

Adaptation of the Score for Allergic Rhinitis in the Chinese Population: Psychometric Properties and Diagnostic Accuracy

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Keywords

Allergic rhinitis · Adaptation · Chinese population · Validation · Psychometric testing

Abstract

Background: Allergic rhinitis (AR) is a worldwide health problem with rising prevalence. To enhance the estimation of AR prevalence in epidemiological studies, the Score for AR (SFAR), a screening tool, has been developed and widely used. An 8-item SFAR is a handy, self-administered instrument assessing the information on nasal and eye symptoms, seasonal increase in symptoms, skin test results, and previous AR diagnoses. This study aimed to adapt the SFAR to the Chinese population (CSFAR) and validate it by testing its psychometric properties and diagnostic accuracy. **Methods:** This methodological study involved translation and validation phases. Different batches of participants were recruited for the above purposes. **Results:** In phase 1, the CSFAR obtained satisfactory item (80–100%) and scale

level (97.8%) semantic equivalence, content validity index (96.7%), comprehensibility (100%), cross-language testing ($\kappa = 0.44$ – 0.83 for item-to-item agreement; intraclass correlation coefficient [ICC] = 0.95 , $p < 0.05$ – 0.001). In phase 2, CSFAR showed satisfactory internal consistency ($\alpha = 0.83$), 1-month (ICC = 0.88) and 1-year stability (ICC = 0.85), and construct validity (significant correlation between CSFAR and impairments induced by AR: $r = 0.47$, $p < 0.001$). Based on the receiver-operating characteristic curve, comparing the CSFAR with diagnosis made by specialists, an optimal cutoff value was 6 (sensitivity 81.8% and specificity 80.3%). **Conclusion:** SFAR was translated into a Chinese version, the CSFAR. Satisfactory results were obtained for its equivalence, appropriateness, comprehensibility, and relevance, as well as its reliability and validity. A cutoff value of 6 was recommended to increase the diagnostic accuracy in environments with less pollen. This study provides evidence that the SFAR we adapted for the Chinese population is a valuable tool in AR screening.

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Introduction

Allergic rhinitis (AR), an IgE-mediated immunologic disease, is caused by inflammation of the lining of the nose and characterized by nasal symptoms of rhinorrhea, sneezing, nasal blockage, and itching of the nose [1]. Although AR is not a fatal disease, its bothering symptoms have profound adverse effects on physical, cognitive, psychological, and social health, causing sleep disturbance, detritions in work, and lower school performance, and hence impairing the quality of life of the AR patients [2, 3].

AR is a worldwide health problem with rising prevalence, affecting people of all ages. In 2010, it was estimated that about 20% of the global population, or 500 million people, were affected by AR [1]. It is not only common among Western and developed countries, 150 million people in the Asia-Pacific region were also troubled by this disease [1, 4]. Given the fact that Asia is undergoing rapid economic development and urbanization, the emergence of risk factors associated with modern urbanized living will further increase the prevalence and disease severity of allergic disorders in the next 2 decades [5]. In the past 10 years, the dramatic increase in AR prevalence has created an economic burden in the Asia-Pacific region [6]. The productivity loss due to the presenteeism and absenteeism of employees because of AR are costly [7]. As reported from the *Harvard Business Review*, it is estimated that allergies and sinus problems costed productivity loss of USD 1.8 million annually across a workforce of 25,000 in Boston [8]. People with uncontrolled AR are predisposed to develop a number of comorbidities, too, including asthma, sinusitis, conjunctivitis, obstructive sleep apnea, and middle ear infection [1, 9]. Early identification and intervention can significantly prevent the development of these morbidities subsequent to poorly managed AR in adolescents in later life, and hence minimizing the health care costs and reducing productivity loss in the society.

Epidemiological studies on AR are crucial in providing essential data for informing health care policy, particularly regarding primary health care resource planning tackling this disease [10, 11]. The current golden standard in diagnosing AR by clinical specialists is expensive and limited by the availability of specialists in the areas of concern. Costs of seeking consultations from physicians also pose a barrier for people to manage their AR conditions with medical support. The pervasiveness of AR summons researchers' effort in identifying its prevalence in different populations with a cheaper but reliable way. The In-

ternational Study of Asthma and Allergies in Childhood (ISAAC) was a representative endeavor of this kind. It is a multicountry cross-sectional epidemiological study on asthma, allergic rhinitis, and eczema among school children of 2 specific age groups (6–7 years and 13–14 years) since the 1990s [12]. Although ISAAC had laid a firm foundation in using the non-physician-diagnosed way to assess the prevalence of asthma and allergies, including AR, it mainly focuses on the impact of asthma on children [13]. Results from large epidemiological studies adopting the ISAAC protocol, therefore, cannot pinpoint the AR prevalence among the concerned populations. In addition, the core questionnaire used in the ISAAC studies in assessing AR was based on a “working definition” of 2 simple questions: “Have you ever had a problem with sneezing, or a runny or blocked nose, when you did not have a cold or the flu?” and “Have you ever had allergic rhinitis?” This screening method was easy to administer, but its discriminating power has attracted criticisms as validation with physician-diagnosed AR is lacking. Kim et al. [14] commented that laypersons may not understand the medical terms used in describing AR symptoms in the ISAAC questionnaires. Results from such studies might, therefore, pose a threat of overestimating the real prevalence of AR [1].

A better screening tool, the Score for AR (SFAR), in terms of sensitivity, specificity, and predictive values [15], was developed by Annesi-Maesano and her research team [16]. It is a handy, self-administered instrument with only 8 items eliciting information on nasal symptoms, eye symptoms, seasonal increase in symptoms, skin test results, and previous AR diagnoses. Each item is well justified by the literature with evidence of likelihood ratios in predicting the diagnosis of AR (Table 1) [16–22]. It has been used to assess the prevalence of AR mainly in the Western countries [15, 23, 24] and partly in Asia [25, 26]. The details of SFAR including items and scoring methods can be found elsewhere [16]. For an epidemiological study of AR in Chinese populations, the process of adaptation is essential. This study aims to translate the SFAR into a Chinese version (CSFAR) and validate this translated version in the Chinese population by testing its psychometric properties and diagnostic accuracy.

Methods

This study had 2 phases: (1) the translation of SFAR, and (2) testing of psychometric properties and diagnostic accuracy. Figure 1 illustrates the entire study flow.

Table 1. The positive and negative likelihood ratios of the SFAR items in the diagnosis of allergic rhinitis

Item label	Statement of the items	Category	Positive likelihood ratio	Negative likelihood ratio	References
E1	In the past 12 months, have you had a problem apart from cold or flu with:	Assessment of nasal symptoms	1.33–1.38	0.14–0.65	Kilpeläinen et al. [20], 2001 Annesi-Maesano et al. [16], 2002
E1a	Sneezing				
E1b	Runny nose				
E1c	Blocked nose				
E2	In the past 12 months, has this nose problem been accompanied by itchy-watery eyes?	Assessment of rhino-conjunctivitis	1.33–2.49	0.50–0.51	Charpin et al. [17], 1996 Annesi-Maesano et al. [16], 2002
E3	In which of the past 12 months (or in which season) did this nose problem occur?	Assessment of period with the symptoms (perennial or seasonal or both)	1.69	0.70	Annesi-Maesano et al. [16], 2002
E3a	Perennial		1.39	0.78	Annesi-Maesano et al. [16], 2002
E3b	Pollen season		1.59–3.33	0.52–0.70	Eriksson [18], 1990 Charpin et al. [17], 1996 Annesi-Maesano et al. [16], 2002
E4	What trigger factors provide or increase your nose problem?	Assessment of trigger factors	3.34	0.39	Annesi-Maesano et al. [16], 2002
E4a	House dust		1.21–1.76	0.49–0.65	Lindberg and Malm [22], 1993 Charpin et al. [17], 1996
E4b	House dust mites		3.34	0.39	Annesi-Maesano et al. [16], 2002
E4c	Pollens		2.52–6.69	0.15–0.49	Kilpeläinen et al. [20], 2001 Charpin et al. [17], 1996
E4d	Animal (cat, dogs...)		4.21–6.69	0.15–0.81	Annesi-Maesano et al. [16], 2002 Kilpeläinen et al. [20], 2001
E4e	Others (please specify)				
E5	Do you think to be allergic?	Assessment of perceived allergic status	3.12	0.33	Annesi-Maesano et al. [16], 2002
E6	Have you already been tested for allergy (SPT, IgE)?	Assessment of self allergic history	3.47	0.56	Annesi-Maesano et al. [16], 2002
E7	Has a doctor already diagnosed that you suffer/suffered from asthma, eczema, or allergic rhinitis?	Assessment of family allergic history	1.94–2.64	0.13–0.80	Kilpeläinen et al. [20], 2001 Annesi-Maesano et al. [16], 2002 Kauppi et al. [19], 1998
E8	Is any member of your family suffering from asthma, eczema, or allergic rhinitis? If YES: Who and what disease?		3.41	0.70	Annesi-Maesano et al. [16], 2002

SPT, skin prick test.

Phase 1: Translation of the SFAR
Translation and Back-Translation
The SFAR was translated from English (original source language; SL) into Chinese (target language; TL) using Brislin's [27] model of forward and backward translation by 2 independent translators. The TL version was then reviewed by a Chinese monolingual reviewer who was a layperson and blinded to the SL version of SFAR for any incomprehensible or ambiguous wordings. The research team then revised those inappropriate wordings until the issues were resolved. The back-translated version (BT; performed by a nursing academic) was compared with the SL version to determine the linguistic congruence and cultural relevancy by a bilingual linguistic expert (a PhD graduate in the relevant field). The translation incongruences and difficulties encountered were discussed. This process of Brislin's model of translation was repeated until a maximum agreement between the SL and BT was obtained.

Semantic Equivalence and Content Validity
This TL version was further reviewed by 6 health care professionals (including physicians, nurses, and academic experts) for semantic equivalence and content validity [28, 29]. The semantic equivalence was generated from rating on a 4-point Likert scale from 1 to 4, representing "not appropriate" to "most appropriate," respectively. The experts were advised to examine the linguistic and cultural equivalence of the translation, and any item rated as inappropriate by >20% of respondents was revised.
The relevancy of the content of the CSFAR was examined by another panel of 6 experts, including physicians, nurses, and academic experts, on a 4-point scale (i.e., 1 = not relevant; 2 = somewhat relevant; 3 = quite relevant; and 4 = highly relevant). Written comments were requested from responses with a rating ≤2. The content validity index (CVI) was calculated with the number of experts giving a rating of 3 or 4 divided by the total number of experts (indicating the proportion of responses in agreement with relevance). A good content validity is indicated by CVI >0.80 [30].

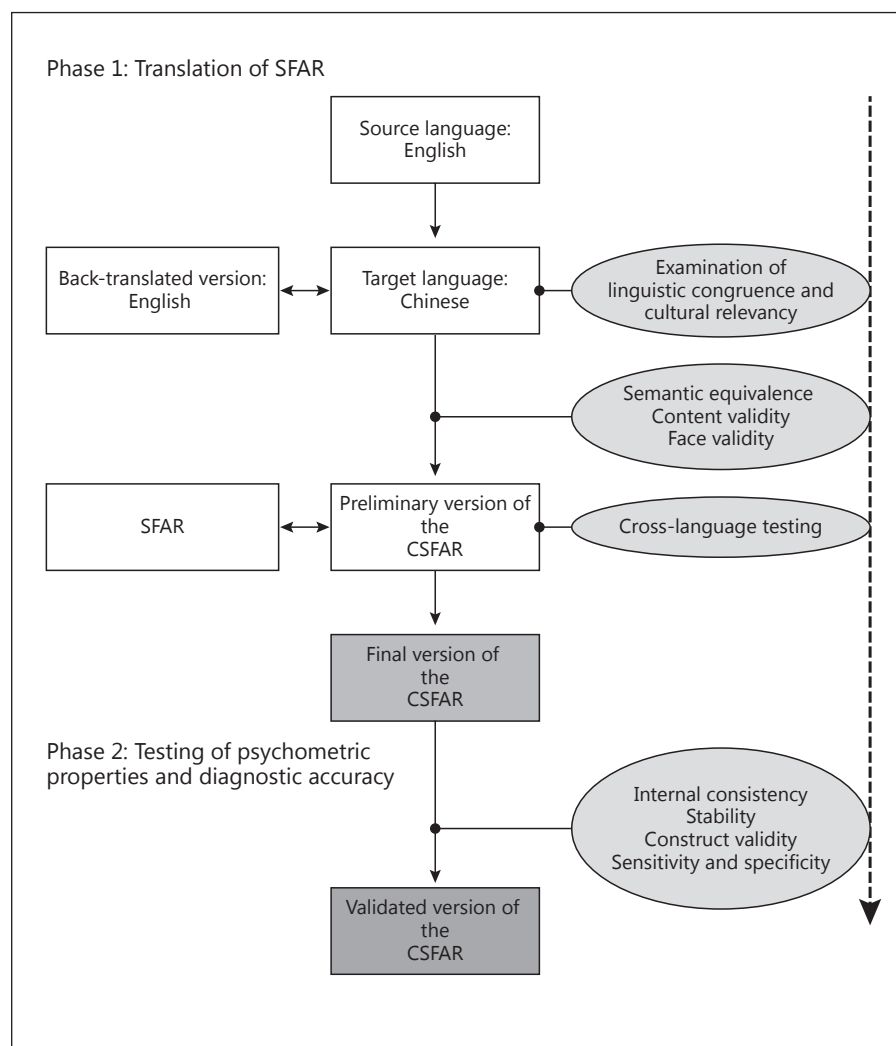


Fig. 1. Flow diagram for the process of translation and validation.

Face Validity

In order to ensure the feasibility of the TL version as a self-administered instrument, the comprehensibility of the items should be assessed through the lowest-educated but affected target population (i.e., children). Therefore, a purposive sample of 20 secondary school students who were about 12 years old was invited to evaluate the TL version for assuring the expression of the items with understandable words and style. The participants inspected, reviewed, commented, and rephrased each item to attain comprehensibility throughout the entire instrument (rating on a yes/no nominal scale) [31]. The participants also revised the items using the suggested wordings and style if necessary [30, 31]. A trained research assistant conducted each individual interview within 20 min. After these processes, the preliminary version of the CSFAR was developed.

Cross-Language Testing

Cross-language testing (or translation adequacy testing) [28], the most stringent method for establishing the equivalence of translation [32], was performed on CSFAR and SFAR. A convenience

sample of 100 undergraduate nursing students was recruited from a local university in Hong Kong for this purpose. Nursing students were chosen because of their health care knowledge and educational level that warranted the comprehension and interpretation of both Chinese and English items of SFAR. They should be able to comprehend those English medical jargons used in the original SFAR (such as eczema) that laypersons usually fail to understand.

The participants were invited to answer the SFAR first. Each participant was indexed with an 8-number code (generated from the student identity number and mobile phone number) for internal matching purpose as well as ensuring their anonymity. The participants were invited to answer the CSFAR 2 weeks later. Item-to-item agreement between the Chinese and the English version was analyzed using Cohen κ statistics. The equivalence between both versions was established by comparing the scores of the SFAR with that of the CSFAR obtained from the same student 2 weeks later. An intraclass correlation coefficient (ICC) >0.75 indicates good equivalence [30].

Table 2. Translation errors or difficulties encountered

Source language (SL)	Back-translation version (BT)	Comments
1 In the past 12 months, have you had a problem apart from cold or flu with (please tick appropriate cases[s]): Sneezing Runny nose Blocked nose If YES (at least one nose problem)	In the past 12 months, do you have the following problems other than cold or flu? (Please put a "✓" in a suitable place) Sneezing Runny nose Stuffy nose If you have at least one of the nasal problem(s)	There are two noticeable differences between SL and BT: SL uses present perfect tense, which implies that the problem(s), if any, were occasional; BT uses simple present tense, which implies regularity of the ailment; given the specified time frame in the past in BT, the use of simple present tense is a mistake and it causes confusion – – SL is an awkward expression and it sounds more serious than BT The meaning is not entirely clear; BT is clearer, but the parentheses are redundant
2 In the past 12 months, has this nose problem been accompanied by itchy-watery eyes?	In the past 12 months, do you have any itchy or tearing eyes accompanying with the nasal problem(s)	BT uses simple present tense, which highlights regularity; the emphasis in SL is on "this nose problem" while that in BT is on "any itchy or tearing eyes"; in SL, the nose problem is singular, while that in BT can be plural; SL refers to only one nasal problem, while BT refers to possibly more than one
3 In which of the past 12 months (or in which season) did this nose problem occur? (or alternatively)	In the past 12 months, in which month (or in what season) you have your nasal problem(s)? (or you can select the following)	In SL, the nose problem is singular while it is possibly plural in the BT; the use of simple present tense in BT, together with the stative verb "have," implies regularity and continuity of the ailment, while the use of simple past tense in SL, together with the nonstative verb "occur," does not carry that implication –
4 What trigger factors provoke or increase your nose problem? House dust House dust mites Pollens Animal (cat, dogs...) Others (please specify)	What factors cause or aggravate your nasal problems? Household dust Household dust mites Pollens Animals (cats, dogs...) Other (please indicate)	SL refers to "trigger factors," which seems more directly related to the nasal problems than "factors" in BT; there is only one problem being referred to in SL, but there are more than one in BT as indicated by the plural ending of "problems" SL associates the dust with the structure of a house, while BT implies that the dust comes from the daily activities within a house – – – –
5 Do you think to be allergic?	Do you think you have allergy?	SL is incomprehensible due to its problematic structure and unclear focus; BT is much clearer
6 Have you already been tested for allergy (SPT, IgE)? If YES: What was the result?	Have you taken any allergy testing (SPT, IgE)? If "yes," what is the results:	The use of "already" in SL implies that the test for allergy is expected; the emphasis is on whether the test has taken place before the time of speaking; there is no such implication that it should sooner or later be taken in the BT SL uses simple past tense, which refers to some result that appeared in the past; BT uses simple present tense, which refers to some unchanging results; the use of the singular verb "is" with the plural noun "results" causes confusion
7 Has a doctor already diagnosed that you suffer/suffered from asthma, eczema, or allergic rhinitis?	Has a doctor diagnosed that you are suffering/have suffered from asthma, eczema, or allergic rhinitis?	SL uses simple present tense in "suffer" and simple past tense in "suffered"; the question refers to either an ongoing or a past condition; in BT, the use of present continuous tense in "are suffering" implies a temporary condition, and the use of present perfect tense implies a condition that occurred at an unspecified time in the past
8 Is any member of your family suffering from asthma, eczema, or allergic rhinitis? If YES: Who and what disease? (please tick appropriate cases[s]): Asthma; eczema; allergic rhinitis	Do you have any family member(s) suffered from asthma, eczema, or allergic rhinitis? If "yes", who is he/she and what kind of diseases he/she has? Asthma; eczema; allergic rhinitis	The use of present continuous tense in SL indicates that the conditions, if any, are ongoing; the use of simple past tense in "suffered" is a grammatical mistake, but it might also give the sense that the diseases, if any, were past conditions – –
SPT, skin prick test.		

Phase 2: Testing of Psychometric Properties and Diagnostic Accuracy

Establishing Psychometric Properties

This phase employed a cross-sectional and correlation design with repeated measures. Apart from the content and face validity examined in phase 1, the psychometric properties of the CSFAR were further evaluated through internal consistency, stability (including 1-month and 1-year test-retest reliability), and construct validity.

Reliability

Internal consistency and stability were examined by Cronbach α statistics (score ≥ 0.75 indicating a satisfactory result) and ICC (score ≥ 0.75 indicating a satisfactory result), respectively [30]. Participants were students ($n = 175$) in a local university (batch 1). They were invited to respond to a self-administered questionnaire consisting of questions on demographics and the CSFAR (T1). To establish the stability, all participants were invited to respond to the questionnaire 1-month (T2) and 1-year (T3) later. These scores were then compared with the initial score of the CSFAR (T1) to compute the respective stability statistics.

Validity

Hypothesis testing was used to test the construct validity of the CSFAR by examining the relationships of the assumptions of the constructs as measured by a valid instrument with another theoretically related construct. The literature indicates that AR disturbs one's living with different extent [2, 3]. The theoretical hypothesis proposed, therefore, is that the score of CSFAR is related to the degree of impairment in living measured by a visual analog scale (VAS). A significant correlation between CSFAR and disturbance VAS provided evidence for the construct validation. Another batch of participants (batch 2) from health check campaigns and a general health clinic was recruited for this validity test. The inclusion criteria were (1) age ≥ 12 years and (2) ability to read Chinese. Eligible participants were invited to complete the questionnaire including demographics, the CSFAR, and disturbance VAS. This batch of participants would also be involved in testing the diagnostic accuracy of CSFAR as explained below.

Testing Diagnostic Accuracy

Diagnostic accuracy was established by sensitivity and specificity analyses. The sensitivity of CSFAR was represented by the proportion of positively screened AR cases who were correctly identified through medical diagnosis by a specialist. The specificity was represented by the proportion of negatively screened AR cases who were correctly identified by a specialist. An optimal cutoff value of the CSFAR was determined by the receiver-operating characteristic (ROC) curve, which allows the comparison of a range of CSFAR scores with the respective sensitivity and specificity. The sensitivity and specificity values are equally important and should reach >0.70 for a valid screening tool [33]. Based on an ROC curve plotted with sensitivity versus $1 - \text{specificity}$, the area under curve (AUC) was computed to indicate the discriminative properties of the CSFAR cutoff value [30].

The completed questionnaires from those eligible batch 2 participants were sealed. Each eligible participant was then examined by an otorhinolaryngologist or family medicine specialist according to the criteria of the International Classification of Diseases for AR. The proportion of AR diagnosed using the CSFAR was then com-

pared with that diagnosed by the specialists. Considering the existing prevalence of AR (i.e., about 35–42%) [10, 11] in communities and keeping the standard error of estimation (θ) <0.03 , an estimated minimum sample of 200 was sufficient to compute the score with optimal sensitivity and specificity through the ROC curve [34].

Ethical Considerations

Ethical approval was sought from the Ethical Committee of the University Research Centre, the Open University of Hong Kong. The research team reproduced and translated the SFAR with the kind permission of the original SFAR developers [16]. Informed consent was obtained from the study participant by appropriate methods (verbal consent: secondary school student and batch 1 participants; written consent: batch 2 participants). All participants' identities were kept anonymous, and all the data generated in this study were kept confidential for research purposes only. Privacy was provided during medical consultations.

Results

Phase 1 Results

The SFAR was translated from English into Chinese and the semantic equivalence between SL and BT versions was maintained. Table 2 documents the comments on the preliminary TL version. Based on these comments from the 6 bilingual health care professionals, the item (80–100%) and scale level (97.8%) semantic equivalences were both satisfactory. According to the comments of another 6 experts (i.e., 2 physicians, 2 nurses, and 2 academics employed in health care), the CVI was 96.7%, indicating a satisfactory content validity. For face validation, $>80\%$ participants (i.e., 12-year-old Chinese children) found it difficult to comprehend the Chinese term 'sneezing' in item C1. After inserting a self-explanatory picture to increase the comprehensibility of this item (refer to C1a, Table 3), the entire TL version of SFAR had then obtained 100% comprehensibility. For cross-language testing, a total of 102 nursing students responded to both English and Chinese versions of SFAR during a 2-week interval. Table 3 presents the agreement between both SFAR versions. In general, κ ranged from 0.44 to 0.83 ($p < 0.001$), and the ICC was 0.945 (95% confident interval [CI] = 0.919–0.962, $p < 0.001$). Some preliminary results and the items of CSFAR were presented in a local primary health care conference [35].

Phase 2 Results

Based on the results of 175 participants (batch 1), Cronbach α was 0.83, indicating a satisfactory internal consistency. The CSFAR was readministered to that group of students in 1-month (T2) and 1-year (T3) inter-

Table 3. Agreement of the English and the Chinese version of SFAR ($n = 102$)

		Kappa measure of agreement (κ value, p)	Percentage agreement
C1	In the past 12 months, have you had a problem apart from cold or flu with (please tick appropriate cases[s]): 除傷風或感冒外，在過去十二個月內，你曾否有以下問題？（請在適當處打»✓«）		
C1a	Sneezing 打噴嚏 	κ 0.48 $p < 0.001$	96.1%
C1b	Runny nose 流鼻水	κ 0.63 $p < 0.001$	93.1%
C1c	Blocked nose 鼻塞	κ 0.65 $p < 0.001$	88.2%
C2	In the past 12 months, has this nose problem been accompanied by itchy-watery eyes? 在過去十二個月內，以上鼻內的問題出現時，有否同時出現眼睛痕癢或多眼水？	κ 0.66 $p < 0.001$	83.3%
C3	In which of the past 12 months (or in which season) did this nose problem occur? 在過去十二個月內，你在哪個月內（或哪季）出現以上鼻內的問題？（注：可填多項）	–	–
C4	What trigger factors provide or increase your nose problem? 哪些因素引致或加重你以上鼻內的問題？	–	–
C4a	House dust 家居塵埃	κ 0.44 $p < 0.001$	83.3%
C4b	House dust mites 家居塵蟎	κ 0.66 $p < 0.001$	83.3%
C4c	Pollens 花粉	κ 0.44 $p < 0.001$	83.3%
C4d	Animal (cat, dogs...) 動物（貓、狗等）	κ 0.45 $p < 0.001$	86.3%
C4e	Others (please specify) 其他（請註明）		
C5	Do you think to be allergic? 你認為你有任何過敏嗎？	κ 0.84 $p < 0.001$	92.2%
C6	Have you already been tested for allergy (SPT, IgE)? 你曾進行過敏測試嗎（皮膚點刺過敏測試[SPT]，IgE過敏血液測試）？	κ 0.56 $p < 0.001$	97.1%
C6a	If YES: What was the result? 如「有」，測試的結果是：	–	–
C7	Has a doctor already diagnosed that you suffer-suffered from asthma, eczema, or allergic rhinitis? 醫生曾診斷你現時／過去患有哮喘、濕疹或過敏性鼻炎嗎？	κ 0.72 $p < 0.001$	90.2%
C8	Is any member of your family suffering from asthma, eczema, or allergic rhinitis? 你的家庭成員有否患有哮喘、濕疹或過敏性鼻炎？	κ 0.83 $p < 0.001$	92.2%

SPT, skin prick test.

vals. There were 87 participants, and 86 participants responded to the CSFAR in T2 and T3, respectively. Comparing these CSFAR scores to those at T1, the ICC were 0.88 and 0.85 in T2 and T3 ($p < 0.001$), respectively, i.e., a good test-retest reliability.

Results from the community samples of 247 participants (batch 2), whose age ranged from 16 to 87 (mean age = 38.14, SD = 14.50), showed a significant correlation

between the CSFAR and AR-induced impairments in living ($r = 0.47$, $p < 0.001$). This result supported the hypothesis testing and hence provided evidence for the construct validation. Table 4 presents the results of psychometric properties of the CSFAR with information of the previous study by Annesi-Maesano et al. [16].

This sample of batch 2 consisted of 74 participants recruited from health check campaigns (mean age = 47.95,

Table 4. Psychometric properties and diagnostic accuracy of the CSFAR with previously published results

	The current study			Previous study ¹ results
	methods	statistic methods	results	
<i>Reliability</i> ²				
1 Internal consistency	Cronbach method	Cronbach α statistic	α = 0.83	α = 0.79
2 Stability	1-month test-retest reliability	Intraclass correlation coefficient	$r = 0.88, p < 0.001$ (95% CI = 0.82–0.92)	–
	1-year test-retest reliability	Intraclass correlation coefficient	$r = 0.85, p < 0.001$ (95% CI = 0.78–0.90)	
<i>Validity</i>				
1 Face validity	Review by samples with the least education level ³	Frequency and percentage	100% comprehensible	–
2 Content validity	Review by 6 experts	Content validity index	CVI = 0.90	Satisfactory
3 Construct validity ⁴	Hypothesis testing	Correlation with CSFAR and disturbance of AR in living (assessed by VAS)	$r = 0.47, p < 0.001$	–
<i>Diagnostic accuracy</i> ⁴				
1 Sensitivity	Compared the score of SFAR against the physician’s diagnosis	Calculated through a standard cross tabulation table and ROC curve	Cutoff value of 6 (88% by specialists, 80% by physician)	Cutoff value of 7 (74%)
2 Specificity	Compared the score of SFAR against the physician’s diagnosis		Cutoff value of 6 (81% by specialists, 80% by physician)	Cutoff value of 7 (83%)

¹ Previous study was based on Annesi-Maesano et al. [16] (2002).

² The results are calculated based on 175 nursing students, where 87 participants responded to 1-month retest and 86 participants responded to 1-year retest.

³ The result is based on 20 children aged 12 years.

⁴ The result is based on 247 participants participating in a health check campaign ($n = 74$) or attending a general health clinic ($n = 173$). Allergic rhinitis is diagnosed by either specialists or physicians as a gold standard.

SD = 18.38 years) and 173 from a general health clinic (mean age = 33.85, SD = 9.75 years). Regarding the health check campaigns, the otorhinolaryngologists diagnosed 42 participants (56%) with AR (served as gold standard). The sensitivity and specificity for the cutoff values of the CSFAR in relation to the gold standard were calculated and plotted in ROC curves (Table 5). The optimal cutoff value of the CSFAR was 6 (sensitivity = 88.1%, specificity = 81.3%). The AUC was 0.833 (95% CI = 0.726–0.940). Regarding a total of 173 samples from the general health clinic, the family medicine specialist diagnosed 134 participants (77.4%) with AR. The optimal cutoff value of the CSFAR was also 6 (sensitivity = 79.9%, specificity = 79.5%). The AUC was 0.878 (95% CI = 0.814–0.942). By interpreting the results from a total of 247 samples, the cutoff value of 6 provided an overall satisfactory sensitivity (81.8%) and specificity (80.3%), with a satisfactory AUC of 0.855 (95% CI = 0.795–0.915). The instruments

of both the English and Chinese SFAR are attached in online supplementary Table S1 and S2 (for all online suppl. material, see www.karger.com/doi/10.1159/000477727).

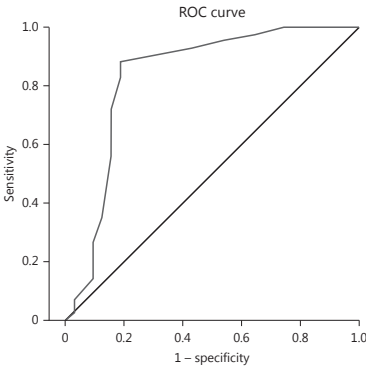
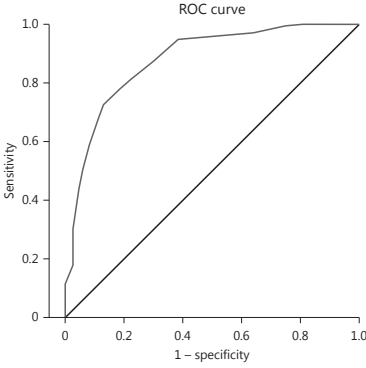
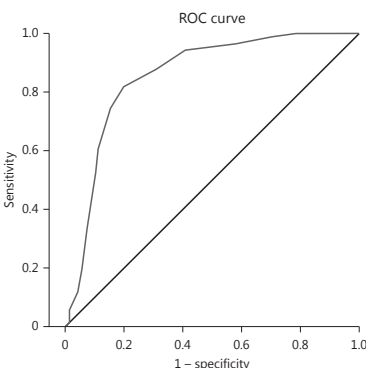
Discussion

Translation and Validation Process

In this study, the applicability of the CSFAR had been confirmed with several stringent translation and validation processes using appropriate methods and participants [30, 36].

Firstly, participants with diverse backgrounds were involved in the different stages of the translation and validation processes of the CSFAR. Originally, the SFAR was developed for use in diverse populations [16]. It is important, therefore, for the CSFAR to be applicable in respondents of different age ranges and educational back-

Table 5. Sensitivity, specificity, sum score, and area under the receiver operating characteristic (ROC) curve (AUC) for the Chinese score for allergic rhinitis (CSFAR) ($n = 247$)

AR is diagnosed by specialists ($n = 74$)				AUC (diagonal segments are produced by ties)
CSFAR score	sensitivity	specificity	sum score	
≤1	1.000	0.250	1.250	 AUC = 0.833 (95% CI = 0.726–0.940)
≤2	0.976	0.344	1.320	
≤3	0.952	0.469	1.421	
≤4	0.929	0.563	1.491	
≤5	0.905	0.688	1.592	
≤6	0.881	0.813	1.693	
≤7	0.833	0.813	1.646	
≤8	0.714	0.844	1.558	
≤9	0.571	0.844	1.415	
≤10	0.357	0.875	1.232	
≤11	0.262	0.906	1.168	
≤12	0.143	0.906	1.049	
≤13	0.071	0.969	1.040	
≤14	0.024	0.969	0.993	
≤15	0.000	1.000	1.000	
≤16	0.000	1.000	1.000	
AR is diagnosed by physicians ($n = 173$)				AUC (diagonal segments are produced by ties)
CSFAR score	sensitivity	specificity	sum score	
≤1	1.000	0.179	1.179	 AUC = 0.878 (95% CI = 0.814–0.942)
≤2	0.993	0.256	1.249	
≤3	0.970	0.359	1.329	
≤4	0.948	0.615	1.563	
≤5	0.858	0.718	1.576	
≤6	0.799	0.795	1.593	
≤7	0.724	0.872	1.596	
≤8	0.575	0.923	1.498	
≤9	0.478	0.949	1.426	
≤10	0.299	0.974	1.273	
≤11	0.179	0.974	1.153	
≤12	0.112	1.000	1.112	
≤13	0.052	1.000	1.052	
≤14	0.015	1.000	1.015	
≤15	0.000	1.000	1.000	
≤16	0.000	1.000	1.000	
AR is diagnosed by either specialists or physicians ($n = 247$)				AUC (diagonal segments are produced by ties)
CSFAR score	sensitivity	specificity	sum score	
≤1	1.000	0.211	1.211	 AUC = 0.855 (95% CI = 0.795–0.915)
≤2	0.989	0.296	1.284	
≤3	0.966	0.408	1.374	
≤4	0.943	0.592	1.535	
≤5	0.869	0.704	1.574	
≤6	0.818	0.803	1.621	
≤7	0.750	0.845	1.595	
≤8	0.608	0.887	1.495	
≤9	0.500	0.901	1.401	
≤10	0.313	0.930	1.242	
≤11	0.199	0.944	1.143	
≤12	0.119	0.958	1.077	
≤13	0.057	0.986	1.043	
≤14	0.017	0.986	1.003	
≤15	0.000	1.000	1.000	
≤16	0.000	1.000	1.000	

grounds. Results in this study revealed that the CSFAR was comprehensible not only towards Chinese adults but also preteen children. This is crucial for the CSFAR to be a valid self-administered tool in population-based studies.

Secondly, the use of cross-language testing was recognized as the most stringent method to establish semantic translation equivalence [32]. In this study, we had strategically employed bilingual nursing students in the equivalence testing to decontextualize the medical jargon terms used in the SFAR into words with equal semantic equivalence. The results of the κ statistics and ICC demonstrated that the Chinese and English versions of SFAR were semantically equivalent. This supports future CSFAR use in cross-cultural epidemiological studies.

Thirdly, the stability of the CSFAR was tested by 1-month and 1-year test-retest reliability. Consideration of the lapsing period between both testing time points should rest on the nature of the constructs to be measured and the ways of the statement items being formulated in the tool [30, 36]. Questionnaires or screening tools on abstract concepts (e.g., perception or mood) may well be tested for their reliability within 2 weeks' time of a retesting period [31]. In SFAR, however, people are required to respond to items eliciting their personal experience of AR symptoms, which are often solid and observable. Respondents can identify the particularly personal experience stated in the items in the SFAR with minimal ambiguity. Actually, several SFAR items even request the respondents to recall their experience of nose problems in the past 12 months [16]. A longer retesting period was, therefore, selected in this study, and the results of the 1-month and 1-year test-retest statistics reflected a very satisfactory stability of the CSFAR.

Lastly, in order to identify the optimal cutoff value of CSFAR, we had incorporated the commonly used diagnostic criteria for comparison in the determination process. AR can be diagnosed by family medicine specialist or otorhinolaryngologist. In our study, we had included data from respondents diagnosed by these 2 groups of specialists. Stand-alone and grouped analyses of sensitivity, specificity, as well as the AUC were all performed and presented. The results were all comparable and supported the new cutoff value of 6/16 (i.e., a score >6 indicates AR).

Change in the Cutoff Value

The cutoff value of 7 (out of a total score of 16) in the SFAR has been adopted in many AR prevalence studies since the development of the scale [16, 23, 25, 37, 38]. However, the current study repeatedly examined the op-

timal cutoff value in 2 different occasions (AR diagnosed by a family medicine specialist and otorhinolaryngologist) and obtained consistent results, which was different from the original one. Therefore, the research team revisited the original scoring method proposed by the SFAR developers. The problem may be the item concerning nose problems occurring during the pollen season. According to the ecological analyses of the ISAAC study [39], exposure to allergenic pollen may not increase the risk of people acquiring respiratory allergic symptoms outside Europe and USA [40]. Hong Kong is a city where many urban areas are full of densely packed high-rise buildings with minimal surrounding plantations. A local study of skin prick test results among 977 AR patients indicated that pollen was the least prevalent causative allergen (4%) identified [41]. This eminent environmental characteristic of Hong Kong renders the results of those European studies, which were often conducted in areas with high pollen count, incomparable to ours [1, 42]. Indeed, during the "pollen season," e.g., spring time in Hong Kong (usually from April to June), the amount of pollen in the environment may not be sufficient to trigger people's AR symptoms. Similar arguments of having 6 as the cutoff value in the SFAR were also discussed in the study by Piau et al. [15]. The relationship between environmental pollen counts and AR symptoms in Hong Kong might warrant further ecological investigations; results of the current study, nevertheless, do augment the discussions on the adoption of different cutoff scores for future epidemiological studies adopting the SFAR among different geographical populations.

Limitations and Recommendations

Despite the satisfactory psychometric testing and diagnostic accuracy results, the high attrition rates in the reliability testing were one of the limitations in this study. Of the 175 university students recruited, only about 50% responded to the subsequent 1-month and 1-year retest. This might be induced by the use of a relatively long test-retest period. Such high attrition rates might pose the risk of overestimating the test-retest reliability coefficients [43]. Moreover, the diagnosis of AR was solely based on the determination of medical specialists without supplementary laboratory investigations such as the skin prick or IgE blood tests. Further studies are warranted to include some relevant laboratory tests to increase diagnostic accuracy.

To conclude, SFAR was translated and validated to a Chinese version, the CSFAR. This methodological study adopted appropriate and stringent procedures to ensure

maximal equivalence, appropriateness, comprehensibility, and relevance during the translation processes. The psychometric properties of this CSFAR were comprehensively examined through internal consistency, 1-month and 1-year stability, and construct validation with satisfactory results. In addition, a more optimal cutoff value was recommended to increase its diagnostic accuracy for application in environments with less pollen. This study provides evidence that the SFAR we adapted for the Chinese population is a valuable tool in AR screening.

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Table S1. Standardized questionnaire for SFAR assessment

1. In the past 12 months, have you had a problem apart from cold or flu with (please tick appropriate cases(s)):

Sneezing	No ☐	Yes ☐
Runny nose	No ☐	Yes ☐
Blocked nose	No ☐	Yes ☐

If YES (at least one nose problem);

2. In the past 12 months, has this nose problem been accompanied by itchy-watery eyes?

No ☐ Yes ☐

3. In which of the past 12 months (or in which season) did this nose problem occur?

Jan	☐	Feb	☐	Mar	☐	Apr	☐
-----	--------------------------	-----	--------------------------	-----	--------------------------	-----	--------------------------

May	☐	June	☐	July	☐	Aug	☐
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Sept	☐	Oct	☐	Nov	☐	Dec	☐
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(or alternatively)

Winter	☐	Spring	☐	Summer	☐	Autumn	☐
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4. What trigger factors provide or increase your nose problem?

House dust ☐

House dust mites ☐

Pollens ☐

Animal (cat, dogs...) ☐

Others (please specify)

5. Do you think to be allergic?

No ☐ Yes ☐

6. Have you already been tested for allergy (SPI, IgE)?

No ☐ Yes ☐

If YES:

6a. What was the result?

Positive ☐ Negative ☐

7. Has a doctor already diagnosed that you suffer/suffered from asthma, eczema or allergic rhinitis?

No ☐ Yes ☐

8. Is any member of your family suffering from asthma, eczema or allergic rhinitis?

No ☐ Yes ☐

If YES: Who and what disease? (please tick appropriate cases(s)):

Father	Asthma ☐	Eczema ☐	Allergic rhinitis ☐
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Mother	Asthma ☐	Eczema ☐	Allergic rhinitis ☐
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Siblings	Asthma ☐	Eczema ☐	Allergic rhinitis ☐
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Source: Annesi-Maesano et al. (2002), Allergy.

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END

Table S2. 評估敏感性鼻炎的標準問卷 (Standardized questionnaire for CSFAR)

C1	除傷風或感冒外 ，在過去十二個月內，你曾否有以下問題？（請在適當處打"✓"）	
C1a	打噴嚏 	有 ☐ ／否 ☐
C1b	流鼻水	有 ☐ ／否 ☐
C1c	鼻塞	有 ☐ ／否 ☐

C2	在過去十二個月內，以上鼻內的問題出現時，有否同時出現眼睛痕癢或多眼水？ 有 ☐ ／否 ☐	
C3	在過去十二個月內，你在哪個月內（或哪季）出現以上鼻內的問題？（注：可填多項）	
C3a	一月 ☐ 二月 ☐ 三月 ☐ 四月 ☐ 五月 ☐ 六月 ☐	
	七月 ☐ 八月 ☐ 九月 ☐ 十月 ☐ 十一月 ☐ 十二月 ☐	
C3b	（或可選答）春季 ☐ 夏季 ☐ 秋季 ☐ 冬季 ☐	

C4	哪些因素引致或加重你以上鼻內的問題？	
C4a	家居塵埃 ☐	
C4b	家居塵蟎 ☐	
C4c	花粉 ☐	
C4d	動物（貓、狗等） ☐	
C4e	其他（請註明） ☐	

C5	你認為你有任何過敏嗎？ 有 ☐ ／否 ☐	
C6	你曾進行過敏測試嗎（皮膚點刺過敏測試[SPT]，IgE 過敏血液測試）？ 有 ☐ ／否 ☐	
C6a	如「有」，測試的結果是： 陽性 ☐ ／陰性 ☐	

C7	醫生曾診斷你 現時／過去 患有哮喘、濕疹或過敏性鼻炎嗎？ 有 ☐ ／否 ☐	
C8	你的家庭成員有否患有哮喘、濕疹或過敏性鼻炎？ 有 ☐ ／否 ☐	
	如「有」，是何人及何種疾病？	
C8a	父親	哮喘 ☐ 濕疹 ☐ 過敏性鼻炎 ☐
C8b	母親	哮喘 ☐ 濕疹 ☐ 過敏性鼻炎 ☐
C8c	兄弟姊妹	哮喘 ☐ 濕疹 ☐ 過敏性鼻炎 ☐

Source: Annesi-Maesano et al. (2002), Allergy.

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多謝你的參與!