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1       **The reliability and validity of the Chinese version of The**  
2       **Metacognitions about Health Questionnaire in college stu-**  
3       **dents**

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10       **Abstract**

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

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

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

1 and beliefs that thoughts are uncontrollable. Convergent validity, divergent validity and in-  
2 cremental validity all were acceptable. Measurement invariance across gender was estab-  
3 lished.

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

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

7

## 8 **Introduction**

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

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

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

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

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

## 17 **Methods**

### 18 **Participants**

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

## 1 **Measures**

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

3 The original MCQ-HA consists of 14 items and has three subscales for assessing three types  
4 of HA-related metacognitive beliefs: *beliefs about biased thinking* (5 items), *beliefs that*  
5 *thoughts can cause illness* (5 items) and *beliefs that thoughts are uncontrollable* (4 items).  
6 Items are rated on a 4-point Likert scale ranging from 1 (do not agree) to 4 (agree very much)  
7 [20]. Subscale score for Beliefs about biased thinking and Beliefs that thoughts can cause ill-  
8 ness ranges from 5 to 20, subscale score for Beliefs that thoughts are uncontrollable ranges  
9 from 4 to 16. The total MCQ-HA score ranges from 14 to 56 with higher score indicating  
10 higher levels of unhelpful HA-related metacognitive beliefs. Permission to use that measure  
11 was obtained from Robin Bailey who was the original author of MCQ-HA. Taking reference  
12 of guideline from Beaton et al, the Chinese version of MCQ-HA was created [27]. First, two  
13 psychological researchers translated the MCQ-HA into Chinese. Then the translations were  
14 synthesized into one. After that, two psychology professors examined the translation for sur-  
15 face-level relevance to the construct of interest and each item's suitability for a Chinese popu-  
16 lation. Next, the Chinese version of the items was back-translated by a professional bilingual  
17 translator who had not read the original MCQ-HA. That version was reviewed and modified  
18 by the author of the MCQ-HA until it expressed exactly the same meanings as the original  
19 measure. Because the resulting description of Item 3 "I will be punished for thinking I am in  
20 good health ", was not a good fit for Chinese culture, and has a religious connotation, it was  
21 modified as follows: "There will be something bad to happen for thinking I am in good  
22 health". This modification was approved by Dr. Bailey. A pilot test was conducted with 25  
23 participants. There were no reports of misunderstandings.

### 24 The Short form of Health Anxiety Inventory (SHAI)

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

1 items, and negative consequences (NC) with 4 items. There are four statements ranging  
2 from 0 (I do not) to 3 (I spend most of my time) in each item. The total SHAI score  
3 ranges from 0 to 54; and higher scores indicating increased health anxiety. The SHAI  
4 showed good psychometric properties in Chinese population. The Cronbach's alpha  
5 of its total and subscales were 0.742 (total), 0.743 (IL) and 0.788 (NC) [28]. In this  
6 study, the Cronbach's alphas of SHAI total and its subscales were 0.805 (total),  
7 0.788(IL), 0.664(NC).

#### 8 The Metacognition Questionnaire-30 (MCQ-30)

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

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

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

## 1 **Data analysis**

### 2 **Item analysis and reliability**

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

### 9 **Validity**

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

### 26 **Gender invariance**

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



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

### 3 **Results**

#### 4 **Descriptive statistics of study subjects**

5 In the 1191 participants, no data was missing for all scales. All the items fell within the rec-  
 6 ommended range reflecting skew and kurtosis coefficients that should not be above 3 and 10,  
 7 respectively [39]. The distribution of each item was close to normality. As shown in Table 1, a  
 8 moderate floor effect was shown for the beliefs about biased thinking subscale (22.67%) and  
 9 beliefs that thoughts are uncontrollable subscale (17.8%) [40]. For the beliefs that thoughts  
 10 can cause illness subscale and total score, the floor effects were 5.46% and 2.35%, respec-  
 11 tively. The observed ceiling effects were negligible. Participants were 726 women (61%) and  
 12 465 men (39%). Age range 17-24, with  $19.33 \pm 1.32$  (mean  $\pm$  S.D.) years; no significant age  
 13 difference was observed between the two gender groups ( $t=0.555$ ; 95% confidence interval  
 14 [CI]:-0.112-0.200;  $p=0.579$ ). Mean and standard deviation for age and each questionnaire are  
 15 presented in Table 1.

16 **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]   |       |      |

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

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

5 **Item analysis and reliability**

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

23 **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** |

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

## 6 Factor structure

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

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

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

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

### 5 **Convergent and divergent validity**

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

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

#### 16 **Incremental validity**

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

1  $p < 0.05$ ), MCQ-30 "Cognitive confidence" ( $\beta = 0.095$ ,  $p < 0.05$ ), MCQ-30 "Uncontrollability  
 2 and Danger" ( $\beta = 0.208$ ,  $p < 0.05$ ). Hence, the MCQ-HA is meaningfully different from the  
 3 MCQ-30.

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

| Dependent variable                       | Predictor                               | $\beta$ | t      | $\Delta R^2$ | $\Delta F$ |
|--|---|---------|--------|--------------|------------|
| 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 Illness | 0.061*  | 2.285  |              |            |
|  | Beliefs about biased Thinking           | 0.074** | 2.671  |              |            |
| Beliefs that Thoughts are Uncontrollable | 0.322**                                 | 11.134  |        |              |            |

6 \* $p < 0.05$  \*\* $p < 0.01$

7 **Invariance and difference across gender**

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

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

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

| Model         | S-B $\chi^2$ | df  | TLI   | CFI   | RMSEA(90% CI)      | SRMR  | Model comparison | $\Delta$ CFI | 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 |

1 Notes: Model1=configural invariance; Model2=metric invariance; Model3=scalar invariance;  
 2 Model4= strict invariance; S-B $\chi^2$  = Satorra-Bentler scaled  $\chi^2$ ; df = degrees of freedom; TLI =  
 3 the Tucker-Lewis index; CFI = Comparative Fit index; RMSEA= root-mean-square error of  
 4 approximation; SRMR = standardized root mean squared residual; BIC = Bayesian infor-  
 5 mation criterion.

6 **Table 6** T-test for scores of CMCQ-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 |

7 Notes: CMCQHAT = Metacognitions about Health total; BI = Beliefs that Thoughts can  
 8 Cause Illness; BT= Beliefs about biased Thinking; BU = Beliefs that Thoughts are Uncon-  
 9 trollable.

## 10 **Discussion**

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

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



1 0.41). The results of Exploratory Factor Analysis (EFA) indicated that CMCQ-HA has the  
2 same three factors as reported by Bailey and Wells [20]. Then the structure of the three factors  
3 was further confirmed by Confirmatory Factor Analysis (CFA). Moreover, good convergent  
4 and discriminant validity was confirmed by correlations between CMCQ-HA total score,  
5 CMCQ-HA subscale scores, SHAI total score and the EPQ-R-N. As expected, the total score  
6 of CMCQ-HA were positively correlated with the SHAI total score, and these correlations  
7 were significantly stronger than the correlations between CMCQ-HA total score and the  
8 EPQ-R-N, indicating that the metacognitive beliefs measured by the CMCQ-HA are specially  
9 related to HA but not to general anxiety. That result is consistent with findings from previous  
10 studies [20], with the same situation was observed for incremental validity. To estimate the  
11 incremental validity, we explored the possibility of the CMCQ-HA accounted for additional  
12 variance in HA over and above the variance in HA explained by general metacognitions as  
13 measured by the MCQ-30. In the final regression model, CMCQ-HA subscales explained an  
14 extra variance of 11.7% over and above MCQ-30 subscales.

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

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

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

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

25

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28

1 **Compliance with ethical standards**

2

3 **Declaration of Conflicting Interests** The authors declared no potential conflicts of interests with re-  
4 spect to the research, authorship, and/or publication of this article.

5

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

8

9 **Appendix**

10 *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 |

1

2

### 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    |

3

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