## ORIGINAL RESEARCH

# Translation and Validation of the Chinese Language Version of the Control of Allergic Rhinitis and Asthma Test in Patients with Allergic Rhinitis

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#### ABSTRACT

**Objective** • Due to the escalating global prevalence of allergic rhinitis (AR) and its status as an independent risk factor for asthma, timely and effective control of AR is crucial. Achieving this often involves the accurate assessment of AR. Currently, the Control of Allergic Rhinitis and Asthma Test (CARAT) is widely used as an assessment tool, but its measurement effectiveness in Chinese AR patients remains unclear. Therefore, this study aims to evaluate the reliability and validity of the Chinese version of the CARAT10 scale (CARAT10-C) and analyze its application value in the assessment of allergic rhinitis and asthma control trials.

**Methods** • The study enrolled 130 patients with AR from the Ear, Nose, and Throat (ENT) outpatient department of a comprehensive teaching hospital from March to May 2022 as participants. The reliability and validity of the CARAT10-C scale were assessed using Cronbach's alpha coefficient (CAC), Kaiser-Meyer-Olkin (KMO), and Bartlett's sphericity test. Additionally, the study analyzed the effectiveness of the CARAT10-C scale in its application within the Control of Allergic Rhinitis and Asthma Test (CARAT). Results • The Cronbach's alpha coefficient ranges between 0 and 1, with higher values indicating better reliability. Significant differences in exploratory factor analysis suggest good validity. The Cronbach's alpha coefficient of the CARAT10-C scale was 0.806. Exploratory factor analysis revealed that the eigenvalues of Component 1 (3.851) and Component 2 (2.193) were both greater than 1, with a cumulative variance contribution rate (CVCR) of 60.436%. Items 6-10 were primarily loaded on Component 1 (Asthma), while items 1-4 were mainly influenced by Component 2 (AR), with loading ranges of 0.508-0.874, all significant at P < .001. The composite reliability (CAC) of the CARAT10-C scale was 0.806, exceeding 0.8, indicating high reliability. Component 1 had a CAC of 0.834, and Component 2 had a CACs of 0.807, both exceeding 0.8, indicating high reliability for both components.

**Conclusion** • The CARAT10-C scale demonstrates good reliability and validity in the preliminary assessment of AR. It holds potential value in the evaluation and management of AR in China, although the specific application effects still require further investigation. (*Altern Ther Health Med.* 2024;30(5):123-129)

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#### INTRODUCTION

Allergic rhinitis (AR), is a very common chronic inflammation of the upper respiratory tract in recent years.<sup>1</sup> At present, AR has a high incidence worldwide. According to relevant research statistics,<sup>2</sup> there are about 500 million patients with AR in the world. The results of AR epidemiology showed that the adult prevalence rate increased from 11.1% in 2005 to 17.6%.<sup>3</sup> Moreover, the incidence of AR in China in recent years is still rising rapidly.<sup>4</sup> Although AR disease does not pose a threat to patients' lives, it can cause secretory otitis media<sup>5</sup> and sleep-disapnea syndrome,<sup>6</sup> etc., leading to hearing or sleep disorders in patients and seriously affecting their quality of life. However, there is no widely available or effective treatment for AR. However, studies have found that standardized comprehensive prevention and treatment has a good control effect on various clinical symptoms, and also

improves patients' quality of life to some extent. Studies have also found that there is a certain relationship between AR and asthma. The probability of asthma in patients with AR disease is 3 - 5 times that of those without AR, and about 75% of asthma patients suffer from AR.<sup>8,9</sup> The clinical manifestations of AR and asthma are similar, but the treatment methods of the two are different, and there is a mutual influence relationship between them. Therefore, it is very important to recognize AR and asthma and fully understand the influence of AR and asthma for the clinical treatment and management of AR.

With the continuous exploration of Allergic Rhinitis and its Impact on Asthma (ARIA)<sup>10,11</sup> by experts from various countries in recent years, it is found that there is a lack of awareness in society on the control of clinical symptoms of AR. To better evaluate AR diseases and effectively control AR diseases, more and more attention has been paid to the application of various AR evaluation tools. After evaluation analysis, it was found that the non-scale evaluation method and clinical auxiliary examination have good sensitivity and specificity. However, due to high cost, trauma, inconvenience, and other problems, its application has great limitations.<sup>12,13</sup> Therefore, scale and questionnaire become the key evaluation methods of clinical concern. After a query, The Control of Allergic Rhinitis and Asthma Test (CARAT)<sup>14</sup> and Rhinitis Control Assessment Test (RCAT)<sup>15</sup> are the most widely studied AR disease control scales. To effectively evaluate AR and asthma simultaneously, there have been studies in several countries, such as Germany<sup>16</sup> and Portugal<sup>17</sup>, that conducted cross-cultural feasibility analysis of CARAT10, the 10-question CARAT version of the scale. CARAT10 is currently used to evaluate the situation of disease control, the results of asthma /AR studies, and the quality of asthma /AR care. CARAT10 is also the only scale that can simultaneously assess asthma and AR. After verification, it was found that both the original CARAT10 and the translated version had good validity.18 There are only 10 questions in CARAT10, and it takes less time to fill out the questionnaire. Moreover, the evaluation content is complete, and the clinical application is convenient, which has been widely recognized in foreign countries. However, there is no special scale for patients with allergic rhinitis in China, and studies on the application effect of CARAT10 in China are also very lacking. Therefore, the adaptability of the CARAT10 scale in the assessment of AR diseases remains to be explored.

In summary, this work carried out Sinicized processing of CARAT10 scale to obtain the Chinese language version of CARAT10 (CARAT10-C), and took Chinese AR patients as research objects to evaluate the reliability and validity of the CARAT10-C scale. This work aimed to provide more effective evaluation methods for the disease control of domestic AR patients to improve the prognosis of patients, and improve patients' quality of life.

#### METHODS

#### **Research objects**

The purpose of this work was to discuss whether the CARAT10 scale can be applied to the test of the AR population

in China. Since there are 10 test items in the CARAT10 scale, the sample content in the study should be 5 to 10 times the number of relevant variables in this work that is, the number of patients involved should be 50 to 100. However, about 20% of questionnaire surveys were invalid.<sup>19,20</sup> Therefore, the sample size should be appropriately increased by 20%, which means that the estimated sample size in this work was between 60 and 120 cases. The specific calculation method is as follows:

$$\begin{cases} 10 \times 5 = 50 \\ 10 \times 10 = 100 \end{cases}$$
(1)  
$$\begin{cases} 50 \times (100\% + 20\%) = 60 \\ 100 \times (100\% + 20\%) = 120 \end{cases}$$
(2)

In this work, 130 patients diagnosed with AR who visited the otolaryngology outpatient Department of a comprehensive teaching hospital in Shanghai from March to May 2022 were selected by convenient sampling as research objects. The diagnosis of all AR patients was based on the 2022 revised Guidelines for Diagnosis and Treatment of Allergic Rhinitis in China.<sup>21</sup> A pre-survey has been conducted before the formal distribution of the questionnaire. Questionnaires were distributed to 130 subjects. After excluding invalid questionnaires, 120 valid questionnaires were obtained, with an effective recovery of 92.31%. The experiment had been approved by the relevant medical ethics committee. The specific inclusion and exclusion criteria were as follows:

**Inclusion criteria**: all patients aged between 18 and 80 years; the diagnostic criteria for all patients included clinical manifestations of sneezing, clear rhinorrhea, nasal congestion, and nasal itching (with two or more of these symptoms), with symptom duration lasting for at least 1 hour. Additionally, physical signs such as pale and edematous nasal mucosa were present, and confirmation was obtained through blood tests, skin tests, and nasal provocation tests. All patients had the ability to comprehend written information and complete the questionnaire independently or with the assistance of the researcher. Informed consent forms were signed by all participants.

**Exclusion criteria**: patients with intellectual impairment or behavioral abnormalities that hindered their cooperation with the study; females in pregnancy or lactation; patients with severe organ dysfunction, such as heart, liver, or kidney failure; and those demonstrating poor compliance during the course of the study were excluded.

#### **Research tools**

**Questionnaire for general clinical data.** Through the inquiry and review of relevant literature, the author investigated the patient's gender, age, residence, education level, working status, satisfaction with income, monthly family income, influence on quality of life, duration of symptom onset, effect of the first treatment, allergen testing, knowledge of AR, necessity of drug treatment, concern about drug dependence, and frequency of nasal congestion (within a week). The method used was to fill in the general information

questionnaire. The questionnaire was specifically designed for the purpose of this study.

**CARAT10 scale.** First, it needed to obtain authorization from the original author of the CARAT10 scale to introduce the English version of the CARAT10 scale. Then, the CARAT10 scale was translated and adapted to a Chinese version, including forward translation, backward translation, and cultural adaptation. In this work, the Functional Assessment of Chronic Illness Therapy (FACIT)<sup>22</sup> was undertaken as the basis for the scale translation and cultural adaptation. The process consists of seven parts -- preparation, forward translation, translation adjustment, backward translation, comparison, matching, and final version formation, as illustrated in Figure 1. The purpose of this process was to make the content of CARAT10-C more in line with the cultural background and language habits of China, being more convenient for patients to understand.

## Investigation method

The following should be noted during the investigation:

- A: Training of researchers was required before conducting investigations;
- B: Patients should be guided by researchers during the questionnaire survey, and patients should fill in the questionnaire in a single room with sufficient time. Meanwhile, researchers should try their best to avoid subjects being affected during the questionnaire filling process, which may lead to inaccurate content.
- C: Researchers needed to check the completion of the questionnaire to avoid omissions by patients. If there was any unfinished content, patients should supplement it.

It was important to note that researchers can help patients fill out questionnaires when they are unable to do so on their own. The answers to each question in the questionnaire were dictated by the patients and written by the researchers.

## Data collection and entry

The data for this study were collected through on-site paper questionnaires. During the questionnaire completion process, researchers provided detailed explanations of the content to participants and promptly addressed any questions they had. After completion, the questionnaires were retrieved, and the survey results were manually entered into a computer. To ensure the accuracy of the entered data, two researchers conducted a review and confirmation process. Additionally, confidentiality was maintained throughout the study to protect patient privacy. This was achieved by establishing a secure data management system and implementing effective measures to prevent unauthorized access, alteration, or disclosure of patient data. Two people check the final questionnaire data twice, and then manually input the data checked by two people into the table, and check again. Statistical analysis can be performed after verification.

## Figure 1. The Translation process of CARAT10-C scale.

$\langle$	Preparation	Authorized + determined the research team members of Shanghai Ninth People's Hospital will participate in CARAT10 localization.
(	Foreward Translation	Two translators who are proficient in both Sinicized and English will translate into Sinicized and obtain two versions of T1 and T2
(	Translation Adjustment	After discussion by the translation team, T1 and T2 were merged into T3.
(	Backward Translation	Two English Sinicized bilingual researchers who did not understand the content of CARAT10 translated T3 respectively and got RT1 and RT2, which were merged into RT3 after discussion.
$\langle$	Comparison	Compare RT3 with the original scale, modify the differences, and form the final draft TE
$\langle$	Check	Check and proofread the problems of CARAT10 in typesetting and language expression.
(	Final version Formation	The final Sinicized version of CARAT10 scale is formed to record the process of Sinicized translation.

#### Statistical analysis

In this work, Statistic Package for Social Science (SPSS) 22.0 (IBM, Armonk, NY, USA) was utilized for data processing and analysis. The reliability of the CARAT10-C scale was evaluated by internal consistency, and the constructive validity of the CARAT10-C scale was evaluated by exploratory factor analysis. Specific evaluation methods were as follows:

**Reliability.** Internal consistency was employed for assessment, i.e., Cronbach's alpha coefficient of the questionnaire was obtained. The reliability evaluation criteria of the questionnaire were as follows. Cronbach's alpha coefficient (CAC) > 0.8 indicated high reliability of the questionnaire; 0.8 > CAC > 0.7 meant the reliability of the questionnaire was good; 0.7 > CAC > 0.6 suggested the reliability of the questionnaire was acceptable; and 0.6 > CAC represented a good questionnaire reliability.

**Validity.** In this work, the constructive validity of the CARAT10-C scale was evaluated by exploratory factor analysis. First, it needed to use the sampling moderate measurement values of Kaiser-Meyer-Olkin (KMO) and Bartlett spherical test values to judge whether the CARAT10-C scale can be factor analyzed.

The measured value of KMO sampling was in the range of 0 - 1. The closer the value was to 1, the better the correlation between items. If the scale can be evaluated by exploratory factor analysis, the KMO value should be above 0.7.

Bartlett's sphericity was a method to test the whole correlation matrix. If the  $\chi^2$  value of Bartlett's sphericity test reached a significant difference, it indicated that the CARAT10 scale can conduct exploratory factor analysis.

After exploratory factor analysis and judgment of the CARAT10-C scale by using KMO sampling moderation measurement value and Bartlett spherical test value, the principal component analysis (PCA) method was employed to extract the factors of each item in the scale, without limiting the number of factors extracted. At the same time, the lithotripsy map was drawn, and the number of common

#### **Table 1.** Statistics of general data (n = 120 cases)

Item		Frequency	Percentage	Effective percentage	Cumulative percentage
Gender	Males	69	57.5	57.5	57.5
	Females	51	42.5	42.5	100
Permanent	City	95	79.2	79.2	79.2
resident	Town	16	13.3	13.3	92.5
	Rural area	9	7.6	7.6	100
Education	Primary school or below	3	2.5	2.5	2.5
level	Middle school	5	4.2	4.2	6.7
	High school or technical secondary school	13	10.8	10.8	17.5
	Junior college	22	18.3	18.3	35.8
	Bachelor's degree or above	77	64.2	64.2	100
Working	Unemployed	22	18.3	18.3	18.3
status	Retired	2	1.7	1.7	20
	Employed	96	80	80	100
Satisfaction	Not satisfied	17	14.2	14.2	14.2
with income	In general	48	40	40	54.2
	More satisfied	45	37.5	37.5	91.7
	Be satisfied	10	8.3	8.3	100
Monthly	< 5,000	14	11.7	11.7	11.7
family	5,000 - 10,000	39	32.5	32.5	44.2
income	10,000 - 20,000	37	30.8	30.8	75
	> 20,000	30	25	25	100
Impacts on	Mild	45	37.5	37.5	43.3
the quality of	Moderate	51	42.5	42.5	85.8
life of	Heavy	17	14.2	14.2	100
patients	No obvious effect	7	5.8	5.8	5.8
Duration	4 d/ week, or 4 consecutive weeks	63	52.5	52.5	52.5
	$\geq$ 4 d/ week, and $\geq$ 4 consecutive weeks	57	47.5	47.5	100
Effect of the	Obvious effect	32	26.7	26.7	26.7
first	Mediocre effect	54	45	45	71.7
treatment	No obvious effect	34	28.3	28.3	100
Allergen	Yes	84	70	70	70
testing	No	36	30	30	100
Knowledge	Do not understand	19	15.8	15.8	15.8
of AR	Have some understanding of	64	53.3	53.3	69.2
	Better understand	30	25	25	94.2
	Very familiar	7	5.8	5.8	100
Necessity of	Yes	103	85.8	85.8	85.8
drug treatment	No	17	14.2	14.2	100
Concern	Always worry	40	33.3	33.3	33.3
about drug	Occasional worry	58	48.3	48.3	81.7
dependence	Not worried	22	18.3	18.3	100

#### Table 2. CAC of CARAT10-C scale

	Scale mean if	Scale variance	Corrected item -	CAC if item
Item	item deleted	if item deleted	total correlation	deleted
1	1807.3402	138058.866	.448	.791
2	1813.3911	138789.989	.468	.806
3	1813.5503	138305.827	.424	.785
4	1800.8115	137091.767	.529	.795
5	1796.9878	136133.573	.625	.774
6	1794.7605	135922.564	.675	.777
7	1786.9580	139108.232	.583	.782
8	1789.1873	137479.060	.642	.780
9	1783.3660	140242.105	.575	.780
10	1806.0663	137190.329	.582	.817

factors was determined by combining the results of the lithotripsy map and PCA. The eigenvalue, variance contribution rate, and cumulative contribution rate of each component were obtained by PCA. Quantitative data were expressed as percentages (%), and the chi-square ( $\chi^2$ ) test was employed for analysis, with a significance level set at *P* < .05 to indicate statistical significance.

### RESULTS

#### Analysis of general data

In this work, 130 CARAT10-C scales were issued, 120 effective questionnaires were issued, and the effective rate was 92.31%. The level of education may influence whether patients can fully read or comprehend the content of the CARAT10-C

scale. Similarly, the employment status can impact a patient's ability to read the CARAT10-C scale calmly and attentively. Furthermore, knowledge about AR can affect a patient's ability to better understand the academic aspects of the scale. Therefore, the study performed statistical analysis on general clinical data of the patients, considering the potential influence of educational level, employment status, and AR knowledge on the comprehension of the CARAT10-C scale. Table 1 lists the survey of general data of all patients in this work. As can be observed from the table, there were 69 male patients (57.5%) and 51 female patients (42.5%). In terms of permanent residence distribution, 95 patients were permanent residents in urban areas, accounting for 79.2%, much higher than those in urban areas (16/13.3%) and rural areas (9/7.6%). In terms of education level, 77 patients had a bachelor's degree or above, accounting for about 64.2%, which was much higher than those in primary school or below (3/2.5%), middle school (5/4.2%), high school or technical secondary school (13/10.8%), and junior college (22/18.3%). In terms of working status, 96 patients were employed, accounting for 80%, higher than unemployed (22/18.3%) and retired (2/1.7%) patients. In terms of satisfaction with income, 48 patients were generally satisfied (40%) and 45 patients were satisfied (37.5%), both higher than dissatisfied (17/14.2%) and satisfied (10/8.3%) patients. The monthly family income of most patients was between 5,000 - 20,000 RMB (76/63.3%). In terms of the impact of rhinitis symptoms on the quality of life of patients, most of the patients were mild (37.5%) and severe (42.5%); severe patients accounted for 14.2%, and only 5.8% had no significant impact. In terms of the effect of the first treatment, 86 patients had effective treatment (71.7%), while only 34 patients had no obvious effect (28.3%). In terms of allergen testing, 70% of patients had been tested for allergens. In terms of patients' knowledge of AR, most of the patients had a certain understanding of the knowledge, but only 15.8% of the patients did not understand the relevant knowledge. In addition, 85.8% of patients with the disease had to be treated with drugs. However, most patients were worried about developing drug dependence.

#### Reliability evaluation results of the scale

Table 2 shows the CAC evaluation results of each item in the CARAT10-C scale in this work. The results suggested that the CAC of items 1 to 10 were all above 0.7. After further internal consistency analysis, the results told us that the CAC of the CARAT10-C scale was 0.806, and the result was greater than 0.8, indicating the high reliability of the CARAT10-C scale.

#### Validity evaluation results of the scale

(1) Exploratory factor analysis applied judgment. Content validity refers to the suitability and logical consistency between items and the measured variables, while structural validity pertains to the ability of the items to measure the intended variables. Empirical analysis typically focuses on examining structural validity; hence, the study can employ exploratory factor analysis to demonstrate the structural validity of the CARAT10-C scale. However, it is crucial to first determine if the CARAT10-C scale is amenable to exploratory factor analysis. A KMO value above 0.7 and significant differences in Bartlett's sphericity test ( $\chi^2$ ) indicate that the CARAT10 scale is suitable for exploratory factor analysis. In this work, KMO sampling moderation measurements and Bartlett's spherical test were utilized to evaluate whether the CARAT10-C scale was suitable for exploratory factor analysis. Among them, the KMO sampling moderate measurement value was 0.803, which was greater than 0.7. Bartlett's spherical test had an r value of 486.580, with *P* < .001. The results suggested that the CARAT10-C scale was suitable for exploratory factor analysis.

(2) Exploratory factor analysis. PCA extraction was utilized to extract common factors in the CARAT10-C scale, as shown in Table 3. The results of initial eigenvalues greater than 1 were 3.851 (component 1) and 2.193 (component 2), respectively. In addition, the CVCR of components 1 and 2 was 60.436%. In general, when the total variance was above 40%, the factors extracted by PCA have a certain significance, and 60.436% was obviously greater than 40%. The results suggested that the above two principal components can fully explain the content expressed by the corresponding items.

The scree plot, in the analysis process, defaults to considering the number of eigenvalues greater than 1 as the criterion for factor extraction. Generally, the factor numbers corresponding to the point where the line on the scree plot changes from steep to flat were considered as the extraction criterion. Figure 2 displays the scree plot for the CARAT10-C scale structure, where the horizontal axis represents the number of indicators, and the vertical axis represents the eigenvalues. From the plot, it is evident that when extracting components 1 and 2, the eigenvalues were both greater than 1, indicating a noticeable change and a significant contribution to explaining the original variables. On the other hand, for components 3 and 10, the eigenvalues were relatively small, all below 1, suggesting a relatively minor contribution to the original variables. Hence, it can be inferred that extracting the first two components (2) significantly affected the original variables.

Figure 3 shows the results of the common factor variance ratio for 10 items in the CTARAT10-C scale. From the figure, it can clearly be observed that except for the 10<sup>th</sup> item, the variance ratio of common factors of the 1<sup>st</sup> to 9<sup>th</sup> items were all above 0.5, which indicated that most of the information in the CTARAT10-C scale can be reflected.

(3) Component matrix of the CTARAT10-C scale. In the factor matrix, the absolute values of factor loading coefficients closer to 1 indicate a closer relationship between the variable and the common factor. Typically, a factor loading coefficient greater than 0.5 is considered to confirm a significant and substantial relationship between the variable and the factor. Table 4 shows the component matrix of the CTARAT10-C scale. It can be observed from the table that component 1 (asthma) of item 1, item 3, item 4, item 6, item 7, item 8, and item 9 was above 0.5, and component 2 (AR) of item 1, item 2, item 3, and item 4 was above 0.5.

#### Table 3. They explained the total variance

				Extraction sums of squared		Rotation sums of squared			
	1	nitial eiger	ivalues	loadings			loadings		
		% of	Cumulative		% of	Cumulative		% of	Cumulative
Component	Total	Variance	%	Total	Variance	%	Total	Variance	%
1	3.851	38.508	38.508	3.851	38.508	38.508	3.418	34.178	34.178
2	2.193	21.928	60.436	2.193	21.928	60.436	2.626	26.258	60.436
3	0.901	9.009	69.445						
4	0.680	6.804	79.445						
5	0.556	5.561	81.810						
6	0.500	5.003	86.813						
7	0.435	4.348	91.161						
8	0.405	4.052	95.213						
9	0.258	2.581	97.794						
10	0.221	4.052	95.213						

Note: Extraction Method: PCA.





Figure 3. Common factor variance ratio of CTARAT10-C scale.



In the rotated component matrix, the magnitude of coefficients for variables across different factors indicates the loading size of the variable on each factor. A loading result greater than 0.5 suggests that the variable is associated with that particular factor. Table 5 shows the composition matrix of the CTARAT10-C scale after rotation. It can be observed from the figure that each item in the CTARAT10-C scale had an information load of more than 0.5 on either component 1 or 2. Among them, item 10 had the smallest load value on component 1, which was 0.508. Item 6 had the highest load value of factor load, it can be concluded that the information on items 6 to 10 was mainly loaded by component 1, and the information on items 1 to 4 was mainly loaded by component 2. In addition, the analysis showed that the CAC of component 1 was 0.834 and

#### **Table 4.** Component matrix of CTARAT10-C scale

	Component	
Item	1	2
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.514	.566
the past 4 weeks, you have experienced the following on average: (1. Stuffy nose?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.354	.743
the past 4 weeks, you have experienced the following on average: (2. Sternutation?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.573	.561
the past 4 weeks, you have experienced the following on average: (3.		
Rhinocnesmus?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.470	.664
the past 4 weeks, you have experienced the following on average: (4. Rhinorrhea?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.768	239
the past 4 weeks, you have experienced the following on average: (5. Shortness of		
breath/difficulty breathing?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.777	405
the past 4 weeks, you have experienced the following on average: (6. Hearable high-		
pitched breathing sounds/wheezing in the chest?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.735	395
the past 4 weeks, you have experienced the following on average: (7. Chest tightness		
during exercise?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.727	211
the past 4 weeks, you have experienced the following on average: (8. Feeling tired		
and struggling to complete daily activities or household chores?)		
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in	.706	161
the past 4 weeks, you have experienced the following on average: (9. Waking up in		
the night?)		
In the past four weeks, how often have you experienced (10. Increased medication	.386	345
use due to allergic respiratory diseases (asthma, rhinitis, allergies)?)		

Note: Extraction method: PCA. 2 components were extracted.

**Table 5.** Exploratory factor analysis and rotating componentfactor load of CARAT10-C scale

	Component		
Item	1	2	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (1. Stuffy nose?)	.153	.750	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (2. Sternutation?)	076	.819	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (3. Rhinocnesmus?)	.206	.775	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (4. Rhinorrhea?)	.065	.811	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (5. Shortness of breath/difficulty breathing?)	.783	.187	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (6. Hearable high-pitched breathing sounds/wheezing in the chest?)	.874	.049	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (7. Chest tight- ness during exercise?)	.833	.037	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (8. Feeling tired and struggling to complete daily activities or household chores?)	.733	.191	
As a result of your allergic respiratory disease (asthma, rhinitis, and allergies), in the past 4 weeks, you have experienced the following on average: (9. Waking up in the night?)	.689	.223	
In the past four weeks, how often have you experienced (10. Increased medication use due to allergic respiratory diseases (asthma, rhinitis, allergies)?)	.508	099	
CAC	0.834	0.807	

Noe: Extraction method: PCA. Rotation method: Caesar's normal maximum variance method. The rotation converged after 3 iterations.

that of component 2 was 0.807, both above 0.8, indicating that component 1 and component 2 had high reliability.

## DISCUSSION

A literature review shows that the CARAT10 scale has been extensively studied abroad. Furthermore, through continuous research and improvement, the content of many national versions of the CARAT10 scale has become quite refined. The accurate assessment provided by CARAT10 contributes to better diagnosis, treatment planning, and monitoring of allergic rhinitis and asthma.<sup>23,24</sup> However, the application research of the CARAT10 scale is still in the initial stage. Based on this, the CARAT10 scale was sinicized in this study, and Chinese AR patients were taken as research objects to evaluate the reliability and validity of the CARAT10-C scale.

Firstly, it analyzed the reliability results of the CARAT10-C scale obtained in this work. The CAC of the CARAT10-C scale was 0.806, indicating the high reliability of this scale. CAC is the average half-reliability coefficient obtained by all possible item division methods of the scale, which is the most common scale reliability measurement method used in current relevant studies.<sup>25,26</sup> Reliability assessment is also used in CARAT10-C scale testing after translation and cultural debugging in other countries. For example, in 2015, van der Leeuw et al.<sup>27</sup> used Cronbach's alpha coefficient to evaluate the cross-cultural verification of CARAT and came up with a CAC of 0.82, basically consistent with the results of this work. It shows that the CARAT10 scale has high reliability after translation and cultural adjustment.

Then the validity of the CARAT10-C scale was analyzed. validity refers to the degree of validity, that is, the degree of accurate measurement of things tested by detection tools.<sup>28</sup> On the basis of verification, exploratory factors were used in this study to analyze the validity of the CARAT10-C scale. Component 1 (3.851) and component 2 (2.193) with eigenvalue > 1 were extracted by PCA, and CVCR was 60.436%. In addition, the component matrix of the CTARAT10-C scale after rotation showed that the information of items 6 to 10 was mainly loaded by component 1 (asthma), and the information of items 1 to 4 was mainly loaded by component 2 (AR), with loads ranging from 0.508 to 0.874. Fonseca et al.29 also conducted an exploratory factor analysis on the CARAT10 scale after translation and cultural adjustment and showed that the correlation coefficient and different control factors of CARAT10 were in line with prior predictions, ranging from 0.58 to 0.79, and the results were all above 0.5, basically consistent with this work. This work suggested that CARAT10-C had high internal consistency and good concurrent validity, and could be used for group comparison in clinical studies. In addition, studies generally believe that the dominant load of each item in the scale is > 0.4 on its corresponding factor, indicating that the scale has good structural validity.<sup>30</sup> Therefore, the results of this study suggest that the CARAT10-C scale has good structural validity.

Although there are certain cultural and linguistic differences, leading to variations in the understanding of CARAT10-C, it is noteworthy that the translation of the CARAT10-C scale involved participants who were professionals from the same country. Since both the translators and the study participants were focused on patients from the same country, there is consistency in their understanding. This uniformity in comprehension contributes to similar assessment results, indicating that the translated version of the scale is applicable in the context of the country and is well-received.

#### CONCLUSION

To sum up, the reliability and validity of the CARAT10-C scale were verified. The Chinese version of CARAT10 played good reliability and validity in the preliminary evaluation of patients with AR in China, and it had the possibility to become a tool for clinical AR disease control evaluation. However, the sample size of this work was relatively simple and the scope was small, leading to the lack of comprehensiveness of the study. Moreover, the study also lacked longitudinal analysis and dynamic monitoring of patients, so further comprehensive exploration was needed. However, this study provided a certain research basis for the clinical application prospect of the Chinese version of the CARAT10 scale in China. However, further research is needed on the improvement of patient prognosis with this scale.

#### ETHICAL COMPLIANCE

This study was approved by the ethics committee of Shanghai Ninth People's Hospital. Signed written informed consent were obtained from the patients and/or guardians.

#### CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

#### AUTHOR CONTRIBUTIONS

Li-Li Jiang: Conceptualization; Methodology; Writing – Original Draft Preparation. Chen-Jie Xu: Conceptualization; Formal Analysis; Resources. Ying-Chao Zhu: Data Curation; Resources. Shu-Lei Meng: Data Curation; Resources. Hong Ruan: Writing – Review & Editing; Supervision. Li-Li Hou: Writing – Review & Editing; Resources. All authors read and approved the final manuscript. Lili Jiang and Chenjie Xu contributed equally to this work.

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