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ORIGINAL RESEARCH

Knowledge, Attitudes, and Practices of Patients with Allergic Rhinitis Towards Allergen-Specific Immunotherapy

Xiaofan Fan[1], Jintang Zhang[2]

[1]Department of Nursing, The Fourth Affiliated Hospital of School of Medicine, and International School of Medicine, International Institutes of Medicine, Zhejiang University, Yiwu, 322000, People's Republic of China; [2]Department of Otolaryngology, The Fourth Affiliated Hospital of School of Medicine, and International School of Medicine, International Institutes of Medicine, Zhejiang University, Yiwu, 322000, People's Republic of China

Correspondence: Jintang Zhang, Department of Otolaryngology, The Fourth Affiliated Hospital of School of Medicine, and International School of Medicine, International Institutes of Medicine, Zhejiang University, Yiwu, 322000, People's Republic of China, Tel +86-13868956056, Email 8014133@zju.edu.cn

Purpose: This study aimed to investigate the knowledge, attitudes, and practices (KAP) of patients with allergic rhinitis towards allergen-specific immunotherapy (AIT).

Methods: This cross-sectional study was conducted through a questionnaire survey at The Fourth Affiliated Hospital of Zhejiang University School of Medicine from October 15, 2023, to December 3, 2023.

Results: A total of 550 valid questionnaires were included in the analysis. The median scores with interquartile ranges (IQR) for knowledge, attitude, and practice were 17 (11, 23), (possible range: 0–34); 20 (17, 22), (possible range: 7–35); and 30 (24, 34), (possible range: 8–40). Multivariate logistic regression analysis showed that individuals engaging in physical activity 1–3 times per week (OR = 2.895, 95% CI: [1.745, 4.804], $P < 0.001$), those participating in physical activity 5–7 times per week (OR = 3.811, 95% CI: [1.502, 9.671], $P = 0.005$), and those with higher knowledge scores (OR = 4.485, 95% CI: [2.942, 6.837], $P < 0.001$) were independently associated with positive practices. The structural equation modeling (SEM) results revealed that knowledge had a significant influence on attitude ($\beta = -0.354$, $P = 0.010$) and practice ($\beta = 0.618$, $P = 0.010$), and attitude also demonstrated a noteworthy impact on practice ($\beta = -0.120$, $P = 0.020$). Furthermore, it is worth noting that the indirect effects of knowledge on practice were statistically significant ($\beta = 0.042$, $P = 0.020$).

Conclusion: Patients with allergic rhinitis had inadequate knowledge, negative attitudes and proactive practices towards AIT. To improve their understanding and adherence, healthcare providers should prioritize education and interventions aimed at enhancing patient engagement with this treatment option.

Keywords: allergic rhinitis, allergen-specific Immunotherapy, knowledge, attitude, practice

Introduction

Chronic rhinitis is typically classified into two types: allergic rhinitis and non-allergic rhinitis. Patients with allergic rhinitis often test positive in skin prick tests (SPT) and/or have elevated serum-specific IgE (sIgE) levels. Nasal allergen provocation tests (NAPT) are useful for confirming this condition. Additionally, there are patients who do not fit neatly into the allergic rhinitis / non-allergic rhinitis dichotomy and are classified as having local allergic rhinitis. These individuals exhibit positive NAPT results but negative SPT and serum sIgE findings.[1,2]

Allergic rhinitis, a prevalent allergic airway disorder, affects patients globally, with an estimated 500 million individuals suffering from this condition.[3,4] It is recognized as the most widespread form of noninfectious rhinitis worldwide.[5] Characterized as an inflammatory disease of the nasal mucosa, allergic rhinitis presents symptoms such as rhinorrhea, sneezing, nasal congestion, and itching following exposure to specific allergens, including ragweed, other pollens, mites, and fungi.[6,7] Recent trends suggest a rising incidence of allergic rhinitis, influenced by evolving

environmental and social factors. A national telephone survey in China indicated prevalence rates ranging from 8.5% to 21.3% across 11 cities, underscoring its significant impact.[8] The disorder profoundly affects various aspects of daily life, including sleep, memory, mood, and work performance. Additionally, chronic sinusitis is a component of systemic inflammatory disorders that impact the respiratory system. This condition is often associated with the severity of asthma and has potential links to other comorbidities.[9] Notably, allergic rhinitis has been demonstrated to be associated with obstructive sleep apnea. Treating allergic rhinitis can lead to improvements in obstructive sleep apnea symptoms.[10]

The current treatment strategies for allergic rhinitis primarily include allergen avoidance, pharmacotherapy, and allergen-specific immunotherapy.[11] For instance, H1 antihistamines are often the initial treatment choice for various forms of allergic rhinitis.[12] Beyond symptomatic relief, allergen-specific immunotherapy (AIT) stands out as the only cause-specific treatment available for allergic diseases.[13] This therapy not only alleviates allergic symptoms but also has the potential to induce clinical remission in patients with IgE-mediated allergic diseases, such as allergic rhinitis, atopic asthma, and venom allergy.[14]

The Knowledge, Attitude, and Practice (KAP) model hypothesizes that individual behaviors are influenced by one's knowledge and attitudes. In public health, the investigation of behavioral practices often entails the assessment of both knowledge and risk perception, typically executed via KAP surveys. This theoretical approach is of critical importance in understanding health-related behaviors.[15–17] AIT utilizes allergen extracts derived from natural sources.[18] Similar to other long-term treatments, AIT faces challenges with patient compliance.[19] Furthermore, by exploring the knowledge, attitudes, and practices of patients with allergic rhinitis towards AIT, a deeper comprehension of their perceptions of this treatment can be achieved. This understanding is vital for enhancing acceptance and efficacy of the therapy. Such research can uncover the issues and challenges patients encounter during AIT, such as potential misunderstandings, concerns, or financial burdens. Recognizing these obstacles can aid healthcare providers and policymakers in developing more effective treatment plans and educational programs. Through this research, medical professionals can gain better insights into patient perspectives and needs, thereby facilitating the creation of more personalized education and communication strategies to improve patient adherence to treatment plans.

Despite the critical need for such investigation, a notable void persists in KAP research specifically addressing allergic rhinitis and the patient perspective on advanced treatments like AIT. This study aims to fill this gap by assessing the awareness and perceptions of patients towards allergic rhinitis and its treatment options.

Methods
Study Design and Participants
This cross-sectional study was conducted between October 15, 2023, and December 3, 2023, at The Fourth Affiliated Hospital of Zhejiang University School of Medicine. Participants in the study were individuals who had been clinically diagnosed with allergic rhinitis. The study was ethically approved by the Ethical Committee of The Fourth Affiliated Hospital of Zhejiang University School of Medicine [K2023148]. Informed consent was duly obtained from all participants, ensuring adherence to ethical standards. This study conforms to the principles outlined in the Declaration of Helsinki (World Medical Association Declaration of Helsinki).

Inclusion criteria for the study were as follows: 1) Patients diagnosed with allergic rhinitis by otolaryngologists, confirmed through positive skin prick tests and/or the presence of serum-specific IgE for one or more allergens, in accordance with the 2022 Chinese Clinical Diagnosis and Treatment Guidelines for allergic rhinitis. 2) Clear consciousness and normal cognitive function, with no barriers to expressive communication, ensuring the ability to complete the questionnaire survey. 3) Age requirement of 18 years and above. Patients unwilling to participate in the study were excluded. The method of questionnaire distribution was through electronic means, specifically via WeChat groups, exhibition boards, and in consulting rooms, facilitating ease of access for the participants".

Questionnaire Introduction
The design of the questionnaire was informed by relevant guidelines and literature in the field. Initially, a draft was created and subsequently refined based on the insights of four experts—two specializing in allergic diseases and two in

rhinology. Following this expert consultation, a pilot test was conducted with a small group of 34 participants to evaluate the questionnaire's effectiveness. The results from this pre-experimental phase demonstrated a high level of internal consistency, as evidenced by a Cronbach's α coefficient of 0.907.

The finalized questionnaire is structured into four dimensions: demographic information, knowledge, attitude, and practice. The knowledge dimension encompasses 17 questions, with responses scored on a scale from "very under-standing" (2 points) to "not clear" (0 points), and a total possible score range of 0–34 points. The attitude dimension includes 3 open-ended and 7 scaled questions, utilizing a five-point Likert scale that ranges from "very positive" (5 points) to "very negative" (1 point). Scores in this dimension range from 7 to 35 points, where higher scores indicate a more accurate attitude towards AIT, and lower scores may reflect overly optimistic expectations. The practice dimension is comprised of 2 open-ended and 8 scaled questions, scored using a similar five-point Likert scale from 'always' (5 points) to "never" (1 point), with a score range of 8–40 points. Here, higher scores denote more effective practical engagement in managing allergic rhinitis. Achieving scores above 75% of the maximum in each section is considered indicative of adequate knowledge, a positive attitude, and proactive practice.[20]

To ensure efficient access and rigorous data integrity, our study deployed the "Questionnaire Star" WeChat mini-program, which facilitates the creation of online surveys with unique QR codes. The questionnaire was primarily distributed through patient WeChat groups, complemented by physical invitation boards strategically placed in clinics specializing in allergic rhinitis. These boards served both to attract potential participants and guide them to scan the QR code to access the survey. Prior to filling out the questionnaire, participants were required to present valid medical documentation confirming their diagnosis of allergic rhinitis, ensuring eligibility. To prevent duplicate responses, our system was configured to restrict submissions to one per IP address or WeChat account. Furthermore, our team rigorously reviewed all submissions for completeness, logical consistency, and plausibility of responses. This meticulous approach not only streamlined participant engagement but also safeguarded the reliability of our data collection process.

Simple Size Calculation

The sample size was calculated using the formula

$$n = z2 * p*(1 - p)/e2,$$

where z=1.96 corresponds to the 95% confidence level, p represents the proportion of interest expressed as a decimal, and e is the margin of error.

Statistical Analysis

To evaluate the reliability of our survey instruments, we calculated Cronbach's alpha for each scale. A Cronbach's alpha value greater than 0.7 is generally considered acceptable, indicating good internal consistency among the items within each scale. Furthermore, to assess the sampling adequacy for conducting factor analysis, we utilized the Kaiser-Meyer-Olkin (KMO) measure. A KMO value above 0.6 is deemed suitable, ensuring that the partial correlations among variables are not too small and that factor analysis may be appropriately applied to our dataset. In our descriptive analysis, we used either mean and standard deviation or median and interquartile ranges (25th and 75th percentiles) based on normality test results for each dimension. The normality of the data distribution was assessed using the Kolmogorov–Smirnov test. Counts and percentages represented demographic and categorical data. For dimensional score comparisons across different demographics, we employed *t*-tests or Wilcoxon-Mann–Whitney tests for two groups and ANOVA or Kruskal–Wallis tests for multiple groups, depending on data normality. Pearson or Spearman coefficients were used for correlation analyses. Univariate analysis identified influential factors on practice with a significance level of $P < 0.1$, and these factors were further analyzed in multivariate regression ($P < 0.05$). Structural equation modeling (SEM) examined relationships between questionnaire dimensions, including the mediating effect of attitudes on the knowledge-practice relationship.

Results

Demographic Characteristics

Table 1 summarizes the baseline information of participants, the overall KAP score of participants and the differences in KAP among patients with different characteristics. In the current research, a total of 600 questionnaires were distributed. Exclusions were made based on the following criteria: 1) Refusal to participate, resulting in 15 responses being excluded; 2) Questionnaire completion times falling below 90 seconds or exceeding 1800 seconds, leading to the exclusion of 13 responses; 3) The presence of logical errors, which led to the exclusion of 21 responses. Valid questionnaires amounted to 550. The Cronbach's α coefficient for the overall feedback was calculated to be 0.908 (with a breakdown by dimension: knowledge dimension: 0.966, attitude dimension: 0.725, practice dimension: 0.899). The Kaiser-Meyer-Olkin (KMO) value was found to be 0.958. Among the participants who reported allergic rhinitis, 279 (50.7%) were male, with an average age of 35 years (with a range of 31 to 40 years). Furthermore, 405 (73.6%) had received a college-level or undergraduate education or higher, 189 (34.4%) had been suffering from allergic rhinitis for more than 5 years, 211 (38.4%) experienced a mildly intermittent condition, 415 (75.5%) had undergone allergen testing, and 306 (55.6%) engaged in physical exercise 1 to 3 times per week.

The median scores for knowledge, attitude, and practice, represented as the 25th percentile and 75th percentile, were as follows: knowledge, 17 (11, 23); attitude, 20 (17, 22); and practice, 30 (24, 34). When analyzing demographic characteristics, it was observed that participants' knowledge scores exhibited variations based on gender ($P < 0.001$), residence ($P = 0.011$), occupation ($P < 0.001$), average monthly household income ($P < 0.001$), duration of allergic rhinitis ($P = 0.021$), whether they had undergone allergen testing or not ($P < 0.001$), and their engagement in physical activity ($P < 0.001$). Regarding attitude scores, differences were noted among patients belonging to different age groups ($P = 0.021$), educational backgrounds ($P = 0.039$), and durations of allergic rhinitis ($P = 0.023$). Furthermore, disparities in practice scores were identified among patients based on their gender ($P = 0.025$), age group ($P = 0.007$), occupation ($P < 0.001$), duration of allergic rhinitis ($P < 0.001$), severity of their condition ($P = 0.022$), whether they had undergone allergen testing or not ($P < 0.001$), and their engagement in physical activity ($P < 0.001$).

Knowledge, Attitudes and Practices

Tables 2–4 shows the distribution of questions in the three dimensions K, A, and P. In terms of the distribution of knowledge dimensions, it is evident that the two questions receiving the highest proportion of respondents choosing the "heard of" option were as follows: "Are you aware that the treatment for allergic rhinitis includes surgical treatment, environmental control, medication, AIT, and health education?" (K1), with a response rate of 60.7%, and "Do you understand that environmental control primarily involves avoiding or reducing exposure to allergens and various irritants?" (K2), with a response rate of 59.3%. Conversely, the two questions garnering the highest proportion of respondents selecting the "not clear" option were: "Do you understand that the mechanism of AIT targets IgE-mediated type I hypersensitivity reactions?" (K6), with 35.8% of respondents indicating uncertainty, and "Do you understand that surgical treatment cannot cure allergic rhinitis?" (K4), with 34.9% expressing ambiguity (as presented in Table 2).

Patients held varying attitudes towards desensitization. Specifically, 50.0% of patients expressed agreement that desensitization had the potential to cure allergic rhinitis (A1), while 57.1% indicated a willingness to consider desensitization as a treatment option (A10). On the contrary, 47.8% of patients acknowledged that they believed desensitization to be both costly and time-consuming (A8), and 49.5% agreed that it was a complex procedure (A9). Notably, 37.1% of patients disagreed with the notion that treatment could be halted once their symptoms had subsided (A5), and 32.5% disagreed with the idea that allergen elimination was unnecessary during desensitization (A6), as illustrated in Table 3.

The analysis of the practice dimension revealed several noteworthy findings. Specifically, 66.2% of the participants reported that they were either currently undergoing or had previously undergone desensitization treatment (P1). Furthermore, a significant majority, amounting to 79.4%, indicated that they had opted for desensitization due to the ineffectiveness of conventional medication (P2). Additionally, a substantial 95.3% of respondents had received desensitization treatment through hypodermic injections (P3). In terms of the frequency with which relevant practices were implemented, it is noteworthy that 42.2% of participants consistently adhered to medical advice (P4), and a comparable percentage of 44.4% consistently

Table 1 Basic Information of Participants and KAP Score

Variables	N(%)	Knowledge Score		Attitude Score		Practice Score	
		Median (25th Percentile, 75th Percentile)	P	Median (25th Percentile, 75th Percentile)	P	Median (25th Percentile, 75th Percentile)	P
Total	550	17(11,23)		20(17,22)		30(24,34)	
Gender			<0.001		0.462		0.025
Male	279(50.7)	17(13,27)		20(16,22)		31(25,35)	
Female	271(49.3)	16(9,19)		20(17,22)		29(24,33)	
Age (years)	35(31,40)	/	/	/	/	/	
Age group (years)			0.180		0.021		0.007
<30	109(19.8)	17(6,19)		21(18,23)		27(21,32)	
30–35	170(30.9)	17(12,23)		19(16,21)		31(25,34)	
35–40	140(25.5)	17(13.5,25.5)		20(16.5,22)		31(25.5,35)	
Above 40	131(23.8)	17(11,25)		20(18,22)		29(24,34)	
Residence			0.011		0.729		0.091
Urban	441(80.2)	17(12,25)		20(17,22)		30(25,34)	
Suburban /rural	109(19.8)	16(6,19)		20(16,22)		29(23,33)	
Education [adjusted]			0.053		0.039		0.143
Below College /undergraduate	145(26.4)	16(10,21)		20(16,21)		29(24,33)	
College /undergraduate and above	405(73.6)	17(11,25)		20(17,22)		30(25,34)	
Occupation [adjusted]			<0.001		0.184		<0.001
Student	132(24.0)	17(15,28)		20(16.5,22)		32(28,37)	
Healthcare professional	55(10.0)	17(12,29)		20(16,23)		27(21,31)	
Employee	121(22.0)	16(6,20)		20(17,22)		29(22,33)	
Public servant (government/ other public institutions)	45(8.2)	16(4,17)		20(19,21)		27(22,32)	
Self-employed	79(14.4)	17(10,21)		21(18,22)		30(27,35)	
Business owner /businessman	83(15.1)	17(12,26)		21(18,22)		30(26,34)	
Other	35(6.4)	12(3,17)		19(16,21)		25(23,32)	
Average monthly household income [adjusted]			<0.001		0.810		0.786
≦5000 CNY	126(22.9)	15.5(8,17)		20(16,22)		29(24,33)	
5000–8000 CNY	139(25.3)	17(9,22)		20(17,22)		30(25,35)	
8000–15000 CNY	167(30.4)	17(13,28)		20(17,22)		29(24,34)	
>15000 CNY	118(21.5)	17(13,27)		20(17,22)		31(25,34)	
Duration of allergic rhinitis [adjusted]			0.021		0.023		<0.001
≤1 year	95(17.3)	15(7,20)		19(16,21)		29(22,32)	
1–3 years	159(28.9)	17(13,24)		20(17,22)		32(26,36)	
3–5 years	107(19.5)	17(12,22)		21(18,22)		30(26,34)	
>5 years	189(34.4)	17(10,25)		20(17,22)		29(23,33)	
Severity of condition			0.586		0.213		0.022
Mild intermittent	211(38.4)	17(12,23)		20(16,22)		29(24,33)	
Mild persistent	174(31.6)	17(11,26)		20(17,22)		30(26,35)	
Moderate-severe intermittent	108(19.6)	17(11,22)		20(16,21)		32(25.5,34)	
Moderate-severe persistent	57(10.4)	17(5,21)		21(18,22)		29(21,32)	
Underwent allergen testing			<0.001		0.307		<0.001
Yes	415(75.5)	17(14,27)		20(17,22)		31(26,35)	
No	135(24.5)	11(2,17)		20(17,21)		25(18,30)	
Engagement in physical activity [adjusted]			<0.001		0.159		<0.001
No	140(25.5)	12(5,17)		20(17.5,22)		25(19.5,30)	
Yes, 1–3 times per week	306(55.6)	17(14,25)		20(16,22)		31(26,35)	
Yes, 3–5 times per week	67(12.2)	17(14,25)		21(17,23)		29(24,34)	
Yes, 5–7 times per week	37(6.7)	17(11,28)		19(16,21)		32(26,35)	

Table 2 Knowledge Dimension of the Participants

	a. Very Familiar	b. Heard of	c. Not Clear
K1. Are you aware that the treatment for allergic rhinitis includes surgical treatment, environmental control, medication, AIT, and health education?	114(20.7)	334(60.7)	102(18.5)
K 2. Do you understand that environmental control primarily involves avoiding or reducing exposure to allergens and various irritants?	169(30.7)	326(59.3)	55(10.0)
K 3. Are you aware that medication treatment can alleviate or improve the symptoms of the disease and is considered symptomatic treatment for allergic rhinitis (ie, addressing symptoms)?	165(30.0)	314(57.1)	71(12.9)
K 4. Do you understand that surgical treatment cannot cure allergic rhinitis?	114(20.7)	244(44.4)	192(34.9)
K 5. Are you aware that AIT, also known as allergen-specific immunotherapy (AIT), can eliminate the root cause of the disease and is considered etiological treatment for allergic rhinitis (ie, addressing the underlying cause)?	139(25.3)	308(56.0)	103(18.7)
K 6. Do you understand that the mechanism of AIT targets IgE-mediated type I hypersensitivity reactions?	99(18.0)	254(46.2)	197(35.8)
K 7. Are you aware that AIT involves gradually increasing doses of allergen extracts (therapeutic vaccines) administered to induce immune tolerance, resulting in reduced or absent clinical symptoms upon subsequent exposure to the corresponding allergen?	133(24.2)	273(49.6)	144(26.2)
K 8. Do you understand that the common methods of AIT in clinical practice are subcutaneous injection and sublingual administration?	164(29.8)	263(47.8)	123(22.4)
K 9. Are you aware that AIT typically consists of two phases: dose escalation and maintenance, with a total treatment duration of 3 years?	185(33.6)	234(42.5)	131(23.8)
K 10. Do you understand that patients deemed suitable for AIT based on comprehensive examinations can initiate treatment in the early stages of the disease without the prerequisite of treatment failure with medications?	121(22.0)	254(46.2)	175(31.8)
K 11(1)Do you understand that AIT is particularly suitable for patients whose symptoms cannot be effectively controlled with conventional medication and allergen avoidance measures?	131(23.8)	283(51.5)	136(24.7)
K 11(2)Do you understand that AIT is particularly suitable for patients who require high doses of medication and/or the concurrent use of multiple medications to control symptoms?	114(20.7)	257(46.7)	179(32.5)
K 11(3)Do you understand that AIT is particularly suitable for patients who experience adverse reactions to medication treatment?	116(21.1)	251(45.6)	183(33.3)
K 11(4)Do you understand that AIT is particularly suitable for patients who wish to avoid long-term medication use?	139(25.3)	272(49.5)	139(25.3)
K 12. Are you aware that AIT can prevent the development of allergic rhinitis into asthma and reduce the development of new sensitivities?	143(26.0)	277(50.4)	130(23.6)
K 13. Do you understand that subcutaneous AIT requires frequent injections, with each administration requiring a visit to the hospital?	217(39.5)	213(38.7)	120(21.8)
K 14. Are you aware that compared to subcutaneous AIT, sublingual AIT has the advantages of being non-invasive, well-tolerated, and safe, and can be self-administered at home after training, but requires daily administration?	139(25.3)	225(40.9)	186(33.8)

Table 3 Attitude Dimension of the Participants

	a. Strongly Agree	b. Agree	c. Neutral	d. Disagree	e. Strongly Disagree
A1. Do you agree that AIT can cure allergic rhinitis?	119(21.6)	275(50.0)	144(26.2)	8(1.5)	4(0.7)
A2. Do you agree that AIT is suitable for any patient with allergic rhinitis?	86(15.6)	209(38.0)	197(35.8)	56(10.2)	2(0.4)
A3. Do you agree that AIT has no side effects?	67(12.2)	132(24.0)	274(49.8)	73(13.3)	4(0.7)
A4. Do you agree that AIT can completely replace medications, especially steroid medications?	69(12.5)	181(32.9)	231(42.0)	64(11.6)	5(0.9)
A5. Do you agree that AIT can be stopped once nasal symptoms are relieved?	50(9.1)	116(21.1)	164(29.8)	204(37.1)	16(2.9)
A6. Do you agree that during AIT, it is not necessary to avoid allergens such as pollen?	60(10.9)	139(25.3)	151(27.5)	179(32.5)	21(3.8)
A7. Do you agree that AIT can reduce the use of medications?	85(15.5)	280(50.9)	154(28.0)	27(4.9)	4(0.7)
A8. Do you agree that AIT is expensive and has a long duration? (open)	74(13.5)	263(47.8)	183(33.3)	22(4.0)	8(1.5)
A9. Do you agree that AIT requires frequent hospital visits and is a complex process? (open)	75(13.6)	272(49.5)	152(27.6)	42(7.6)	9(1.6)
A10. Do you wish to try AIT? (open)	107(19.5)	314(57.1)	122(22.2)	6(1.1)	1(0.2)

maintained a healthy and positive state of mind during their treatment (P11). Moreover, 34.7% of respondents reported that they often took measures to avoid allergens (P5), and 35.6% frequently paid attention to their diet, exercise, and lifestyle habits during the course of their treatment (P10). Interestingly, 25.8% occasionally engaged in self-assessment and recorded their symptoms, medication usage, and quality of life related to their treatment (P9), as detailed in Table 4.

Correlation Analyses

As demonstrated in Table 5, correlation analyses revealed several significant findings. There were negative correlations between knowledge and attitude (r = −0.189, P < 0.001) and between attitude and practice (r = −0.267, P < 0.001). In contrast, a positive correlation was observed between knowledge and practice (r = 0.588, P < 0.001).

Multivariate Logistic Regression

As demonstrated in Table 5, the results of the multivariate logistic regression analysis indicate several significant associations. Specifically, individuals with occupations in healthcare (OR = 0.259, 95% CI: [0.119, 0.564], P = 0.001), employees (OR = 0.460, 95% CI: [0.252, 0.839], P = 0.011), public servants (OR = 0.279, 95% CI: [0.122, 0.637], P = 0.002), and other occupations (OR = 0.241, 95% CI: [0.092, 0.630], P = 0.004), as well as those who had never undergone allergen testing (OR = 0.493, 95% CI: [0.295, 0.826], P = 0.007), and those with lower attitude scores (OR = 0.366, 95% CI: [0.241, 0.556], P < 0.001) were independently associated with negative practices. Conversely, individuals engaging in physical activity 1–3 times per week (OR = 2.895, 95% CI: [1.745, 4.804], P < 0.001), those participating in physical activity 5–7 times per week (OR = 3.811, 95% CI: [1.502, 9.671], P = 0.005), and those with higher knowledge scores (OR = 4.485, 95% CI: [2.942, 6.837], P < 0.001) were independently associated with positive practices, as demonstrated in Table 6.

SEM Results

Following adjustments, we derived a relatively optimal SEM (Figure 1), referred to as model two (as presented in Table 7). Bootstrap analysis results demonstrated that knowledge exerted a significant influence on attitude (β = −0.354, P = 0.010) and practice (β = 0.618, P = 0.010), while attitude also had a notable impact on practice (β = −0.120, P = 0.020). Notably, the indirect effects of knowledge on practice were also found to be statistically significant (β = 0.042, P = 0.020), as indicated in Table 8.

Table 4 Practice Dimension of the Participants

	a. Yes			b. No	
P1 If you have undergone or are undergoing AIT, please answer:	364(66.2)			186(33.8)	
	a. yes			b. no	
P2I underwent AIT after inadequate response to medication treatment.(n=364)(open)	289(79.4)			75(20.6)	
	a. Subcutaneous injection method			b. Sublingual administration method	
P3 The method of my AIT is:(n=364)(open)	347(95.3)			17(4.7)	

	a. always	b. often	c. sometimes	d. occasionally	e. never
P4 Have you followed medical advice for the treatment of allergic rhinitis, such as medication or AIT?	232(42.2)	151(27.5)	75(13.6)	62(11.3)	30(5.5)
P5 Do you stay away from or avoid exposure to potential allergens that could trigger rhinitis?	121(22.0)	191(34.7)	146(26.5)	63(11.5)	29(5.3)
P6Do you undergo regular check-ups during the treatment of allergic rhinitis?	166(30.2)	165(30.0)	88(16.0)	82(14.9)	49(8.9)
P7 Have you actively sought knowledge related to the treatment of allergic rhinitis?	137(24.9)	177(32.2)	145(26.4)	68(12.4)	23(4.2)
P8Do you persist in the use of medications or allergen extracts at the prescribed dosage and frequency, even if your symptoms are relieved?	156(28.4)	168(30.5)	112(20.4)	68(12.4)	46(8.4)
P9Do you assess and record your own relevant symptoms, medication usage, and quality of life?	96(17.5)	138(25.1)	142(25.8)	107(19.5)	67(12.2)
P10Do you pay attention to diet, exercise, and lifestyle habits during the treatment of allergic rhinitis?	113(20.5)	196(35.6)	130(23.6)	76(13.8)	35(6.4)
P11 Do you maintain a healthy and positive mindset during the treatment of allergic rhinitis?	244(44.4)	194(35.3)	68(12.4)	29(5.3)	15(2.7)

Table 5 Correlation Analysis of KAP Scores

	Knowledge	**Attitude**	**Practice**
Knowledge	1.000	−0.189(P<0.001)	0.588(P<0.001)
Attitude	−0.189(P<0.001)	1.000	−0.267(P<0.001)
Practice	0.588(P<0.001)	−0.267(P<0.001)	1.000

Discussion

Patients with allergic rhinitis demonstrated insufficient knowledge, unfavorable attitudes, and suboptimal practices concerning AIT. It is crucial to enhance patient education and awareness about AIT to improve their understanding, attitudes, and adherence to this treatment option, ultimately optimizing the management of allergic rhinitis.

The main research findings of this study reveal that patients suffering from allergic rhinitis exhibit inadequate knowledge, negative attitudes, and proactive practices towards AIT. These findings are in line with previous research in the field of allergic rhinitis, which has consistently highlighted the importance of patient education and engagement in managing chronic condition.[21,22]

The study further investigates the associations between demographic and clinical factors and knowledge, attitude, and practice scores among these patients. Significantly, this study observed gender disparities in knowledge scores, where males outperformed females. This finding contrasts with prior research indicating that females generally display greater proactive engagement regarding their health conditions.[23] Occupation was a significant factor affecting knowledge and

Table 6 Univariable and Multivariable Logistic Regression on Practice

Cutoff:≥30/<30	No.	Univariable		Multivariable (Forward, P<0.1)		Multivariable (Forward, P<0.25)	
		OR(95% CI)	P	OR(95% CI)	P	OR(95% CI)	P
Gender							
Male		ref.					
Female		1.337(0.956,1.870)	0.089				
Age group (years)							
<30		ref.					
30–35		1.801(1.107,2.931)	**0.018**				
35–40		1.789(1.078,2.969)	**0.024**				
Above 40		1.278(0.765,2.134)	0.349				
Residence							
Urban		ref.					
Suburban /rural		0.677(0.443,1.033)	0.070				
Education [adjusted]							
Below College /undergraduate		ref.					
College /undergraduate and above		1.198(0.819,1.751)	0.351				
Occupation [adjusted]							
Student		ref.		ref.		ref.	
Healthcare professional		0.229(0.118,0.448)	**<0.001**	0.259(0.119,0.564)	**0.001**	0.259(0.119,0.564)	**0.001**
Employee		0.350(0.209,0.587)	**<0.001**	0.460(0.252,0.839)	**0.011**	0.460(0.252,0.839)	**0.011**
Public servant (government/ other public institutions)		0.240(0.117,0.490)	**<0.001**	0.279(0.122,0.637)	**0.002**	0.279(0.122,0.637)	**0.002**
Self-employed		0.519(0.291,0.925)	**0.026**	0.653(0.335,1.273)	0.211	0.653(0.335,1.273)	0.211
Business owner /businessman		0.515(0.291,0.910)	**0.022**	0.534(0.277,1.030)	0.061	0.534(0.277,1.030)	0.061
Other		0.199(0.089,0.445)	**<0.001**	0.241(0.092,0.630)	**0.004**	0.241(0.092,0.630)	**0.004**
Average monthly household income [adjusted]							
≦5000 CNY		ref.					
5000–8000 CNY		1.217(0.751,1.972)	0.426				
8000–15000 CNY		1.061(0.668,1.686)	0.801				
>15000 CNY		1.349(0.815,2.233)	0.244				
>15,000							
Duration of allergic rhinitis [adjusted]							
≤1 year		ref.					
1–3 years		1.711(1.024,2.861)	**0.040**				
3–5 years		1.085(0.624,1.886)	0.772				
>5 years		0.816(0.498,1.339)	0.421				
Severity of condition							
Mild intermittent		ref.					
Mild persistent		1.181(0.790,1.766)	0.417				
Moderate-severe intermittent		1.286(0.807,2.049)	0.290				
Moderate-severe persistent		0.696(0.384,1.261)	0.232				
Underwent allergen testing							
Yes		ref.		ref.		ref.	
No		0.280(0.183,0.427)	**<0.001**	0.493(0.295,0.826)	**0.007**	0.493(0.295,0.826)	**0.007**

(*Continued*)

Table 6 (Continued).

Cutoff:≥30/<30	No.	Univariable		Multivariable (Forward, P<0.1)		Multivariable (Forward, P<0.25)	
		OR(95% CI)	P	OR(95% CI)	P	OR(95% CI)	P
Engagement in physical activity [adjusted]							
No		ref.		ref.		ref.	
Yes, 1–3 times per week		3.960(2.563,6.116)	<0.001	2.895(1.745,4.804)	<0.001	2.895(1.745,4.804)	<0.001
Yes, 3–5 times per week		2.368(1.293,4.337)	0.005	1.538(0.763,3.101)	0.229	1.538(0.763,3.101)	0.229
Yes, 5–7 times per week		4.781(2.215,10.321)	<0.001	3.811(1.502,9.671)	0.005	3.811(1.502,9.671)	0.005
Knowledge score							
<17		ref.		ref.		ref.	
≥17		6.530(4.485,9.508)	<0.001	4.485(2.942,6.837)	<0.001	4.485(2.942,6.837)	<0.001
Attitude score							
<20		ref.		ref.		ref.	
≥20		0.391(0.276,0.553)	<0.001	0.366(0.241,0.556)	<0.001	0.366(0.241,0.556)	<0.001

practice scores, with healthcare professionals and students scoring higher. This finding underscores the importance of targeted educational interventions for patients from different occupational backgrounds. Moreover, the duration and severity of allergic rhinitis were associated with knowledge, attitude, and practice scores, suggesting that patients with longer-standing and more severe conditions may require specialized support and guidance.

The results of the multivariate logistic regression analysis provide further insights into factors independently associated with negative and positive practices. Occupation in healthcare, employees, public servants, and other occupations were associated with negative practices, indicating a need for tailored interventions for individuals in these occupational groups. Conversely, engaging in regular physical activity and having higher knowledge scores were associated with positive practices, emphasizing the role of physical activity and knowledge dissemination in improving patient outcomes. Based on the findings, it is recommended to develop customized interventions for occupational groups such as healthcare workers, employees, and public servants, as they exhibited negative practices in relation to AIT. Concurrently, efforts should focus on promoting regular physical activity and disseminating knowledge effectively to enhance patient outcomes, while also addressing negative attitudes through cognitive-behavioral approaches and involving patients in shared decision-making processes to empower their treatment choices.[24,25] Regular follow-up and monitoring mechanisms should be established to track patient progress, identify challenges, and provide necessary support and adjustments to treatment plans.[26,27]

In addressing the notable positive practice scores among teenagers, several potential explanations can be considered. First, teenagers often receive robust family support, which might encourage more proactive management of their condition and openness to new treatments. Additionally, their frequent engagement with social media might facilitate more effective dissemination and uptake of health information pertinent to managing allergic conditions. Moreover, the healthcare professionals in our study, who might not specialize in allergology, could face challenges in self-managing due to inadequate specific knowledge and the high demands of their work.

Correlation analyses revealed significant relationships between knowledge, attitude, and practice, highlighting the interdependence of these factors in managing allergic rhinitis. The positive correlation between knowledge and practice suggests that increasing patient knowledge can lead to better adherence to recommended practices. On the other hand, the negative correlation between attitude and practice underscores the need to address negative attitudes and beliefs that may hinder proactive behavior. The SEM analysis in this study demonstrated that knowledge significantly influenced attitude and practice, with attitude also influencing practice. These findings reinforce the importance of knowledge dissemination and attitude modification in promoting positive practices among patients with allergic rhinitis. The significant indirect effect of knowledge on practice further highlights the multifaceted nature of patient behavior and the need for
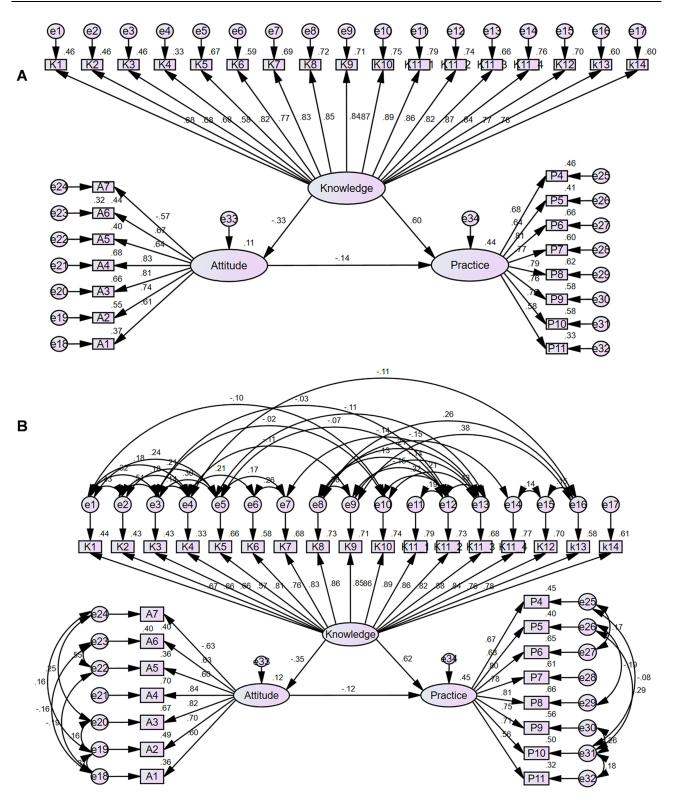
Figure 1 The Structural Equation Model (SEM) Before and After Model Adjustment. (**A**) Before Model Adjustment; (**B**) After Model Adjustment. Rectangle shows observed variables, ellipses indicate potential variables, and circles represent residual terms.

comprehensive interventions that target both knowledge and attitude. It is recommended to implement integrated educational programs that emphasize these relationships and focus on attitude modification. Psychosocial support should be incorporated into patient care to address negative attitudes, and targeted behavior change interventions such as

Table 7 The Fit Indices of the Structural Equation Model (SEM) Before and After Model Adjustment

Indicators	Ideal Standard	Acceptable Standard	Model Before Adjustment (Model One)	Model After Adjustment (Model Two)
CMIN/DF value	<3	<5	5.346	2.429
RMSEA value	<0.05	<0.07	0.089	0.051
GFI value	>0.9	>0.8	0.735	0.894
AGFI value	>0.9	>0.8	0.696	0.865

Table 8 Bootstrap Analysis of Mediating Effect Significance Test for the Final Mode

Models	Standardized Direct Effects	P	95% CI		Standardized Indirect Effects	P	95% CI	
			LLCI	ULCI			LLCI	ULCI
K-A	−0.354	0.010	−0.457	−0.238	-	-	-	-
K-P	0.618	0.010	0.547	0.689	-	-	-	-
A-P	−0.120	0.020	−0.220	−0.023	-	-	-	-
K-P	-	-	-	-	0.042	0.020	0.009	0.074

motivational interviewing and cognitive-behavioral therapy should be employed.[28,29] Encouraging patient-centered decision-making and establishing long-term follow-up and reinforcement mechanisms can further enhance positive practices and patient outcomes in the management of allergic rhinitis.[30]

The knowledge dimension revealed a notable gap in knowledge among participants, particularly regarding the details of AIT. For instance, a significant portion of participants were not clear about the existence of AIT (18.5%) or did not understand its mechanisms (35.8%). Furthermore, a considerable number of participants held misconceptions, such as believing that AIT can cure allergic rhinitis (26.2%) or has no side effects (49.8%). To address the gaps in knowledge identified among participants, healthcare providers should prioritize patient education. They should offer clear and comprehensive information about allergic rhinitis treatment options, including AIT. Utilizing a variety of educational materials such as brochures, websites, and multimedia resources can enhance patient knowledge. Additionally, one-on-one counseling sessions with healthcare professionals can provide opportunities for patients to ask questions and clarify any misconceptions.[31,32]

When analyzing the participants' attitudes, it is evident that misconceptions and unrealistic expectations regarding AIT exist. For instance, a substantial proportion of participants believed that AIT can cure allergic rhinitis (21.6%) or completely replace medications, especially steroid medications (42.0%). Such attitudes may lead to unrealistic expectations and potentially impact treatment adherence. To mitigate unrealistic attitudes and misconceptions, healthcare providers should engage in open and transparent discussions with patients. It is essential to provide realistic expectations for AIT, emphasizing both its benefits and limitations. Patient education should include discussions about the therapy's role in managing allergic rhinitis rather than promising a cure. This approach helps align patient attitudes with the actual capabilities of AIT.[33,34]

Regarding the participants' practices, a positive aspect is that a significant number have either undergone (66.2%) or are undergoing AIT. However, it is concerning that a substantial portion of participants did not follow medical advice for allergic rhinitis treatment (41.8%) or did not actively seek knowledge related to treatment (41.6%). Additionally, some participants did not stay away from potential allergens (43.5%) or maintain regular check-ups (43.9%). To improve patient practices, healthcare systems should implement structured follow-up and monitoring mechanisms. Regular check-ups and assessments can help track patient progress and address any barriers or concerns they may face during treatment. These follow-up appointments also provide opportunities for healthcare professionals to reinforce treatment recommendations and educate patients on the importance of treatment adherence.[34,35] Patients should also be encouraged to actively

seek knowledge and engage in self-management of their condition. Support groups and online forums can facilitate information exchange and provide a sense of community among patients.

This study had several limitations that should be considered when interpreting its findings. Firstly, it was conducted at a single hospital, which may limit the generalizability of the results to a broader population of patients with allergic rhinitis. Additionally, the data relied on self-reported responses from participants, introducing the potential for recall bias or social desirability bias, which could affect the accuracy of reported knowledge, attitudes, and practices. Lastly, the cross-sectional design of the study allows for the observation of associations but does not establish causality. Despite these limitations, the study provides valuable insights into patient perspectives on AIT for allergic rhinitis, offering a foundation for targeted interventions to enhance patient understanding and engagement with this treatment option. Moreover, this study did not distinguish between the allergens responsible for allergic rhinitis in the analysis, precluding any comparison of KAP based on different allergens. This limitation highlights an area for future research that could significantly contribute to tailored patient education and management strategies.

Conclusion

In conclusion, patients with allergic rhinitis demonstrated insufficient knowledge, unfavorable attitudes, and suboptimal practices regarding AIT. These findings emphasize the need for targeted educational interventions and counseling for patients with allergic rhinitis to enhance their understanding, foster more positive attitudes, and encourage proactive engagement in AIT, ultimately improving treatment outcomes and patient well-being.

Author Contributions

Xiaofan Fan and Jintang Zhang carried out the studies, participated in collecting data, and drafted the manuscript. Xiaofan Fan and Jintang Zhang performed the statistical analysis and participated in its design. Xiaofan Fan and Jintang Zhang participated in acquisition, analysis, or interpretation of data and draft the manuscript. All authors read and approved the final manuscript. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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