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Research Article

Cross-cultural adaptation and validation of a Chinese Preventive Health Model instrument for measuring the psychosocial factors in hepatocellular carcinoma screening among patients with hepatitis B

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SUMMARY

Purpose: Screening for hepatocellular carcinoma (HCC) as an effective instrument to reduce the burden of late diagnoses remains underutilized in China, much of the Asian countries, and in a sense all over the world. Modifiable psychosocial factors should be identified to improve screening utilization and reduce the burden of late diagnoses. However, valid psychosocial measures are unavailable. This study aimed to translate, culturally adapt, and validate the preventive health model (PHM) instrument for measuring psychosocial factors of HCC screening among patients with hepatitis B.

Methods: This study was conducted from June 2020 to April 2021 in three rigorous phases: (1) committee-based translation from English to Chinese; (2) cognitive interviews (n = 33) and Delphi expert consultations (n = 7) for cultural adaptation; and (3) a cross-sectional study (n = 305) for validation.

Results: In phase I, two items were reworded, and two retranslated for semantic equivalence. In phase II, issues related to comprehension, sensitive wording, wording clarity, question relevance, and cultural sensitivity were addressed by including pictures, rewording five items, and developing seven items. In phase III, exploratory and confirmatory factor analyses suggested a five-factor 20-item solution: it explained 76.9% of the variance; had adequate factor loading (.60–.91), convergent and discriminant validity; satisfactory model fit indices; and reliability (Cronbach's α, .86–.91). Known-group analysis showed that patients with optimal HCC screening behavior had significantly higher scores on each subscale than those not having such.

Conclusion: The Chinese PHM instrument is culturally sensitive, reliable, and valid to measure the psychosocial factors of HCC screening. It can help nurses and researchers to tailor strategies to improve clinical HCC screening practices in high-risk HCC regions.

Introduction

Hepatocellular carcinoma (HCC) is the third leading cause of cancer mortality worldwide [1]. The predominant cause of HCC is hepatitis B virus infection in most high-risk HCC areas, including China, with 55.1% HCC cases and 54.1% deaths attributable to hepatitis B [2]. Owing to the asymptomatic onset of HCC, more than 60.0% of patients are diagnosed at intermediate or advanced stages and have a median survival of less than one year [3]. Thus, international guidelines have highlighted the significance of screening patients with hepatitis B, using liver ultrasound with or without serum alpha-fetoprotein biannually, to detect HCC at an early stage and achieve better survival [4,5]. However, given the biannual repetitive nature of HCC screening, maintaining consistent patient utilization is a major challenge [6]. Unlike Japan and Korea, China does not have a national government-funded HCC screening program; participation in HCC screening mainly depends on personal compliance, ranging from 9.4% to 26.0% [7,8]. And, less than 50.0% of patients undergo subsequent screening rounds [9]. Worldwide, the pooled adherence rate to liver imaging

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every 6–12 months is only 32.0% among patients with hepatitis B [10].

To date, factors that influence HCC screening are understudied, and studies have largely relied on clinical data [11]. Old age, number of clinic visits, and cirrhosis are positively correlated with HCC screening utilization, whereas rural residence, low income, and educational level are negatively correlated [6,11]. The lack of further understanding of factors related to HCC screening has limited the intervention strategies to traditional outreach, patient reminders, and quality improvement programs, that have achieved less than 30.0% semi-annual HCC screening rates [6,12]. Thus, it is imperative to elucidate other modifiable psychosocial factors, which may be the main drivers of HCC screening utilization and targeted interventions [13,14].

Psychosocial factors are multidimensional, encompassing cognitive behavior responses, affective and social aspects; these can influence health outcomes by modifying behaviors [15]. The cognitive (cancer awareness), affective (cancer worry, shame, and stigma regarding cancer screening), and social aspects (social norms) of psychosocial factors have significantly influenced screening modality use in breast, cervical, colorectal, and lung cancer [16]. However, only a few studies have explored the psychosocial predictive roles of fear of HCC detection and perceived HCC screening efficacy with respect to HCC screening utilization [17–19]. The measures used also lack support from behavioral theories and applying a single question (e.g. 'I do not believe that HCC screening is an effective prevention') [18], which might not be able to capture the multidimensional psychosocial aspects of screening utilization. The dichotomous yes–no responses in most of these measures may not allow for sensitivity [18,20]. Moreover, none of these measures provide psychometric validation, thereby limiting the generalization and comparison of results across studies [17–19]. Thus, a multidimensional and reliable psychosocial measure based on health behavior theory is needed to understand patient compliance with HCC screening.

Drawing on the major constructs from the health belief model, self-regulation, and social cognitive theory, the preventive health model (PHM) has been advanced and extensively verified to identify major psychosocial constructs in cancer screening utilization [21,22]. These include salience and coherence (consistency between perceptions of undertaking cancer screening and beliefs for maintaining health); perceived susceptibility to cancer; response efficacy (perceived cancer screening efficacy); cancer worries (concerns over negative consequences of cancer screening); and social influence [21]. Based on these constructs, a five-factor, 16-item PHM instrument was initially developed for measuring colorectal cancer screening factors, which posits that screening is linked to higher salience and coherence, perceived susceptibility, response efficacy, and social influence, but lower cancer worries [21,23]. The correlations between these PHM psychosocial factors and colorectal cancer screening utilization have also been verified in empirical cross-sectional and longitudinal studies [24,25]. Strategies tailored to the psychosocial factors of the PHM instrument, including web-based screening messages [26], education [27], and decision support [24], have demonstrated positive predictive effects on intention and utilization of colorectal cancer screening. Owing to its extensive utilization and predictive effects, the PHM instrument has also been modified and reported to have established reliability and validity, and demonstrated consistent predictive effects on using screening modalities for breast [22], cervical [28], and prostate cancer [29] in two languages (English and Spanish) and among different populations (African-American, Australian, Caucasians, and Hispanic). Despite item deletion or addition has been made to the original PHM instrument, the five-factor structure is identical across studies [22,25]. Given its wide application and reliability, the PHM instrument has the potential to measure the psychosocial factors for HCC screening.

However, items in the original PHM instrument, such as 'colorectal cancer screening makes sense to me,' applied specifically to colorectal cancer and required modifications before being applied to HCC [21]. HCC screening also has some particularities with respect to colorectal cancer. It targets people with chronic diseases such as hepatitis B and aims to detect early-stage HCC to achieve curative treatment and prolong survival [5], whereas colorectal cancer screening targets average-risk adults and helps to detect and remove precursor polyps to prevent colorectal cancer development [30]. Therefore, the contents of the PHM instrument, including the perceived cancer susceptibility and response efficacy need to be adapted to consider the risk group and effectiveness of HCC screening. In addition, considering language and cultural differences, it is unknown whether the PHM constructs would be perceived in similar ways in current population. To maintain equivalence and accurately measure the psychosocial factors affecting HCC screening, this study aimed to: (1) translate the PHM instrument from English to Chinese by applying a committee-based approach; (2) adapt the instrument to achieve culture sensitivity and content validity through cognitive interviews and expert consultation; and (3) conduct psychometric validation via a cross-sectional study. The adaptation and validation of the PHM instrument form the basis for identifying the modifiable psychosocial factors for HCC screening and developing culturally sensitive interventions to improve real-world HCC screening practice and reduce HCC mortality globally.

Methods

Study design

This study adopted a methodological study design and were conducted in three phases to validate the Chinese version of the PHM instrument, including (1) translation of the PHM instrument from English into Chinese; (2) cultural adaptation and content validation of the PHM instrument through three-round cognitive interviews and two-round expert consultations; (3) validation of the Chinese version of the PHM instrument through a cross-sectional study among patients with hepatitis B.

Ethics

This study was approved by the Institutional Review Board of the XGZW university (Approval no. SBRE-20-072) and the HNPP hospital (Approval no. 2020169). All participants were informed about voluntary participation, data confidentiality, and signed a written informed consent form before participation. Each participant received a gift worth 10 Renminbi as appreciation for their cooperation.

Phase I: Instrument translation

The original preventive health model instrument

The PHM instrument was developed by professionals in cancer prevention, control, and behavioral epidemiology in the 1970s [21,23]. It has five subscales and 16 items measuring psychosocial factors to colorectal cancer screening, including salience and coherence (four items), cancer worries (two items), perceived susceptibility (four items), response efficacy (two items), and social influence (four items). The instrument was rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), and the original item 6 and item 12 were reversely scored. The subscale scores were standardized by averaging the corresponding items

and thus ranged from 1 to 5 [21]. The PHM instrument has been widely applied to evaluate psychosocial correlates of colorectal cancer screening [24,25] and demonstrated good construct, convergent, and discriminant validity, with Cronbach's α ranging from 0.61 for social influence to 0.91 for salience and coherence [21,23].

Translation process

After receiving permission from the developer via email, a committee-based translation approach according to the guidelines for cross-cultural adaptation of study instruments was applied from June 2020 to September 2020 [31]. The forward translation from English to Chinese was conducted by two independent and native Mandarin-speaking bilingual translators, including the researcher and a qualified linguistic specialist. A third bilingual independent translator, a Ph.D. candidate, compared the two forward-translated versions with the original instrument regarding discrepancies in words, sentences, and meanings. Identified issues were subsequently discussed and resolved by a committee (composed of one hepatologist, one nursing professor, two nursing specialists in hepatitis care, and all involved translators) to settle on an initial translated version. The blind back-translation was conducted by two other independent and native English-speaking translation experts, with one of them having a medical background. The two back-translated versions were compared with the original instrument by the committee to resolve any discrepancies.

Phase II: Cultural adaptation and content validation

The cognitive interviewing techniques and expert consultations were applied to: (1) examine differences in the perception of PHM constructs among the current population; (2) identify instrument issues for cultural adaptation; and (3) reach content validity.

Three-round cognitive interview for concept discussion and pilot testing

Setting and sample. Following the cognitive interview guideline [32], three rounds of interviews were conducted from October 2020 to January 2021 with 33 purposively selected patients with hepatitis B in a university-affiliated hospital in China to ensure adequate samples and variations in educational level and past HCC screening behavior. Eligible patients included those with hepatitis B and aged 18 to 65 years who were recommended to undergo HCC screening [4,5] in relation to factors of liver cirrhosis, family HCC history, or old age (men, >40 years old and women, >50 years old). Patients with hepatitis C, autoimmune hepatitis, alcoholic liver disease, HCC diagnosis, hepatic encephalopathy, or liver transplantation were excluded.

Data collection. Given the limited knowledge concerning the psychosocial factors for HCC screening [6], concept discussions were conducted through semi-structured interviews in the first round of cognitive interviews to explore patient perceptions HCC screening and its alignment with the PHM constructs. The constructs include salience and coherence (e.g. How do you perceive HCC screening for maintaining health?), susceptibility (e.g., How do you see disease progression from hepatitis B to HCC?), cancer worries, response efficacy (e.g. How do you see the pros/cons of HCC screening?), and social influence (e.g., What helped you undertake HCC screening?).

The adapted version from the first-round cognitive interview was pilot tested in the second round. Patients (n = 5) were asked to read each item, select a response, and express thoughts following the think-aloud approach [32]. Probing questions were also used to clarify their comprehension of the instructions and items (e.g., What do you think this question is asking?), and their memory retrieval, decision, and response processes. General questions were asked regarding uncomfortable items related to HCC, appropriateness of instrument length, and suggestions for improvement. Identified issues were revised and reassessed in the third round among different participants (n = 5). Each interview was conducted by the researcher with knowledge and field experience in qualitative studies, was audio-recorded, and lasted about 20 to 75 minutes.

Data analysis. Data were coded using an established approach for analyzing cognitive interviews [33], including transcription, patient interpretation summarization, problem identification following the Question Appraisal System [34], and revised decision making. All adjustments were performed following Delphi expert consultation.

Two-round Delphi expert consultation for content validity evaluation

Seven experts were purposively selected, as per previous literature [35]: a hepatologist; two hospital nurse directors with clinical and research experience in cancer prevention and four nursing faculty members from different institutions with expertize in instrument development, hepatitis B, or HCC-related research. All were professors with more than 20 years of work experience. Using email consultation, the experts were invited to rate the relevance (1 = *not relevant*, 2 = *a bit relevant*, 3 = *relevant but needs minor alteration*, 4 = *very relevant*) and clarity of items, comment on improvement or revisions during cognitive interviews, and suggest new items as needed. The item-level content validity index (I-CVI) and average scale-level CVI (S-CVI/Ave) were calculated, with values exceeding .78 and .90, respectively, considered as adequate content validity [36].

Phase III: Psychometric validation

Setting and sample

The study was conducted from January to April 2021 in three departments of a university-affiliated hospital in China. Patients were recruited by convenience sampling using the same selection criteria as those used in the cognitive interviews. Based on an appropriate sample size of 150 to 200 for exploratory factor analysis (EFA) and at least 150 for confirmatory factor analysis (CFA) [37], the minimum sample size was set to 300, following the principle that the minimum required ratio for a sample size is 5 to 10 participants per item to ensure factor stability [38].

Data collection

The demographic information and adapted PHM instrument was administered, which were self-completed by the patients with help from the researcher or two trained research assistants. Patient clinical data, including past HCC screening behavior, were collected from electronic medical records. Validation of the HCC screening behavior was done mutually by the researcher with one of the research assistants.

Data analysis. The SPSS 26.0 (IBM Corp., NY) and AMOS 23.0 (IBM Crop., Chicago) were used. Sample characteristics were summarized applying descriptive analysis. Differences between samples were compared using independent-samples *t*-test for continuous data with normal distributions, or the Mann–Whitney *U* test for non-normal distributions, and the chi-square test for categorical data. All analyses were two-sided, with $p < .05$ considered significant. Items were removed if the critical ratio (CR) or item–total scale correlation coefficient were not significant [38].

Since modifications were made, EFA and CFA were performed to test the underlying structure of the instrument and confirm its consistency with data from the current population. The total samples were randomly divided into two equal parts to perform EFA (n = 152) and CFA (n = 153). The EFA was conducted using principal component analysis (PCA) with varimax rotation [38]. The data were deemed suitable for EFA if the Kaiser–Meyer–Olkin (KMO) value > .60 and Bartlett's test of sphericity achieved a p value < .05 [39]. The number of potential factors was determined according to the formula of eigenvalue >1 and a scree plot representing all factors above the elbow [38]. Items were retained if the primary factor loadings and communities exceeded .40 [39]. CFA was conducted using the maximum likelihood [40]. Model fitness criteria were as follows: minimum discrepancy divided by its degree of freedom (CMIN/DF) < 2, comparative fit index (CFI) > .95, Tucker–Lewis Index (TLI) > .95, standard root mean squared residual (SRMR) < .08, and root mean square error of approximation (RMSEA) < .06 [40]. Convergent validity was considered sufficient if the average variance extracted (AVE) > .50, composite reliability (CR) > .70, and CR > AVE [41]. Discriminant validity was established when the AVE for each construct was higher than its shared variance and the square of the correlation coefficient, with other constructs [42].

To test against the external criteria of cancer screening behavior [38,43], known-group analysis was performed to test the PHM-based hypothesis that patients with optimal HCC screening behavior (undertaking liver ultrasound with serum alpha-fetoprotein at least semiannually in the past two years) [4] would have higher mean scores on each subscale, except cancer worriers, compared with those having suboptimal or poor HCC screening behavior (undertaking liver ultrasound with serum alpha-fetoprotein more than every six months or without undertaking HCC screening in the past 2 years).

For reliability, Cronbach's alpha coefficient, split-half (odd–-even) reliability coefficient, and test–retest reliability coefficient were used. The test–retest reliability was evaluated at a recommended two-week interval with 50 participants randomly selected from the total sample by calculating the intraclass correlation coefficient [38].

Results

Phase I: Instrument translation

In the forward translation, 'immediate family' was translated to 'family,' which also concerns close family in Chinese culture. 'Doctor or health professional' was translated to 'doctor or nurse,'" which is widely used to represent medical professionals in China. After back-translation, two items did not retain their original meaning. For the original item 2 ('*I want to do what members of my immediate family think I should do about colorectal cancer screening*'"), the multiple attributive adjuncts in literal translation challenged comprehension. Its back-translation, '*I want to take the colorectal cancer screening that my family members think I should take*,' emphasized the individual's motivation instead of the family's influence on screening utilization. After consolidation for semantic equivalence, the item was retranslated to '*Regarding colorectal cancer screening, I would like to listen to the views of my family*'. The original item 10 was retranslated for similar reasons ('*Regarding colorectal cancer screening, I would like to listen to the views of my doctor or nurse*'). 'Colorectal cancer'" was replaced with 'HCC' for this study.

Phase II: Cultural adaptation and content validation

For cultural adaptation, issues related to comprehension, sensitive wording, wording clarity, question relevance, and cultural sensitivity were identified and addressed during expert consultation and cognitive interviews with 33 patients (mean age: 45.70 [11.95] years) (Table 1). Table 2 illustrates the adaptation details, with expert comments and patient quotes.

Cultural adaptation

Regarding comprehension, 'HCC screening' was difficult for eight patients to understand owing to their lack of awareness or misperception that 'HCC screening' entailed an inspection of water, soil, or diet that may cause HCC. Thus, photographs demonstrating HCC progression and screening tests in the instruction to assist comprehension were included. As respondents indicated poor knowledge of 'curative treatment' and 'liver resection' as the primary treatment choice for early-stage HCC, 'better treatment' was finally adopted. Sensitive wording, such as 'very likely' and 'improve survival rates' for HCC risk and screening efficacy, made patients feel nervous and were, thus, revised to 'may' and 'prolong life' respectively. Two items had wording clarity issues: 'I will just be healthy' was reworded to 'it will not influence my health' and 'chance' to 'risk.' For question relevance, one item was reworded and another item, measuring colorectal polyp risk, was deleted because it did not apply to HCC. Two items in the response efficacy subscale were not aligned with HCC screening efficacy and were replaced by items 21, 22, and 23 (Table 2), which were developed based on HCC screening guidelines [4,5].

Cultural sensitivity was enhanced by seven new items added in the first round of concept discussion and expert consultation. For salience and coherence, most perceived a low need to undertake HCC screening or health checks if they had no discomfort or symptoms of abdominal distension or pain, black stool, or jaundice. For example, they mentioned that 'I would not go to the hospital unless I had symptoms (lower limb edema),' and 'Until I lost my appetite, I did not go to the hospital, where I was diagnosed with liver cirrhosis and ascites.' Item 7 was added to reflect the perceived salience of taking preventive actions in the absence of symptoms. For cancer worries, three experts believed that negative emotions and concerns about being a burden to their family if diagnosed with HCC were important to the perceived negative consequences of undertaking HCC screening in Chinese culture. Patients expressed similar feelings: 'If HCC was detected, my family would have to spend a large sum for the costs. Where would we get the money for treatment? I decided not to undertake HCC screening, regardless of the severity of my symptoms.' Thus, items 10 and 11 were added (Table 2). For perceived susceptibility, item 20 (Table 2) was added because of the common misconceptions among patients that HCC could be precluded by antiviral drugs and healthy lifestyles. For social influence, items 14, 15, and 16 were added, as suggested by all content experts and patients, to measure the influence of friends/colleagues and social media on the intention to undertake HCC screening.

Content validity

Consensus on cultural adaptations was reached in the second round of expert consultation. The Chinese PHM instrument comprised 5 subscales with 23 items (Table 3). The I-CVI was .86 for items 8, 9, and 12, and 1 for the remaining items; thus, the S-ICV/Ave reached .98, demonstrating excellent content validity [36].

Phase III: Psychometric validation

After excluding data from five patients with missing values due to survey incompletion (n = 3) or dropout (n = 2), the entire sample consisted of 305 individuals, with a mean age of 47.41 years. No statistical differences were found in the general data between the EFA and CFA samples (Table 1). The 23 items were all retained for

Table 1 *Demographic and Clinic Data of Participants (n = 338).*

Variables	Phase II: Total Sample (n = 33)	Phase III: Total Sample (n = 305)	EFA Sample (n = 152)	CFA Sample (n = 153)	$t/\chi^2/Z$ value	p
	N (%) or Median (IQR) or Mean (SD)				(EFA vs. CFA samples)	
Age	45.70 (11.95)	47.41 (8.87)	47.45 (8.99)	47.37 (8.77)	−.07	.941
Gender					.23	.633
Men	25 (75.8%)	221 (72.5%)	112 (73.7%)	109 (71.2%)		
Women	8 (24.2%)	84 (27.5%)	40 (26.3%)	44 (28.8%)		
Marital status					2.80	.094
With a partner	31 (93.9%)	286 (93.8%)	139 (91.5%)	147 (96.1%)		
Without a partner	2 (6.1%)	19 (6.2%)	13 (8.5%)	6 (3.9%)		
Residence					.23	.633
Urban	14 (42.4%)	84 (27.5%)	40 (26.3%)	44 (28.8%)		
Rural	19 (57.6%)	221 (72.5%)	112 (73.7%)	109 (71.2%)		
Education					1.50	.683
Elementary school	5 (15.2%)	107 (35.1%)	52 (34.2%)	55 (36.0%)		
Middle school	14 (42.4%)	118 (38.7%)	58 (38.2%)	60 (39.2%)		
High school	10 (30.3%)	37 (12.1%)	17 (11.2%)	20 (13.1%)		
College or postgraduate	4 (12.1%)	43 (14.1%)	25 (16.4%)	18 (11.7%)		
Monthly household income (RMB)					2.07	.558
< 2000	5 (15.2%)	83 (27.2%)	38 (25.0%)	45 (29.4%)		
2000-3999	18 (54.6%)	95 (31.2%)	53 (34.9%)	42 (27.5%)		
4000-5999	8 (24.2%)	86 (28.2%)	41 (27.0%)	45 (29.4%)		
≥ 6000	2 (6.0%)	41 (13.4%)	20 (13.1%)	21 (13.7%)		
Hepatitis B duration (months)	144 (288)	96 (207)	96 (192)	108 (213)	−1.16	.872
Liver cirrhosis					.43	.514
Yes	28 (84.8%)	236 (77.4%)	120 (79.0%)	116 (75.8%)		
No	5 (15.2%)	69 (22.6%)	32 (21.0%)	37 (24.2%)		
HCC screening interval (months)					3.47	.325
≤ 6	6 (18.2%)	77 (25.3%)	38 (25.0%)	39 (25.5%)		
7-12	9 (27.3%)	121 (39.7%)	62 (40.8%)	59 (38.6%)		
≥ 13	16 (48.4%)	59 (19.3%)	24 (15.8%)	35 (22.9%)		
None	2 (6.1%)	48 (15.7%)	28 (18.4%)	20 (13.0%)		

Abbreviations: CFA, confirmatory factor analysis; EFA, exploratory factor analysis; HCC, hepatocellular carcinoma; IQR, interquartile range; RMB, renminbi or Chinese yuan; SD, standard deviation.

significant CR between the first 27.0% high total score group and the last 27.0% low total score group (CR = 4.12–20.28, $p < .001$). The item–total scale correlation ranged from .30 to .80 ($p < .001$) [38].

Exploratory factor analysis

The KMO was .89, and Bartlett's test of sphericity reached statistical significance (chi-square = 2473.68, $p < .001$), demonstrating adequate sampling and variable relations [39]. The PCA and varimax rotation revealed five factors with eigenvalues above 1, consistent with the scree plot. Factor loadings and community values were above .40 for all items, except for item 20, which was thus eliminated. Item 3 was cross-loaded on factors 2 and 4 but was retained in factor 2 for its content coherence. Items 8 and 12 from factor 1 unexpectedly loaded on factors 2 and 4 and were deleted for not conceptually fitting the relocated factors. The five-factor solution for the adapted PHM instrument explained 76.9% of the total variance. Factor loadings and communalities of the 20 retained and 3 deleted items are presented in Table 3.

Factor 1, social influence, had five items, accounting for 41.4% of the variance. This factor reflected the desire to undergo HCC screening in compliance with key references' views and social media influence. Factor 2, salience and coherence, had five items, accounting for 13.9% of the variance. This factor measured the perception that undertaking preventive action is consistent with beliefs for maintaining good health. Such perception reflected the perceived sense to undertake HCC screening for health maintenance and whether the patient attended health checkups in the absence of symptoms. Factor 3, cancer worries, had four items, accounting for 9.3% of the variance. This factor reflected concerns on the negative consequences of undertaking HCC screening, including HCC diagnosis, negative emotions, and worries about burdens on the family. Factor 4, perceived susceptibility, had three items, accounting for 7.1% of the variance. This factor measured individuals' perceived risk of developing HCC. Factor 5, response efficacy, had three items, accounting for 5.2% of the variance. This factor reflected the belief that HCC screening effectively reduces disease threat, including early diagnosis of HCC with better treatments and survival.

Confirmatory factor analysis

CFA was performed based on the EFA results for the five-factor 20-item PHM instrument. The initial fit indices suggested a lack of fit with the data (CMIN/DF = 1.72, CFI = .95, TLI = .94, SRMR = .06, RMSEA = .07). Based on modification indices, a correlated error term between items 6 and 7—both related to a lower sense of undertaking preventive actions—was added. The final model provided a good fit to the data, with model fitness indices within suggested range (CMIN/DF = .47, CFI = .96, TLI = .96, SRMR = .06, RMSEA = .06) [40]. All items loaded strongly onto latent factors (.67–.94), with factor loading coefficients reaching significance ($p < .001$) (Figure 1).

Convergent and discriminant validity analyses

The AVE and CR values revealed that the five subscales had adequate convergent validity (Table 4). Discriminant validity was also acceptable, with AVE values generally higher than the square of the correlation between each pair of subscales [42] (Table 4).

Known-group analysis

Known-group analysis demonstrated that patients with optimal HCC screening behavior had higher subscale scores than those not (Table 4), including social influence ($z = -11.20$, $p < .001$), salience and coherence ($z = -12.51$, $p < .001$), cancer worries ($z = -2.56$, $p = .010$), perceived susceptibility ($z = -10.98$, $p < .001$), and response efficacy ($t = 18.95$, $p < .001$).

Table 2 *Cultural Adaptation of the Chinese Preventive Health Model (PHM) Instrument Based on Expert Consultations and Cognitive Interviews.*

Identified Issues (Study Rounds)	Adaptation	Reasons for Adaptation
Comprehension Issue (Three rounds of cognitive interviews)		
HCC screening	Cartoon pictures of HCC progression and photographs of HCC screening tests (e.g. liver ultrasound) were used to explain HCC screening in the instrument's instruction.	During two rounds of cognitive interviews, most patients demonstrated unawareness of HCC screening. For example, P 10 said, 'I hadn't heard about HCC screening until you told me.' Some misperceived HCC screening as an epidemiological study on HCC risks. For example, 'I perceive that HCC screening relates to the study or screening of water, soil, or diet that may cause HCC, in a place where HCC incidence is high.' (P 24) Thus, we added pictures and photographs to the instrument to assist their understanding of HCC screening. These implements received high acceptability among patients with lower educational levels.
Curative treatment	Revised to 'liver resection' and finally to 'better treatment.'	In the second round of cognitive interviews, almost all patients reported not understanding 'curative treatment' and misperceived it as complete cure or whole liver resection after HCC diagnosis. 'Does it mean complete cure? I don't really think so. HCC cannot be cured.' (P 25) 'I believe that curative treatment is to resect the whole liver. Is it possible to live without a liver?' (P 24) The item was thus revised to 'liver resection' as it is the primary treatment of choice for early-stage HCCs. However, in the third round, we found that some may not know this detail. 'I don't think liver resection is the primary choice. I observed that they (patients with HCC) use transarterial chemoembolization.' Thus, the lack of knowledge may influence patients' comprehension of this item. It was finally revised to 'better treatment' to help those with lower educational level understand the item.
Sensitive wording (First-round expert consultation and second-round cognitive interview)		
It is very likely that I will develop HCC.	Revised to 'I may develop HCC in the future.'	As suggested by three experts in the first round consultation, 'in the future' was added to specify the period. Compared with 'may,' 'very likely' has a stronger meaning that HCC would happen. Experts suggested to use 'may' to replace 'very likely,' with the latter being potentially offensive in Chinese and could make patients feel nervous when answering the question.
Improve survival rates	Revised to 'prolong life.'	During the second round of cognitive interviews, two patients expressed that the use of 'improve survival rates' made them feel scared that they 'cannot survive' (P 26), and suggested to revise it to 'prolong life,' which is more psychological acceptable.
Wording clarity (First-round expert consultation)		
I will just be healthy.	Revised to 'it will not influence my health.'	As suggested by two experts in the first round of consultation, we revised 'I will just be healthy' to 'it will not influence my health.' The revision did not change the item's sense orientation but improved overall understanding of the item: 'it will not influence my health if I avoid having HCC screening.'
The chance that I might develop HCC is high.	Revised to 'the risk that I might develop HCC is high.'	The words 'chance' and 'risk' have a slight difference in Chinese. 'Chance' refers to the current probability of getting HCC, whereas 'risk' is the potential of getting HCC in the future. Given that patients typically undertake HCC examinations in hospital and are aware of their diagnoses, they may be inclined to rate 'no' if the item uses 'chance' without HCC diagnoses. Thus, as suggested by three experts in the first round of consultation, we used 'risk' to evaluate patients' perceived susceptibility of developing HCC.
Question relevance (First-round expert consultation)		
Compared with other persons my age, I am at lower risk for HCC.	Revised to 'compared with other persons without hepatitis B, I am at higher risk for HCC.'	Compared with age, hepatitis B infection is a major risk for developing HCC in China. As suggested by two experts in the first round of consultation, the revision is more relevant to the current population.
The chances that I will develop colorectal polyps are high.	Deleted.	The colorectal polyp relates to a different anatomical location of the gastrointestinal tract and is not relevant to HCC, which relates to the liver.
Items in original response efficacy subscale:	Deleted and replaced by three new items, including	The research team and content experts suggested the revision. First, the original items are not aligned with the current evidence on HCC surveillance efficacy regarding early diagnosis, more curative treatment, and better survival; these were deleted. After an integrative review of the current HCC surveillance guidelines, we developed three items to constitute this domain. The use of 'better treatment' and 'prolong life' were finally implemented. See revisions on wordings. The added items are also consistent with patients' perceived efficacy of undertaking HCC screening: 'HCC screening helps detect HCC early. The earlier you find HCC, the better the treatment would be. Now, I have liver cirrhosis and have the risk of developing HCC. I usually undergo CT scanning to check for HCC. If the results are negative, I will feel reassured.' (P 1)
When colorectal polyps are found and removed, colorectal cancer can be prevented.	Item 21: HCC screening is helpful for the timely detection of early-stage HCC.	
	Item 22: When HCC is detected in the early stages, curative treatment could be achieved.	
When colorectal cancer is found early, it can be cured.	Item 23: Early detection of HCC through screening can improve survival rates.	
Culture sensitivity (First-round expert consultation and cognitive interview)		
Salience and coherence	Added item 7: It doesn't make sense to me to go to hospital for health checkups if I didn't feel discomfort.	During the first round of cognitive interviews, most patients expressed that they undertook opportunistic HCC screening when they experienced symptoms. 'At that time, my face and eyes were yellow. I also felt bloated in my abdomen. There was irregular liver pain, but not too painful. It didn't hurt from time to time, but did for a while when it came up. So, I went [to the hospital] to have a liver ultrasound' (P 18). Thus, patients tended to perceive a lower need to undertake health checks or HCC screening if they do not feel uncomfortable or can stand the discomfort/pain. 'If my liver has problems, my ankle would be swollen; I could feel a pit after pressing. If there is no swelling and the examination results are normal, I will not go to the hospital […] unless I have the symptoms I just mentioned' (P 7). For patients from rural areas, they may believe that 'even if we feel uncomfortable, we don't even take medicine; just drink more water. If I can bear it, I won't have it checked' (P 22). 'For rural people, as long as you can move, you can do

(*continued on next page*)

Table 2 (*continued*)

Identified Issues (Study Rounds)	Adaptation	Reasons for Adaptation
		the labor. That's all. We never thought to have health examinations; we don't go to hospitals unless the disease is very serious' (P 2). Thus, to enhance the instrument's culture sensitivity, we added item 7 to assess for perceived salience, the felt need or importance, of undertaking preventive action in the absence of symptoms.
Cancer worries	Added item 10: I am worried that if HCC is detected, it will bring me fear and pressure. Added item 11: I am worried that if HCC is detected, it will bring an unbearable burden on my family.	Three experts believed that negative emotion and concern of being a burden to the family if diagnosed with HCC should also be assessed. Further interviews also revealed that patients had psychological distress toward HCC diagnoses, worried that they may bring a heavy burden to their family. This influenced patients' utilization of HCC screening. 'I don't want to think about it. The more I think about HCC, the more psychological pressure I feel' (P 8). 'When HCC is mentioned, my heart sinks' (P 5). 'If we don't know the diagnosis, we can still muddle along. If we know, what should my family and I do? Ordinary people don't have money' (P 17). Meanwhile, others expressed that undertaking HCC screening would help detect HCC at an early stage and reduce health costs and negative influences to them and their families (P 4). Thus, items 10 and 11 were added to help explore the predictive effects of these culture-bound perceptions.
Perceived susceptibility	Added item 20: I will not get HCC if I take anti-hepatitis B virus drugs and adopt a healthy lifestyle.	The cognitive interviews revealed the patients' misunderstanding of HCC risks. Most of them perceived that HCC could be precluded by antivirus drugs and healthy lifestyles; these patients had a lower perceived need for undertaking HCC screening. 'For me, I pay attention to my diet, have regular rest, and quit smoking and drinking last year. Further, I take antiviral drugs on time. I believe that the progression from hepatitis B to HCC is reversible. Anyway, I have a lower risk of HCC and don't consider HCC screening' (P 5). Thus, this item was added to further assess patients' perceived HCC susceptibility.
Social influence	Added item 14: My friends or colleagues think I should have HCC screening. Added item 15: I want to do what my friends or colleagues think I should do about HCC screening. Added item 16: Regarding HCC screening, I will refer to relevant information on the internet, TV, or in books.	All experts reported on the item inadequacy of this subscale and suggested to consider influences from social media and friends and colleagues who are also important members in one's social circle. During the cognitive interviews, the patients also expressed that information from social media helped them understand the importance of HCC screening. Reminders from friends/colleagues helped them undertake HCC screening. 'I also pay attention to HCC screening and search relevant information online. There is much information on HCC screening from Baidu' (P 5). 'In fact, when I came here [the hospital] this time, I didn't feel discomfort. There was a wedding ceremony, and I sat there drinking. Two friends said that my eyes were yellow and suggested that I go to hospital for examinations. So, I came here' (P 19).

Abbreviations: CT, computed tomography; HCC, hepatocellular carcinoma.

Reliability analyses

The Cronbach's α were 0.91 for the 20-item PHM instrument; and .91, .88, .87, .86, and .89 for the subscales of social influence, salience and coherence, cancer worries, perceived susceptibility, and response efficacy, respectively (Table 3). The split-half reliability coefficient was .79, and the intraclass correlation coefficient for test–retest reliability was .80 ($p < .001$), indicating established stability [38].

Discussion

HCC screening is underutilized globally and significantly precluded timely diagnosis of HCC [6]. Although exploration of its modifiable psychosocial factors has been highly emphasized [14], the lack of valid instruments has impeded progress. The three-phase study is the first that translated, culturally adapted, and validated a Chinese version of the PHM instrument for measuring psychosocial factors of HCC screening among patients with hepatitis B. The instrument provided new insights for future efforts to improve HCC screening practices across geographic regions.

In the first phase, cultural and linguistic issues were revealed in translating 'immediate family,' 'doctor or health professional,' and original items 2 and 10, consolidated through semantic translation. The translated version was easy to understand, except for the instruction, due to patients' miscomprehension of HCC screening. To avoid incorrect assumptions about HCC screening, the study added pictures demonstrating HCC screening, thereby also reducing response bias. Future studies should clarify patients' comprehension of HCC screening when administering the instrument.

In the second phase, the PHM instrument was adapted by considering the particularities of HCC screening, such as the risk group of hepatitis B and screening effectiveness; patients' cultural perceptions of undertaking HCC screening; and content experts' suggestions. The cognitive interviews revealed that patients' perceptions of HCC screening overlapped with the five PHM constructs but with slight differences. For salience and coherence, most patients perceived lower needs for health checkups and undertook HCC screening only when symptoms appeared. A total of 20.0–69.0% of high HCC risk patients believed that HCC screening was unnecessary in absence of abdominal pain [17,18,20]. Item 7 was thus added, consistent with previous cancer screening belief instruments that adopted items regarding attitudes toward preventive actions in absence of symptoms [43,44]. Measuring this perception is vital to HCC screening, given that early-stage HCC is typically asymptomatic and screening only after symptoms leads to late diagnoses [3].

The cancer worries factor measured the perceived negative consequences of cancer screening, including cancer detection [21]. Concern about HCC detection is common in patients with hepatitis B [19,20], which is why 13.8% of them do not undertake HCC screening [18]. However, the negative emotion and fear of being a burden to the family if diagnosed with cancer are also considered important aspects of cancer worries [45]. First, in Chinese culture, HCC has been perceived as incurable and implies death [46]. The negative emotions toward HCC are inevitable. Most patients in current study also expressed fear and anxiety when mention about HCC, such as 'my heart sinks.' This may influence their attitude toward early diagnosis of HCC and behavior in undertaking HCC screening. Item 10 was thus added to gather insights for future targeted psychological interventions to reduce the negative emotions relating to HCC and HCC screening. Second, familialism is highly valued in Chinese culture regarding responsibilities in supporting and self-sacrificing for family [47]. Some patients thus avoided HCC screening for possible HCC diagnoses that may bring

Table 3 *Items, Factor Loadings, Communalities, and Cronbach's Alpha Values of the Chinese Preventive Health Model (PHM) Instrument.*

Factors and Items	Factor Loadings					Communalities	Cronbach's α
	1	2	3	4	5		
Factor One: Social Influence							.91
[a]14. My friends or colleagues think I should have HCC screening	**.88**	.12	-.01	.16	.15	.85	
[a]15. I want to do what my friends or colleagues think I should do about HCC screening.	**.88**	.07	.08	.12	.18	.83	
13. I want to do what my doctor or nurse thinks I should do about HCC screening.	**.76**	.25	.15	.15	.36	.80	
[a]16. Regarding HCC screening, I will refer to relevant information on the internet, TV, or in books.	**.72**	.38	.06	.13	.16	.72	
2. I want to do what members of my family think I should do about HCC screening.	**.71**	.26	.09	.15	.14	.62	
Factor Two: Salience and Coherence							.88
[a]7. It doesn't make sense to me to go to hospital for health checkups if I didn't feel discomfort.	.20	**.87**	-.02	.05	.16	.82	
[c]6. It will not influence my health if I avoid having HCC screening.	.25	**.80**	.07	.04	.16	.74	
1. HCC screening makes sense to me.	.12	**.69**	.10	.37	.22	.69	
3. Having HCC screening is an important thing for me to do.	.20	**.61**	.13	**.48**	.32	.76	
4. Having HCC screening can help to protect my health.	.27	**.60**	-.01	.38	.17	.61	
Factor Three: Cancer Worries							.87
[a] 10. I am worried that if HCC is detected, it will bring me fear and pressure.	.02	.03	**.91**	.05	-.02	.84	
9. I am worried that HCC screening will show that I have HCC.	.07	-.01	**.90**	.11	.02	.83	
[a]11. I am worried that if HCC is detected, it will bring an unbearable burden on my family.	.01	-.05	**.83**	.17	.09	.73	
5. I am afraid of having an abnormal HCC screening test result.	.18	.21	**.73**	-.08	.06	.62	
Factor Four: Perceived Susceptibility							.86
[c]17. The risk that I might develop HCC is high.	.18	.18	.05	**.88**	.10	.84	
[c]19. I may develop HCC in the future.	.24	.12	.08	**.84**	.18	.82	
[c]18. Compared with other persons without hepatitis B, I am at higher risk for HCC.	.08	.22	.14	**.78**	.30	.77	
Factor Five: Response Efficacy							.89
[b]22. When HCC is detected in the early stages, better treatment could be achieved.	.29	.26	.07	.16	**.83**	.88	
[b]23. Early detection of HCC through screening can prolong life.	.25	.29	.06	.24	**.82**	.88	
[b]21. HCC screening is helpful for the timely detection of early-stage HCC.	.31	.20	.02	.30	**.72**	.75	
Total Scale							.91
Deleted Items							
8. Members of my family think I should have HCC screening.	.02	**.64**	.01	.09	.30	.51	
12. My doctor or nurse thinks I should have HCC screening.	.33	.40	.09	**.43**	.20	.50	
[a]20. I will not develop HCC if I take anti-hepatitis B virus drugs and adopt a healthy lifestyle.	.31	.29	-.06	.36	.28	.39	

Abbreviations: HCC, hepatocellular carcinoma.
Boldface indicates factor loadings that exceed the criterion .40.
[a] Newly added items for increasing cultural sensitivity.
[b] Newly added items for increasing question relevance.
[c] Corrected items.

their family economic and caring burdens. The added item 11 enhanced cultural sensitivity.

Regarding perceived susceptibility, most patients misbelieved that HCC could be precluded by antiviral drugs and healthy lifestyles. Indeed, 48.6% to 71.6% of patients with chronic liver diseases are unaware that a healthy diet does not sufficiently lower all HCC risks [17,20]. Item 20 was thus added but was finally deleted owing to poor factor loading. This may be because the item was reversely worded and could have confused patients after responding to previously positively worded items in this subscale. For social influence, influences from important social members (friends/colleagues) and social media in changing individual attitudes and behaviors toward cancer screening cannot be neglected [48], and were thus incorporated. These adaptations to the instrument have led to an excellent S-CVI/Ave (.98).

In the third phase, psychometric validation was conducted. Aligning with previous studies on Australians [25], African-Americans, and Caucasians [21], EFA and CFA also supported a five-factor structure. However, in contrast to the findings of Vernon et al. [23], social influence, instead of salience and coherence, accounted for the highest variance (41.4%) in the current study. This may be due to the increased number of items and may not sufficiently support that social influence has more predictive effects than salience and coherence on patient utilization of HCC screening. In addition, items 8 and 12 from social influence were relocated to different factors. Item 8 was loaded on salience and coherence. In Chinese culture, to avoid psychological harm to patients, medical professionals tend to avoid directly informing patients of cancer-related examinations and results; families are told first [49]. Patients would feel the need for HCC screening if their families believed so. Thus, responding to item 8 may lead to ambiguous meaning, being related to social influence from families and salience and coherence, the perceived need for HCC screening. Similarly, item 12 loaded on perceived susceptibility, which may be because patients would perceive HCC risks if their doctors suggested that they undergo HCC screening. Given the lack of conceptual consistency with relocated factors, both items were deleted.

The adapted PHM instrument also showed known-group validity, with significantly higher scores on each subscale among patients with optimal HCC screening behavior than those not. However, the PHM construct of cancer worries has been conceptualized as a barrier to cancer screening and negatively predicted cancer screening uptake in previous studies [23,24]. Based on concept discussions, this contradiction may be explained by patients' available resources and beliefs toward HCC screening efficacy. Patients with lower income may not be willing to undergo HCC screening to avoid being a burden to their families in case of positive diagnoses. Conversely, other participants, who believed that undertaking HCC screening helps to detect early-stage HCC with lower tumor burden, were more willing to undertake HCC screening to avoid negative influences on them and their families caused by late diagnosis of HCC. The predictive direction of cancer worries regarding HCC screening can be further explored. Regarding reliability, the Cronbach's α values of salience and coherence, cancer worries, and perceived susceptibility in the current study were similar to those in a previous report [23]. However, the coefficients were generally higher than other

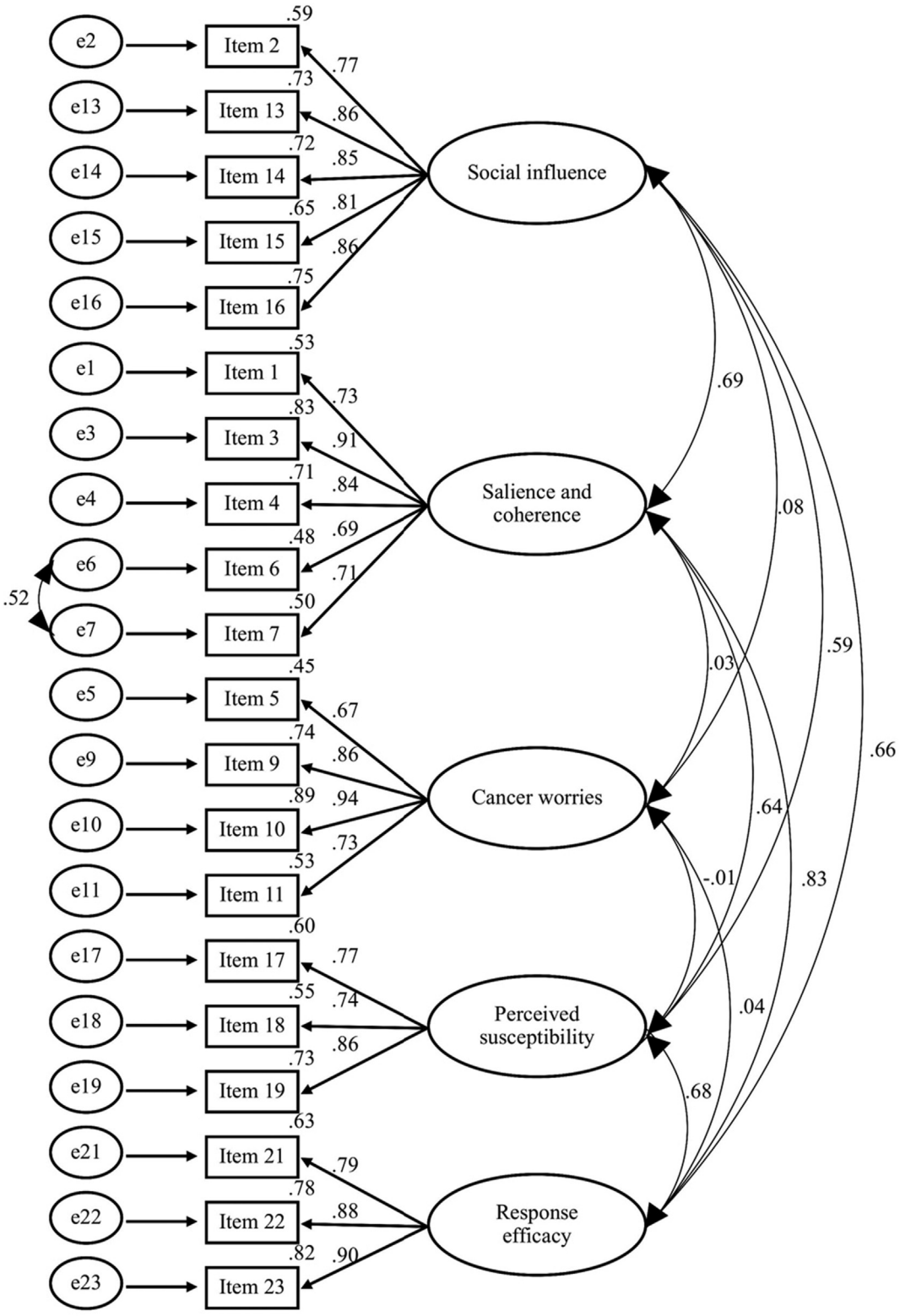

Figure 1. Five-Factor Model for the Chinese Preventive Health Model (PHM) Instrument.

validations, ranging from .56 for salience and coherence to .68 for perceived susceptibility among Caucasians, and African Americans [21]; and from .53 for social influence to .68 for perceived susceptibility among Australians [25]. The reason may be that these studies [21,25] were conducted in English-speaking countries and did not require adaptations. In contrast, this study adopted a systematic translation and adaptation process that maintained item, semantic, and conceptual equivalence, and added items that reflected culture-based perceptions of HCC screening, which might have led to the higher coefficients.

Table 4 *Average Variance Extracted (AVE), Composite Reliability (CR), Square Correlation between Subscales, and Known-group Analysis of the Chinese Preventive Health Model (PHM) Instrument.*

Latent Constructs	AVE	CR	Social Influence	Salience and Coherence	Cancer Worries	Perceived Susceptibility	Response Efficacy	Known-Group Analysis Median (IQR) or Mean (SD)		t/Z value	p
								Optimal HCC Screening Group	Suboptimal or Poor HCC screening Group		
Social influence	.69	.92	**.69**					3.87 (.46)	2.65 (.76)	−11.20	<.001
Salience and coherence	.61	.89	.48	**.61**				4.23 (.38)	2.91 (.49)	−12.51	<.001
Cancer worries	.65	.88	.01	.01	**.65**			3.83 (.69)	3.54 (.85)	−2.56	.010
Perceived susceptibility	.63	.83	.35	.41	.01	**.63**		3.84 (.54)	2.81 (.58)	−10.98	<.001
Response efficacy	.74	.90	.44	.68	.01	.47	**.74**	4.30 (.41)	3.02 (.54)	18.95	<.001

Limitations and strengths

Our study did not conduct a concurrent validity assessment because related scales for psychometric comparison are lacking. However, known-group validity was established based on the external criteria of HCC screening behavior. Second, although sample diversity was ensured by recruiting patients with hepatitis B with different indications for HCC screening, the generalizability of the results may be limited by convenience sampling of patients.

The study adopted a rigorous validation process. First, through committee-based translation, cognitive interviews, and expert consultations, instrument issues regarding comprehension, sensitive wording, wording clarity, question relevance, and cultural sensitivity were addressed. The systematic methodology guaranteed that the adapted PHM instrument had adequate construct, convergent, discriminant, and known-group validity and reliability to be administered to patients with hepatitis B.

Clinical implications

Currently, there is a gap between international guideline recommendations to improve HCC screening and the real-world utilization among high-risk populations. The adapted 20-item PHM instrument would facilitate clinical practices and studies in this area. First, it would help nurses and other health professionals to understand patient perception gaps regarding HCC screening, such as perceived HCC susceptibility. Thus, relevant education and tailored counseling can be provided to address the misbeliefs that preclude utilization. Second, it can also help researchers develop efficient strategies to improve HCC screening utilization and reduce HCC burden across high-risk regions. Since the five-factor structure is consistent with the original version, it would also permit comparisons of intervention effects between cross-cultural studies. Moreover, the three-step rigorous study process, especially the cultural adaptations through concept discussions and cognitive interviews, is also valuable for future cross-cultural validation of instruments in other countries.

Conclusions

This study applied a rigorous sequential process of translation, cognitive interviews, expert consultations, and cross-sectional surveys to ensure that the Chinese version of the PHM instrument is culturally sensitive, reliable, and valid in measuring psychosocial factors (social influence, salience and coherence, cancer worries, perceived susceptibility, and response efficacy) to HCC screening among patients with hepatitis B. Unpacking these psychosocial predictors is vital for health professionals and researchers to develop enhancive strategies to improve the globally underutilized HCC screening. The five-factor, 20-item adapted PHM instrument can be further tested among diverse samples with other HCC risks across practice settings, regions, and cultures to increase generalizability.

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Ethical consideration

The study received ethical approval from the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong (No.SBRE-20-072), and Medical Ethics Committee of the Henan Provincial People's Hospital (No.2020169).

Conflict of interest

The authors declare no conflicts of interest.

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