

# Development And Preliminary Evaluation Of Psychometric Properties Of A Tuberculosis Self-Efficacy Scale (TBSES)

This article was published in the following Dove Press journal:  
*Patient Preference and Adherence*

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**Purpose:** No instrument exists for measuring TB patients' self-efficacy which is vital for choosing and insisting in benefit TB-management behaviors. Our study aimed to develop and test a new tuberculosis self-efficacy scale (TBSES).

**Patients and methods:** The TBSES was designed through literature review, individual interviews, Delphi surveys, and pilot testing. After that, 460 TB patients were recruited to validate TBSES. Exploratory and confirmatory factor analysis and correlation analysis were used to evaluate the scale reliability and validity. The cut-off point for TBSES was identified using receiver operating characteristic (ROC) analysis.

**Results:** The final TBSES includes 21 items scored on a 5-point Likert scale, and these items are loaded in four distinct factors that explain 67.322% of the variance, both exploratory and confirmatory factor analysis proved that the scale had good construct validity. The scale had adequate internal consistency, split-half reliability, test-retest reliability, as well as demonstrated content, concurrent validity. The ROC analysis results showed the cut-off point was 86.5.

**Conclusion:** This 21-item TBSES demonstrated favorable psychometric properties. It provides an instrument for not only measuring specific self-efficacy in TB, but also identifying patients with low self-efficacy and determining the specific area toward designing interventions for enhance self-efficacy.

**Keywords:** tuberculosis, self-efficacy, scale development, reliability, validity

## Introduction

Tuberculosis (TB) is still a worldwide public health issue imperiling the health of humans.<sup>1</sup> The situation is extremely grim with regard to TB prevention and control in China, with the continuously high TB incidence and mortality rates and the severe threat of drug-resistant TB.<sup>2</sup> Regular treatment and management of TB is crucial to decrease drug resistance rates, improve health outcomes, and control disease spread.<sup>3</sup> Regular management requires TB patients, who are responsible for their disease and health, to perform multiaspect day-to-day disease management tasks, such as taking their medicine, quitting smoking and alcohol consumption, alleviating unhealthy psychological conditions, and seeking social support. Self-efficacy is important for TB patients to choose and pursue the aforementioned beneficial behaviors.<sup>4</sup>

Perceived self-efficacy is a measurable and modifiable concept that was defined by Bandura as a personal judgement of "how well one can execute courses of action

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required to deal with prospective situations;<sup>5</sup> it affects both the behavior choice and the effort and persistence people expend in adhering to that choice.<sup>6</sup> Recent studies have shown that self-efficacy can significantly contribute to patients' appropriate and effective disease management behaviors, such as adhering to medicine regimens,<sup>7</sup> seeking support,<sup>8</sup> limiting risk behaviors,<sup>9</sup> and obtaining better health outcomes through these specific behaviors.<sup>10</sup> Thus, self-efficacy has been a key factor in designing interventions to improve patients' disease management.<sup>11,12</sup>

Accurate measurement is the foundation of evaluating the level of self-efficacy and the effects of specific interventions, such as health education.<sup>13</sup> Bandura believed that self-efficacy will change based on the situations; thus, to obtain high measurement accuracy and better prediction ability, the measurement of self-efficacy should be related to specific categories of activities.<sup>14</sup> As a chronic infectious disease, TB management processes the characteristics of both chronic and infectious diseases. For medical treatment, patients are required to take medicine as prescribed, undergo regular reexaminations, alleviate adverse drug reactions, maintain a healthy lifestyle and so on.<sup>3</sup> Meanwhile, the negative emotions,<sup>15</sup> stigma<sup>16</sup> and interpersonal stress caused by having TB,<sup>17</sup> an infectious disease, need to be addressed by patients. The existing general instruments, such as the general self-efficacy scale (GSES)<sup>18</sup> or the chronic disease self-efficacy questionnaire,<sup>19</sup> do not evaluate patient self-efficacy in specific situations; therefore, they have limited value in the accurate assessment of TB-related self-efficacy and the guidance of the development of targeted interventions to improve self-efficacy. However, no effective method has been created for measuring self-efficacy in TB patients.

In this study, we developed and validated a specific TB self-efficacy scale (TBSES). We designed and refined the TBSES on the bases of a literature review, individual in-depth interviews with TB patients, Delphi surveys, and pilot tests. Correlation, exploratory and confirmatory factor analyses were used to assess the scale's reliability and validity. A receiver operating characteristic (ROC) analysis was performed to determine the cut-off value for the TBSES. Once validated, the TBSES will be available for researchers and health professionals to use to assess the self-efficacy levels of TB patients, which may be helpful for informing targeted intervention planning to enhance the disease management abilities of patients.

## Materials And Methods

### Stage I: Instrument Development

The TBSES was developed in three steps. In step 1, we conducted a comprehensive literature review with the keywords "TB", "TB management", "self-efficacy" and the "specific self-efficacy scales development" and in-depth individual interviews with TB patients to explore the disease management tasks, the challenges and barriers they faced while following their treatment regimen; the information garnered from the search and the interviews were included in the TBSES. At the end of this step, a draft of TBSES was generated, with 29 candidate items.

In step 2, we organized a two-round Delphi survey to select and expand the items on the draft. The 29 candidate items were evaluated by 15 experts at the national, provincial, municipal, district and county levels, including three nursing experts, three clinical diagnosis and treatment experts, four TB control workers, and two TB prevention and control researchers. All experts rated the relevance of each item using a five-point Likert scale that ranged from 1=least relevant to 5=most relevant. Items with a mean score >3.5, a coefficient of variation (CV) <0.25, and the item level Content Validity index (I-CVI, defined as the proportion of experts who rated it as 4 or 5) >0.78 were retained.<sup>20,21</sup> The experts were also required to evaluate each item's accuracy and clarity and then provide his or her specific suggestions regarding the item. After two rounds of expert consultation, the number of items decreased to 23. After the two Delphi rounds, the experts received their consultation fees.

In step 3, the 23-item TBSES was pilot-tested in 44 TB patients to evaluate the clarity, understandability and ease of response of this new instrument. The 44 patients were selected by a convenience sampling method using the following inclusion criteria: 1) confirmed diagnosis of TB, 2) age  $\geq$  18 years, 3) able to read and understand Chinese, and 4) willing to participate in this study. Patients who had cognitive deficits, a history of mental illness, and other severe physical problems or serious organ injuries were excluded. The 44 participants ranged in age from 18 to 66 years ( $M=37.07$ ,  $SD=14.84$ ); 56.8% ( $n=25$ ) were male; only 2.3% of participant ( $n=1$ ) had a primary education, 25.0% ( $n=11$ ) had junior high school education, 38.6% ( $n=17$ ) had junior high school education, 15.9% ( $n=7$ ) had college degree, and 18.2% ( $n=8$ ) had bachelor degree or above; and 63.6% of the participants ( $n=28$ ) had been treated for less than 2 months. The 23 items of the TBSES were rated by TB patients on a 5-point Likert

scale ranging from “not at all confident” to “completely confident” and coded with the values from 1 to 5, respectively. All participants completed the questionnaire within 6–12 mins. We added more detailed and clearer questionnaire instructions based on the feedback from the participants in this stage.

## Stage II: Field Testing: Data Collection

We used a cross-sectional study design for item analysis and reliability and validity testing of the TBSES. The data reported in this study were collected from June 2018 to October 2018 by 3 trained investigators. The inclusion and exclusion criteria were the same as those of the pilot study. Finally, 460 TB patients were recruited in six locations in Xi'an, Shaanxi Province (Xi'an Chest Hospital, Shaanxi Province Tuberculosis Hospital, and four primary health-care settings). The 23-item TBSES was administered on site alongside the GSES and a self-designed patient general information questionnaire. The 460 patients were interviewed face-to-face using the three instruments by three trained investigators with the assistance of the doctors and nurses. To assess the test-retest reliability, 50 patients who were willing to complete the questionnaire twice resubmitted the TBSES two weeks later. We gave the patients who participated in individual interviews, pretesting, or field testing, some little presents to show our appreciation.

## Stage III: Data Analysis

Data analyses were performed using IBM SPSS Statistics (version 22.0) and AMOS (version 20.0). Descriptive statistics were used for the demographic variables and the scores of the entire TBSES and those of each item. We conducted the following analyses to screen items and evaluate the reliability and validity of the resulting 23-item TBSES. In addition, ROC analysis was performed to identify the cut-off point of TBSES. Generally, the  $\alpha$  level was set at 0.05.

### Item Analysis

The aim of item analysis is to quantitatively determine whether each item should be eliminated or retained. In this study, an item was removed if it met one or more of the following criteria: (1) the mean of the item was extreme or its variance was zero; (2) the critical ratio value of an item was found to be insignificant; or (3) the item total correlation coefficient was not significant, or the coefficient was  $<0.3$ .

## Validity Analysis

### Content Validity

The scale level content validity index (S-CVI) of the last round of the Delphi consultation was used to evaluate the content validity of the TBSES. The S-CVI should be larger than 0.8, suggesting that the content validity of the scale is good.<sup>22</sup>

### Construct Validity

The valid samples were randomly divided into two groups (group 1 with 216 samples and group 2 with 219 samples) that were then used for exploratory and confirmatory factor analyses, respectively. The factor structure of the TBSES was investigated by exploratory factor analysis using principal component analysis and Promax rotation. Before that, the sample suitability for factorial analysis was measured by the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. Items were retained when meet the following criteria: 1) item factor loading  $> 0.4$ ; and 2) there was conceptual coherence of the items with their corresponding factors.<sup>23</sup> The number of factors was determined by the eigenvalues and the scree plot. The first point at which Catell's scree plot begins to flatten is considered the maximum factor that should be extracted. After the EFA, confirmatory factor analysis with a structural equation was conducted to examine the underlying factor structure of the TBSES. The parameters of this model were estimated using the general least square (GLS) method because of the nonnormal distribution of some of the observed variables,<sup>24</sup> the CMIN/DF, good fit index (GFI), adjusted good fit index (AGFI), and root mean square error of approximation (RMSEA) were calculated to assess how well the model fit the data, with CMIN/DF $<3$ , GFI, AGFI $>0.90$ , and RMSEA $<0.08$  indicating a good model fit.<sup>25</sup> In addition, the average variance extracted (AVE), construct reliability (CR) and the correlation coefficients between factors were calculated to validate the discriminant validity and convergent validity of the sub-factors of the tool. The AVE $>0.7$ , CR $>0.5$  indicating good convergent validity,<sup>26</sup> and the square root of AVE larger than the correlation coefficients between factors, indicating a good discriminant validity.<sup>27</sup> The reliability was assessed by Cronbach's alpha coefficients, the split-half reliability coefficient, and the test-retest reliability coefficient. Reliability coefficients  $>0.70$  were considered satisfactory.<sup>28</sup>

### Concurrent Validity

Concurrent validity was assessed by the Spearman correlation coefficient between the GSES scores and the TBSES scores as well as factor scores.

## Reliability Analysis

### Cronbach's Alpha Coefficients

The Cronbach's alpha coefficients for the overall scale and each subscale were calculated to evaluate the internal consistency.

### Split-Half Reliability Coefficient

Spearman correlation was measured between the scores of two halves divided by the whole scale according to the parity of the item number.

### Test-Retest Reliability

Spearman correlation coefficient and the intraclass correlation coefficients (ICC) were calculated between the scores of the 50 patients who completed TBSES twice in a two-week interval, to determine the test-retest reliability.

### Receiver Operating Characteristic (ROC) Analysis

The ROC analysis was used to identify the cut-off point of TBSES to identify the patients with low self-efficacy who are the target population for intervention. We drew the ROC curve by plotting the TBSES scores and used the GSES as the reference criteria to obtain the best decisive threshold. GSES developed by professor Ralf Schwarzer and his colleagues is one of the most representative tools in the universal scale, to measure individual's overall confidence in coping with all difficulties and challenges.<sup>19</sup> GESE was composed of 10 items, scored on 4-likert grade. The number 1–4 represented four different degrees from “totally incorrect” to “totally correct”.

## Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Xi'an Jiaotong University Ethics Committee, and written informed consent was obtained from all participants before individual interviews and questionnaire surveys were administered. The investigation process adhered to the principle of confidentiality, with the questionnaires completed anonymously, and the research data were used only in this research.

## Results

### Sample Characteristics

Twenty-five invalid questionnaires were excluded because of missing data out of the total 460 collected questionnaires, with an effective rate of 94.56%. The subjects' ages ranged from 18 to 72 years old ( $M=35.56$ ,  $SD=14.353$ ); other characteristics of the subjects are shown in Table 1.

**Table 1** Demographic Characteristic Of The Participants (n = 435)

Characteristics	n	Percent
Gender		
Male	265	60.9
Female	170	39.1
Ethnicity		
Han nationality	423	97.2
Others	12	2.8
Education		
High school or less	255	58.6
Junior college	96	22.1
Bachelor degree or above	84	19.3
Marriage		
Unmarried	178	40.9
Married	244	56.1
Others	13	3.0
Treatment period		
<2 months	295	67.8
2–8 months	129	29.7
>8 months	11	2.5
Treatment site		
Hospital	329	75.6
Home	106	24.4
Family monthly income		
<1999 yuan	133	30.6
2000–4999 yuan	211	48.5
>5000 yuan	91	20.9

## Item Analysis

The means of all items ranged from 3.16 to 4.48, and there were no items with a variance of 0. The critical ratio was significant for all items, and the item-total correlation was  $>0.3$ . There were no items that met the elimination criteria mentioned above, and all 23 items were retained. (see Table 2)

## Validity Analysis

### Exploratory Factorial Analysis

The construct validity of the 23-item TBSES was analyzed with a sample of 216 adults with TB (group 1) using principal components to extract factors. Barlett's test of sphericity for appropriate assumptions was significant ( $\chi^2=3334.298$ ,  $DF=253$ ,  $p<0.001$ ), and the KMO value was 0.904, which is well above the recommended 0.50, indicating that there was sufficient support to perform the exploratory factorial analysis.<sup>29</sup> Prior to the final factor analysis, two items were eliminated because they did not conceptually fit with the other items pertaining to the same

**Table 2** Results Of Item Analysis

Item	Mean (SD)	Critical Ratio Value	Item-Total Correlation
1	3.90(1.10)	12.068*	0.610*
2	4.24(0.88)	12.185*	0.646*
3	4.02(0.98)	15.574*	0.730*
4	3.94(1.01)	15.154*	0.687*
5	4.44(0.75)	13.117*	0.639*
6	4.46(0.75)	13.465*	0.663*
7	4.47(0.70)	13.444*	0.640*
8	4.40(0.70)	16.695*	0.679*
9	4.26(0.85)	18.048*	0.740*
10	4.20(0.92)	12.114*	0.569*
11	4.40(0.75)	16.072*	0.693*
12	4.29(0.80)	15.693*	0.676*
13	4.46(0.77)	13.287*	0.596*
14	4.43(0.75)	10.579*	0.582*
15	4.44(0.80)	12.352*	0.613*
16	4.48(0.72)	11.993*	0.572*
17	4.02(1.08)	15.178*	0.695*
18	4.13(0.96)	13.408*	0.627*
19	4.08(0.96)	14.436*	0.654*
20	3.85(1.12)	13.341*	0.621*
21	3.77(1.11)	11.257*	0.546*
22	3.16(1.36)	11.160*	0.492*
23	3.29(1.26)	12.296*	0.524*

Note: \* $P < 0.001$ .

Abbreviation: SD, standard deviation.

factor. Then, the final factorial analysis was conducted on the remaining 21 items to verify the construct validity. As a result, four factors were extracted using the principal components method based on eigenvalues  $\geq 1$ , the scree plot yielded a four-factor solution as well, see Figure 1, the four factors accounted for 67.322% of the total variance. The communalities ranged between 0.499 and 0.828 (see Table 3), were greater than the threshold of 0.4;<sup>30</sup> the factors were labeled as “medical care management self-efficacy, support seeking self-efficacy, psychological adjustment self-efficacy, and transmission management self-efficacy”. The factor structure was described as follows.

Factor 1 was named “medical care management self-efficacy” and consists of 9 items with factor loadings ranging from 0.633 to 0.883 explaining 41.381% of the total variance. Items belonging to this factor concentrate on TB patient confidence related to medical care activities involving not only medications, reexaminations, and management of symptoms and adverse reactions but also maintaining a healthy lifestyle. For example, item 6 reads

“I can persist in regularly taking my medication long-term (6–8 months or more)” and item 12 states “During the treatment, I can maintain good living habits such as: paying attention to resting, exercising, strengthen nutrition, and breathing fresh air”.

Factor 2, called “support seeking self-efficacy”, has 6 items with factor loadings ranging from 0.649 to 0.793, accounting for 15.554% of the total variance. This factor contains items related to confidence in seeking support, including emotional support, information support and behavior support. For instance, item 20 states “I can seek help from relatives and friends for housework, financial support, etc.”.

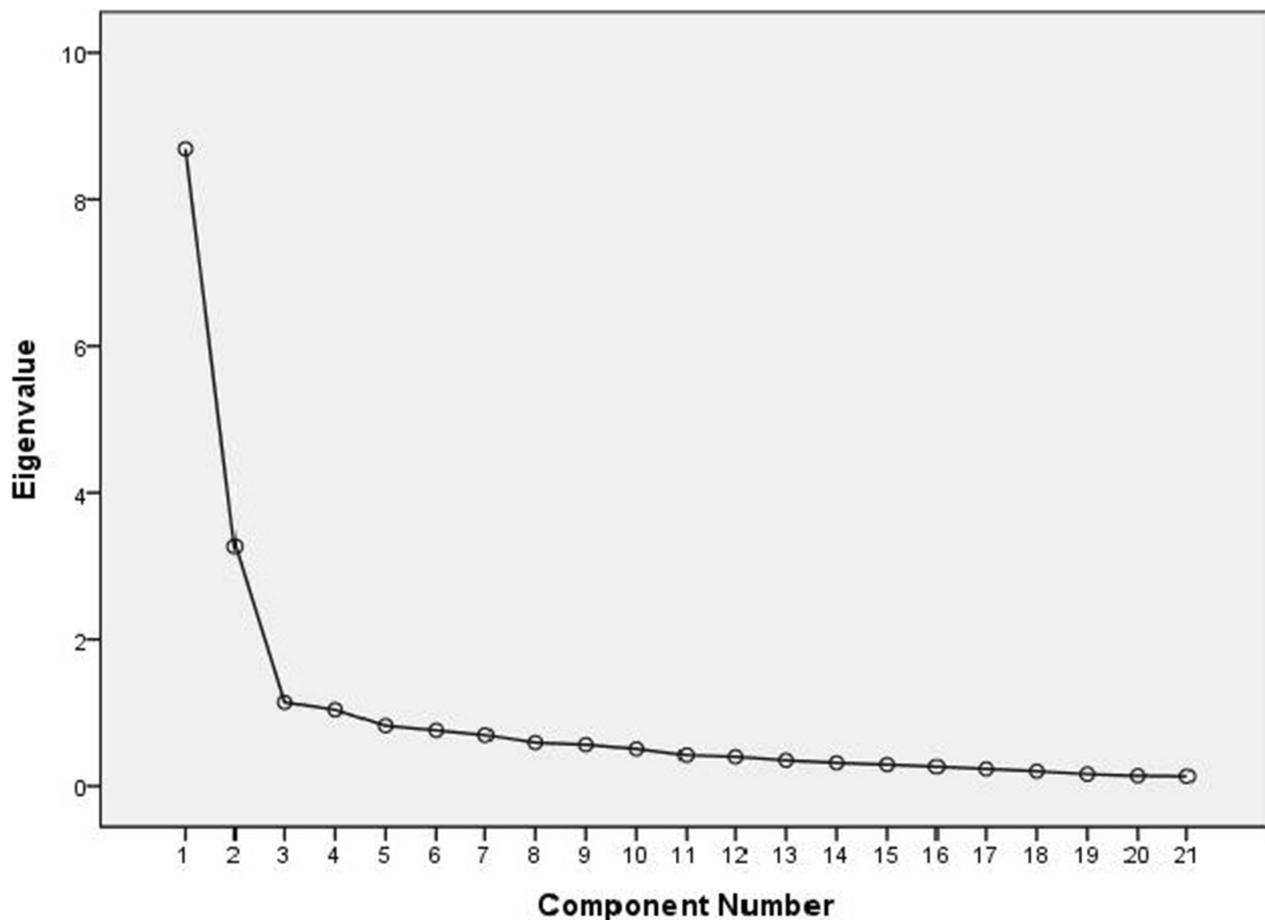
Factor 3 was named “psychological adjustment self-efficacy”, and it has 4 items with factor loadings ranging from 0.727 to 0.900, accounting for 5.437% of the variance. This factor reflects patients’ confidence in coping with adverse psychological reactions such as stigma, bad moods, and interpersonal disturbances. For example, item 4 states “I can try to alleviate TB-related stress such as the disturbance of interpersonal relationships, worrying about my prognosis and worrying about infecting others”.

Factor 4, labeled “transmission management self-efficacy”, is composed of 2 items with factor loadings ranging between 0.817 and 0.874, accounting for 4.950% of the total variance. Items contained in this factor reflect patients’ confidence in controlling the transmission of TB by appropriate sterilization and isolation. For example, item 14 states

If I am in an infectious period, I can take measures to avoid infecting others, such as wearing masks, living in a separate room, separating tableware, not spitting anywhere, and ventilating the air, etc.

### Confirmatory Factor Analysis

we drew the primary path diagram of the model according the result of EFA and added the error covariances according to modification indices provided by AMOS. Finally, a satisfactory model fit was indicated by CMIN/DF=1.841, GFI=0.855, adjusted AGFI=0.814, RMSEA=0.062. The standardized factor loadings of all items were statistically significant and greater than 0.40. The parameter estimates of the CFA are shown in Figure 2. The AVE of the 4 factors were 0.770, 0.612, 0.632, 0.697, respectively. The CR values of the factors were 0.968, 0.905, 0.870 and 0.900, respectively. Also, the square root of AVE were greater than the correlation coefficients between 4 factors (See Table 4).



**Figure 1** Scree plot of principal component factor analysis (n=216).

### Content Validity And Concurrent Validity

The content validity of this scale was 0.951. Spearman's rank correlation analysis was used to indicate the concurrent validity due to the non-normally distributed scores of the TBSES and GSES ( $p < 0.10$ ). The correlation coefficient between the total scores of the TBSES and GSES was 0.656 ( $p < 0.001$ ), and the correlation coefficient between the scores of each subscale of the TBSES and the GSES ranged from 0.438 to 0.527. (see [Table 5](#))

### Reliability Analysis

Cronbach's alpha for the total 21-item TBSES was 0.916 and ranged from 0.801 to 0.925 for each of the subscales. The split-half coefficient was 0.958 and ranged from 0.801 to 0.938 for each of the sub-scales (see [Table 6](#)). The test-retest correlation for the 21-item TBSES was 0.799 ( $p < 0.001$ ,  $n = 50$ ) and the ICC was 0.819 ( $p < 0.001$ ,  $n = 50$ ).

### Receiver Operating Characteristic (ROC) Analysis

We drew the ROC curve, with GSES as the reference criteria, see [Figure 3](#). The area under the ROC curve of the TBSES was 0.855, the cut-off point was 86.5, and the sensitivity and specificity were 0.821 and 0.764, respectively. According to this standard, 215 of the 435 (49.4%) TB patients had low levels of self-efficacy, and the remaining 220 TB (50.6%) patients had high levels of self-efficacy.

### Discussion

Self-efficacy plays a vital role in maintaining healthy habits and adhering to treatments and has therefore attracted increasing attention from researchers.<sup>31,32</sup> Specific self-efficacy instruments have been developed for many chronic and/or infectious diseases, such as HIV,<sup>33</sup> stroke,<sup>34</sup> and diabetes,<sup>35</sup> but none have targeted TB. Our study generated and tested a new 21-item instrument for measuring self-efficacy among Chinese adult TB patients. The evaluation of its validity and

**Table 3** Results Of The Exploratory Factorial Analysis

Item	Factor Loading	Communality
<b>Factor 1: Medical care management (Eigenvalue= 8.690, % of variance= 41.381%)</b>		
7. I can recheck and obtain my medicine on time.	0.883	0.793
8. I can persist in taking my medicine while there are other things I need to do (be out of the home, go to work, etc.)	0.878	0.775
6. I can persist in regularly taking my medication long-term (6–8 months).	0.849	0.724
11. If there is any discomfort during treatment, I can consult a doctor or seek help in a timely manner.	0.826	0.683
13. During the treatment, I can completely quit smoking and stop consuming alcohol.	0.803	0.670
5. I can take different drugs correctly according to the doctor's advice (for example, rifampicin: once a day, take it on an empty stomach).	0.785	0.613
12. During the treatment, I can maintain good living habits such as paying attention to resting, exercising, nutrition, and breathing fresh air.	0.781	0.626
9. I can take measures to avoid missing or overtaking drugs, such as using alarm clocks and medication notes.	0.765	0.640
10. When the symptoms improve or disappear, I can continue to take the medicine according to the doctor's advice.	0.663	0.499
<b>Factor 2: Support seeking (Eigenvalue= 3.266, % of variance= 15.554%)</b>		
22. I can seek help from other social resources such as insurance companies and work.	0.793	0.712
23. I can seek emotional support from other social resources such as medical staff, patients, and community organizations.	0.781	0.694
20. I can seek help from relatives and friends for housework, financial support, etc.	0.766	0.622
21. I can seek emotional support from friends and relatives to talk about annoyances and worries.	0.764	0.622
17. I can acquire TB-related knowledge through a variety of methods such as networks, medical staff, books, and other patients.	0.675	0.598
19. Even if the medical staffs are busy, I can find other opportunities to raise my questions.	0.649	0.533
<b>Factor 3: Psychological adjustment (Eigenvalue= 1.142, % of variance= 5.437%)</b>		
3. I can alleviate the effects of depression, anxiety, stigma and other negative emotions on my treatment and life.	0.900	0.828
4. I can try to alleviate TB-related stress such as the disturbance of interpersonal relationships, worrying about my prognosis and worrying about infecting others.	0.888	0.790
1. I can accept the fact that I have tuberculosis.	0.735	0.548
2. I can maintain a positive attitude and believe that my illness can be cured.	0.727	0.718
<b>Factor 4: Transmission management (Eigenvalue=1.039, % of variance =4.950%)</b>		
14. If I am in an infectious period, I can take measures to avoid infecting others, such as wearing masks, living in a separate room, separating tableware, not spitting anywhere, and ventilating the area.	0.874	0.777
15. I can dispose of sputum correctly.	0.817	0.673

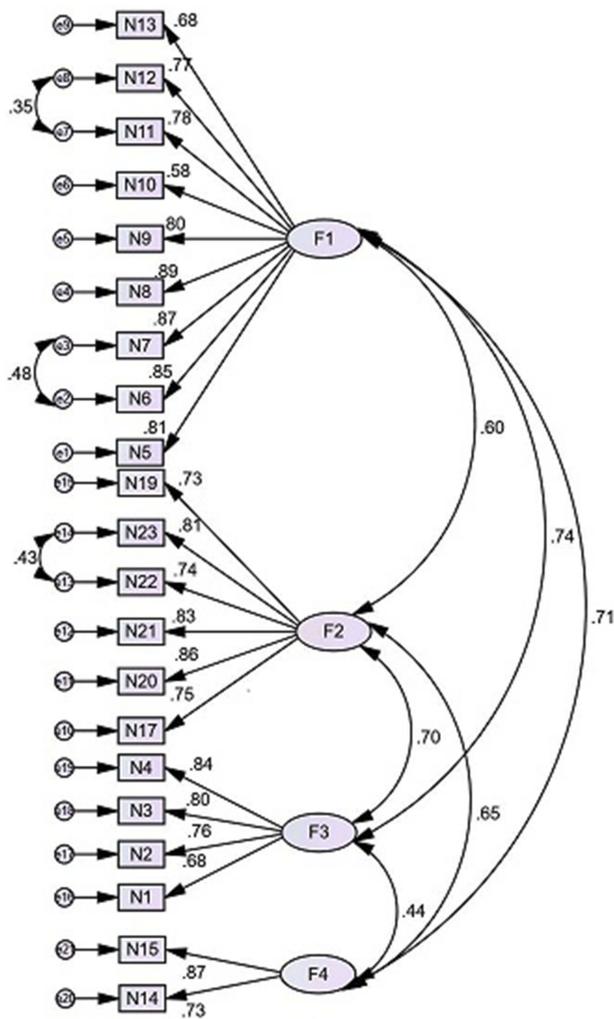
**Note:** Total scale: % of variance: 67.322%.

reliability was conducted to test the psychometric properties, and the ROC analysis was used to identify the cut-off point. Overall, the TBSES is both reliable and valid for measuring self-efficacy-related self-management areas specific to TB, with an appropriate number of items, which improves the applicability and operability of the TBSES.

The total Cronbach's alpha coefficient, split-half coefficient, and test-retest reliability coefficient and ICC were 0.916, 0.958, 0.799 and 0.816, respectively, fulfilling the requirement for the reliability coefficient to be  $> 0.7$  and indicating that this scale has adequate internal consistency and stability over a 2-week interval.<sup>36</sup> The content validity of the TBSES, which has been reviewed twice by an

expert panel, was sufficiently demonstrated by a CVI of 0.951, which indicated that the content of TBSES is in good agreement with the concept of self-efficacy.<sup>37</sup>

Both exploratory and confirmatory factor analyses were used to evaluate the construct validity, and the results of the exploratory factorial analysis revealed that this scale was naturally multidimensional. Four factors were extracted and termed "medical management self-efficacy", "support seeking self-efficacy", "psychological adjustment self-efficacy", and "transmission management self-efficacy". The four factors accounted for 67.322% of the total variance, with all items' factor loadings greater than 0.4, supporting the appropriate construct validity of the



**Figure 2** The standardized path diagram of the confirmatory factor analysis.  
**Note:** N1 to N23 represents the items of TBSES, F1 to F4 represents the four factors of TBSES.

TBSES. Furthermore, the abovementioned 4-factor model was demonstrated to be reasonable by confirmatory factor analysis, with CMIN/DF=1.841, meeting the criteria of less than 3; the RMSEA was 0.062, representing a moderate model fit,<sup>38</sup> while the GFI, AGFI did not reach 0.90, possibly they are strongly affected by sample size and tend to underestimation when the sample size is less than 300.<sup>39</sup>

**Table 4** Results Of The Confirmatory Factorial Analyses

Factors	F1	F2	F3	F4
F1	0.877*			
F2	0.602	0.782*		
F3	0.737	0.703	0.795*	
F4	0.715	0.655	0.436	0.835*

**Note:** \*Represents the square root of AVE of 4 factors, the others represent the correlation coefficients between 4 factors.

**Table 5** Concurrent Validity (The Correlation Between The Scores Of TBSES And GSES)

Area	Spearman's Rho Correlation Coefficients
Medical care management	0.493*
Support seeking	0.522*
Psychological adjustment	0.527*
Transmission management	0.438*
Total	0.656*

**Note:** \*P < 0.001.

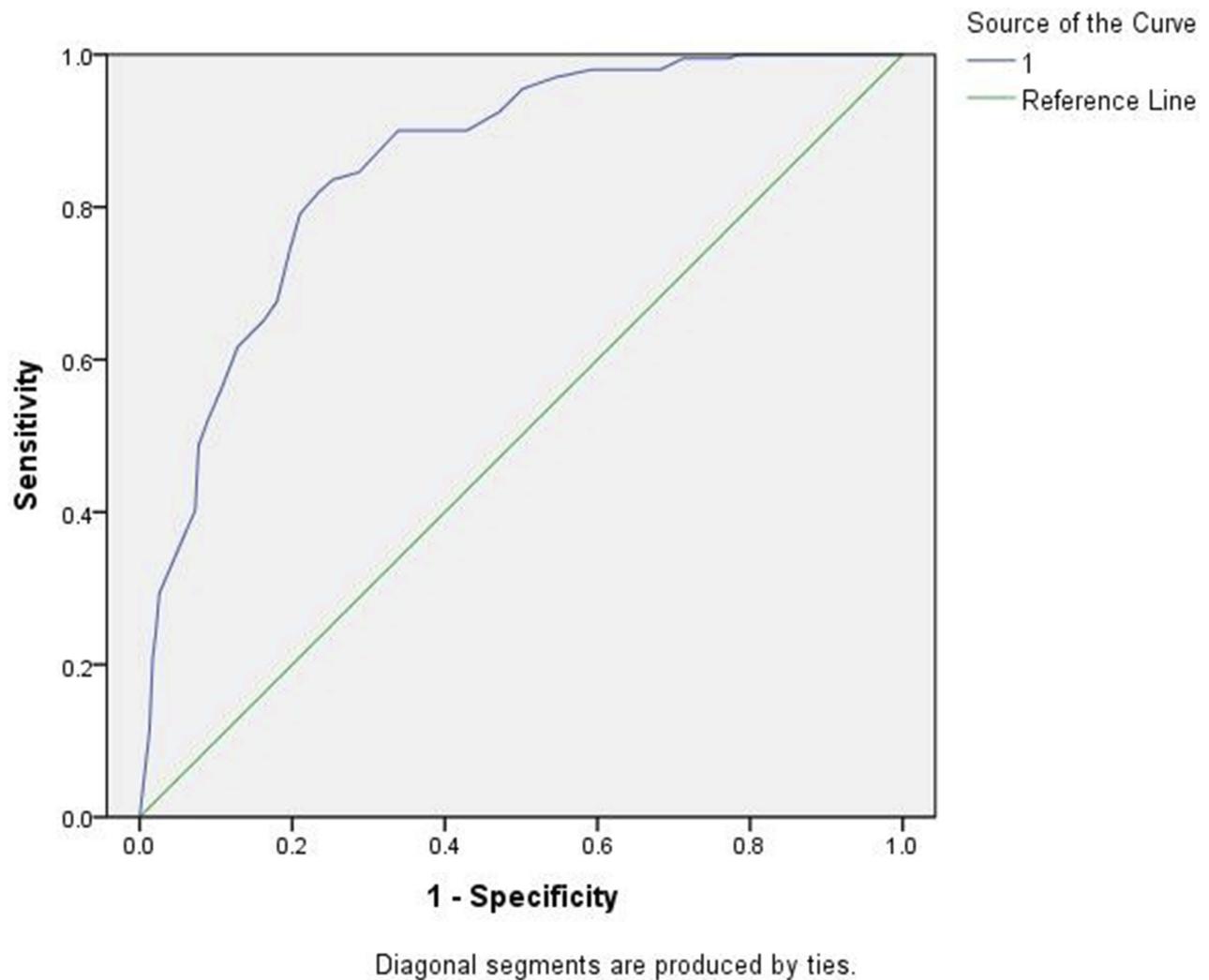
**Table 6** Cronbach Alpha And Split-Half Reliability

Area	Cronbach Alpha	Split-Half Reliability
Medical care management	0.925	0.938
Support seeking	0.856	0.893
Psychological adjustment	0.850	0.884
Transmission management	0.801	0.801
Total	0.916	0.958

It is worth mentioning that we add the error covariances between item 11 and 12, item 6 and 7, item 22 and 23 according to modification indices, the content of 3 groups items was similar but not the same, may have part common measuring content, so the error covariances were allowed to be exist. The AVE and CR values indicates good convergence validity and discriminatory validity according to the criteria of AVE > 0.5, CR > 0.7, and the square root of AVE > correlation coefficients between factors. Overall, the results showed an acceptable model fit in the tested sample of Chinese TB patients. The results of the EFA and CFA supported the construct validity of the TBSES.

The GSES, developed by Schwarzer,<sup>19</sup> is mostly used as a reference assessment in studies seeking to develop specific self-efficacy scales.<sup>40,41</sup> In our study, we used the GSES to assess the concurrent validity. The results revealed significant positive correlations between the total scores of the TBSES and GSES and moderately strong correlations between the TBSES subscales and the GSES. This moderate correlation could be the result of the GSES measuring general self-efficacy while the TBSES measures TB-specific self-efficacy, which is the advantage of the TBSES.

In addition, the cut-off value of the TBSES score for the diagnosis of low self-efficacy was determined with a ROC analysis. We demonstrated that at the cut-off point of



**Figure 3** ROC curve of the TBSES.

86.5, the TBSES had a sensitivity of 0.821 and a specificity of 0.764, suggesting that the TBSES could be a valid screening tool to detect patients with low levels of self-efficacy. According to this criterion, almost half the patients in our study were found to have low levels self-efficacy, which are not conducive to the successful implementation of self-management behavior, indicating that attention should be paid to targeting interventions aimed at improving TB patient self-efficacy.

In contrast to other general scales, the TBSES was developed based on Bandura's guide for self-efficacy scale construction, which suggests that the construction of efficacy scales relies on a good conceptual analysis of the relevant disease management behaviors performed in specific areas.<sup>14</sup> We conducted a comprehensive literature review and in-depth individual interviews to explore self-management tasks and

challenges or impediments to completing those tasks when generating the first draft of the items. Therefore, the TBSES measures self-efficacy in specific situations that are genuinely experienced by TB patients during their treatment, providing not only a holistic but also a specific perspective for assessing TB patients' self-efficacy, which is valuable for theoretical research and practical clinical application. The TBSES may be the basis for verifying the relationships between self-efficacy and other related factors. Furthermore, in a clinical setting, it can be used to identify not only patients with low levels of self-efficacy but also those with difficulty with specific tasks, providing evidence for medical professionals in a clinical setting to design and implement targeted interventions to help those patients develop the necessary confidence with regard to managing their treatment, such as taking their medicine or relieving the associated stigma.

## Limitation

This new instrument demonstrated satisfactory psychometric properties for measuring the self-efficacy of Chinese TB patients. However, some limitations need to be noted. First, the study sample populations were all recruited from Shaan'xi Province, and further studies need to be conducted in different settings nationwide to determine the generalizability of the TBSES. Second, due to the difficulty of implementation, we adopted various methods of psychometric evaluation, but they lacked predictive validity, suggesting the need for further validation.

## Conclusion

The 21-item TBSES, which was developed in accordance with the scale development guidelines and the guidance for constructing a self-efficacy scale provided by Bandura, showed that the TBSES is reliable and valid. This scale has appropriate sensitivity and specificity values at the cut-off value of 86.5 and can effectively diagnose patients with low levels of self-efficacy. Further validation is suggested. It can be a useful clinical tool to assess TB patient self-efficacy and can be used to guide clinicians to adopting individualized intervention measures to strengthen the perceived self-efficacy of TB patients, thereby facilitating their adherence to healthy behaviors.

## Acknowledgments

This study was supported by the National Nature Science Foundation of China (Award number: 71774131). We would like to thank the experts who reviewed this scale, the participants who participated in the study, and the doctors and nurses who helped us recruit patients.

## Disclosure

The authors report no conflicts of interest in this work.

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