# Beliefs about medication and their association with adherence in Chinese patients with non-dialysis chronic kidney disease stages 3–5

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## Abstract

There is a scarcity of research into the impact of medication beliefs on adherence in patients with non-dialysis chronic kidney disease (CKD). This study is to determine the psychometric properties of the Chinese version of the Beliefs about Medicines Questionnaire (BMQ)-Specific among patients with non-dialysis CKD stages 3–5, and to assess the beliefs of CKD patients and their association with medication adherence.

A cross-sectional study was conducted in CKD patients who recruited at the nephrology clinics of Xi'an Central Hospital, Xi'an, Shaanxi, China. The original BMQ-Specific was translated into Chinese. The internal consistency and test–retest reliability of the Chinese version of the BMQ-Specific scale were assessed, while exploratory and confirmatory factor analyses were also applied to determine its reliability and validity. The Kruskal–Wallis test and multiple ordered logistic regression were performed to identify the relationship between beliefs about and adherence to medication among CKD patients.

This study recruited 248 patients. Cronbach's α values of the BMQ-Specific necessity and concern subscales were 0.826 and 0.820, respectively, with intraclass correlation coefficients of 0.784 and 0.732. Factor analysis showed that BMQ-Specific provided a good fit to the two-factor model. The adherence of patients was positively correlated with perceived necessity ($r = 0.264$, $P < .001$) and negatively correlated with concern ($r = -0.294$, $P < .001$). Medication adherence was significantly higher for the accepting group (high necessity and low concern scores) than for the ambivalent group (high necessity and concern scores; $\beta = -0.880$, 95% confidence interval [CI] $= -1.475$ to $-0.285$), skeptical group (low necessity and high concern scores; $\beta = -2.620$, 95% CI $= -4.209$ to $-1.031$) and indifferent group (low necessity and concern scores; $\beta = -0.918$, 95% CI $= -1.724$ to $-0.112$).

The Chinese version of BMQ-Specific exhibited satisfactory reliability and validity for use in patients with non-dialysis CKD stages 3–5 and has been demonstrated to be a reliable screening tool for clinicians to use to predict and identify the non-adherence behaviors of patients.

**Abbreviations:** AVE = average of variance extracted, BMQ = beliefs about medicines questionnaire, CFA = confirmatory factor analysis, CI = confidence interval, CKD = chronic kidney disease, CR = composite reliability, DV = discriminant validity, EFA = exploratory factor analysis, MMAS = Morisky Medication Adherence Scale.

**Keywords:** beliefs about medication, medication adherence, non-dialysis CKD, psychometric properties

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## 1. Introduction

Chronic kidney disease (CKD) is receiving increasing attention globally as an important public health problem. A cross-sectional survey showed that the prevalence of CKD was 10.8% in China, affecting an estimated 120 million people.[1] The progression of CKD seriously impacts the health-related quality of life and imposes a financial burden. Regardless of whether or not they receive renal replacement therapy, patients with CKD often have multiple complications and co-morbidities, resulting in complex regimens involving multiple medications while increasing the likelihood of poor medication adherence.[2] The term "medication adherence" refers to the extent to which a patient follows the medication regimen of his or her doctor or other healthcare provider.[3] Medication adherence is an important determinant of whether treatment goals are attained in patients with CKD,[4,5] and the reported prevalence of non-adherence to medication in patients with non-dialysis CKD has ranged from 17.4% to 53%.[6,7] Medication non-adherence was shown to be associated with worse clinical outcomes such as increasing the risk of CKD progression and all-cause death in the Chronic Renal Insufficiency Cohort Study.[8]

Increasing the medication adherence requires an accurate understanding of the underlying causes of non-adherence. Non-adherence to medication is influenced by many factors, including those related to the medical condition, patient, therapy, health system, and socioeconomic domains.[9] One factor whose influence on medication non-adherence in patients with non-dialysis CKD remains unclear is medication belief. Medication non-adherence is the result of reasonable decisions by the patient and the cognitive representation that is important to those decisions. The presence of beliefs about the necessity of taking medicine is associated with higher adherence.[10] In contrast, the presence of concern about the adverse consequences of medication is more likely to lead to failure to comply with taking prescribed medication.[11]

The 8-item Morisky Medication Adherence Scale (MMAS-8)[12] and the Beliefs about Medicines Questionnaire (BMQ)[13] were developed for objectively measuring patient adherence to and beliefs about medication. MMAS-8 is frequently used for measuring medication adherence because of its simplicity, cost-effectiveness and operability. Some studies have applied MMAS-8 to Chinese patients, which can be well adapted to the psychological characteristics and meets the requirements of Chinese-speaking populations. Horne et al were the first to propose a measure based on a necessity-concern framework of BMQ to identify the beliefs of patients about medication.[13] BMQ comprises 2 sections: BMQ-Specific and BMQ-General. BMQ-Specific is based on a necessity-concern framework, and is more closely related to adherence to medication than is BMQ-General (the more-general form of the scale).[13] Beliefs about medication have been found to be a modifiable factor that are more predictive of adherence than are other social and clinical factors.[14] Therefore, identifying the modifiable negative beliefs about medication might be an effective approach for clinicians to improve medication adherence in patients with non-dialysis CKD.

As a self-reported questionnaire, BMQ has been translated and verified in different cultural backgrounds and language environments, and its results are associated with other measures of adherence.[15] The BMQ-Specific scale is widely used to evaluate the psychometric properties of medication beliefs in patients with chronic diseases,[15,16] but it has not been applied to non-dialysis CKD patients who take multiple medicines. There is a general scarcity of research into the impact of medication beliefs on adherence in patients with non-dialysis CKD. Moreover, the scale has not been validated in Chinese patients with CKD. Therefore, the aims of the present study were (a) to determine the reliability and validity of the Chinese version of the BMQ-Specific scale in patients with non-dialysis CKD stages 3–5, and (b) to determine the beliefs of CKD patients and their association with medication adherence.

## 2. Methods

### 2.1. Study design and participants

This cross-sectional study was conducted in the nephrology clinic of a large general hospital (Xi'an Central Hospital, Xi'an, China) between March 1, 2018 and August 31, 2019. The study recruited 291 participants with non-dialysis CKD stages 3–5. Trained pharmacists and nurses of the hospital surveyed in- and outpatients and informed them about the purpose and content of the study. An informed-consent form was signed by all participants included in the study. The inclusion criteria were as follows:

1. older than 18 years,
2. diagnosed as CKD stages 3–5 (estimated glomerular filtration rate $< 60$ mL/min/1.73 m$^2$) but not receiving dialysis, and
3. taking a single or multiple medications to control CKD stages 3–5 (including complications and co-morbidities) for at least 3 months.

Participants were excluded if they had a diagnosis of mental or psychosocial disease, cognitive impairment, cancer or failure of another important organ. This study was approved by the Institutional Review Board of Xi'an Central Hospital.

All of the participants were interviewed in a face-to-face manner by a trained pharmacist or nurse to complete the questionnaires. The questionnaires included the following information:

1. demographics and clinical characteristics (age, sex, marital status, education level, occupation, stage of CKD, duration of CKD stages 3–5, number of medications and experience of adverse drug reactions);
2. score on the BMQ-Specific scale;
3. score on the MMAS-8 scale; and
4. test–retest reliability of the BMQ-Specific scale, by randomly selecting 10% of the participants to complete the scale again after 2 to 4 weeks.

Finally, the adherence-related beliefs of the participants about medicines were assessed.

### 2.2. BMQ-specific

The BMQ-Specific scale was used to assess the beliefs of patients about medication. The original BMQ-Specific was independently translated to Chinese by 2 native Chinese speakers (a pharmacist and a medical doctor) who both were proficient in English and had academic and clinical experience. Both the translators and investigators discussed the translations and agreed on a final version, while focusing on producing a conceptually equivalent forward translation of the original questionnaire. An Irish native bilingual pharmacist who lived in China and spoke Chinese well performed a back translation of the BMQ-Specific scale (Chinese to English) while blinded to the content of the original BMQ-Specific scale. After completing the back translation, the original and back-translated versions were compared to identify potential discrepancies in meanings. The back-translated version only exhibited subtle semantic differences from the original questionnaire. The final version of BMQ-Specific was used in face-to-face interviews with 16 CKD patients.

The BMQ-Specific scale comprised 2 5-item subscales evaluating the beliefs of patients about the necessity of prescribed drugs for controlling chronic diseases and their concern about the potential adverse consequences.[13] Each response item was scored on a 5-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). The total scores on the necessity and concern subscales ranged from 5 to 25. The beliefs of patients about medicines represented by the 2 subscales were positively correlated with the scores. A subscale score of 15 were used as a cut-off for classifying into high and low necessity or concern.

The attitudes of patients toward medications could be divided into the following 4 groups to assess the relationship between beliefs about and adherence to medication:[17]

1. high necessity and high concern scores were classified into the ambivalent group,
2. high necessity and low concern scores were classified into the accepting group,
3. low necessity and high concern scores were classified into the sceptical group, and
4. low necessity and low concern scores were classified into the indifferent group.

A necessity–concern differential score (range –20 to 20) was calculated by subtracting the score on the concern subscale from that on the necessity subscale, due to the subscales of necessity and concern presenting different dimensions in the opposite direction. A higher differential score implies stronger beliefs in the necessity for medication than the concern about adverse consequences, and vice versa.[18]

### 2.3. MMAS-8

We used MMAS-8 to assess medication adherence in patients with non-dialysis CKD stages 3–5. Items 1 to 4, 6 and 7 on the scale are scored as 1 ("no") or 0 ("yes"), item 5 is scored as 0 ("no") or 1 ("yes"), and item 8 is measured on a 5-point Likert scale (1 = "never," 0.75 = "once in a while," 0.5 = "sometimes," 0.25 = "usually" and 0 = "all the time"). The total scores ranged from 0 to 8, with a score of 8 indicating high adherence, scores of <8 and ≥6 indicating moderate adherence, and scores <6 indicating low adherence. Cronbach's α was found to be 0.556 for the internal consistency of Chinese version of the MMAS-8 by Yang et al[19]

### 2.4. Data analysis

The reliability of BMQ-Specific was assessed using Cronbach's α. A Cronbach's α of ≥0.70 is usually considered satisfactory. Intraclass correlation coefficients were used to evaluate test–retest reliability, with an ICC of >0.7 indicating a good reliability. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to assess the construct validity of BMQ-Specific and determine its suitability for Chinese speakers. EFA with geomin rotation was performed to examine whether the 10 items measured at least 1 of the constructs. Eigenvalues of >1 were used to decide the number of factors. CFA were conducted using Amos (version 24.0) software to evaluate whether the covariance among all item answers comprised 2 hypothesized factors or an alternate construct based on the EFA results. The goodness of fit was evaluated according to empirically supported criteria:[20] the relative Chi-Squared ($\chi^2$/df) <3.0, the root-mean-square error of approximation <0.08, the standardized root mean squared residual (SRMR) <0.05, the comparative fit index > 0.90, the goodness of fit index and adjusted goodness of fit index > 0.90, the composite reliability (CR) > 0.7, the average of variance extracted (AVE) > 0.36.

Mean ± standard-deviation, median (range) and number (%) values were calculated using descriptive statistics for the demographic variables and clinical characteristics of the participants. Pearson's correlation coefficient was used to quantify the associations between MMAS-8 scores and scores on the BMQ-Specific subscales. The Kruskal–Wallis test was utilized to investigate the differences in medication adherence among the 4 attitudinal groups. Multiple ordered logistic regression was used to identify the factors that influence medication adherence. Independent variables for which $P < .25$

in the univariate analysis were included in a multivariate analysis model. We controlled for independent variables based on clinical experience: age, sex, marital status, education level, occupation, attitudes toward medication, experience of adverse drug reactions, stage of CKD, number of medications and duration of CKD stages 3–5. A $P$ value of <.05 was considered statistically significant. All statistical analyses were conducted using the SPSS (version 24.0) program.

## 3. Results

### 3.1. Sample characteristics

Twenty four of the 299 CKD patients invited to participate in the study did not meet the inclusion criteria (19 because of having received dialysis treatment within the previous 3 months), 13 refused to participate in the study (10 because of unwillingness to provide basic information) and 8 withdrew from the study. In addition, 6 surveys were excluded due to being incomplete filled. Hence, 248 patients with non-dialysis CKD stages 3–5 were finally included in the study, corresponding to a dropout rate of 5.1%.

The included patients were aged 58.6 ± 17.4 years, with 54.4% being younger than 60 years. Additionally, 56.0% were male, 77.4% were married and 40.7% had retired. Moreover, 85.1% had received primary or secondary education, 19.0% reported that they had experienced an adverse drug reaction and 63.7% used more than 5 kinds of medications. The respondents had been diagnosed with CKD 4.8 ± 3.6 years previously. Their MMAS-8 score was 5.53 ± 1.95, and 15.7%, 30.6% and 53.6% of the respondents exhibited high, moderate and low adherence, respectively (Table 1).

### 3.2. BMQ-specific translation and measurements

The results of the interviews of 16 CKD patients indicated that BMQ-Specific was understandable and readable for Chinese respondents. Patients with non-dialysis CKD stages 3–5 were more focused on the necessity of the prescribed medications (score of 17.46 ± 2.56) than being concerned about the potential adverse consequences (score of 14.87 ± 2.98). The necessity–concern differential score was 2.60 ± 3.97, ranging from –8 to 10. Among the 248 patients, 79.8% expressed the high necessity of medication, 45.2% had a high concern about medication (Fig. 1) and 20.6% had a negative value for the necessity–concern differential score.

### 3.3. Reliability

Cronbach's α for the necessity and concern subscales were 0.826 and 0.820, indicating satisfactory reliability of the Chinese version of BMQ-Specific. Cronbach's α decreased slightly when any single item was deleted. The test–retest reliability was calculated for 25 participants over a time interval of 18.32 ± 3.84 days. The intraclass correlation coefficients for the necessity and concern subscales were 0.784 and 0.732, respectively, which good test–retest reliability and reproducibility of the Chinese version of BMQ-Specific.

### 3.4. Construct validity

The $P$ value in Bartlett test of sphericity was <.001 and the value in the Kaiser–Meyer–Olkin test was 0.803, which indicated that

**Table 1**

**Demographics and clinical characteristics of the sample[*].**

| Characteristics | CKD Stage 3 60 > eGFR≥30 n = 102 (41.1%) | CKD Stage 4 30 > eGFR≥15 n = 86 (34.7%) | CKD Stage 5 eGFR < 15 n = 60 (24.2%) | Total n = 248 |
|---|---|---|---|---|
| Age | | | | |
| >60 yr | 45 (44.1) | 44 (51.2) | 24 (40.0) | 113 (45.6) |
| ≤60 yr | 57 (55.9) | 42 (48.3) | 36 (60.0) | 135 (54.4) |
| Sex | | | | |
| Male | 59 (57.8) | 47 (54.7) | 33 (55.0) | 139 (56.0) |
| Female | 43 (42.2) | 39 (45.3) | 27 (45.0) | 109 (44.0) |
| Marital status | | | | |
| Single[†] | 25 (24.5) | 18 (20.9) | 13 (21.7) | 56 (22.6) |
| Married | 77 (75.5) | 68 (79.1) | 47 (78.3) | 192 (77.4) |
| Education level | | | | |
| Higher education | 15 (14.7) | 13 (15.1) | 9 (15.0) | 37 (14.9) |
| Primary/secondary education | 87 (85.3) | 73 (84.9) | 51 (85.0) | 211 (85.1) |
| Occupation | | | | |
| Farmer | 26 (25.5) | 17 (19.8) | 8 (13.3) | 51 (20.6) |
| Employed | 26 (25.5) | 18 (20.9) | 18 (30.0) | 62 (25.0) |
| Retired | 37 (36.3) | 38 (44.2) | 26 (43.3) | 101 (40.7) |
| Others[‡] | 13 (12.7) | 13 (15.1) | 8 (13.3) | 34 (13.7) |
| Duration of CKD | | | | |
| ≤5 yrs | 70 (68.6) | 60 (69.8) | 44 (73.3) | 174 (70.2) |
| 5–10 yrs | 20 (19.6) | 18 (20.9) | 9 (15.0) | 47 (19.0) |
| >10 yrs | 12 (11.8) | 8 (9.3) | 7 (11.7) | 27 (10.9) |
| Number of medications | | | | |
| ≤5 | 35 (34.3) | 31 (36.0) | 24 (40.0) | 90 (36.3) |
| >5 | 67 (65.7) | 55 (64.0) | 36 (60.0) | 158 (63.7) |
| Experience of drug-related side effects | | | | |
| Yes | 26 (25.5) | 14 (16.3) | 7 (11.7) | 47 (19.0) |
| No | 76 (74.5) | 72 (83.7) | 53 (88.3) | 201 (81.0) |
| MMAS-8 score, mean (SD) | 5.86 (1.84) | 5.46 (2.06) | 5.05 (1.88) | 5.53 (1.95) |
| High | 22 (21.6) | 13 (15.1) | 4 (6.67) | 39 (15.7) |
| Medium | 31 (30.4) | 30 (34.9) | 15 (25.0) | 76 (30.6) |
| Low | 49 (40.0) | 43 (50.0) | 41 (68.3) | 133 (53.6) |

CKD = chronic kidney disease, eGFR = estimated glomerular filtration rate, MMAS = Morisky Medication Adherence Scale, SD = standard deviation.

[*] The data are reported as N (%) of patients unless otherwise indicated.

[†] Including divorced and widowed.

[‡] Involving students, driver, merchant (trade), mechanic, guard.
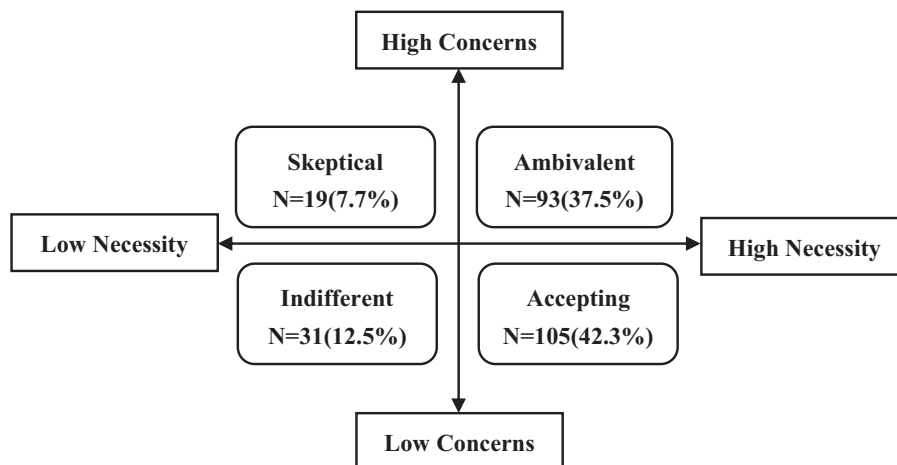


**Figure 1.** Distribution of the beliefs and attitudes of patients toward medication.
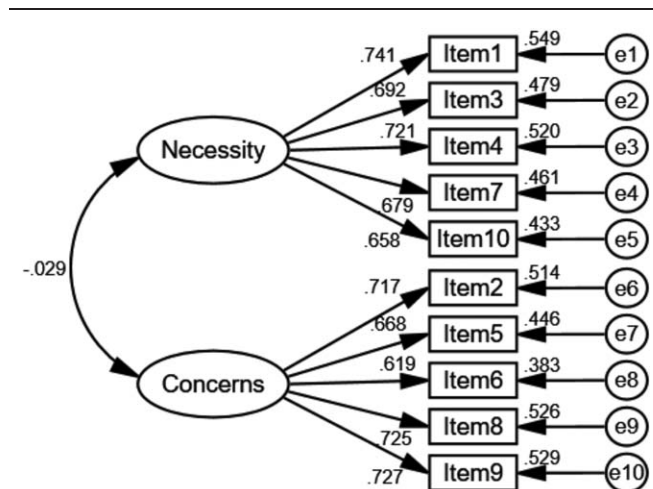
**Table 2**

**Factorial loading on the BMQ-specific[*].**

| | Factor 1 Necessity | Factor 2 Concerns |
|---|---|---|
| Item4: Without my medicines I would be very ill | 0.658 | |
| Item3: My life would be impossible without my medicines | 0.657 | |
| Item1: My health, at present, depends on my medicines | 0.642 | |
| Item7: My health in the future will depends on my medicines | 0.612 | |
| Item10: My medicines protect me from becoming worse | 0.58 | |
| Item5: I sometimes worry about long-term effects of my medicines | | 0.647 |
| Item2: Having to take medicines worries me | | 0.644 |
| Item9: I sometimes worry about becoming too dependent on my medicines | | 0.626 |
| Item8: My medicines disrupt my life | | 0.594 |
| Item6: My medicines are a mystery to me | | 0.576 |
| Eigenvalue | 3.003 | 2.876 |
| Explained variance (58.8%) | 30.03% | 28.76% |

BMQ = beliefs about medicines questionnaire.

[*] Factor loadings < 0.5 are not presented in the table.

the Chinese version of BMQ-Specific was fit for factor analysis. Two factors (with eigenvalues >1) were extracted in the study, and they explained more than 50% of the data variance (Table 2). Absolute fit indices were used to test the hypothesis that the structure would fit the two-factor model. The relative Chi-Squared value ($\chi^2$/df) was 2.165. The goodness of fit index, adjusted goodness of fit index and comparative fit index were all larger than 0.90 (0.942, 0.907 and 0.951, respectively). The root-mean-square error of approximation was 0.069 and the SRMR was 0.045. These fit indices indicated that the model provided a good fit to the data.

The results of the two-factor model are presented in Figure 2. All standardized factor loadings (>0.6) and standardized regression weights (>0.36) were acceptable in the model. The CR and AVE of the two-factor model were >0.7 and >0.36, respectively. The discriminant validity (DV) values among different dimensions were 0.699 and 0.693. These results show that the reliability and validity of the two-factor model were satisfactory in the BMQ-Specific scale.

### 3.5. Relationship between adherence and belief

Pearson's correlation analysis showed that the adherence score of patients was positively correlated with the necessity score ($r = 0.264$, $P < .001$) and the necessity–concern differential score ($r = 0.391$, $P < .001$), but negatively correlated with the concern score ($r = -0.294$, $P < .001$). Among the 4 attitudinal groups, 105 patients (42.3%) were accepting, 93 (37.5%) were ambivalent, 19 (7.7%) were skeptical and 31 (12.5%) were indifferent (Fig. 1). There were significant differences in adherence among the 4 attitudinal groups ($\chi^2 = 38.519$, $P < .001$). The MMAS-8 score was highest in the accepting group ($6.35 \pm 1.54$) and lowest in the skeptical group ($3.71 \pm 1.94$). Medication adherence were higher in the accepting group than in the ambivalent ($P < .001$), skeptical ($P < .001$) and indifferent ($P = .007$) groups (Table 3). In the multiple ordered logistic regression, patients with ambivalent ($\beta = -0.880$, 95% confidence interval [CI] $= -1.475$ to $-0.285$), skeptical ($\beta = -2.620$, 95% CI $= -4.209$ to $-1.031$) and indifferent ($\beta = -0.918$, 95% CI $= -1.724$ to $-0.112$) attitudes toward medication had significantly lower adherence compared with those who were accepting of medication, after adjusting for confounding factors such as experience of adverse drug reactions, number of medications, stage of CKD and duration of CKD



**Figure 2.** Confirmatory Factor Analysis of the BMQ-specific in non-dialysis CKD stages 3-5.

**Table 3**

**A Kruskal–Wallis single factor ANOVA test of the difference of medication adherence among attitudinal groups.**

| Attitudinal groups[*] | MMAS-8 scores[†] | P value |
|---|---|---|
| Accepting | $6.35 \pm 1.54$ | <.001 |
| Ambivalent | $5.14 \pm 1.91$ | |
| Skeptical | $3.71 \pm 1.94$ | |
| Indifferent | $5.00 \pm 1.95$ | |
| Accepting vs ambivalent | | <.001 |
| Accepting vs skeptical | | <.001 |
| Accepting vs indifferent | | .007 |
| Ambivalent vs skeptical | | .058 |
| Ambivalent vs indifferent | | >.999 |
| Skeptical vs indifferent | | .204 |

MMAS = Morisky Medication Adherence Scale.

[*] Using the BMQ-specific scores with the level of necessity and concerns.

[†] Significant differences on adherence among the four attitudinal groups ($\chi^2 = 38.519$).

**Table 4**

**Multiple ordered logistic regression of the factors associated with medication adherence.**

| Variables | Crude[†] | | | Adjusted | | |
|---|---|---|---|---|---|---|
| | β coefficient | 95% CI | P value | β coefficient | 95% CI | P value |
| Attitudes toward medication[*] | | | | | | |
| Accepting | Reference | | | Reference | | |
| Ambivalent | −1.162 | −1,715, −0.608 | <.001 | −0.880 | −1.475, −0.285 | .004 |
| Skeptical | −2.765 | −4.290, −1.240 | <.001 | −2.620 | −4.209, −1.031 | .001 |
| Indifferent | −0.962 | −1.747, −0.177 | .016 | −0.918 | −1.724, −0.112 | .026 |
| Number of medications | | | | | | |
| ≤5 | Reference | | | Reference | | |
| >5 | −1.154 | −1.756, −0.551 | <.001 | −1.055 | −1.688, −0.421 | .001 |
| Experience of drug-related side effects | | | | | | |
| No | Reference | | | Reference | | |
| Yes | −1.035 | −1.568, −0.502 | <.001 | −0.744 | −1.330, −0.159 | .013 |
| Stage of CKD | | | | | | |
| CKD 3 | Reference | | | Reference | | |
| CKD 4 | −0.176 | −0.719, 0.366 | .524 | −0.101 | −0.677, 0.474 | .730 |
| CKD 5 | −0.938 | −1.591, −0.284 | .005 | −0.836 | −1.530, −0.142 | .018 |
| Duration of CKD | | | | | | |
| ≤5 yrs | Reference | | | Reference | | |
| 5–10 yrs | 0.383 | −0.229, 0.994 | .220 | 0.281 | −0.375,0.937 | .401 |
| >10 yrs | 0.526 | −0.236,1.287 | .176 | 0.504 | −0.298,1.305 | .218 |

CI = confidence interval, CKD = chronic kidney disease.

* Using the BMQ-specific scores with the level of necessity and concerns.

† A P value of <.25 in univariate analysis was included in the multivariate analysis.

(Table 4). In addition, patients who used more than 5 medications (β=−1.055, 95% CI=−1.688 to −0.421) and had experienced drug-related side effects (β=−0.744, 95% CI=−1.330 to −0.159) exhibited significantly lower adherence. Regarding the progression of CKD, CKD stage 4 (β=−0.101, 95% CI=−0.677 to 0.474) and CKD stage 5 (β=−0.836, 95% CI=−1.530 to −0.142) were associated with low adherence. A longer duration of CKD was associated with greater medication adherence, but this relationship was not statistically significant. In contrast, age, sex, marital status, education level and occupation were not associated with adherence.

## 4. Discussion

We assessed the reliability and validity of the Chinese version of BMQ-Specific in patients with non-dialysis CKD stages 3–5. This scale exhibited satisfactory reliability, and Cronbach's α values for the necessity and concern subscales were 0.826 and 0.820, respectively. These values are higher than the values obtained (0.55 and 0.73, respectively) when applying the original English version of the scale to renal dialysis inpatients.[13] Several validation studies have been conducted for the BMQ-Specific scale in different cultures and languages.[15,16] Cinar et al[15] validated the Turkish version in patients with Behçet's disease, and Cronbach's α values for the necessity and concern subscales were 0.81 and 0.67, respectively. Tan et al[16] verified the Malaysian version in hypertension patients, with Cronbach's α values for the necessity and concern subscales of 0.759 and 0.762, respectively. These values are similar to those that we obtained, which indicates that the Chinese version of BMQ-Specific has potential as a tool to help clinicians to assess the beliefs of non-dialysis CKD patients about medication.

EFA showed that the factorial structure of the Chinese version of BMQ-Specific was the same as that of the original English version and that each item loaded onto its expected factor. CFA also verified the hypothesis that the structure of the scale fit the two-factor model. All standardized regression weights squared were >0.4 except for item 6, which had a factor loading of slightly lower than 0.4. This lower loading may have been due to item 6 being phrased as "My medicines are a mystery to me," whose multiple meanings in Chinese could have made it difficult for patients to answer. It has been reported that replacing the word "mystery" in the Danish and Swedish translated versions of the scale with "riddle" made the statement clearer.[21] However, we did not modify the word "mystery" in the Chinese version in order to preserve the original meaning of the BMQ-Specific scale. The CR, AVE and DV of each subscale were acceptable, indicating that the Chinese version of BMQ-Specific had good convergent validity and DV in patients with non-dialysis CKD stages 3–5. The original BMQ scale has shown similarly satisfactory results in construct validity analyses among patients with various diseases, such as asthma, diabetes, kidney disease, heart disease and psychosis.[13] It is therefore speculated that the versatility of the BMQ-Specific scale allows it to be applied to Chinese patients with other diseases.

This study has demonstrated the utility of the necessity- and concern-related framework in explaining medication non-adherence. High adherence among patients with non-dialysis CKD was associated with high necessity and low concern toward medication. Our results are consistent with Horne et al[13] finding that the beliefs of patients can indeed be a powerful predictor of medication adherence. We discovered that the subjects in the 4 attitudinal groups exhibited significant differences in adherence, being highest in the accepting group (high necessity and low concern) and lowest in the skeptical group (high necessity and high concern). Patients with a higher level of health awareness for CKD are more likely to consider medication treatment necessary, which may have a positive impact on their adherence to medication.[22] However, non-adherence is directly related to patients having excessive concerns about medication addiction,

dependence, side effects and long-term toxicity.[23] In our study, drug-related side effects played a particularly important role in non-adherence. Patients who experience side effects will often stop taking a medication, reduce the prescribed dose or apply complementary alternative medicines, which lead to lower adherence. Informing patients about known drug side effects and the countermeasures for dealing with them may be helpful for improving their beliefs about long-term medication treatment.

In addition, the number of medicines is always a determinant of medication adherence in patients with chronic diseases.[24] Because CKD patients often have various co-morbidities (e.g., hypertension, diabetes and cardiovascular disease) and complications (e.g., anaemia, hyperkalaemia, osteodystrophy and acidosis), the use of multiple medicines can complicate their treatment regimens.[25] A high burden of medicines will inevitably be associated with non-adherence behaviors, as demonstrated by our study finding that patients taking more than 5 medicines exhibited lower adherence. In terms of the severity of the disease, the adherence was lower among patients with CKD stage 5 than among those with CKD stages 3 and 4. Patients with CKD may suffer from an overwhelming psychologically burdened due to disease progression and the long-term effects of medicines. In many patients with CKD stage 5, medications do not provide significant symptom improvement and the necessity of taking medicines is often considered irrelevant, leading to negative beliefs about medication. A cohort study found that the non-adherence behaviors of patients were related to the progression of CKD,[4] and it has also been found that worse kidney function is associated with a lower level of medication adherence.[26] A particularly interesting finding in the present study was that a longer time since being diagnosed with CKD was associated with higher medication adherence. This result contradicts the finding of Naderi et al,[27] and so further studies are needed to clarify this. Providing patients with a better understanding of CKD and a strong belief about their prescribed medicines are crucial to improving medication adherence.

This study was subject to several limitations. First, the study had a cross-sectional design, and so it could only explain adherence to medication at a certain time, whereas this can change over time. Second, although self-reporting is the most appropriate method for evaluating medication adherence, only using a self-reported questionnaire on medication adherence may lead to bias in the results. Third, the included patients were recruited at a medical institution, which may have led to overestimation of the adherence rate. Fourth, we only studied the specific beliefs about medicines in patients with non-dialysis CKD stages 3–5, and there was a lack of evidence for the influence of general beliefs on medication adherence. Finally, the study population might not represent the medication beliefs of all patients with chronic diseases. Therefore, future studies need to investigate patients with other diseases in order to confirm the relationship between the beliefs of patients and their adherence to medication.

## 5. Conclusions

The present study found strong evidence for the reliability and validity of the Chinese version of BMQ-Specific, making it suitable for use in patients with non-dialysis CKD stages 3–5. The beliefs of patients about medication have an important impact on their adherence, thus influencing whether they actively participate in their own CKD management. The Chinese version of the BMQ-specific has been demonstrated to be a reliable screening tool for clinicians to use to predict and identify the non-adherence behaviors of patients.

## Author contributions

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