The reliability and validity of the Chinese version of The Metacognitions about Health Questionnaire in college students

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Abstract

Purpose In order to explain the potential mechanism that might motivate and maintain health anxiety (HA), researchers have developed several measures to assess the level of HA and to identify related cognitions and personality features. However, such instruments typically measure general metacognitions (e.g., the Metacognition Questionnaire-30, MCQ-30), thereby compromising the degree of sensitivity and specificity of measurement as applied to HA-related metacognitions. To address that issue, the Metacognitions about Health Questionnaire (MCQ-HA) was designed especially for measuring metacognitive beliefs specific to HA. Because a Chinese version of MCQ-HA may be helpful in improving our understanding of HA in a Chinese population, in the current study we sought to develop a Chinese version of the MCQ-HA (CMCQ-HA).

Methods We translated the MCQ-HA into Chinese with consideration of cultural diversity. For evaluation of its validity and stability, a sample of 1290 Chinese college students answered the CMCQ-HA, the Short Health Anxiety Inventory, the MCQ-30 and the Neuroticism scale of the Eysenck Personality Questionnaire. 292 students of them answered the CMCQ-HA twice.

Results Good internal consistency (α=0.81) and test-retest reliability (ICC=0.70) of the CMCQ-HA was presented. Exploratory and confirmatory factor analyses indicated a three-factor structure: beliefs about biased thinking, beliefs that thoughts can cause illness,

and beliefs that thoughts are uncontrollable. Convergent validity, divergent validity and incremental validity all were acceptable. Measurement invariance across gender was established.

Conclusions The CMCQ-HA shows promise for the measurement of specific HA-related metacognitions in Chinese populations.

Keywords Health anxiety, Metacognition, Reliability and validity, Chinese population

Introduction

Health anxiety (HA) is a psychological condition that involves excessive worry about one's own health in the absence of relevant physical illness [1]. People with elevated levels of HA may experience excessive distress and functional impairment, and utilize medical services at a greater frequency [2]. Such experiences are not uncommon in either general population or clinical samples, and have attracted increasing attention in the health field [3]. Epidemiological studies indicate that the prevalence rate of HA is 3.4% in community samples and even higher in primary practice samples [4, 5]. Furthermore, HA is usually comorbid with physical disease and other psychological disorders, and has been shown to complicate disease diagnosis and to elevate treatment difficulty [4]. Recently, there has been a lot of progress in the mechanism of HA. A meta-analysis supported a consistent link between the personality trait neuroticism and various clinical disorders [6], while other work found a strong correlation between neuroticism and severe HA [7]. Cognitive-behavioral theory is currently the most influential model for conceptualizing and treating HA [8], and studies have identified cognitive variables that play a role in the development and maintenance of HA, including dysfunctional illness beliefs, catastrophic misinterpretation, and somatosensory amplification [9-11]. A range of instruments were developed to estimate those variables, such as the Whiteley Index [12] and Health Anxiety Questionnaire [13] for level of HA, and the Health Cognitions Questionnaire [14] and Somatosensory Amplification Scale [11] for HA-related cognitive variables.

There is also evidence suggesting that cognitive and personality variables may not fully ex-

plain the development and persistence of HA [15]. Metacognitive Theory (MCT) [16, 17], which is based on the Self-Regulatory Executive function (S-REF) model, argues that HA usually results from extended and repetitive negative thinking about illness, and that such negative thinking is the consequence of dysfunctional metacognitive beliefs [15]. The role of metacognitive beliefs in HA has been studied in a range of studies, including HA as a cross-sectional and longitudinal predictor of disorder [15-18]. In some of those studies the generic Metacognition Questionnaire-30 (MCQ-30), a shortened version of the Metacognition questionnaire (MCQ), was used to measure metacognitive beliefs [19]. However, as the MCQ-30 is designed for measuring general metacognition in psychological disorders, none of the items are specifically HA-related. Another study used the Metacognitions about health anxiety (MCHA) scale, which was revised based on the MCQ; however, this is an unpublished scale, and knowledge of its psychometric properties is very limited [20]. In order to further explore the psychological mechanism of HA and promote more appropriate treatments for it, an improved measure of HA-related metacognitive beliefs is essential. In 2015, Bailey and Wells developed a 14-item questionnaire, the Metacognitions Questionnaire-Health Anxiety (MCQ-HA) [20] to measure metacognitive beliefs specific to HA. The measure captures three different HA-related metacognition constructs: *beliefs about biased thinking, beliefs that thoughts can cause illness* and *beliefs that thoughts are uncontrollable*. The MCQ-HA has been shown to have good reliability and validity, and a useful measurement of HA-related metacognitive beliefs [15, 16].

In 2012, Rachman first proposed the concept of health anxiety disorders (HAD), and regarded HAD as an anxiety disorder just like panic disorder, social phobia, general anxiety disorder [21]. It's worth noting that no scale yet can measure both anxiety and health anxiety [22]. In China, a plenty of measures for anxiety disorders were established but a few scales were developed to assess HA or hypochondriasis which is deemed as the extreme form of HA [23]. Most studies in this field focus on the cognitive characteristics and treatment of hypochondriasis. The Whiteley Index is the most widely used measurement in Chinese population, but the full information about its psychometric properties in mainland China is not clear [24]. And a

majority of HA-related measurements available in China each are concentrating on one cognitive aspect of HA, such as the Anxiety Sensitivity Index, Health Anxiety Inventory and so on [25]. The cognitive structure of HA or hypochondriasis is still under controversy [15], so more measures to assess different aspects of HA are needed to developed for either researchers or clinic practice. To our best knowledge, there was no research exploring the role of metacognition in developing HA in Chinese population. It may be the case that there is no appropriate Chinese scale to measure it. Several researches suggest that cultural diversity has extensive influence on cognition, emotion and motivation [26]. Across different culture contexts, people may hold particular culturally-related traditional views that influence their cognitions regarding health. Accordingly, metacognitions may be culture-based and the development of a measurement for HA-related metacognitions in China can be helpful in improving our understanding of metacognitions and HA. It is unknown whether the MCQ-HA which is a validated scale for HA can be a good measurement of HA-related metacognitions in China. We aimed to address this issue through the current research. The main purpose of our study was to translate the MCQ-HA into Chinese and test the reliability and validity of CMCQ-HA in measuring HA-related metacognitions in the context of Chinese culture.

Methods

Participants

Participants were recruited by convenience sampling from a university medical school in the Hunan Province in China. Questionnaires containing information about the study were distributed during a class break. 1290 undergraduate students in 13 classes voluntarily agreed to participate and gave informed consent. In the present study, we acquired 1191 fully completed questionnaires; the effective return ratio is 92.3%. Two weeks later, a random sample drawn from three classes comprised of a total of 292 students were chosen for a second testing session; of them, 268 completed the CMCQ-HA. That second sample was used for the test-retest reliability analysis; effective return ratio was 91.8%. Information about age and gender were obtained from all participants. There was no academic or other reward for their participation. The study protocol received full approval from the local ethics committee.

Measures

The Chinese version of MCQ-HA (CMCQ-HA)

The original MCQ-HA consists of 14 items and has three subscales for assessing three types of HA-related metacognitive beliefs: *beliefs about biased thinking* (5 items), *beliefs that thoughts can cause illness* (5 items) and *beliefs that thoughts are uncontrollable* (4 items). Items are rated on a 4-point Likert scale ranging from 1 (do not agree) to 4 (agree very much) [20]. Subscale score for Beliefs about biased thinking and Beliefs that thoughts can cause illness ranges from 5 to 20, subscale score for Beliefs that thoughts are uncontrollable ranges from 4 to 16. The total MCQ-HA score ranges from 14 to 56 with higher score indicating higher levels of unhelpful HA-related metacognitive beliefs. Permission to use that measure was obtained from Robin Bailey who was the original author of MCQ-HA. Taking reference of guideline from Beaton et al, the Chinese version of MCQ-HA was created [27]. First, two psychological researchers translated the MCQ-HA into Chinese. Then the translations were synthesized into one. After that, two psychology professors examined the translation for surface-level relevance to the construct of interest and each item's suitability for a Chinese population. Next, the Chinese version of the items was back-translated by a professional bilingual translator who had not read the original MCQ-HA. That version was reviewed and modified by the author of the MCQ-HA until it expressed exactly the same meanings as the original measure. Because the resulting description of Item 3 "I will be punished for thinking I am in good health ", was not a good fit for Chinese culture, and has a religious connotation, it was modified as follows: "There will be something bad to happen for thinking I am in good health". This modification was approved by Dr. Bailey. A pilot test was conducted with 25 participants. There were no reports of misunderstandings.

The Short form of Health Anxiety Inventory (SHAI)

The SHAI measures the severity of health anxiety and contains 18 items [13]. In current study, it was employed for exploration of convergent validity, divergent validity and incremental validity. The Chinese version of SHAI consists of two factors: illness likelihood (IL) with 14

items, and negative consequences (NC) with 4 items. There are four statements ranging from 0 (I do not) to 3 (I spend most of my time) in each item. The total SHAI score ranges from 0 to 54; and higher scores indicating increased health anxiety. The SHAI showed good psychometric propertied in Chinese population. The Cronbach's alpha of its total and subscales were 0,742 (total), 0.743 (IL) and 0.788 (NC) [28]. In this study, the Cronbach's alphas of SHAI total and its subscales were 0.805 (total), 0.788(IL), 0.664(NC).

The Metacognition Questionnaire-30 (MCQ-30)

The MCQ-30 is widely used to measure metacognitive beliefs [19]. In the current study, we chose to use it for an incremental validity study. The 30 items is a refinement of the original MCQ [29]. The Chinese version of MCQ-30 shown good psychometric properties and consists of five specific subscales: positive beliefs about worry, negative beliefs about uncontrollability of thoughts and danger, cognitive confidence, beliefs about the need to control thoughts and cognitive self-consciousness [30]. The response options for of each item ranged from 1 (do not agree) to 4 (agree very much). The MCQ-30 total was ranging from 30 to 120 and indicating different tendency in generic metacognitive beliefs. In this study, the Cronbach's alphas for the MCQ-30 were 0.857 for total items, and ranged from 0.674 to 0.822 for subscale items.

Neuroticism scale of the Eysenck Personality Questionnaire-Revised: Short Form (EPQ-R-N)

EPQ-R is a well-known personality assessment instrument with 100 items and 4 subscales: extraversion, neuroticism, psychoticism and lie; Eysenck et al developed a revised version that consists of 48 items [31]. The Chinese version of the EPQ-R includes 48 items and 4 subscales as does the original version [32]. The response to each item is "yes" or "no" with scored 1 or 0. In order to better explain the results, the raw score of each subscale should be converted to standard score. The neuroticism subscale assesses the feature of emotional response. In the present study we only use the neuroticism subscale for evaluating divergent validity; Cronbach's alpha for this subscale was 0.818.

Data analysis

Item analysis and reliability

A corrected item-total correlation were estimated for homogeneity and the recommended criterion was above 0.3 [33]. Reliability of the CMCQ-HA was evaluated by investigating its internal consistency and test-retest reliability. Internal consistencies of total score and three subscales of the CMCQ-HA were assessed. For the test-retest reliability, the intraclass class correlation coefficient (ICC) was considered to be more suitable compared to Pearson's correlation coefficients [34]; accordingly, the ICC results are reported.

Validity

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) was conducted to explore the factor structure. To do those analyses we randomly divided the participants into two equal groups (n=596 and n=595) by the SPSS algorithm. In Group 1, we conducted the EFA for the purpose of identifying the latent variables by SPSS 22.0. For factor extraction, principal axis factoring (PAF) and promax rotation were used, while the results of parallel analysis, eigenvalues and scree plot were inspected. In the pattern matrix, the primary factor loading higher than 0.32 was acceptable [35]. The parallel analysis was conducted by SPSS syntax script from O'Connor [36]. In Group 2, we conducted the CFA with maximum likelihood estimation by Mplus 7.0. According to the criteria proposed by Hu and Bentler [37], four commonly used indices were chosen: comparative fit index (CFI), root mean squared error of approximation (RMSEA), standardized root mean square residual (SRMR) and the Tucker-Lewis index (TLI). The convergent validity, divergent validity, and criterion-related validity of this scale were evaluated by Pearson's correlation coefficients for the CMCQ-HA score, the CSHAI score, and the EPQ-R score. A *P*-value less than 0.05 were considered as statistically significant. The incremental validity of CMCQ-HA beyond MCQ-30 for HA was examined with hierarchical multiple regression.

Gender invariance

Multigroup CFA was performed for the gender invariance of CMCQ-HA with Mplus 7.0.

There were four models tested for measurement invariance across gender: configural invariance, metric invariance, scalar invariance, and strict invariance [38].

Results

Descriptive statistics of study subjects

In the 1191 participants, no data was missing for all scales. All the items fell within the recommended range reflecting skew and kurtosis coefficients that should not be above 3 and 10, respectively [39]. The distribution of each item was close to normality. As shown in Table 1, a moderate floor effect was shown for the beliefs about biased thinking subscale (22.67%) and beliefs that thoughts are uncontrollable subscale (17.8%) [40]. For the beliefs that thoughts can cause illness subscale and total score, the floor effects were 5.46% and 2.35%, respectively. The observed ceiling effects were negligible. Participants were 726 women (61%) and 465 men (39%). Age range 17-24, with 19.33±1.32 (mean±S.D.) years; no significant age difference was observed between the two gender groups (t=0.555; 95% confidence interval [CI]:-0.112-0.200; *p*=0.579). Mean and standard deviation for age and each questionnaire are presented in Table 1.

Table 1 Descriptive statistics for age and measurements

	N	Mean(SD)	Min	Max	95%CI	%Min	%Max
Age	1191	19.33 (1.32)	17	24			
CMCQHAT	1191	24.40 (6.17)	14	55	[24.05-24.75]	2.35	0.08
CMCQHAT-R	286	22.45 (4.51)	14	43	[21.90-22.99]	1.12	0.37
BI	1191	10.24 (3.25)	5	20	[10.06-10.43]	5.46	0.67
BT	1191	7.29 (2.35)	5	20	[7.15-7.42]	22.67	0.34
BU	1191	6.87 (2.47)	4	16	[6.73-7.01]	17.80	0.34
SHAI	1191	11.73 (5.32)	0	35	[11.43-12.04]		
MCQ30	1191	69.50 (11.73)	31	116	[68.83-70.17]		
EPQ	1191	5.62 (3.37)	0	12	[5.43-5.82]		

Notes: CMCQHAT = Metacognitions about Health total; CMCQHAT-R = Metacognitions

about Health total at second time; BI = Beliefs that Thoughts can Cause Illness; BT = Beliefs about biased Thinking; BU = Beliefs that Thoughts are Uncontrollable; SHAI = Short Health Anxiety Inventory; MCQ-30 = Metacognition questionnaire-30; EPQ = Neuroticism subscale of the Eysenck Personality Questionnaire-Revised: Short Form.

Item analysis and reliability

To test the homogeneity of the scale, corrected item-total correlations ranging from 0.35-0.54 were examined and all above the recommended cut off 0.3 [33]. As shown in Table 2, correlations between each of the CMCQ-HA subscales and the total score ranged from 0.73-0.80 (p<0.01). The inter-correlations between subscales ranged from 0.35-0.43 (p<0.01), suggesting that these subscales are related to each other but assess independent aspects of HA-related metacognitions. Internal consistency was evaluated with Cronbach's alpha. A Cronbach's alpha of lower than 0.6 or 0.50 was seen as unacceptable for total score or subscale scores, respectively [41]. This index of CMCQ-HA total score was 0.81. The Cronbach's alphas with each item deleted all were less than 0.81. The alphas of subscales ranged from acceptable to good: "Beliefs that thoughts can cause illness, BI" α=0.76; "Beliefs about biased thinking, BT" α=0.72; "Beliefs that thoughts are uncontrollable, BU" α=0.68. The test-retest reliability was tested by ICC. Based on the recommendation of Landis and Koch [42], an ICC of 0.1 or lower was rated as no consistency, an ICC between 0.11 and 0.40 was rated as poor, an ICC between 0.41 and 0.6 was rated as ordinary, an ICC between 0.61 and 0.80 was rated as moderate, and an ICC above 0.8 was rated as good. The results showed that ICC was 0.70 for CMCQ-HA total (p<0.001), 0.63 for BI (p<0.001), 0.52 for BT (p<0.001), 0.59 for BU (p<0.001), indicating an acceptable test-retest reliability for the CMCQ-HA [42].

Table 2 Inter-correlations between scales

	1	2	3	4	5	6
1.CMCQHAT						
2.BI	.797**					
3.BT	.732**	.377**				

4.BU	.752**	.354**	.433**			
5.SHAI	.466**	.282**	.321**	.488**		
6.MCQ30	.384**	.292**	.271**	.371**	.344**	
7.EPQ	.200**	.111**	.136**	.224**	.338**	.307**

Notes: Data presented as Pearson's correlation coefficient (r). ** means p<0.01 (two tailed). CMCQHAT = Metacognitions about Health total; BI = Beliefs that Thoughts can Cause Illness; BT= Beliefs about biased Thinking; BU = Beliefs that Thoughts are Uncontrollable; SHAI = Short Health Anxiety Inventory; MCQ30 = Metacognition questionnaire-30; EPQ = Neuroticism subscale of the Eysenck Personality Questionnaire-Revised: Short Form.

Factor structure

The EFA was performed on scores from a randomly selected subsample (n=596). The significance of Bartlett's test of sphericity was observed (χ^2=2008.30, p<0.001). The Kaiser-Meyer-Olkin score was 0.84, which is considered good [43]. Both of those indices indicated that the factor analysis was appropriate. The inspection of the scree plot and eigenvalues showed three factors in this analysis, which accounted for 51.05% of variance. The results of the parallel analysis also showed three factors having eigenvalues above values obtained from a random dataset. The first factor was well above the chance level (actual eigenvalue=2.493; estimated mean=0.216; 95th percentile eigenvalue=0.250), so as the second factor (actual eigenvalue=2.345; estimated mean=0.172; 95th percentile eigenvalue=0.201) and the third factor (actual eigenvalue=1.881; estimated mean=0.134; 95th percentile eigenvalue=0.167). As shown in Table 3, there were five items which loaded highly on Factor 1 (beliefs about biased thinking), factor 2 (beliefs that thoughts can cause illness), respectively. Meanwhile four items loaded highly on Factor 3 (beliefs that thoughts are uncontrollable). The loading of each item on its factor ranged from acceptable to good [35]. We conducted CFA on the remaining members of the sample (n=595) using maximum likelihood estimation (MLM) to evaluate the fitness of the EFA identified three-factor model. The MLM estimator reports a mean adjusted chi-square (Satorra-Bentlerχ^2), which is appropriate for our data characterization. In general, the cutoffs for acceptable fit are RMSEA with SRMR values of $\leqslant$0.08, and TLI with CFI

values of ⩾0.90 [37]. Results indicated that the three-factor model fit the data well: SBχ^2 = 223.911, df =74, p<0.001, CFI = 0.930, TLI = 0.913, RMSEA = 0.052, SRMR = 0.049.

Table 3 Exploratory factor analysis pattern matrix and structure matrix rotated to the Promax criterion using principal axis factoring (N=596)

Items	Pattern Matrix			Structure Matrix		
	Factor1	Factor2	Factor3	Factor1	Factor2	Factor3
5	**0.893**	-0.129	-0.046	**0.823**	0.196	0.248
6	**0.682**	0.047	0.055	**0.724**	0.350	0.367
4	**0.601**	0.010	-0.020	**0.597**	0.236	0.237
9	**0.521**	0.164	-0.043	**0.568**	0.344	0.272
1	**0.448**	0.034	0.134	**0.517**	0.291	0.340
14	0.011	**0.741**	-0.016	0.297	**0.735**	0.431
8	-0.008	**0.602**	0.022	0.239	**0.613**	0.379
3	0.019	**0.577**	-0.017	0.240	**0.574**	0.335
11	-0.028	**0.480**	0.018	0.169	**0.480**	0.293
10	0.075	**0.440**	0.033	0.262	**0.489**	0.327
12	-0.093	0.050	**0.720**	0.226	0.444	**0.711**
7	0.074	-0.037	**0.653**	0.331	0.382	**0.661**
2	0.066	-0.041	**0.505**	0.260	0.287	**0.508**
13	-0.011	0.076	**0.461**	0.211	0.347	**0.502**

Convergent and divergent validity

As presented in Table 2, there was a significant positive correlation between total score of CMCQ-HA and SHAI which measured the HA symptoms (r=0.466, p<0.01). According to the categorization used by Dancey and Reidy [44], an r below 0.40 was rated as a low correlation, an r between 0.40 and 0.60 was rated as moderate, and an r above 0.60 was rated as strong. The scores of three subscales also were significantly correlated with SHAI total score. Only "Beliefs that thoughts are uncontrollable" showed correlations with SHAI above 0.40 (r=0.488). These results supported the convergent validity of CMCQ-HA. Furthermore, the

CMCQ-HA total was positively correlated with the SHAI (r=0.466, p<0.01), which indicated that the criterion-related validity was adequate. To examine the divergent validity, we calculated the Pearson's correlation values between CMCQ-HA total, SHAI total and EPQ-R-N. Because neuroticism has been designated as a vulnerability of general anxiety both theoretically and clinically [45], we predicted that the correlation between CMCQ-HA and SHAI would be stronger than correlations between CMCQ-HA and EPQ-R-N, the same as the results found in Bailey and Wells' study [20]. Our results revealed significant correlations existed between all the scales. Only the correlation between CMCQ-HA total and SHAI total was above 0.40, which was considered to be a moderate correlation [44] (see Table 2). Based on the results above, we used Steiger's Z test to further examine whether the magnitude of the correlation between CMCQ-HA total and SHAI total (r=0.466) was statistically significantly higher than the correlation between CMCQ-HA total and EPQ-R-N (r=0.338) [46]. The results suggested that the correlation between HA-related metacognitions and HA was significantly stronger than that between HA-related metacognitions and neuroticism (Z=8.665, p<0.001), as we predicted. Those results supported the divergent validity of CMCQ-HA.

Incremental validity

Because the CMCQ-HA is specially designed to measure of HA-related metacognitions, we explored whether CMCQ-HA could explain additional variance in HA over MCQ-30 with hierarchical multiple regression. The SHAI total was used as the dependent variable and all subscales of MCQ-30 were included in the model as a block (Model 1). Then the subscales of CMCQ-HA were added to the model in the second step (Model 2). As presented in Table 4, there was 20.1% variance in SHAI explained by the subscales of MCQ-30 in the first model. The subscales of CMCQ-HA accounted for an additional 11.7% of the variance in SHAI in the second model. The variance explained by Model 2 was statistically significant and higher than Model 1 (ΔF=67.600, p<0.05). In the final model, three CMCQ-HA subscales and two MCQ-30 subscales significantly contributed to the variance of SHAI: CMCQ-HA "Beliefs that thoughts can cause illness" (β=0.061, p<0.05), CMCQ-HA "Beliefs about biased thinking" (β=0.074， p<0.05), CMCQ-HA "Thoughts about illness are uncontrollable" (β=0.322，

p<0.05), MCQ-30 "Cognitive confidence" (β=0.095，p<0.05), MCQ-30 "Uncontrollability and Danger" (β=0.208，p<0.05). Hence, the MCQ-HA is meaningfully different from the MCQ-30.

Table 4 Hierarchical regression analyses of health related metacognitions as predictors of health anxiety

Dependent variable	Predictor	β	t	ΔR^2	ΔF
Health anxiety	Step 1			0.201**	59.683
	Cognitive confidence	0.113**	3.853		
	Positive Beliefs	0.050	1.606		
	Cognitive self-consciousness	-0.032	-1.040		
	Uncontrollability and Danger	0.368**	11.990		
	Need to control thoughts	0.031	0.992		
	Step 2			0.117**	67.600
	Cognitive confidence	0.095**	3.488		
	Positive Beliefs	0.037	1.277		
	Cognitive self-consciousness	-0.027	-0.956		
	Uncontrollability and Danger	0.208**	6.818		
	Need to control thoughts	0.004	0.127		
	Beliefs that Thoughts can Cause Ill-ness	0.061*	2.285		
	Beliefs about biased Thinking	0.074**	2.671		
	Beliefs that Thoughts are Uncontrolla-ble	0.322**	11.134		

*p<0.05 **p<0.01

Invariance and difference across gender

The maximum likelihood estimation (MLM) estimator was also performed in this analysis. To

test the measurement invariance across gender, we first conducted CFA in each gender group separately to confirm the three-factor structure of CMCQ-HA. As shown in Table 5: all TLI and CFI were above 0.90; the RMSEA values and SRMR values were below 0.08. Thus the structure proposed by Bailey and Wells [20] fit the data well for each gender group. We tested the four degrees of measurement invariance across gender step by step. As presented in Table 5, the data fit every model well. In different consecutive models, the following indices were used to evaluate the invariance: the changes in CFI (ΔCFI), the Bayesian information criterion (BIC) value. A $\Delta CFI \leq 0.010$ and a descending BIC value was regarded as evidence of invariance across gender [47]. The results showed that the ΔCFI were below 0.01 and the BIC decreased between any two models. In comparing the metric model to the configural model, the ΔCFI = 0.001, the BIC decreased by 63.492; comparing scalar model to metric model, the ΔCFI = -0.004, the BIC decreased by 44.793; in comparing the strict model to the scalar model, the ΔCFI = -0.04, the BIC decreased by 49.183. Taking those findings together, the measurement invariance was tenable across both gender groups. The confirmation of strict invariance means that the difference among observed scores' variance was exactly the difference among latent variables' variance [48]. Based on that, we conducted a t-test to explore whether a difference existed in CMCQ-HA scores between men and women. The results indicated that s no significant difference ($p>0.05$) existed between the two gender groups in CMCQ-HA total score and the three subscale scores (see Table 6).

Table 5 Fit indices of measurement invariance for the CMCQ-HA across gender

Model	S-Bχ^2	df	TLI	CFI	RMSEA(90% CI)	SRMR	Model comparison	ΔCFI	BIC
Male(n=465)	171.526	74	0.933	0.946	0.046(0.035-0.057)	0.051			
Female(n=726)	228.270	74	0.922	0.937	0.048(0.040-0.056)	0.041			
Model1	399.778	148	0.927	0.940	0.047(0.041-0.054)	0.045			36679.127
Model2	414.220	159	0.932	0.941	0.045(0.039-0.052)	0.048	2 vs. 1	0.001	36615.635
Model3	433.161	170	0.932	0.937	0.046(0.039-0.052)	0.048	3 vs. 2	-0.004	36570.842
Model4	483.120	184	0.933	0.933	0.045(0.039-0.051)	0.051	4 vs. 3	-0.004	36521.659

Notes: Model1=configural invariance; Model2=metric invariance; Model3=scalar invariance; Model4= strict invariance; S-Bχ^2 = Satorra-Bentler scaled χ^2; df = degrees of freedom; TLI = the Tuker-Lewis index; CFI = Comparative Fit index; RMSEA= root-mean-square error of approximation; SRMR = standardized root mean squared residual; BIC = Bayesian information criterion.

Table 6 T-test for scores of CMACQ-HA between two gender group

	Mean(SD)		t	p
	Female(n=726)	Male(n=465)		
CMCQHAT	24.437(6.048)	24.341(6.374)	-0.263	0.792
BI	10.207(3.302)	10.293(3.175)	0.446	0.656
BT	7.316(2.180)	7.237(2.606)	-0.546	0.585
BU	6.915(2.470)	6.811(2.475)	-0.703	0.482

Notes: CMCQHAT = Metacognitions about Health total; BI = Beliefs that Thoughts can Cause Illness; BT= Beliefs about biased Thinking; BU = Beliefs that Thoughts are Uncontrollable.

Discussion

This study describes the development of the CMCQ-HA in a sample of more than 1000 college students, undertaken in order to better measure the psychological mechanism of health anxiety (HA) in a Chinese sample in mainland China. The quality of data in this study was satisfactory; the effective return ratio was 92.3% and no missing data existed for the remaining 1191 respondents. Low to moderate floor effects were found in our study. One possible explanation for it is the characteristics of our sample. As our participants were selected from college students which have a lower level of health anxiety compared with the clinic sample, most respondents scored at the positive pole of MCQ-HA.

The Psychometric characteristics, including reliability and validity, were tested in the total sample and across gender. The CMCQ-HA showed an acceptable to good reliability with a Cronbach's alpha value 0.81 for total and 0.68-0.76 for three subscales. Equally, good stability was also confirmed by its test-retest reliability which estimated by ICC (ICCs higher than

0.41). The results of Exploratory Factor Analysis (EFA) indicated that CMCQ-HA has the same three factors as reported by Bailey and Wells [20]. Then the structure of the three factors was further confirmed by Confirmatory Factor Analysis (CFA). Moreover, good convergent and discriminant validity was confirmed by correlations between CMCQ-HA total score, CMCQ-HA subscale scores, SHAI total score and the EPQ-R-N. As expected, the total score of CMCQ-HA were positively correlated with the SHAI total score, and these correlations were significantly stronger than the correlations between CMCQ-HA total score and the EPQ-R-N, indicating that the metacognitive beliefs measured by the CMCQ-HA are specially related to HA but not to general anxiety. That result is consistent with findings from previous studies [20], with the same situation was observed for incremental validity. To estimate the incremental validity, we explored the possibility of the CMCQ-HA accounted for additional variance in HA over and above the variance in HA explained by general metacognitions as measured by the MCQ-30. In the final regression model, CMCQ-HA subscales explained an extra variance of 11.7% over and above MCQ-30 subscales.

Overall our findings supported the metacognitive model which indicated that some specific metacognitive beliefs have positive correlations with HA symptoms. However the correlation coefficients between HA and the CMCQ-HA total and subscale scores were a little lower than coefficients reported by Bailey and Wells. In Bailey's research [20], the correlation coefficient between MCQ-HA total and HA was 0.693 compared to 0.466 in the present study, and the correlation coefficients between MCQ-HA subscale scores and HA ranged from 0.486-0.711 compared to 0.282-0.488 in our study. Only one subscale "Beliefs that thoughts are uncontrollable" showed a moderate correlation with SHAI, with the others showing significant but weak correlations, whereas in the previous study all three subscales showed moderate correlations with HA [20]. A reason for this result may be attributed to the different measures used to assess HA in the two studies. Bailey and Wells [20] used the Whiteley Index to measure HA while the SHAI was used in the current study. These two measures may vary with regard to their degree of efficacy in assessing the level of HA. Items in the Whiteley Index are based on the symptom clusters of hypochondriasis [12], while the SHAI was designed according to the

cognitive theory of HA [13]. Such results suggest that the key content of HA or hypochondriasis and the mechanism of symptom maintenance need further exploration. The possible cultural diversity in metacognition may be another reason for this. The baseline level of HA-related metacognition in people from different cultures may be not the same; or people may hold particular HA-related metacognition in some cultures. Future researches should do more comparisons across culture. We also tested the measurement invariance of the CMCQ-HA across gender. The configural, metric, scalar and strict invariance all were established. Then we compared the scores of CMCQ-HA between the two gender groups, and no statistically significant difference was found. That result further supported the validity of the CMCQ-HA.

There are some limitations in current study. First, the Chinese study participants are a convenience sample recruited from a single university and were all medical students. As such, they were predominantly young, female, and without physical diseases. Further studies based on more randomly selected Chinese population samples as well as a clinical sample are needed to establish the generalisability of this measure. Second, we used only two scales for the validity estimation. Because the key content of HA is controversial, a variety of measures about HA should be included to consider alternative theories of HA. Finally, we used only the SHAI for evaluating a limited number of criterion variables. Evaluations of more relevant criterion variables with other measures are needed for further research.

In conclusion, sufficient reliability and validity of CMCQ-HA were confirmed in a Chinese college student sample. More important, this study presented further evidence for the metacognitive model of HA in a different culture. The CMCQ-HA will be a promising tool to assess HA-related metacognitions in China, and to enhance understanding of the link between metacognitive beliefs and HA.

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Compliance with ethical standards

Declaration of Conflicting Interests The authors declared no potential conflicts of interests with respect to the research, authorship, and/or publication of this article.

Ethical approval The Institutional Review Board of the Third Xiangya Hospital in Hunan approved the study (2017-S208).

Appendix

The Metacognitions about Health Questionnaire

Items	Do not agree	Agree slightly	Agree moderately	Agree very much
1. Thinking of illness could change my health.	1	2	3	4
2. I cannot have peace of mind so long as I have physical symptoms.	1	2	3	4
3. I will be punished for thinking I am in good health.	1	2	3	4
4. Thinking negatively can increase my chances of disease.	1	2	3	4
5. Worrying about illness is likely to make it happen.	1	2	3	4
6. Some thoughts have the power to make me ill.	1	2	3	4
7. Dwelling on thoughts of illness is uncontrollable.	1	2	3	4
8. Thinking the worse about symptoms will keep me safe.	1	2	3	4
9. Worrying about my health will damage my body.	1	2	3	4
10. If I think positively about physical symptoms I will be caught off guard.	1	2	3	4
11. Worrying about my health will help me cope.	1	2	3	4
12. I have no control over thinking about my health.	1	2	3	4
13. Only if I have a diagnosis will I be able to	1	2	3	4

stop worrying.				
14. Thinking positively about my health will tempt fate and I will become ill.	1	2	3	4

健康焦虑元认知量表中文版

条目	不同意	有点同意	基本同意	完全同意
1.对疾病的思考会影响我的健康状况。	1	2	3	4
2.只要我有身体症状，我就不能保持平和心态。	1	2	3	4
3.如果我认为自己健康状况很好，那么可能会发生一些不好的事。	1	2	3	4
4.消极地思考会增加我患病的可能性。	1	2	3	4
5.对疾病的担心有可能引发疾病。	1	2	3	4
6.有些与疾病有关的想法会导致我生病。	1	2	3	4
7.思考与疾病有关的想法是我无法控制的。	1	2	3	4
8.我把症状想得更严重就会更安全	1	2	3	4
9.对自己健康的担忧会损害我的身体健康	1	2	3	4
10.如果我太乐观地看待我的身体症状，我将会意识不到疾病的存在	1	2	3	4
11.对疾病的担忧会帮助我应对疾病。	1	2	3	4
12.我无法控制自己对自身健康的思考。	1	2	3	4
13. 只有当我得到了一个诊断，我才能停止对自己身体状况的担忧。	1	2	3	4
14.如果我对自身健康持乐观的想法，我是会因此生病的	1	2	3	4

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