

Original article

The score for allergic rhinitis (SFAR): a simple and valid assessment method in population studies

Background: No validated assessment of allergic rhinitis (AR) is presently available that can be used in population studies in the absence of medical diagnosis and of objective measurements of allergy. To compensate for this lack, a quantitative Score For Allergic Rhinitis (SFAR) ranging between 0 and 16 has been developed by experts.

Methods: The SFAR, encompassing eight features of AR, was validated in three different ways: 1) among 269 outpatients taking the specialist's diagnosis of AR and skin prick tests (SPT) positivity as a gold standard (diagnosis validation); 2) using psychometric methods (internal validation); and 3) in a random population-based sample of 3001 individuals by telephone interview (population acceptability).

Results: A SFAR value ≥ 7 allowed satisfactory discrimination between the outpatients with AR from those without (sensitivity = 74% [95% confidence interval CI: 0.69, 0.79], specificity = 83% [0.79, 0.87], positive predictive value = 84% [0.80, 0.88], negative predictive value = 74% [0.69, 0.79] and Youden's index = 0.57, respectively). Internal consistency of the score was also high (among others, Cronbach's alpha coefficient = 0.79). On average, it took only 3 min for the individuals interviewed on the phone to complete the questionnaire, the questions of which were well understood. Among these subjects, the prevalence of AR was 21% [95% CI: 19.5%, 22.5%], which is comparable to other determinations in France.

Conclusions: The newly *a priori* proposed Score For Allergic Rhinitis (SFAR) is easy to use and can be useful to estimate prevalence and to study causation of AR in population settings.

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Allergic rhinitis (AR) is a common condition affecting 5–40% of the general population and there is evidence that its prevalence is rising (1). An important contribution to the investigation of AR is provided by epidemiological studies conducted in large population-based samples. In such samples (where it is difficult to obtain doctor's evidence of AR or to identify the environmental antigens that are responsible for AR) 'working definitions' of AR must be implemented in order to discriminate with reasonable accuracy between those individuals who have AR and those individuals who are free from it. A quite complete working definition of allergic rhinitis among children drawn from population-based samples has been provided, using a set of six questions, by the International Study of Asthma and Allergies in Childhood (ISAAC) (2). The ISAAC questionnaire for rhinitis has been validated both in children (3) and adults (4) using skin prick tests (SPT), and the fact that the prevalence distribution of hayfever was similar in the ISAAC and

European Community Respiratory Health Study (ECRHS) studies (5) suggests that questions on hayfever are relevant. However, due to the type of construct design used, the ISAAC questionnaire does not compute any quantitative score for AR. Nevertheless, it has been shown that quantitative scores are more informative than dichotomous variables in characterization of the disease (6).

A working party of six specialists was convened in France to develop a minimum list of reliable questions about AR, which could be used to compute a quantitative diagnostic criteria score for differentiation between AR and other nasal problems (such as infectious rhinitis, occupational rhinitis, drug-induced rhinitis, hormonal rhinitis, idiopathic rhinitis) in the absence of a doctor's diagnosis. The score was developed to separate AR according to its variety (allergen, season of the year, etc.), information which is greatly relevant in the study of AR. In order to assess the validity of the proposed Score For Allergic Rhinitis

(SFAR), three methods were used. Firstly, the SFAR was validated using a doctor's diagnosis of AR among outpatients (diagnostic validation). Secondly, internal validation of items was performed using psychometric methods. Thirdly, the score acceptability was tested in a random population-based sample.

Material and methods

Study population

Data were obtained from 269 consecutive first-visit outpatients during 1 month in 1997 referred by the GP because of nasal problems to the Allergy or ENT clinics of four hospitals situated in different zones of France (Brest, Montpellier, Poitiers, and Toulouse). Each outpatient filled in a questionnaire containing items on nasal problems and related features (see Appendix A) and was then examined by a clinical consultant who was blinded to the answers of the questionnaire. The consultant prescribed SPT to major aeroallergens when he/she thought that it was necessary to ascertain atopic status of the outpatient. Standard aeroallergens were used to this end.

A random population-based sample of 3001 individuals aged ≥ 18 years, representing the general adult population of 22 regions of France, participated by phone in the study of population acceptability of SFAR. The sample consisted of consecutive individuals at home during the phone call, until the estimated sample size was reached for each region. Appropriate methodology was applied to estimate the size and to make the sample representative. Phone numbers for the different regions were randomly selected from the phone directories that were available on computer files.

Development of the score

The epidemiological questionnaire on nasal problems (see Appendix A) included the following items as established by the panel of specialists in order to construct the quantitative score for AR, the SFAR:

1. nasal symptoms in the past year, including sneezing, runny nose, and blocked nose when the subject did not have a cold or 'flu', in the past year;
2. nasal symptoms accompanied by itchy-watery eyes (rhinoconjunctivitis);
3. months of the year in which nasal symptoms occur. Seasonal (pollen season) vs. perennial rhinitis could then be assessed according to the pollen calendar of each region;
4. triggers of nasal symptoms including pollens, house dust mites, house dust and epithelia;
5. perceived allergic status;
6. previous medical diagnosis of allergy;
7. previous positive tests of allergy;
8. familial history of allergy.

For each item a weighting was attributed by the working party of specialists on the basis of their experience in clinical practice and using appropriate statistical methods (Table 1). Specialists' choice was confirmed by medical knowledge on characteristics of rhinitis (1). Statistical methods included: multiple correspondence analysis (see under Statistical methods) which allowed lining up and thus weighting the various items according to the presence or the absence of a medical diagnosis of AR; and odds ratios (OR) between medical diagnosis of AR and the various items estimated using the logistic regression model.

For each outpatient, the SFAR based on the number of points made in the questionnaire was then set. The SFAR ranged between 0 and 16.

Validation of the score

Three validations of the SFAR were performed: diagnosis validation, internal validation and population acceptability.

In the diagnosis validation, the gold standard diagnosis of rhinitis was made by the specialist's evaluation and the results of SPT were used to assess the SFAR cut-off point value discriminating individuals with AR from those without. The reliability of the specialists in diagnosing allergic rhinitis was guaranteed by a common clinical definition of the disease, according to European consensus guidelines for the diagnosis and treatment of allergic rhinitis (7).

Internal validation of the SFAR required a quantitative approach consisting of the study of the items' validity (content validity, face validity, construct validity) and homogeneity, respectively. Content validity, the extent to which the considered items incorporated the domain of AR, was guaranteed by the expertise of the panel. This was also confirmed by previously published data (1). Face validity of the items was given by the high degree of acceptability and comprehension of the outpatients, in particular those of a pilot study conducted separately. Construct validity and homogeneity were tested as presented in the section Statistical methods.

Finally, the population acceptability, defined as the degree of comprehension of the score among individuals drawn from the general population, was tested in a population-based sample by telephone interview. Actually, face validity had been assessed amongst only outpatients of the clinics. The sample was randomly selected using the phone books of 22 regions of metropolitan France after having estimated with appropriate techniques the different sample sizes. It was decided that in the case of nonresponse, the next phone number on the list would be tried. This survey provided an opportunity to estimate the prevalence of allergic rhinitis in France.

Statistical methods

Diagnosis validation. Using the key medical diagnosis of AR as a gold standard, the following four different methods (8), largely applied in clinical epidemiology, were considered to assess the SFAR cut-off point value (i.e. 'the best score value' of the SFAR) allowing optimum discrimination between individuals with AR and those without:

1. sensitivity, that is the proportion of individuals with AR who were diagnosed by the doctor; and specificity, that is the proportion of individuals without AR who were not diagnosed (sens and spec, respectively);
2. positive and negative predictive values: PPV, the probability of AR, given the results of the tests (diagnosis and SPT); and NPV, the probability of not having AR, given the results of the tests, respectively;
3. receiver operator characteristics (ROC) curve, which is used to describe the accuracy of the SFAR over a range of cut-off values and thus helps to decide where the best cut-off value of the score would be;
4. the Youden's index (i.e. $J = \text{specificity} + \text{sensitivity} - 1$), which allows comparison of SFAR values in terms of specificity and sensitivity under the assumption that specificity and sensitivity have to be equally important.

Internal validation. Construct validity (9) of the SFAR items was examined using the following complementary methods (6):

1. The multicorrespondence analysis (MCA) (10). This is an explanatory technique for visually interpreting multivariate data. It involves three or more categorical variables and graphical display of the corresponding contingency tables.
2. The graphical method of analysis of the line of items. According to this method the more the total score is elevated the more the percentage of positive answers to one item must increase (11).

Table 1. Self-completed questionnaire, attributed score and repartition of the items for the Score For Allergic Rhinitis (SFAR)

Items/discriminators	Score (points) attributed by experts	Cumulative score	Outpatients reporting the item (%) (n=269)	Outpatients with medical diagnosis of AR reporting the item (n=144)
Blocked nose, runny nose, sneezing in past year (nasal symptoms)	1 for each symptom	3	83.6 ¹	95.8 ¹
Months of the year	1 for perennial 1 for pollen season	5	43.5 41.6	50.0 51.4
Nasal symptoms plus itchy eyes (rhinoconjunctivitis)	2	7	44.6	61.8
Triggers:*				
Pollens, house dust mites, dust	2		46.8 ²	69.4 ²
<i>Epithelia</i> (cat, dog)	1	9	15.2	23.6
Perceived allergic status	2	11	51.3	75.0
Previous positive allergic tests	2	13	35.3	52.8
Previous medical diagnosis of allergy	1	14	29.0	38.2
Familial history of allergy	2	16	25.7	38.2
Total points		16		

*Divided according to factor analysis.

¹At least one symptom.

²At least one trigger.

Homogeneity of the SFAR items was established using:

1. The alpha coefficient of Cronbach (11). It has been established that to a coefficient included in the interval [0.61, 0.80] correspond a good agreement among items used to compute it.

2. The focused principal component analysis (focused FPCA) (6). This method allows description of the relationships among variables by prioritising the relationships of a particular variable (medical diagnosis of allergic rhinitis, in our case) to the others (the items), by computing the correlations of this variable with the others.

Lastly, the weights attributed to the SFAR items were obtained statistically on the basis of the results of both MCA and the logistic regression model in which the medical diagnosis of AR was included as a dependent variable and the items as independent variables (10).

Analyses were performed using BMDP software (University of California Press, Berkeley, 1992) (10).

Results

Characteristics of the study samples

One hundred and forty-one males and 128 females participated in the hospital validation study. There was no difference in age among them. Main occupations were teachers, clerks and technicians. The distribution of each item in these outpatients is shown in Table 1. Out of the initial 269 individuals, 144 (53%) were diagnosed as suffering from allergic rhinitis at the time of the survey during the consultation (Fig. 1). One hundred and forty-six outpatients (54%) had SPT to common aeroallergens following the physician's request for allergic tests. Seventy-three percent of the subjects having performed SPT were found to be positive to at least one aeroallergen. Eighty-nine individuals (61%) had both a clinical diagnosis of AR and positive SPT; 34 (23%) did not present any positivity and were not diagnosed as suffering from AR; 17(11%) presented positive SPT but were not diagnosed as suffering from AR (because of positivity to allergens other than those usually involved in AR); and 6 (4%) were diagnosed as suffering from AR but had negative SPT.

Among the 3001 individuals that participated in the

population acceptability study, classes of age were equally represented but there were slightly more men than women. The predominant occupations were managers, teachers and being retired.

Diagnosis validation

Sensitivity and specificity as well as predictive values indicated that a SFAR cut-off value ≥ 7 optimally discriminated between individuals with AR and those without (Figs 1,2 and 3). This value allowed the SFAR to be sufficiently sensitive (74%, [95% CI : 0.69, 0.79]) and specific (83%, [0.79, 0.87]) and to have good positive (84%, [0.80, 0.88]) and negative (74%, [0.69, 0.79]) predictive values, respectively. Similarly, expressing the relationship between specificity and sensitivity with a ROC curve showed that the best SFAR cut-off value was ≥ 7 , as this value crowded individuals toward the upper left corner of the ROC curve (Fig. 4). Furthermore, a diagnostic SFAR of ≥ 7 was derived on the basis of the Youden's index (Fig. 5). Results were confirmed when excluding individuals who had not performed SPT (sensitivity=88% [0.83, 0.93], specificity=69% [0.62,0.77], PPV=84% [0.78, 0.90], NPV=76% [0.69, 0.83] and J=0.57, respectively). It must be noted that the weightings attributed by the specialists were confirmed using the logistic regression models as well as the MCA (data not shown). The more the item was weighted in the score, according to the specialists' point of view, the higher the corresponding OR was. Furthermore, the items were ranked in the same order of importance by MCA.

Internal validation

Regarding construct validity of the SFAR, the MCA showed that on the first axis (32.6% of the inertia) all the affirmative answers to the items were close to the doctor's diagnosis of AR and, as expected, on the

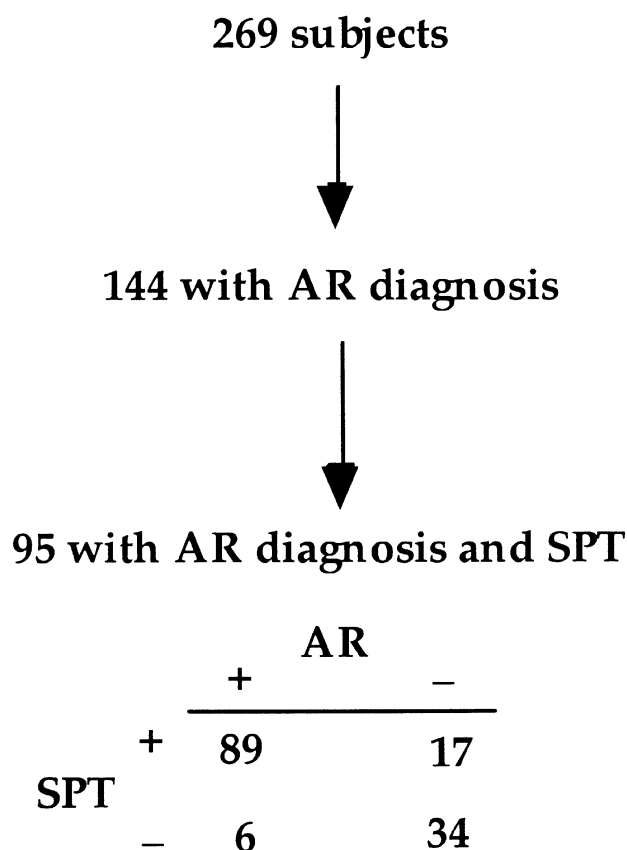


Figure 1. Study design and repartition of the outpatients according to allergic rhinitis (AR) and skin prick test (SPT) positivity (n = 269)

second axis (12.4% of inertia) seasonal rhinitis was opposed to perennial rhinitis. The analysis of the lines of the items always showed unimodal curves except in the cases of seasonal and perennial rhinitis and familial history of allergy. Regarding homogeneity, the internal consistency of the SFAR was good (Cronbach's $\alpha = 0.79$), suggesting that all the items were appropriate for assessing AR. Furthermore, the FPCA focusing on the medical diagnosis of AR showed that previous medical diagnosis of allergy, perceived allergic status, previous positive tests of allergy, rhinoconjunctivitis, and being susceptible to the various triggers (house dust mites, pets, etc.) constituted a group of variables that correlated positively with each other (data not shown).

General acceptability

The questionnaire was well understood by individuals randomly drawn from the general population, who were interviewed over the phone. There was no effect of age, sex or socioeconomic status in the answers. Among the 3001 individuals interviewed, 21% [95% CI: 19.5%, 22.5%] had a SFAR ≥ 7 . Factors associated with a population with AR, as defined on the basis of SFAR,

are young age, living in the north and south-east of France, working in craft or trade, and being unemployed.

Discussion

In spite of the fact that allergic rhinitis is an extremely common health problem in industrialized countries, few standardized instruments have been developed to assess it. The diagnostic criteria of SFAR, as proposed herein, are easy to use; SFAR takes under 3 min per individual to be complete and might be useful to estimate AR prevalence in population settings, as well as to study causation of AR.

The landscape offered by instruments allowing the assessment of allergic rhinitis has been poor until now. Most instruments deal with quality of life and/or treatment benefits among individuals with rhinitis. A preference-based measure of rhinitis symptoms, useful for clinical trials and for cost-effectiveness studies comparing treatments for rhinitis, is the Rhinitis Symptom Utility Index (12), which consists of 10 questions on the severity and the frequency of stuffy or blocked nose, runny nose, sneezing, itching, watery eyes and itching nose or throat over a 14-day period. A simple symptom scale assessing rhinoconjunctivitis and asthma, two interdependent conditions, was developed and fully validated in 102 patients with rhinoconjunctivitis and asthma (13). The purpose was to use these two instruments with existing validated tools such as treatment needs and quality of life assessment, in order to provide a comprehensive picture of allergic airway disease for quality assurance or research purposes. A 134-item questionnaire was developed to distinguish between patients with allergic rhinitis (AR) and those with perennial nonallergic rhinitis or vasomotor rhinitis (VMR) (14). Although useful in pointing out the many differences in the medical histories of AR and VMR patients, this questionnaire is not practical in epidemiological studies. Two instruments were used in population studies to assess AR. The ISAAC core questionnaire for rhinitis consisting of six questions aimed at distinguishing between rhinitic and nonrhinitic individuals in the general population, predicting which subjects with rhinitis are likely to be atopic and giving some indication of the severity of rhinitis among affected individuals. ISAAC questions on nasal symptoms when the subjects did not have a cold or flu were found to have a positive predictive value of 80% in detecting rhinitis in a community sample of adults (aged 16–65 years) (15). The ISAAC question on rhinoconjunctivitis had the highest positive predictive value (78%) for detecting atopy among subjects with rhinitis in the same population. Finally, the ISAAC question on the month of the year during which symptoms occur had a positive predictive value of 71% in detecting atopy among subjects with rhinitis. In

The Score For Allergic Rhinitis (SFAR)

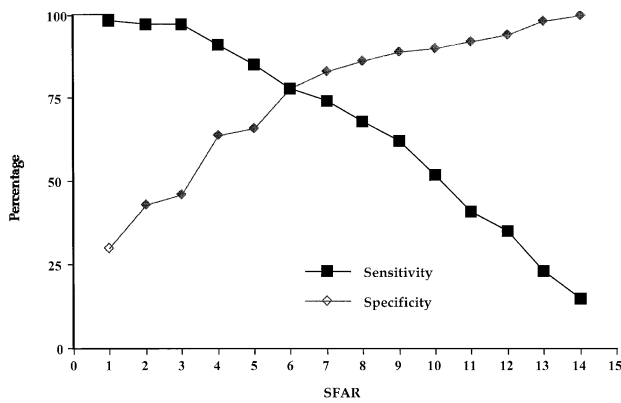


Figure 2. Sensitivity and specificity of the Score For Allergic Rhinitis (SFAR) (n=269)

the *a posteriori* validation of the ISAAC core questions on rhinitis, by comparing them with SPT results in a large population-based sample of Swiss schoolchildren (3), questions on rhinitis were found to be highly specific (ranging from 77.5% to 97.6%) and therefore useful for excluding atopy. In addition, they had a high positive predictive value (63% for sneezing accompanied by itchy-watery eyes, 67% for symptoms occurring only during the pollen season and 70% for reported hayfever) in detecting atopy among subjects with symptoms. However, they were not helpful for detecting atopy in the general population (low sensitivity). By questionnaire, both allergic and nonallergic nasal complaints were assessed among 1469 randomly selected persons

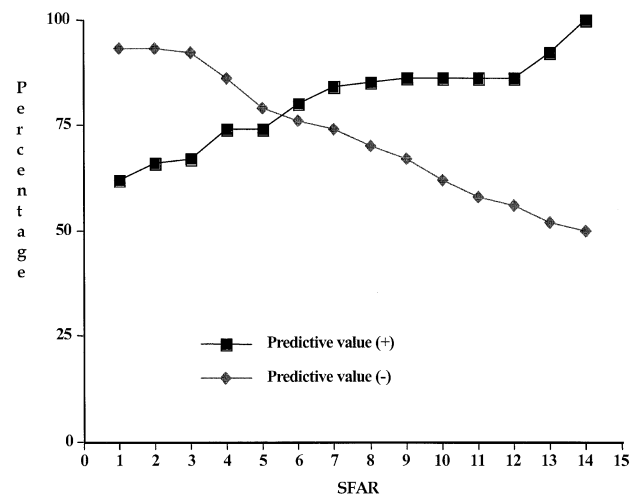


Figure 3. Positive (+) and negative (-) predictive values of the Score For Allergic Rhinitis (SFAR) (n=269)

between 16 and 82 years of age (16). However, this questionnaire, for which few elements of validation were provided, has not been used in other studies. Recently, a scoring system was introduced to diagnose allergic rhinitis on a routine basis in a small cohort of 47 allergic rhinitis and 23 normal subjects assembled at the hospital (17). However, the scoring was based on symptoms, signs, SPT and IgE levels, and is therefore difficult to use in large populations. Similarly, questions on allergic rhinitis were validated using objective measurements of SPT and specific IgE (18) but in 150 subjects who had

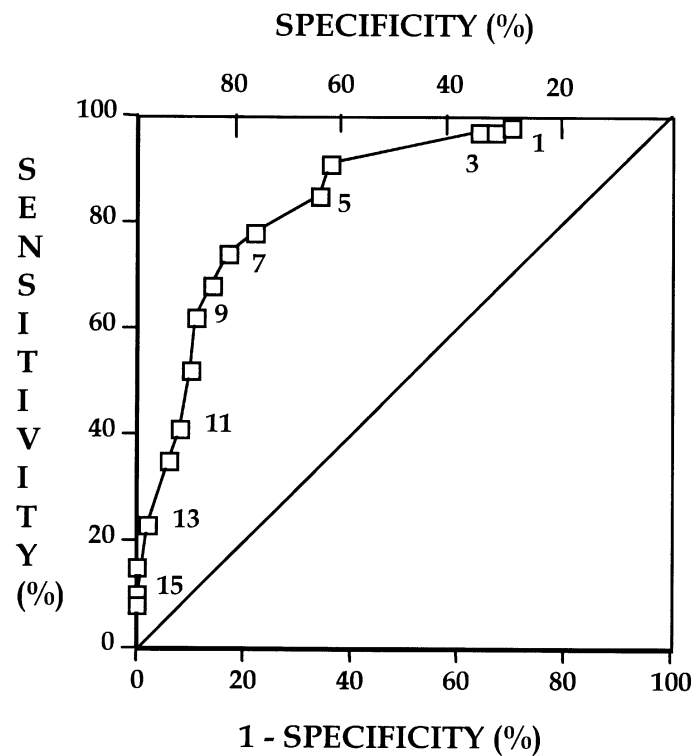


Figure 4. Receiver operator characteristics (ROC) curve of the Score For Allergic Rhinitis (SFAR) (n=269)

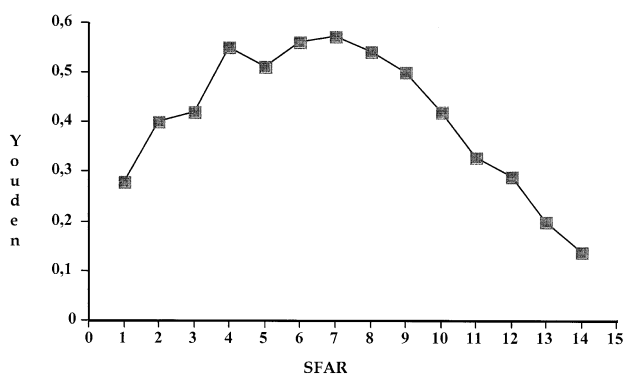


Figure 5. Youden's index according to the different values of the Score For Allergic Rhinitis (SFAR) (n = 269)

ever reported asthma or wheezing and 140 without symptoms in Finland so attributing a special meaning to the validation.

Compared to all the other existing instruments, the SFAR developed here has two advantages. From the methodological point of view, the SFAR is a quantitative score, thus more informative than the other unidimensional instruments usually employed. This meant that better sensitivity, specificity and predictive values were obtained than with other instruments were obtained in ascertaining individuals' suffering from AR. The SFAR has a higher positive predictive value and specificity than the ISAAC questionnaire on rhinitis. More importantly, the SFAR has a much higher sensitivity than the ISAAC questionnaire, which has been shown to be unhelpful in the detection of atopy in the general population of children. Excluding individuals not having performed SPT and taking SPT positivity into account yielded even better results in terms of sensitivity (88% vs. 74%) in the case of SFAR.

Furthermore, appropriate statistical methods issued from psychometric techniques were applied for the internal validation of SFAR. This is not usually done in the development of a score for AR (13). Psychometric techniques indicated that all the items were very good. The SFAR was homogeneous even when seasonality of

nasal symptoms was taken into account, as the Cronbach's coefficient was always higher than 0.70. Reporting in detail the months in which nasal symptoms occurred has not been shown to provide much better information because of recall bias. Actually, individuals are prone to report that nasal symptoms occurred in months of the year closer to the period of the survey both in France (19) and elsewhere (20). That is why we did not use the SFAR to discriminate between seasonal and perennial rhinitis. However, this could be done after further implementation and development of specific questions. More relevant information on the variety of AR can be obtained by considering the allergens to which the individual is sensitized. From a practical point of view, a questionnaire in large scale population surveys will be successful if it is simple and acceptable to the subjects, requiring only a few minutes to complete, if it has adequate reproducibility and yields relevant information which cannot be obtained more conveniently in other ways. The SFAR seems to satisfy all such criteria but intraindividual reproducibility has not been tested. The SFAR is a very short validated instrument including only eight items which can be assessed with a self-reported questionnaire taking only 3 min to be filled in. The phone survey showed that the SFAR is well accepted by individuals of various socioeconomic statuses.

In conclusion, for the first time a quantitative score for AR (SFAR) is proposed that can be useful in estimating prevalence and to study causation of AR in population settings. Additional uses of the SFAR might include the determination of AR probands in genetic studies which aim to identify genetic markers of this disease.

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Appendix

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	☐
Sept	☐	Oct	☐	Nov	☐	Dec	☐

(or alternatively)

Winter	☐	Spring	☐	Summer	☐	Autumn	☐
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4 What trigger factors provoke 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 (SPT, 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	☐
Mother	Asthma	☐	Eczema	☐	Allergic rhinitis	☐
Siblings	Asthma	☐	Eczema	☐	Allergic rhinitis	☐
