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Acoustic Characteristics of Voice in Patients with Allergic Rhinitis

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【**Abstract**】***Objective*** Allergic rhinitis (AR) is a chronic IgE-mediated inflammatory disease of the nasal mucosa that may affect voice quality through altered nasal resonance, respiratory-laryngeal coordination, and laryngeal function. However, existing studies have mainly focused on vocal fold lesions, and the impact of abnormal nasal resonance function on voice in AR patients remains insufficiently explored. This study aimed to investigate abnormalities in voice acoustic parameters in patients with AR and their correlation with disease severity, thereby providing preliminary evidence for clinical evaluation. ***Methods*** This case-control study enrolled 34 patients with AR and 34 healthy controls matched by sex and age group. Participants were aged 18-35 years, and each group included 30 females and 4 males. AR was diagnosed according to clinical criteria at a tertiary grade-A hospital (a high-level referral hospital in China's hospital grading system), with an SFAR score ⩾ 7 and at least one positive result from a skin prick test (SPT) or serum specific IgE (sIgE) to common aeroallergens. Individuals with vocal fold lesions, chronic pharyngitis, asthma, gastroesophageal reflux disease, chronic cough, postnasal drip syndrome, smoking history, or occupational voice use were excluded. Subjective voice impairment was assessed using the Voice Handicap Index-30 (VHI-30). Patients with AR also completed the Total Nasal Symptom Score (TNSS) and Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ). Acoustic parameters, including s/z ratio, Maximum Phonation Time (MPT), Maximum Counting Ability (MCA), Fundamental Frequency (F0), Jitter, Shimmer, and Normalized Noise Energy (NNE), were measured using the Dr. Speech™ computerized voice assessment and acoustic analysis system under standardized conditions. All recordings were performed in a quiet room with background noise ⩽ 30 dB(A), with the microphone placed 15 cm from the mouth at a 45° angle. Statistical analyses were performed using SPSS 26.0. Between-group comparisons and correlation analyses were conducted. Because of the limited sample size, multivariate regression, ROC curve analysis, and diagnostic performance analysis were not performed. ***Results*** The AR group exhibited significantly higher VHI-30 scores and s/z ratio, and significantly lower MPT and MCA than the control group (all $P < 0.01$). Shimmer and NNE were significantly higher in the AR group ($P < 0.05$ and $P < 0.01$, respectively), while F0 and Jitter showed no significant differences ($P > 0.05$). TNSS was positively correlated with RQLQ ($r = 0.528$, $P = 0.001$) and VHI-30 ($r = 0.427$, $P = 0.012$); RQLQ was positively correlated with s/z ratio ($r = 0.358$, $P = 0.037$) and negatively correlated with MCA ($r = -0.407$, $P = 0.017$). Correlation analyses did not adjust for age, gender, disease duration, or symptom severity. ***Conclusion*** Patients with AR showed greater subjective voice handicap and differences in selected voice parameters. These findings do not support classifying the entire AR group as having subclinical voice dysfunction. The diagnostic or predictive utility of the observed acoustic differences requires further validation.

【**Key words**】Allergic rhinitis; Voice characteristics; Voice handicap index; Acoustic parameters; Voice dysfunction

Allergic rhinitis (AR) is a chronic non-infectious inflammation of the nasal mucosa mediated by immunoglobulin E (IgE). Clinically, it is characterized by nasal congestion, rhinorrhea, sneezing, and nasal mucosal edema. Some patients may also experience non-nasal symptoms such as decreased sense of smell and sleep disorders, significantly reducing their quality of life and causing a socioeconomic burden[1,2]. Epidemiological surveys show that the global prevalence of AR in adults is approximately 40%[3], and about 13.26% of adults in China suffer from AR, with a prevalence as high as 14.51% in East China[4]. Due to its prolonged and recurrent nature, AR has become an important issue in the global public health field.

Voice, as the primary medium of human communication, depends on synergistic effects of respiratory dynamics, vocal fold vibration, nasal resonance, and articulatory organs. The nasal cavity is an important resonating cavity. Abnormal anatomical structure or function of the nasal cavity (such as mucosal swelling and secretion retention caused by AR) may change the aerodynamic

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characteristics and resonance frequency, thus affecting voice quality[5]. However, existing studies on voice disorders mostly focus on lesions of vibratory organs such as the vocal cords, and there is a relative lack of exploration on the impact of abnormal nasal resonance function caused by AR on voice function. Although the Voice Handicap Index (VHI) has been widely used for subjective assessment[6-8], its results are susceptible to interference from patients' subjective statements and evaluators' experience differences. Therefore, objective acoustic parameters should be incorporated to complement subjective assessment.

This study focused on subjective voice handicap and acoustic voice characteristics in young adults with AR. We aimed to explore the multidimensional characteristics of voice (VHI-30 scale) with objective acoustic parameter analysis (such as MPT, Shimmer, and NNE). This approach complements existing research focusing on vocal fold lesions. In addition, by strictly controlling confounding factors (such as excluding drug interference, occupational voice users, etc.), the reliability of the results was ensured. These findings may provide a theoretical basis for optimizing the diagnosis and management strategies for AR and voice disorders.

1 Materials and Methods

1.1 General Information

1.1.1 Subject This case-control study recruited participants from Zhejiang Chinese Medical University and Zhejiang Vocational and Technical College of Commerce. Patients with AR were recruited from these two institutions and had a documented diagnosis of AR confirmed by physicians at a tertiary grade-A hospital according to clinical diagnostic criteria. In China's hospital classification system, tertiary hospitals provide specialist care for complex conditions, and grade A denotes a high accreditation standard for service capacity, quality, and management. Healthy controls were recruited from the same institutions and matched to patients with AR by sex and age group. In the initial screening stage, a total of 90 questionnaires were distributed (50 to individuals with suspected AR and 40 to potential healthy controls). Valid data were preliminarily screened by questionnaire completion time (excluding < 120 seconds) and internal logical consistency. After applying the pre-established inclusion and exclusion criteria, 16 individuals with suspected AR were excluded for the following reasons: SFAR score < 7 , lack of objective allergy evidence, meeting exclusion criteria such as smoking, occupational voice use, or comorbid conditions affecting voice, and refusal to participate. In the control group, 6 individuals were excluded due to SFAR score ⩾ 7 or presence of allergic symptoms, meeting exclusion criteria, and refusal to participate. Finally, 34 eligible patients with AR (30 females and 4 males, aged 18-35 years) and 34 matched healthy controls were included. This study received ethics approval (approval no. KL20261015-08). All participants signed informed consent forms. Patients with AR completed the Voice Handicap Index-30 (VHI-30) , Total Nasal Symptom Score (TNSS) , and Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ) , while controls completed the VHI-30. Both groups underwent acoustic parameter collection using professional equipment, including Jitter, Shimmer, and NNE.

1.1.2 Inclusion criteria AR group: (1) Documented diagnosis of AR confirmed at a tertiary grade-A hospital according to the clinical diagnostic criteria[9] , with typical nasal symptoms (paroxysmal sneezing, watery nasal discharge, nasal itching, nasal congestion, etc.) and an SFAR score ⩾ 7. Additionally, all patients with AR had at least one positive result from either a skin prick test (SPT) or serum specific IgE (sIgE) to common aeroallergens. (2) No use of antihistamines, allergen barriers, or nasal steroids within 4 weeks before acoustic parameter collection[10].

Control group: (1) No history of nasal polyps, sinusitis, or allergic symptoms, and an SFAR score < 7. (2) No use of antihistamines, allergen barriers, or nasal steroids within 4 weeks before acoustic parameter collection.

1.1.3 Exclusion criteria (1) Concomitant diseases that may affect the voice, including vocal polyps, vocal nodules, laryngeal tumors, chronic pharyngitis, asthma, gastroesophageal reflux disease (GERD) , chronic cough, or postnasal drip syndrome. (2) Patients with a recent history of throat surgery, trauma, or voice therapy. (3) Patients with neurological disorders, mental illnesses, or cognitive impairments that may affect cooperation. (4) Smoking history, occupational voice users (teachers, salespeople, singers, theater actors)[11].

1.2 Experimental Equipment

The Dr. Speech™ computerized voice assessment and acoustic analysis system（Shanghai Taiyige Rehabilitation Medical Technology Co.，Ltd.）was used to collect and analyze voice acoustic parameters.

1.3 Research methodology

1.3.1 Clinical data collection Demographic characteristics and clinical history data were collected through structured questionnaires，including：（1）demographic information：age，gender，occupation；（2）disease characteristics：Type of allergic rhinitis（seasonal/perennial），duration of illness（months/year），family history of allergic diseases，smoking history；（3）exclusion of other possible comorbidities of throat disease，vocal cord organic lesions，neurological disorders，as well as asthma，gastroesophageal reflux disease，chronic cough，and postnasal drip syndrome.

1.3.2 AR-related symptoms and quality of life assessment SFAR（Score for Allergic Rhinitis）was used for screening patients with AR，including 8 items that quantify medical history and symptoms. The total score is 0-16 points，with 7 points as the critical value，⩾ 7 points as positive，and < 7 points as negative[12]. The scale has demonstrated good sensitivity and diagnostic efficacy in AR diagnosis，and its results are in good agreement with the diagnosis of skin prick test. It has been widely used by researchers in China and abroad in the clinical diagnosis and treatment of AR[13].

TNSS（Total Nasal Symptom Score）is a standardized tool used to assess the severity of nasal symptoms in patients with AR，covering four core symptoms：nasal congestion，rhinorrhea，nasal itching，and sneezing. Each symptom is scored on a scale of 0-3（asymptomatic to severe），with a total score range of 0-12 points. The higher the score，the more significant the nasal symptoms. It has the characteristics of easy operation and high clinical consistency，and is widely used in drug efficacy evaluation and disease severity stratification.

RQLQ（Rhinoconjunctivitis Quality of Life Questionnaire），as a tool for assessing the quality of life of patients with rhinitis，consists of 28 items（standard version）or 7 dimensions（activity，sleep，non nasal/eye symptoms，actual problems，nasal symptoms，eye symptoms，and emotions），using a Likert seven point scale（0-6 points），with a total score range of 0-126 points. The higher the score，the more severe the impairment of quality of life. It can sensitively reflect the multidimensional impairment of patients' physiological，psychological，and social functions，and is one of the core indicators in the study of allergic rhinitis.

1.3.3 Assessment of Voice Handicap Index The Voice Handicap Index-30（VHI-30）is a standardized assessment tool for evaluating voice dysfunction，covering three dimensions：functional（10 items），physiological（10 items），and emotional（10 items）[14]. It uses the five-point Likert scoring method（0-4 points），with a total score range of 0-120 points，and can reflect the multi-level impact of voice disorders in patients with AR in detail. The multidimensional design of VHI-30 can comprehensively capture such complex impacts，while the simplified version of VHI-10 may miss key information such as emotional aspects due to the limited number of items[15].

A study in China[16] used the VHI-30 to evaluate AR-related voice disorders. Using this scale enhanced the comparability of results and facilitated cross-study data integration and evidence-based practice. In addition，the Chinese version of VHI-30 has undergone cross-cultural adaptation and reliability and validity verification，and its high internal consistency and validity can systematically capture the details of patients' subjective perception of voice function impairment，providing multidimensional support for laryngoscopy examination，acoustic analysis，and treatment strategy optimization，especially in the evaluation of complex voice disorders（such as neurogenic or organic lesions），for which it has irreplaceable clinical value.

1.3.4 Acoustic parameter measurement

（1）Equipment calibration and parameter setting

The measurements were performed in a quiet indoor environment with background noise intensity ⩽ 30 dB（A）. Participants were seated with their mouths 15 cm from the microphone，and the microphone was placed at a 45° angle to the horizontal plane. Signal acquisition parameters were as follows：sampling frequency 44.1 kHz，gain 25 dB，and bandwidth 5 kHz.

（2）Acoustic parameter measurement process

① s/z ratio：Participants were instructed to take a deep breath through the mouth and continuously produce the /s/ sound at a comfortable pitch and intensity as long as

possible. After a 1-minute interval, the same method was used to produce the /z/ sound. The s/z ratio was calculated as the longest /s/ duration divided by the longest /z/ duration. ② Maximum Phonation Time (MPT): After taking a deep breath, the subject continuously produced the /a/ sound in a comfortable tone until exhaustion. The task was repeated three times with a 2-minute interval, and recording the maximum value. ③ Maximum Counting Ability (MCA): After taking a deep breath, the subject continuously counted "1" at a consistent frequency, intensity, and speed, and the maximum duration was recorded. ④ Average speech fundamental frequency (F_0): Participants read the standardized Chinese sentence "Mom loves baby, baby loves mom" at a natural pace. After unstable segments at the beginning and end were removed, a 1-second steady-state segment from the middle of the recording was used to calculate the mean F0. ⑤ Fundamental frequency perturbation (Jitter), amplitude perturbation (Shimmer), and NNE: The subject pronounced a steady-state vowel /æ/ for 3-5 seconds. A 1-second segment with signal strength > 65 dB and a stable waveform was selected, the parameters were calculated through software, and the minimum value of 3 measurements was taken.

1.3.5 Statistical analysis SPSS 26.0 was used for data analysis. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. The Shapiro-Wilk test was used to assess normality, and Levene's test was used to assess homogeneity of variance. For between-group comparisons, independent-samples *t*-tests were used for continuous variables that met normality and homogeneity assumptions; otherwise, the Mann-Whitney *U* test was used. Chi-square tests were used for categorical variables. For correlation analysis, Pearson correlation coefficients (r) were calculated between clinical scores and voice parameters in the AR group. Due to the limited sample size, multivariate regression, ROC curve analysis, and diagnostic performance analysis were not performed. A two-tailed $P < 0.05$ was considered statistically significant.

2 Results

2.1 Basic information comparison

This study included 34 patients with AR and 34 healthy controls, with balanced age and gender distribution between the two groups (Table 1). The AR group mainly consisted of individuals aged 18-25 years (29 cases, 85.3%), while those aged 26-35 years accounted for 14.7% (5 cases). The age distribution of the control group matched that of the AR group. Both groups had 30 females and 4 males, with no significant difference in gender ratio ($P > 0.05$).

Table 1 Comparison of basic information between two groups[n(%)]

Characteristic	AR group	Control group	*P* value
Age			1.000
18-25 years	29 (85.3)	29 (85.3)	
26-35 years	5 (14.7)	5 (14.7)	
Gender			1.000
Female	30 (88.2)	30 (88.2)	
Male	4 (11.8)	4 (11.8)	

Note: Data are presented as *n* (%). Each group included 34 participants. AR, allergic rhinitis. *P* values are for between-group comparisons

2.2 Analysis of aerodynamic parameters

The AR group showed significantly lower MPT and MCA but a significantly higher s/z ratio than the control group (all $P < 0.01$). Specifically, MPT and MCA were significantly shorter in the AR group, whereas the s/z ratio was significantly higher in the AR group (Table 2).

Table 2 Comparison of differences in aerodynamic parameters between two groups

	MPT (s)	MCA (s)	s/z ratio
AR group	9.34 ± 2.49	10.50 ± 2.89	1.29 ± 0.33
Control group	12.07 ± 3.00	13.21 ± 1.95	1.06 ± 0.30
P value	< 0.01	< 0.01	< 0.01

Note: Data are presented as mean ± standard deviation (n = 34 per group). AR, allergic rhinitis; MPT, maximum phonation time; MCA, maximum counting ability; s/z ratio, maximum /s/ duration divided by maximum /z/ duration. *P* values are for between-group comparisons.

2.3 Comparison of subjective and acoustic voice parameters

The AR group had significantly higher VHI-30, Shimmer, and NNE than the control group, while F0 and Jitter showed no significant differences. Specifically, VHI-30 was significantly higher in the AR group, indicating more severe subjective voice impairment; Shimmer was significantly higher in the AR group; and NNE was significantly higher (less negative) in the AR group (Table 3).

2.4 Correlation analysis

The TNSS score was positively correlated with the VHI-30 score ($r = 0.427$, $P = 0.012$), indicating that more

Table 3 Comparison of differences in voice parameters between two groups

	VHI-30	F0 (Hz)	Jitter (%)	Shimmer (%)	NNE (dB)
AR group	38.12 ± 8.02	214.71 ± 38.27	0.29 ± 0.16	2.53 ± 1.22	−10.67 ± 4.57
Control group	13.32 ± 11.07	227.76 ± 45.29	0.24 ± 0.08	1.72 ± 0.58	−14.37 ± 3.44
P value	< 0.01	> 0.05	> 0.05	< 0.05	< 0.01

Note: Data are presented as mean ± standard deviation (n = 34 per group). AR, allergic rhinitis; VHI-30, Voice Handicap Index-30; F0, fundamental frequency; Jitter, frequency perturbation; Shimmer, amplitude perturbation; NNE, normalized noise energy. *P* values are for between-group comparisons

severe nasal symptoms were associated with greater subjective voice handicap. The RQLQ score was positively correlated with TNSS (r = 0.528, P = 0.001) and s/z ratio (r = 0.358, P = 0.037), and negatively correlated with MCA (r = −0.407, P = 0.017) (Table 4).

Table 4 Correlation analysis between clinical scores and acoustic parameters in AR group

Scale	TNSS	MPT	MCA	s/z ratio	Jitter	Shimmer	NNE
VHI-30	r = 0.427, P = 0.012	-	-	-	-	-	-
RQLQ	r = 0.528, P = 0.001	-	r = -0.407, P = 0.017	r = 0.358, P = 0.037	-	-	-

Note: Values are Pearson correlation coefficients (r) and corresponding two-tailed *P* values for the AR group (n = 34). A dash indicates a result not reported in this table. AR, allergic rhinitis; VHI-30, Voice Handicap Index-30; TNSS, Total Nasal Symptom Score; RQLQ, Rhinoconjunctivitis Quality of Life Questionnaire; MPT, maximum phonation time; MCA, maximum counting ability; s/z ratio, maximum /s/ duration divided by maximum /z/ duration; Jitter, frequency perturbation; Shimmer, amplitude perturbation; NNE, normalized noise energy

3 Discussion

Allergic rhinitis is one of the most common allergic diseases. In recent years, with the rapid urbanization and lifestyle change under the rapid development of social economy, the prevalence of AR has increased significantly, seriously affecting the quality of life of patients[17]. The united airway disease concept views the upper and lower airways as a continuous functional unit. Their tissue morphology and physiological function are similar, and inflammatory reactions often affect each other[18].

3.1 Analysis of acoustic parameter results

MPT is the longest duration of sustained vowel /a/ after an individual takes a deep breath, which can measure the ability to support speech and breathing. The MPT of the AR group was significantly shorter than that of the control group (P < 0.01), which is consistent with the research results of Li et al[16]. One possible explanation is an imbalance of laryngeal airflow associated with nasal obstruction and oral breathing, although this mechanism was not directly measured; this finding is also consistent with the description of decreased respiratory-laryngeal coordination in patients with allergic rhinitis during pollen season in foreign studies[8]. The s/z ratio can effectively reflect the glottal regulation during pronunciation and is one of the criteria for judging speech respiratory diseases; the s/z ratio does not differ significantly by age or gender, and is approximately 1. In this study, the s/z ratio of the AR group was 1.29 ± 0.33 (P < 0.01), which is in the range of 1.2-1.4, consistent with the increasing trend of s/z ratio in patients with AR reported by Koç et al[19], suggesting possible functional voice alterations in this group. MCA reflects the coordination between exhalation and vocalization, as well as the level of respiratory control during speech. When counting, people need the laryngeal muscles to perform orderly contraction and relaxation movements, as well as exhalation movements combined with laryngeal muscle movements. The decrease in MCA and increase in s/z ratio in the AR group (both P < 0.01) may be related to altered respiratory airflow control, a possible explanation that requires direct testing.

Jitter and Shimmer are important acoustic parameters for evaluating laryngeal function, used to assess the degree of F0 fluctuations and amplitude disturbances during the vocal cycle. Together, they form a quantitative indicator of vocal fold vibration stability. The smaller the value, the better the periodic regularity of the acoustic signal generated by laryngeal vibration during the vocal process. From a physiological mechanism perspective, the changes in acoustic characteristics of this type are mainly attributed to differences in vocal cord mass, tension, and biomechanical properties. In theory, the biomechanical properties of the vocal cords are closely related to the thickness, elasticity, and viscosity of the liquid layer on the surface of the vocal cords[20]. In this study, the Shimmer value of the AR group was significantly higher

than that of the control group ($P < 0.05$), indicating an increased fluctuation in vocal cord vibration amplitude. Possible explanations for this finding include the following speculative mechanisms: 1. Throat mucosal edema: Inflammatory mediators in AR (such as histamine) may contribute to congestion and edema of the vocal cord mucosa, potentially increasing vibration resistance. 2. Neural reflex regulation[5]: Nasal inflammation might indirectly affect laryngeal muscle tone and interfere with vocal cord coordination through the trigeminal vagus nerve pathway. However, these mechanisms were not directly measured in this study. In addition, the NNE value in the AR group was significantly higher (less negative) than that in the control group ($P < 0.01$), indicating increased noise energy. This finding does not establish incomplete glottal closure. This finding should be interpreted with caution, as the direction and magnitude of NNE changes have varied across studies, and glottal closure was not directly visualized. The following factors may be involved: 1. Mechanical stimulation of postnasal drip[21]: Although clinical postnasal drip syndrome was excluded, subclinical postnasal drip may still exist and cannot be fully ruled out. If present, nasal secretions reaching the larynx could interfere with glottal closure. 2. Spread of airway inflammation: AR related inflammatory mediators (such as IL-4 and CysLTs) may affect the larynx through a unified airway model, potentially inducing vocal cord edema and incomplete closure. However, there was no significant difference in the F0 and Jitter between the two groups ($P > 0.05$). One possible explanation is altered nasal resonance without detectable changes in F0 or Jitter. Young patients may also maintain F0 stability through compensatory regulatory mechanisms, such as enhancing the tone of the cricothyroid muscle.

Wang[22] and Grazyna[23] reported elevated Jitter, Shimmer, and NNE in children with rhinitis, which differs from our findings in adults. Possible reasons are as follows: on the one hand, there are multidimensional differences in allergic mechanisms between children and adults in terms of tissue structure, immune response, and exposure characteristics[24], which significantly increase the risk of allergies in children compared to adults. On the other hand, significant differences in nasal anatomy and physiological function between children and adults[25] may also lead to age-specific changes in the acoustic characteristics of rhinitis-related voice disorders. This anatomical and functional specificity may make the Jitter/Shimmer/NNE elevation observed in the study by Wang Jindong and Grazyna et al. specific to the pediatric population, while the adult population may exhibit different characteristics of the impact mechanism of allergic rhinitis on voice due to the completion of sinus development (maxillary sinus maturation at 12 years old, frontal sinus formation at 15 years old) and the balance of the immune system.

Although there were significant differences in subjective voice assessment (VHI-30) and multiple objective parameters (such as MPT, Shimmer, NNE) between the AR group and the control group (all $P < 0.05$), these group differences do not establish individual clinical abnormality. The mean VHI-30 score was 38.12 ± 8.02 in the AR group, compared with 13.32 ± 11.07 in controls, indicating greater self-perceived voice handicap. These findings do not support classifying the entire AR group as asymptomatic or as having subclinical voice dysfunction. Group means and standard deviations do not identify the symptom status of each participant. Individual VHI-30 scores and symptom data are required to assess group heterogeneity through subgroup analysis. Acoustic normality cannot be determined without validated Dr. Speech reference intervals for this protocol, and acoustic findings alone cannot establish the absence of organic vocal fold damage. The diagnostic or predictive value of these changes was not established in this cross-sectional study; longitudinal studies with ROC analysis are needed. It should be noted that antihistamines can be used to treat allergic diseases, but all antihistamines have a drying effect on upper respiratory secretions. Previous studies[26] have pointed out that antihistamines (especially the first generation) reduce laryngeal lubricity and affect laryngeal function by inhibiting mucus secretion and anticholinergic drying effects. In this experiment, users of antihistamines within 4 weeks prior to data collection were excluded to avoid direct interference of drug drying effects on the biomechanical properties of vocal cords.

Absolute acoustic values should not be assumed to be interchangeable between Dr. Speech and other systems[27]. Comparisons with Praat and other systems show that agreement depends on the parameter and study

conditions[28,29]. Accordingly, Shimmer and NNE are interpreted as within-study group comparisons. Standardized voice-assessment protocols and sample-specific reliability estimates are needed for clinical interpretation[30].

3.2 Correlation analysis

In the AR group, TNSS was positively correlated with RQLQ ($r = 0.528$, $P < 0.01$) and VHI-30 ($r = 0.427$, $P < 0.05$). RQLQ was positively correlated with s/z ratio ($r = 0.358$, $P = 0.037$) and negatively correlated with MCA ($r = -0.407$, $P < 0.05$). These findings indicate that more severe nasal symptoms were associated with greater impairment in quality of life and subjective voice handicap, while poorer quality of life was associated with reduced vocal efficiency. Given the cross-sectional design, these correlations should be interpreted as associations rather than causal relationships. Nasal congestion may contribute to mouth breathing and altered laryngeal airflow dynamics, and nasal inflammation may influence laryngeal muscle tone through neural reflexes; however, these mechanisms were not directly measured in this study. Altered respiratory-laryngeal coordination is a possible explanation for the association between RQLQ and MCA, but interventional studies are needed to test whether improving nasal ventilation can enhance vocal efficiency.

3.3 Limitations

Several limitations should be acknowledged. The sample size was relatively small and predominantly consisted of young women, limiting generalizability. Selection bias may exist due to the screening process from 90 distributed questionnaires to 34 patients with AR and 34 controls, and requiring SPT or sIgE positivity may have excluded some clinically diagnosed patients with AR. In addition, comorbidities were excluded based on self-report and clinical history, and subclinical conditions may still affect voice. Test-retest reliability and inter-rater agreement were not formally evaluated in this sample. The absence of suitable repeated-measurement data precluded additional reliability analyses. System-specific normative classification was not established. Future studies should include larger, more balanced samples and multimodal assessments.

4 Conclusion

In summary, this study identified group-level differences in subjective voice handicap and selected voice parameters in patients with AR. Compared with healthy controls, patients with AR showed significantly higher VHI-30 and s/z ratio, lower MPT and MCA, and higher Shimmer and NNE, while F0 and Jitter did not differ. Correlation analysis showed that more severe nasal symptoms were associated with greater subjective voice handicap and poorer quality of life. These associations should be interpreted as exploratory because the cross-sectional design and lack of adjustment for potential confounders preclude causal interpretation.

Shimmer and NNE differed between groups, but their diagnostic utility requires further validation. The proposed mechanisms remain possible explanations and were not directly tested. Future longitudinal studies with larger, more balanced samples, multivariate adjustment, multimodal assessments, and diagnostic performance analysis are warranted to confirm these findings.

References

[1] Jiang WX, Zhang JJ, Ma XQ, et al. Acupoint selection patterns for moxibustion in the treatment of allergic rhinitis[J]. Chinese. Zhejiang Clin Med J. 2022;24(4):537-539.

[2] Wu LS, Liu YC, Wang CW. Progress in the treatment of allergic rhinitis [J]. Chinese. Xinjiang J Tradit Chin Med. 2024;42(3):128-131.

[3] Brożek JL, Bousquet J, Agache I, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines—2016 revision. J Allergy Clin Immunol [J]. 2017;140(4):950-958.

[4] Hu SJ, Wei P, Kou W, et al. Prevalence and risk factors of allergic rhinitis: a meta-analysis[J]. Chinese. J Clin Otorhinolaryngol Head Neck Surg. 2017;31(19):1485-1491.

[5] Zhang S, Xu JJ. Diseases of nasal and pharyngeal resonance organs and voice disorders[J]. Chinese. J Audiol Speech Pathol. 2014;22(3): 332-335.

[6] Liu B, Polce E, Jiang J. An objective parameter to classify voice signals based on variation in energy distribution[J]. J Voice. 2019;33 (5):591-602.

[7] Simberg S, Sala E, Tuomainen J, et al. Vocal symptoms and allergy—a pilot study[J]. J Voice. 2009;23(1):136-139.

[8] Millqvist E, Bende M, Brynnel M, et al. Voice change in seasonal allergic rhinitis[J]. J Voice. 2008;22(4):512-515.

[9] Gu YR, Li HB. Interpretation of the Chinese guidelines for diagnosis and treatment of allergic rhinitis (2022 revision) [J]. Chinese. Chin J Ophthalmol Otorhinolaryngol. 2022;22(2):209-211.

[10] Ma ZP, Ge Y, Wang YH. Application and safety of allergen barrier agents combined with immunotherapy for allergic rhinitis[J]. Chinese. J Med Theory Pract. 2024;37(20):3496-3498.

[11] González-Gamboa M, Segura-Pujol H, Oyarzún Díaz P, et al. Are

occupational voice disorders accurately measured? A systematic review of prevalence and methodologies in schoolteachers to report voice disorders[J]. J Voice. 2025;39(3):842.e1-842.e14.

[12] Liu J, Wang XX, Wang JX, et al. Investigation of the prevalence of allergic rhinitis among college students in Hefei[J]. Chinese. Occup Health. 2018;34(23):3286-3289.

[13] Zhang J. Study on the effects of changes in solar terms on allergic immune responses and peripheral blood SLFN12 gene-related levels in college students with allergic rhinitis[J]. Chinese. Dissertation. Tianjin University of Traditional Chinese Medicine; 2021.

[14] Jacobson BH, Johnson A, Grywalski C, et al. The Voice Handicap Index (VHI): development and validation[J]. Am J Speech Lang Pathol. 1997;6(3):66-70.

[15] Rosen CA, Lee AS, Osborne J, et al. Development and validation of the Voice Handicap Index-10[J]. Laryngoscope. 2004;114(9):1549-1556.

[16] Li QM, Lin CZ, Huang SH, et al. Voice investigation and analysis in patients with allergic rhinitis[J]. Chinese. China J Mod Med. 2015;25 (27):108-110.

[17] Subspecialty Group of Rhinology, Editorial Board of Chinese Journal of Otorhinolaryngology Head and Neck Surgery; Subspecialty Group of Rhinology, Society of Otorhinolaryngology Head and Neck Surgery, Chinese Medical Association. Chinese guideline for diagnosis and treatment of allergic rhinitis (2022 revision) [J]. Chin J Otorhinolaryngol Head Neck Surg. 2022;57(2):106-129.

[18] Wang XM, Zhang WX, Li CC. Paying attention to the joint management of chronic inflammatory diseases of upper and lower airways[J]. Chinese. Chin J Pract Pediatr. 2022;37(9):656-659.

[19] Özbal Koç EA, Koç B, Erbek S. Comparison of acoustic and stroboscopic findings and Voice Handicap Index between allergic rhinitis patients and controls[J]. Balkan Med J. 2014; 31(4): 340-344.

[20] Li W, Qu JN, Zhou T, et al. Effects of vocal fold dryness on frequency and amplitude perturbations in voice[J]. Chinese. J Audiol Speech Pathol. 2013;21(3):252-254.

[21] Spantideas N, Bougea A, Drosou E, et al. The role of allergy in phonation[J]. J Voice. 2019;33(5):811.e19-811.e27.

[22] Wang JD, Ge YM, Zhou XB, et al. Vocal analysis of preschool children with chronic cough caused by rhinitis[J]. Chinese. Int J Lab Med. 2017; 38(22):3170-3172.

[23] Niedzielska G. Acoustic estimation of voice when incorrect resonance function of the nose takes place[J]. Int J Pediatr Otorhinolaryngol. 2005;69(8):1065-1069.

[24] Liu YH, Zheng XY, Wang Y, et al. Differences in allergens between children and adults with suspected allergies[J]. Chinese. Chin J Health Lab Technol. 2022;32(22):2752-2755.

[25] Chen YL, Xu XL, Chen YL, et al. Preliminary study on the aerobes distribution of nasal cavity from the healthy children and adults[J]. Chinese. J Clin Otorhinolaryngol Head Neck Surg. 2007;21(23):1068-1069.

[26] Hall-Landers RJ, Morton-Jones ME, Plexico LW, et al. First-generation OTC antihistamine use and voice function in individuals with allergic rhinitis: a preliminary report of clinically impactful findings[J]. J Voice, Published online July 6, 2024.

[27] Smits I, Ceuppens P, De Bodt MS. A comparative study of acoustic voice measurements by means of Dr. Speech and Computerized Speech Lab[J]. J Voice. 2005;19(2):187-196.

[28] Núñez Batalla F, González Márquez R, Peláez González MB, et al. Acoustic voice analysis using the Praat program: comparative study with the Dr. Speech program[J]. Spanish. Acta Otorrinolaringol Esp. 2014;65(3):170-176.

[29] Maryn Y, Corthals P, De Bodt M, et al. Perturbation measures of voice: a comparative study between Multi-Dimensional Voice Program and Praat[J]. Folia Phoniatr Logop. 2009;61(4):217-226.

[30] Patel RR, Awan SN, Barkmeier-Kraemer J, et al. Recommended protocols for instrumental assessment of voice: American Speech-Language-Hearing Association expert panel to develop a protocol for instrumental assessment of vocal function[J]. Am J Speech Lang Pathol. 2018;27(3):887-905.

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