
Urban	232 (59.9)	155 (40.1)	
Rural	434 (58.4)	309 (41.6)	
Ethnicity (ref.: no)			0.657
Han	619 (59.1)	428 (40.9)	
Minority	47 (56.6)	36 (43.4)	
Academic year (ref.: Higher grade)			0.013*
Lower grade	512 (57.1)	385 (42.9)	
Higher grade	154 (66.1)	79 (33.9)	
Father's education level (ref.: less than high school)			0.451
Junior high school or below	432 (58.1)	311 (41.9)	
Senior high school or above	234 (60.5)	153 (39.5)	
Mother's education level (ref.: less than high school)			0.147
Junior high school or below	478 (57.7)	351 (42.3)	
Senior high school or above	188 (62.5)	113 (37.5)	
Annual household income (ref.: <50 000)			0.976
≤50,000 CNY	325(59.0)	226 (41.0)	
>50,000 CNY	341(58.9)	238 (41.1)	
HBsAg screening status (ref.: Not screened)			0.011*
Screened	278 (63.6)	159 (36.4)	
Not screened	388 (56.0)	305 (44.0)	
Completed HBV vaccination (Past 4 Years) (ref.: Not vaccinated)			0.586
Vaccinated	214 (60.1)	142 (39.9)	
Not vaccinated	452 (58.4)	322 (41.6)	
Knowledge and behaviors			<0.001**
Knowledge of Hepatitis B (ref.: Low)			
low knowledge groups	201 (42.6)	271 (57.4)	
high knowledge groups	465 (70.7)	193 (29.3)	
Knowledge of HBV vaccine (ref.: Low)			<0.001**
low knowledge groups	197 (43.8)	253 (56.2)	
high knowledge groups	469 (69.0)	211 (31.0)	
HBV infection prevention behaviors (ref.: Low)			<0.001**
low behaviors groups	184 (40.0)	276 (60.0)	
high behaviors groups	482 (71.9)	188 (28.1)	
The PMT related factors			
Perceived severity	20.1±4.4	18.6±4.5	<0.001**
Perceived selfefficacy	15.6±2.9	13.7±2.6	<0.001**
Perceived response efficacy	11.5±2.3	10.0±1.8	<0.001**
Perceived susceptibility	6.4±1.5	6.2±1.2	0.006**
Perceived reaction cost	11.3±2.8	12.1±2.2	<0.001**

Values are presented as n (%) or mean±S.D., *p-value=0.05, **p-value=0.01

CNY=Chinese Yuan, ref=reference group, PMT=protection motivation theory, S.D.=standard deviation, HBV=chronic hepatitis B virus

Independent predictors of HBV vaccination intention

To further identify the independent predictors of HBV vaccination intention, we constructed three logistic regression models. In Model 1, which included only knowledge and awareness-related factors, higher levels of hepatitis B knowledge, HBV vaccine knowledge, and infection prevention behaviors were significantly associated with stronger vaccination intention. In Model 2, after incorporating PMT constructs, perceived severity, self-efficacy, response efficacy, and lower perceived response cost emerged as significant predictors, while the associations of knowledge-related factors remained significant but were slightly attenuated.

In Model 3, after adjusting for sociodemographic characteristics, most cognitive and motivational factors retained their significance. Specifically, students with higher hepatitis B knowledge were 1.41 times more likely to intend to receive the vaccine compared to those with lower knowledge (odds ratio [OR] =1.41, 95% confidence interval [CI]:1.02–1.95, p -value=0.038). Similarly, students with higher vaccine knowledge were 1.49 times more likely to report willingness to vaccinate (OR=1.49, 95% CI: 1.11–2.00, p -value=0.009), and those with stronger prevention behaviors had a 1.60-fold higher likelihood of intention (OR=1.60, 95% CI:1.15–2.23, p -value=0.006). Regarding PMT constructs, perceived severity (OR=1.05, 95% CI:1.01–1.10, p -value=0.015), self-efficacy (OR=1.10, 95% CI:1.02–1.18, p -value=0.013), and response efficacy (OR=1.16, 95% CI:1.04–1.29, p -value=0.007) were all positively associated with vaccination intention, indicating that students who recognized the seriousness of HBV, trusted the effectiveness of the vaccine and felt confident in their ability to receive it and were more likely to intend to get vaccinated. In contrast, perceived response cost was a strong negative predictor: students perceiving higher barriers were 15% less likely to express vaccination intention

(OR=0.85, 95%CI: 0.79–0.91, p -value<0.001). Notably, sociodemographic factors, including gender, academic year, and parental education, did not show significant associations after adjustment (Table 4).

Beyond the statistical significance of these predictors, the practical interpretation of the effect sizes adds further insight. Students with higher hepatitis B knowledge were 41% more likely to intend vaccination than their peers with lower knowledge, while those with stronger prevention behaviors had a 60% higher likelihood. Similarly, each incremental increase in self-efficacy score translated into a 10% higher probability of intention, underscoring the importance of confidence in one's ability to take preventive action. Model diagnostics indicated acceptable fit (Hosmer–Lemeshow p -value=0.317), and the model explained a substantial proportion of variance in hepatitis B vaccination intention (Nagelkerke R^2 =0.265), supporting overall regression adequacy. These results emphasize that both cognitive awareness and motivational factors are not only statistically significant but also practically relevant in predicting vaccine uptake.

Overall, students with greater HBV knowledge, vaccine knowledge, and preventive behaviors were 41.0%, 49.0%, and 60.0% more likely to intend vaccination, respectively. Each one-point increase in perceived severity, self-efficacy, and response efficacy raised intention by 5.0%, 10.0%, and 16.0%, while each point increase in perceived response cost reduced intention by 15.0%.

Discussion

This cross-sectional study investigated the intention to receive HBV vaccination and its influencing factors among 1,130 college students in Huanggang, Hubei Province, China, using the PMT as a theoretical framework. The findings showed that cognitive and motivational determinants, rather than sociodemographic characteristics, were the primary predictors of vaccination intention. In

Table 4 Independent predictors of hepatitis B vaccination intention

Variable	Model 1 (crude)		Model 2 (adjusted for PMT)		Model 3 (fully adjusted)	
	OR (95%CI)	p-value	OR (95%CI)	p-value	OR (95%CI)	p-value
Knowledge and information receiving						
Knowledge of HBV(ref.:low)	1.68 (1.242.28)	<0.001**	1.42 (1.031.95)	0.034*	1.41 (1.021.95)	0.038*
Knowledge of hepatitis B vaccine (ref.: low)	1.67 (1.262.22)	<0.001**	1.50 (1.122.01)	0.007**	1.49 (1.112.00)	0.009**
HBV infection prevention behaviors (ref.: low)	2.43 (1.803.28)	<0.001**	1.58 (1.142.20)	0.006**	1.60 (1.152.23)	0.006**
The PMT related factors						
Perceived severity	–	–	1.05 (1.011.09)	0.016*	1.05 (1.011.10)	0.015*
Perceived self-efficacy	–	–	1.09 (1.021.18)	0.014*	1.10 (1.021.18)	0.013*
Perceived response efficacy	–	–	1.16 (1.041.29)	0.006**	1.16 (1.041.29)	0.007**
Perceived susceptibility	–	–	1.04 (0.901.19)	0.597	1.04 (0.901.19)	0.621
Perceived reaction cost	–	–	0.85 (0.800.91)	<0.001**	0.85 (0.790.91)	<0.001**
Sociodemographic factors						
Gender (ref.: female)	–	–	–	–	1.02 (0.751.40)	0.884
Academic year (ref.:higher grade)	–	–	–	–	0.97 (0.691.38)	0.872
Mother's education level (ref.: less than high school)	–	–	–	–	0.80 (0.591.08)	0.141
HBsAg screening status (ref.: Not screened)	–	–	–	–	1.01 (0.771.35)	0.921

*p-value=0.05, **p-value=0.01

OR=odds ratio, CI=confidence interval, ref=reference group, PMT=protection motivation theory, CNY=Chinese Yuan, HBV=chronic hepatitis B virus

particular, knowledge- and behavior-related variables and PMT constructs consistently showed strong associations in both bivariate and multivariate analyses.

Theoretical frameworks such as HBM emphasize that accurate knowledge enhances perceived susceptibility and severity of hepatitis B, thereby motivating preventive actions²², while insufficient knowledge contributes to hesitancy through misinformation or fear²³. This is consistent with our finding that hepatitis B-related knowledge, vaccine-specific knowledge, and preventive behaviors were independent predictors of intention, suggesting the crucial role of health literacy.

Participants with higher scores across all three domains (hepatitis B knowledge, vaccine knowledge, and preventive behaviors) demonstrated significantly greater intention to be vaccinated. Awareness of transmission routes strengthens risk perception, aligning with the prior

findings by Sok²⁴ and others, which highlight the role of understanding HBV consequences in shaping perceived severity²⁵. Vaccine knowledge, including confidence in efficacy and safety, also appears essential, consistent with adolescent vaccination research showing that stronger vaccine confidence and involvement in decision-making promote uptake²⁶. Preventive behaviors, such as avoiding shared needles and practicing safer sex, reflect higher health consciousness and align with Diniarti's findings²⁷. Together, these results highlight the importance of improving hepatitis B-related knowledge to promote vaccination among college students.

Using the PMT framework, perceived severity, self-efficacy, and response efficacy all emerged as significant positive predictors, while perceived cost was a strong negative predictor. Students who recognized the seriousness of hepatitis B, believed in the effectiveness

of the vaccine, and felt capable of receiving it were more likely to intend to vaccinate. Conversely, higher perceived barriers reduced willingness by about 15%. These findings are consistent with previous studies, including Yang²⁸ and Cai¹⁷, though the predictive significance of individual PMT constructs varies across populations and vaccine contexts^{29,30}.

Importantly, perceived susceptibility was not a significant predictor in multivariate analysis. Several explanations may account for this. College students often display optimistic bias, underestimating personal vulnerability to infectious diseases. In addition, many students in China received childhood HBV vaccination as part of the national immunization program, potentially reducing perceived need for additional doses. These factors may weaken the predictive role of susceptibility despite adequate knowledge. Moreover, PMT suggests that threat and coping appraisals may interact; thus, susceptibility may influence intention indirectly by strengthening coping appraisals, such as self-efficacy or response efficacy. Although this study did not test interaction or moderation effects, future research using structural equation modeling or moderated mediation designs may help clarify these potential pathways.

Cultural and contextual factors within the Chinese student population may also shape PMT constructs. China's collectivist culture places strong emphasis on social responsibility and community protection, which may enhance the influence of coping appraisals, particularly response efficacy, over individual risk perception. High trust in public health authorities and established vaccination systems may further increase confidence in vaccine safety and reduce perceived barriers. Thus, intention formation in this context may be more strongly driven by confidence, perceived benefits, and social norms than by perceived susceptibility.

Although gender, academic year, and parental education showed associations in univariate analyses, these effects disappeared in multivariate models, suggesting that

cognitive and motivational factors outweigh demographic characteristics. Students in this study were from universities of similar institutional type and within the same region, likely sharing comparable access to health information. Under such conditions, differences in vaccination behavior may stem more from variations in knowledge, risk perception, and coping appraisal than from sociodemographic traits.

Overall, these findings reinforce the theoretical assertion of PMT, emphasizing the centrality of threat and coping appraisals in motivating health behavior³⁰. They also highlight the practical importance of designing health interventions that strengthen perceived severity, self-efficacy, and response efficacy while reducing perceived barriers. From an applied perspective, integrating hepatitis B-related knowledge into university health curricula³¹, using diverse communication channels³², collaborating with community health centers for free HBV screening³³, and providing convenient on-campus vaccination services³⁴ may help increase vaccination uptake. In summary, this study validates the applicability of PMT in understanding vaccination intention and provides evidence-based guidance for developing targeted interventions to enhance HBV prevention among college students.

Limitations and recommendations

This study has several limitations. First, the cross-sectional design restricts the ability to infer causal relationships between variables, as it only reveals associations. Future research could adopt longitudinal or experimental designs to further verify the causal influence of key factors on vaccination intention. Additionally, the use of self-reported questionnaires may introduce potential biases³⁵, such as social desirability or recall bias, which could affect the accuracy of responses regarding vaccination status or knowledge level. Incorporating actual vaccination records or health data in future studies may enhance objectivity. Moreover, the present study focused

primarily on knowledge and PMT constructs, while other important psychological and sociocultural factors, such as family attitudes, physician recommendations, and vaccine accessibility, were not included. Qualitative approaches may be valuable for exploring these aspects in greater depth. Although Structural Equation Modeling (SEM) can examine complex relationships among observed and latent variables, it was not applied in this study due to the cross-sectional design and sample size, which were more suitable for identifying direct predictors using PMT constructs. Finally, although the sample covered three universities, all were located in Huanggang, Hubei Province, representing a limited geographic and institutional diversity. Expanding to other regions and varied types of universities could improve generalizability. Nonetheless, this study included a large sample and controlled for multiple covariates, offering a valuable contribution to understanding the complex factors influencing HBV vaccination intention among college students. The findings also provide important insights to inform future intervention programs aimed at improving vaccination coverage.

Conclusion

The results indicate that the formation of vaccination intention is primarily influenced by hepatitis B and vaccine-related knowledge, preventive behaviors, perceived severity, response efficacy, self-efficacy, and response cost. In contrast, sociodemographic characteristics such as gender, grade level, and residence were not significantly associated with vaccination intention in the multivariate regression model. These findings not only confirm the applicability of PMT in explaining vaccination behavior among college students but also highlight the critical role of threat appraisal and coping appraisal in promoting health-protective behaviors. This suggests that HBV vaccination promotion efforts in colleges should focus on improving students' knowledge and preventive behaviors, enhancing

awareness of the severity of hepatitis B consequences, strengthening confidence in vaccine safety and efficacy, and reducing both psychological and practical barriers. Overall, this study provides empirical evidence for designing theory-based interventions to promote HBV vaccination among college students and offers valuable insights for public health strategies aimed at increasing vaccination coverage and developing HBV prevention programs in this population. Beyond these findings, the study underscores the importance of integrating vaccination programs into broader campus health initiatives, ensuring sustainable and equitable access to HBV prevention for college students.

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Conflict of interest

There are no potential conflicts of interest to declare.

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Supplementary Table 1 Participant demographic characteristics

Demographic factor	Value
Age (mean±S.D.) years	19.7±2.4
Gender n (%)	
Male	281 (24.9)
Female	849 (75.1)
Place of residence n (%)	
Urban	387 (34.2)
Rural	743 (65.8)
Ethnicity n (%)	
Han	1,047 (92.7)
Minority	83 (7.3)
Academic year n (%)	
Lower grade	897 (79.4)
Higher grade	233 (20.6)
Father's education level n (%)	
Junior high school or below	743 (65.8)
Senior high school or above	387 (34.2)
Mother's education level n (%)	
Junior high school or below	829 (73.4)
Senior high school or above	301 (26.6)
Annual household income n (%)	
≤50,000 CNY	551 (48.8)
>50,000 CNY	579 (51.2)
HBsAg screening status n (%)	
Screened	437 (38.7)
Not Screened	693 (61.3)
Completed HBV vaccination (past 4 years) n (%)	
Vaccinated	356 (31.5)
Not vaccinated	774 (68.5)

Values are presented as n (%) or mean±S.D., CNY=Chinese Yuan, HBV=chronic hepatitis B virus

Supplementary Table 2 protection motivation theory (PMT) scale items

Response format: All items were measured using a 5-point Likert scale: 1 = Strongly disagree; 2 = Disagree; 3 = Unsure; 4 = Agree; 5 = Strongly agree.

Perceived Severity (F1)	
Item code	Item description
F1-1	Hepatitis B is incurable.
F1-2	Hepatitis B treatment is very expensive.
F1-3	Hepatitis B can bring great mental pressure to the family.
F1-4	Hepatitis B symptoms are unbearable.
F1-5	Hepatitis B patients and carriers may suffer from social discrimination.
F1-6	Hepatitis B infection may lead to liver cirrhosis and liver cancer.
Perceived self-efficacy (F2)	
Item code	Item description
F2-1	If most of my classmates choose to receive the hepatitis B vaccine, I will also get vaccinated.
F2-2	If hepatitis B vaccination is organized at my school, I will get vaccinated.
F2-3	If my family or friends suggest receiving the hepatitis B vaccine, I will get vaccinated.
F2-4	If a doctor recommends receiving the hepatitis B vaccine, I will get vaccinated.
Perceived response efficacy (F3)	
Item code	Item description
F3-1	The hepatitis B vaccine has been developed long enough for universal use.
F3-2	Hepatitis B vaccination is the most effective way to prevent HBV infection.
F3-3	The hepatitis B vaccine can reduce the risk of liver cirrhosis and liver cancer.
Perceived susceptibility (F4)	
Item code	Item description
F4-1	As a college student, my risk of HBV infection is higher than that of other populations.
F4-2	There are more hepatitis B infections around me than before.
Perceived reaction cost (F5)	
Item code	Item description
F5-1	It is very inconvenient for me to receive the hepatitis B vaccine.
F5-2	I do not have enough information about hepatitis B vaccination.
F5-3	The hepatitis B vaccine is costly.
F5-4	The hepatitis B vaccine has serious side effects.

HBV=chronic hepatitis B virus