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Correlations among visual analog scales, total nasal symptom scores, and peak nasal inspiratory flow in children with perennial allergic rhinitis

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Abstract

Background: Visual analog scale (VAS) correlates well with total nasal symptom score (TNSS) but negatively correlates with peak nasal inspiratory flow (PNIF) in adults with allergic rhinitis (AR). Small children may not rate VAS properly and parents usually help assess their child's symptoms. Data on the correlations among parent-assessed VAS (P-VAS), VAS, TNSS, and PNIF in children with AR was limited.

Objective: To assess correlations among P-VAS, VAS, TNSS, and PNIF in children and adolescents with perennial AR (PAR).

Methods: Patients with PAR aged 6-18 years and their parents were instructed to record daily VAS, TNSS, PNIF, and P-VAS in an electronic diary for 8 weeks.

Results: 2387 records from 46 patients (56.5% male) were obtained. VAS and P-VAS showed a strong correlation (r_s = 0.82, p < 0.001). Moderate correlations were found between VAS vs TNSS (r_s = 0.53, p < 0.001) and between P-VAS vs TNSS (r_s = 0.48, p < 0.001). There was a weak negative correlation between PNIF vs VAS, PNIF vs TNSS, and PNIF vs P-VAS (r_s = -0.20, r_s = -0.22, r_s = -0.18, p < 0.001 respectively). In addition, a weak negative correlation was found between nasal congestion and PNIF (r_s = -0.26, p < 0.001). The overall inter-rater agreement between VAS and TNSS was fair (Kappa = 0.37, p < 0.001). Higher inter-rater agreement was found in moderate-severe than in the mild PAR group (Kappa = 0.50 vs 0.17) and in adolescents than in the children group (Kappa = 0.44 vs 0.26).

Conclusions: In small children, P-VAS was a reliable tool to assess nasal symptoms. Both subjective and objective measurements provided complementary information for symptom monitoring in patients with AR.

Key words: allergic rhinitis, children, correlations, peak nasal inspiratory flow, perennial allergic rhinitis, total nasal symptom score, visual analog scale

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Abbreviations:

AR	Allergic rhinitis
ARIA	Allergic Rhinitis and its Impact on Asthma
E-diary	Electronic-diary
NO	Nasal obstruction
PAR	Perennial allergic rhinitis
PNIF	Peak nasal inspiratory flow
QOL	Quality of life
SAR	Seasonal allergic rhinitis
SPT	Skin prick test
TNSS	Total nasal symptom score
VAS	Visual analog scale

Introduction

Allergic rhinitis (AR) is a common allergic disease in children. The global prevalence was 8.5% in children aged 6–7 years and 14% in adolescents aged 13–14 years.[1] In Thai children and adolescents, the prevalence of AR was 16.3%.[2] It is crucial for patients to receive appropriate treatment to prevent further complications such as sinusitis and otitis media.[3,4] AR affects patients' quality of life (QOL), work, study, and sleep.[5,6] Additionally, patients with AR experience a 2-fold increase in medication costs and nearly a 2-fold increase in physician visits.[7]

The former classification of AR consists of seasonal AR (SAR), mainly linked to pollen allergy, and perennial AR (PAR), mainly linked to house dust mites or common indoor allergens like pet dander and cockroaches.[8] A recent classification was introduced by the Allergic Rhinitis and its Impact on Asthma (ARIA) guideline-2016.[9] It is based on the duration, severity of symptoms, and impact on QOL, reflecting the clinical course and features of the disease.[9]

Symptom monitoring is crucial for adjusting treatment. The commonly used tool for this purpose is the visual analog scale (VAS), a simple, self-administered scale that allows individuals to rate their symptoms on a continuous scale, usually from 0 to 100 mm.[10] VAS can be used to evaluate symptoms such as nasal congestion, sneezing, itchy nose, and runny nose or overall symptoms of AR. In many recent AR guidelines, VAS was used to adjust treatment. In adults, VAS is well validated for measuring AR symptoms, showing a strong correlation with total nasal symptom score (TNSS) and a significant negative correlation with peak nasal inspiratory flow (PNIF).[11,12]

In children with AR, parents play an important role in adjusting the environment to avoid allergens, supervising medication usage, and monitoring symptoms after treatment. Although VAS is a simple, visual scale to indicate the levels of symptoms, small children may not rate their symptoms properly and parents are often asked to rate the child's symptoms. However, it is unclear whether parent-assessed VAS (P-VAS) can be used in children unable to rate VAS.

The objective measurements of AR, included PNIF, acoustic rhinometry, and anterior rhinomanometry (RMN). PNIF is a portable, inexpensive, reproducible, and noninvasive method used to objectively measure nasal airflow. It also can be used at home to monitor daily symptoms. On the other hand, acoustic rhinometry and anterior RMN, require time and complex equipment and must be carried out by trained personnel. These methods have limitations in routine clinical practice and cannot be assessed at home. The study of VAS and its correlation with other symptom measurements such as TNSS or objective measurements such as PNIF in children with AR were limited. More data are needed before adjusting AR treatment in children based on VAS only.

Our study aimed to investigate the correlation between subjective measurements (VAS, TNSS) and objective measurement (PNIF), in children and adolescents diagnosed with PAR. Additionally, we assessed comparisons of VAS, TNSS, and PNIF between children and their parents using P-VAS.

Materials and methods

Study design and subjects

This prospective, observational study was conducted at the Pediatric Allergy Clinic of the Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand. It was approved by the Siriraj Institutional Review Board (COA no. 059/2022). Written informed consent was obtained before the study.

We recruited patients aged 6–18 years with PAR. All underwent thorough examinations of the ears, nose, and throat by pediatric allergists to rule out anatomical abnormalities. Patients with rhinosinusitis, nasal polyps, significant deviated nasal septum, upper respiratory tract infection within 14 days, treated with allergen immunotherapy, uncontrolled asthma, chronic lung disease, cardiovascular, hepatic, renal diseases, primary or secondary immunodeficiency, were excluded.

AR was defined by chronic rhinitis symptoms including rhinorrhea, nasal itching, sneezing, and nasal obstruction after exposure to allergens, with positive skin prick test (SPT) to aeroallergens.[13] PAR patients experienced year-round symptoms and were sensitized to indoor allergens such as dust mites, pet dander, or cockroaches.[8]

Skin prick test

A skin prick test was conducted for common aeroallergens, which included house dust mites (*Dermatophagoides pteronyssinus*, *Dp* and *Dermatophagoides farinae*, *Df*), American and German cockroaches, cat and dog dander, Acacia, Careless weeds, grass pollens (Johnson and Bermuda), and molds (*Alternaria* spp., *Aspergillus* spp., *Cladosporium* spp., *Curvularia* spp. and *Penicillium* spp.). Commercial allergens from ALK-Abello, Port Washington, NY, were used. Histamine and glycerine were used as positive and negative controls, respectively. The SPT was considered positive if there was a mean wheal diameter of 3 mm larger than the negative control for at least one aeroallergen. Patients were asked to discontinue antihistamines for at least seven days before skin tests.

Total nasal symptom score (TNSS), visual analog scale (VAS), and peak nasal inspiratory flow (PNIF)

The daily TNSS was determined by summing scores for nasal congestion, rhinorrhea, nasal itching, and sneezing. These symptoms were rated on a 4-point scale ranging from 0 (no symptoms) to 3 (severe, sufficiently troublesome to interfere with normal daily activity or sleep).[14] Baseline severity was classified based on the TNSS score, in alignment with the ARIA classification. Mild and moderate-to-severe PAR were defined based on TNSS scores, with scores less than 6 indicating mild PAR and equal to or greater than 6 indicating moderate-to-severe PAR.[10,15]

The VAS score was obtained by having children or their parents mark the severity on the E-diary's scroll line, ranging from 0 to 100 mm. Zero indicated no symptoms, while 100 indicated the worst overall nasal symptoms. The distance of the mark from 0 was then measured by the investigator and this value was used as the VAS score. The VAS assessed by parents was designated as parent-assessed VAS (P-VAS).[10]

The PNIF was measured using the In-Check Nasal, portable inspiratory flow meters (Clement Clarke International Ltd, Harlow, UK). All patients were provided portable inspiratory flow meters to measure daily PNIF at home. Patients and parents were trained to record PNIF on the first visit to our allergy clinic at enrollment. In brief, patients were instructed to forcefully inhale through the nose and the air drawn through the meter. The flow rate (L/min) could be noted by checking the cursor's position against the calibrated scale. After measuring PNIF three times, the best flow was recorded. Subsequently, the PNIF was adjusted for age and sex to a Z score before statistical analysis.[16]

Patients and their parents were guided to record TNSS, VAS, P-VAS, and PNIF measurements daily in an electronic diary (E-diary) throughout an 8-week period. For children under 8 years old, parents could assist in completing the daily E-diary. In such cases, a parent was asked to rate P-VAS before helping their child complete E-diary. Follow-up assessments were conducted at the Pediatric Allergic Clinic or via telemedicine during weeks 1, 2, 4, 6, and 8 for E-diary reviews.

Statistical analysis

Statistical analyses were conducted using SPSS Statistics version 18.0 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were reported as frequency and percentage for categorical variables, mean ± SD for normally distributed continuous variables, and median with interquartile ranges (Q1, Q3) for non-normally distributed continuous variables.

Correlations between VAS, P-VAS, TNSS, and the Z score of PNIF were analyzed using Pearson's correlation coefficient (r_s) if the data were in the normal distribution or Spearman's rank if the data were in a non-normal distribution. The significant level was set at $p < 0.05$. Additionally, correlations between VAS, P-VAS, TNSS, and the Z score of PNIF were analyzed and compared across age groups and severity levels.

The agreement of VAS and TNSS between severity groups was assessed using Cohen's Kappa to evaluate reliability. Additionally, the agreement was analyzed and compared between age groups and severity at enrollment.

Results

A total of 2387 electronic diary records from 46 patients were assessed during an 8-week period. Thirty-eight patients consistently completed the E-diary on a daily basis. Eighteen patients experienced gaps in E-diary entries, ranging from 5 to 12 days. However, their overall compliance remained high, exceeding 79%. The baseline characteristics are summarized in **Table 1**. Twenty-six patients (56.5%) were male. The mean age was 11.6 years with 47.8% children (age ≤ 12 years) and 52.2% adolescents (age > 12 years). The median duration of AR symptoms was 64 months. Using the TNSS score, we categorized patients into mild (60.9%) and moderate-severe (39.1%) PAR groups. The baseline TNSS was 6/12 (range 4.75–8). The most common co-morbidity was asthma (30.4%), followed by atopic dermatitis (19.6%) and food allergy (19.6%). The majority of patients (80.4%) had a background of atopy, encompassing AR (73.9%), asthma (13%), food allergy (8.7%), and atopic dermatitis (4.3%). The most common allergen sensitization was house dust mites (97.8%), followed by cockroaches (34.8%), grass (28.3%), cat (21.7%), dog (8.7%), and fungi (8.7%). All patients exhibited sensitization to at least one indoor allergen.

Table 1. Demographic and baseline characteristics of all patients.

Characteristics	All participants (N = 46)
Male gender (n, %)	26 (56.5%)
Current age (years), mean (SD); range	11.6 (3.2); 6-17.6
Children (< 12-year-old) (n, %)	22 (47.8%)
Adolescents (≥ 12-year-old) (n, %)	24 (52.2%)
Duration of AR symptoms (months), median (Q1, Q3)	64 (39-88.5)
PAR severity at baseline (n, %)	
Mild	28 (60.9%)
Moderate to severe	18 (39.1%)
Baseline symptoms (points), median (Q1, Q3)	
TNSS	6 (4.75-8)
Rhinorrhea	2 (1-3)
Nasal itching	1 (0.75-2)
Sneezing	2 (1-2)
Congestion	2 (1-2)
Other allergic diseases (n, %)	
Asthma	14 (30.4%)
Atopic dermatitis	9 (19.6%)
Food allergy	9 (19.6%)
Family history of allergic diseases (n, %)	37 (80.4%)
Allergic rhinitis	34 (73.9%)
Asthma	6 (13%)
Food allergy	4 (8.7%)
Atopic dermatitis	2 (4.3%)

Abbreviations: AR, allergic rhinitis; PAR, perennial allergic rhinitis; TNSS, total nasal symptoms score

The Spearman's rank correlation coefficient (r_s) was used to evaluate correlations between parameters since the data were in a non-normal distribution. The degree of correlation was categorized as follows: 0 (no correlation), ≤ 0.40 (weak), 0.41–0.79 (moderate), and ≥ 0.8 (strong).[17] A strong correlation between VAS vs P-VAS (r_s = 0.82; p < 0.001) is illustrated in **Figure 1** and detailed in **Table 2**. A moderate correlation was found between VAS vs TNSS (r_s = 0.53; p < 0.001) and between P-VAS vs TNSS (r_s = 0.48; p < 0.001). Weak negative correlations were observed between PNIF vs VAS, PNIF vs TNSS, and PNIF vs P-VAS (r_s = -0.20, r_s = -0.22, r_s = -0.18; p < 0.001 respectively), as detailed in **Table 2**.

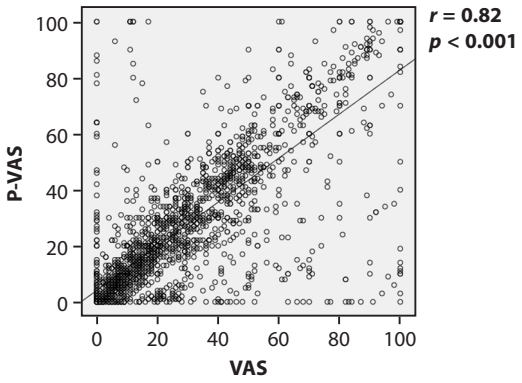

Figure 1. The correlations between symptom assessment using the visual analog scale (VAS) by patients and their parents (P-VAS)

In both children and adolescents, the correlation coefficients for the same pairs were consistent in their degree of correlation (**Table 2**). In the mild and moderate-severe PAR severity, a strong correlation between VAS vs P-VAS (r_s = 0.80, r_s = 0.83; p < 0.001, respectively) persisted in both severity groups. Interestingly, specific comparisons indicated a higher degree of correlation in the moderate-severe PAR group. In the moderate-severe PAR group, a moderate correlation between VAS and TNSS was observed (r_s = 0.60; p < 0.001), while in the mild PAR group, a weak correlation was found (r_s = 0.35; p < 0.001). In the moderate-severe PAR group, a moderate correlation between P-VAS and TNSS was identified (r_s = 0.55; p < 0.001), while in the mild PAR group, a weak correlation was observed (r_s = 0.29; p < 0.001).

The correlation between specific nasal symptoms and VAS or P-VAS was further investigated. Rhinorrhea, nasal itching, and sneezing showed weak correlations with VAS (r_s = 0.39, 0.37, 0.27, respectively; p < 0.001) and P-VAS (r_s = 0.38, 0.30, 0.24, respectively; p < 0.001). In contrast, nasal congestion exhibited a moderate correlation with VAS (r_s = 0.52, p < 0.001) and P-VAS (r_s = 0.49, p < 0.001). In comparison to PNIF, nasal congestion exhibited a weak negative correlation (r_s = -0.26, p < 0.001).

Table 2. The Spearman's rank correlation coefficient between VAS, P-VAS, TNSS and PNIF in all patients and subdivided according age group and severity.

Spearman's rank correlation coefficient						
	Overall	Age group		PAR severity		*p* value
		Children	Adolescents	Mild	Moderate to severe	
VAS vs P-VAS	0.82	0.84	0.80	0.80	0.83	< 0.001
VAS vs TNSS	0.53	0.54	0.54	0.35	0.60	< 0.001
P-VAS vs TNSS	0.48	0.52	0.47	0.29	0.55	< 0.001
PNIF* vs VAS	-0.20	-0.23	-0.24	-0.14	-0.38	< 0.001
PNIF* vs TNSS	-0.22	-0.22	-0.36	-0.23	-0.30	< 0.001
PNIF* vs P-VAS	-0.18	-0.23	-0.17	-0.16	-0.38	< 0.001

Abbreviations: PAR, perennial allergic rhinitis; PNIF, peak nasal inspiratory flow; P-VAS, parent-assessed VAS; TNSS, total nasal symptoms score; VAS, visual analog scale
*PNIF was Z score of PNIF (adjusted for age and sex)

Table 3. The level of inter-rater agreement between VAS and TNSS by age groups and severity of PAR.

	Overall	Age group		PAR severity	
		Children	Adolescents	Mild	Moderate to severe
Kappa value	0.37	0.26	0.44	0.17	0.50
Agreement	Fair	Fair	Moderate	Slight	Moderate

Abbreviations: PAR, perennial allergic rhinitis; TNSS, total nasal symptoms score; VAS, visual analog scale

The inter-rater agreement levels between VAS and TNSS were analyzed based on age groups and the severity of PAR, as presented in **Table 3**. The agreement levels were classified as follows: < 0 (less than a chance of agreement), 0.01–0.20 (slight agreement), 0.21–0.40 (fair agreement), 0.41–0.60 (moderate agreement), 0.61–0.80 (substantial agreement), and 0.81–0.99 (almost perfect agreement).[18] The overall agreement between VAS and TNSS was classified as fair (Kappa = 0.37; $p < 0.001$). In adolescents, a moderate agreement was found (Kappa = 0.44; $p < 0.001$), while in children, the agreement was classified as fair (Kappa = 0.26; $p < 0.001$). Similarly, a moderate agreement was observed in the moderate-severe PAR group (Kappa = 0.50; $p < 0.001$), while a slight agreement was found in the mild PAR group (Kappa = 0.17; $p < 0.001$).

Discussion

Effective symptom monitoring is crucial for adjusting treatment in patients with AR. Accurate and reliable subjective instruments that align with the patient's symptoms are invaluable. Assessing AR symptoms in children and adolescents is challenging.[19] VAS, a widely used self-reporting tool, provides a simple means to measure patients' perceptions of AR symptoms. In adults with AR, VAS correlated well with Total Symptom Scores (TSS6) and the Rhinoconjunctivitis Quality-of-Life Questionaire (RQOL).[11] Changes exceeding 23 mm on VAS could indicate significant alterations in both symptoms and quality of life (QoL).[11]

The VAS can be used for the quantitative evaluation of the severity of AR, contributing to the assessment and management of the condition.[10] Most recent AR guidelines suggest using patients' symptoms for diagnosis and adjusting treatment. The 2020 ARIA guidelines for AR recommend incorporating VAS into a step-up treatment algorithm for both untreated and treated AR patients, including adolescents and adults.[20] The Rhinitis 2020: A practice parameter update, suggests using VAS to assess the severity of AR and non-allergic rhinitis (NAR) patients aged 12 and older.[21] In the international consensus statement on allergy and rhinology: Allergic rhinitis – 2023, VAS is highlighted as one of the subjective instruments for diagnosing AR and assessing severity and treatment outcomes.[22]

A clinical examination in patients with AR is often difficult to reproduce, as highlighted in previous studies.[23,24] Given the challenges in clinical examinations, PNIF has emerged as a valuable objective measurement for nasal obstruction in routine clinical practice and research.[25]

The correlations between subjective symptoms and objective measurements of AR have primarily been explored in adults. Assessing subjective symptoms in AR included the evaluation of VAS, TNSS, and the Nasal Obstruction Symptom Evaluation Scale (NOSE). Objective measurements of AR, included PNIF, acoustic rhinometry, and anterior rhinomanometry (RMN). Mixed results on the degree of correlation between subjective and objective measurements depended on the study design, patient selection, and measure comparison. In the study by Ciprandi et al., a very strong correlation between VAS for nasal obstruction and RMN ($r_s = 0.81$; $p < 0.001$) was found.[26] Similarly, Teixeira et al found a moderate negative correlation between VAS for nasal obstruction and PNIF ($r_s = -0.41$; $p < 0.001$).[27] In the same way, Ottaviano et al identified a weak negative correlation between VAS and PNIF in 641 adults with rhinitis ($r_s = -0.13$; $p < 0.001$).[12]

In contrast, Yepes-Nunez et al assessed the correlations between subjective symptoms (symptom scores, VAS) and objective measurements (acoustic rhinometry, RMN, PNIF) of AR in volunteer physicians. They identified weak and absent correlations between objective and subjective measurements, which were not statistically significant ($r_s = 0.09–0.18$).[28] In a study by Lam et al, correlations between NOSE, VAS, PNIF, and acoustic rhinometry were investigated in adults referred for obstructive sleep apnea evaluation. They identified very weak negative correlations between subjective symptom measurements by NOSE or VAS and objective measurements by PNIF and acoustic rhinometry, which were not statistically significant ($r_s = -0.16–0.03$).[29] In another study, Martins de Oliveira et al observed a weak negative correlation between PNIF and symptom score ($r = -0.26$; $p = 0.03$) and found no correlation between VAS and PNIF in adults with AR.[30]

In the pediatric population, research on this subject has been limited, and findings have been inconsistent. Occasi et al. identified a moderate negative correlation between NOSE and RMN in children with AR ($r_s = -0.74$; $p < 0.001$).[31] The author mentioned that children aged 6–9 years tended to underestimate their symptoms, while those older than 12 years tended to overestimate their symptoms.[31] In another study, Calvo-Henriquez et al. investigated the correlation between RMN and the Likert scale for nasal obstruction in children aged 4–15 years experiencing varying degrees of nasal obstruction. The study found that only healthy children with good nasal breathing exhibited a moderate negative correlation between the nasal obstruction score and RMN ($r_s = -0.52$, $p = 0.003$).[32]

In contrast, Mendes et al. conducted histamine nasal provocation (NPT) to evaluate the correlations between nasal obstruction score, acoustic rhinometry, and RMN in patients with AR and control subjects aged 7–18 years.[33] No significant correlation was found between subjective and objective measurements. The authors concluded that neither AR nor the acute induction of obstruction affected the correlation between objective and subjective measurements.[33] Visconti et al. reported no significant correlation between VAS for nasal obstruction and PNIF before and after vasoconstrictor administration in children aged 8–15 years with chronic rhinitis ($r_s = -0.19$ and $r_s = -0.18$, respectively).[34] Additionally, the author found that older children had a lower perception of nasal obstruction than younger children.[34] In another study, Watson et al. found no significant correlation between VAS and anterior rhinometry in children aged 6–12 years ($r_s = -0.12$).[35]

Our study explored the correlation between subjective symptoms (VAS, TNSS, P-VAS) and objective measurement (PNIF). Notably, our findings revealed weak negative correlations between PNIF vs VAS, PNIF vs TNSS, and PNIF vs P-VAS. These results align with previous reports.[12,28,29] These findings might be explained by the patients who had longstanding nasal obstructions could become insensitive to the degree of nasal obstruction over time and under-rate their nasal obstruction symptoms. Our results suggested that both subjective and objective measurements should be used in a complementary way to monitor symptoms and guide treatment.

Several studies have identified correlations among subjective or objective measurements. For subjective measurements, Yepes-Nunez et al. identified moderate correlations between symptom scores and VAS in volunteer physicians (r = 0.69, p = 0.001).[28] In a study by Watson et al., it was revealed that VAS correlated with nasal stuffiness scores in children aged 6–12 years with seasonal AR (r = 0.45, p = 0.001).[35] For objective measurements, Mendes et al. discovered moderate correlations between acoustic rhinometry and RMN in children with AR both at baseline (r_s = 0.59, $p < 0.001$) and after NPT (r_s = 0.48, $p < 0.001$).[33]

In our study, we identified moderate correlations between VAS vs TNSS and P-VAS vs TNSS, findings consistent with those reported in previous studies.[28,35] Notably, the degree of correlation remained consistent in children and adolescents. However, when patients were subgrouped based on AR severity, the correlation degree between VAS vs TNSS and P-VAS vs TNSS was moderate in the moderate-severe group and weak in the mild AR group (**Table 2**).

We further explored the correlations between each AR symptom and VAS, or P-VAS. Nasal congestion was the symptom that showed a moderate correlation with VAS and P-VAS. Interestingly, a weak negative correlation was found between PNIF and nasal congestion. These findings may be related to the complexity of patients' perceptions which might lead to over- or underestimation of their symptoms.

Parents may help identify symptom scores, especially in small children who cannot verbalize their symptoms. Studies exploring patients' and parents' ratings of symptoms or QoL were limited. Wamboldt et al. found differences between parent and child assessments of asthma symptom severity using the QoL score.[36] Parents tended to rate their child's symptoms as more severe than the children themselves did. In rhinitis, Calvo-Henriquez et al. found no correlation between RMN and the Likert scale for nasal obstruction assessed by children aged 4–15 years. However, they observed a weak correlation for nasal obstruction assessed by parents (r = -0.28, p = 0.004).[32] Interestingly, our study found a strong correlation between VAS and P-VAS, suggesting that parents were able to assess VAS for their children in daily practice.

The inter-rater agreement between VAS vs TNSS was moderate in adolescents and moderate-severe AR patients, while the agreement was fair in children and slight in mild AR. This finding might reflect that older children or patients with more severe diseases could assess their symptoms more accurately than other groups.

The strength of our study was the high number of E-diaries recorded. Patients recorded E-diaries along with daily PNIF measurements with good adherence. There were some limitations. In children under 8 years old, parents can help the children fill in the E-diary, so this may interfere with the VAS and P-VAS assessment. However, a parent was asked to rate P-VAS before helping their child complete E-diary. Additionally, most of the patients were classified as having mild PAR at enrollment, which results in a weaker correlation between VAS, P-VAS, and TNSS than in moderate-severe PAR.

In conclusion, we propose using both subjective measurements such as VAS, TNSS, together with an objective measurement such as PNIF for symptom monitoring of AR in children. Notably, in small children who can not rate VAS, P-VAS was a reliable tool to assess nasal symptoms.

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Conflict of interest

None

References

1. Schuler Iv CF, Montejo JM. Allergic Rhinitis in Children and Adolescents. Immunol Allergy Clin North Am. 2021;41:613-25.
2. Chinratanapisit S, Suratannon N, Pacharn P, Sritipsukho P, Vichyanond P. Prevalence and risk factors of allergic rhinitis in children in Bangkok area. Asian Pac J Allergy Immunol. 2019;37:232-9.
3. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology. 2020;58:1-464.
4. Tewfik TL, Mazer B. The links between allergy and otitis media with effusion. Curr Opin Otolaryngol Head Neck Surg. 2006;14:187-90.
5. Katelaris CH, Lee BW, Potter PC, Maspero JF, Cingi C, Lopatin A, et al. Prevalence and diversity of allergic rhinitis in regions of the world beyond Europe and North America. Clin Exp Allergy. 2012;42:186-207.
6. Lunn M, Craig T. Rhinitis and sleep. Sleep Med Rev. 2011;15:293-9.
7. Nathan RA. The burden of allergic rhinitis. Allergy Asthma Proc. 2007;28:3-9.
8. van Cauwenberge P, Bachert C, Passalacqua G, Bousquet J, Canonica GW, Durham SR, et al. Consensus statement on the treatment of allergic rhinitis. European Academy of Allergology and Clinical Immunology. Allergy. 2000;55:116-34.
9. Brożek JL, Bousquet J, Agache I, Agarwal A, Bachert C, Bosnic-Anticevich S, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) guidelines-2016 revision. J Allergy Clin Immunol. 2017;140: 950-8.

10. Bousquet PJ, Combescure C, Neukirch F, Klossek JM, Mechin H, Daures JP, et al. Visual analog scales can assess the severity of rhinitis graded according to ARIA guidelines. Allergy. 2007;62:367-72.
11. Demoly P, Bousquet PJ, Mesbah K, Bousquet J, Devillier P. Visual analogue scale in patients treated for allergic rhinitis: an observational prospective study in primary care: asthma and rhinitis. Clin Exp Allergy. 2013;43:881-8.
12. Ottaviano G, Pendolino AL, Nardello E, Maculan P, Martini A, Russo M, et al. Peak nasal inspiratory flow measurement and visual analogue scale in a large adult population. Clin Otolaryngol. 2019;44:541-8.
13. Bousquet J, Khaltaev N, Cruz AA, Denburg J, Fokkens WJ, Togias A, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 update (in collaboration with the World Health Organization, GA(2)LEN and AllerGen). Allergy. 2008;63 Suppl 86:8-160.
14. Restimulia L, Pawarti DR, Ekorini HM. The Relationship between Serum Vitamin D Levels with Allergic Rhinitis Incidence and Total Nasal Symptom Score in Allergic Rhinitis Patients. Open Access Maced J Med Sci. 2018;6:1405-9.
15. Aneeza WH, Husain S, Rahman RA, Van Dort D, Abdullah A, Gendeh BS. Efficacy of mometasone furoate and fluticasone furoate on persistent allergic rhinoconjunctivitis. Allergy Rhinol (Providence). 2013;4:e120-6.
16. Papachristou A, Bourli E, Aivazi D, Futzila E, Papastavrou T, Konstandinidis T, et al. Normal peak nasal inspiratory flow rate values in Greek children and adolescents. Hippokratia. 2008;12:94-7.
17. Shi R, Conrad SA. Correlation and regression analysis. Ann Allergy Asthma Immunol. 2009;103:S35-41.
18. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med. 2005;37:360-3.
19. Priftis KN, Drigopoulos K, Sakalidou A, Triga M, Kallis V, Nicolaidou P. Subjective and objective nasal obstruction assessment in children with chronic rhinitis. Int J Pediatr Otorhinolaryngol. 2006;70:501-5.
20. Bousquet J, Schünemann HJ, Togias A, Bachert C, Erhola M, Hellings PW, et al. Next-generation Allergic Rhinitis and Its Impact on Asthma (ARIA) guidelines for allergic rhinitis based on Grading of Recommendations Assessment, Development and Evaluation (GRADE) and real-world evidence. J Allergy Clin Immunol. 2020;145:70-80.e3.
21. Dykewicz MS, Wallace DV, Amrol DJ, Baroody FM, Bernstein JA, Craig TJ, et al. Rhinitis 2020: A practice parameter update. J Allergy Clin Immunol. 2020;146:721-67.
22. Wise SK, Damask C, Roland LT, Ebert C, Levy JM, Lin S, et al. International consensus statement on allergy and rhinology: Allergic rhinitis - 2023. Int Forum Allergy Rhinol. 2023;13:293-859.
23. Ottaviano G, Fokkens WJ. Measurements of nasal airflow and patency: a critical review with emphasis on the use of peak nasal inspiratory flow in daily practice. Allergy. 2016;71:162-74.
24. Valero A, Navarro AM, Del Cuvillo A, Alobid I, Benito JR, Colás C, et al. Position paper on nasal obstruction: evaluation and treatment. J Investig Allergol Clin Immunol. 2018;28:67-90.
25. Ta NH, Gao J, Philpott C. A systematic review to examine the relationship between objective and patient-reported outcome measures in sinonasal disorders: recommendations for use in research and clinical practice. Int Forum Allergy Rhinol. 2021;11:910-23.
26. Ciprandi G, Mora F, Cassano M, Gallina AM, Mora R. Visual analog scale (VAS) and nasal obstruction in persistent allergic rhinitis. Otolaryngol Head Neck Surg. 2009;141:527-9.
27. Teixeira RUF, Zappelini CEM, Alves FS, da Costa EA. Peak nasal inspiratory flow evaluation as an objective method of measuring nasal airflow. Braz J Otorhinolaryngol. 2011;77:473-80.
28. Yepes-Nuñez JJ, Bartra J, Muñoz-Cano R, Sánchez-López J, Serrano C, Mullol J, et al. Assessment of nasal obstruction: correlation between subjective and objective techniques. Allergol Immunopathol (Madr). 2013;41:397-401.
29. Lam DJ, James KT, Weaver EM. Comparison of anatomic, physiological, and subjective measures of the nasal airway. Am J Rhinol. 2006;20: 463-70.
30. Martins de Oliveira GM, Rizzo J, Camargos PA, Sarinho ES. Are measurements of peak nasal flow useful for evaluating nasal obstruction in patients with allergic rhinitis? Rhinology. 2015;53:160-6.
31. Occasi F, Duse M, Vittori T, Rugiano A, Tancredi G, De Castro G, et al. Primary school children often underestimate their nasal obstruction. Rhinology. 2016;54:164-9.
32. Calvo-Henriquez C, Martínez-Seijas P, Boronat-Catalá B, Faraldo-García A, Martínez-Capoccioni G, Alobid I, et al. Assessing the ability of children and parents to rate their nasal patency. A cross sectional study. Int J Pediatr Otorhinolaryngol. 2022;156:111094.
33. Mendes AI, Wandalsen GF, Sole D. Objective and subjective assessments of nasal obstruction in children and adolescents with allergic rhinitis. J Pediatr (Rio J). 2012;88:389-95.
34. Visconti P, Saranz RJ, Lozano NA, Alegre G, Robredo P, Sacco Ramello M, et al. Assessment of nasal obstruction by subjective methods and peak nasal inspiratory flow in children and adolescents with chronic rhinitis. Arch Argent Pediatr. 2021;119:331-8.
35. Watson WT, Roberts JR, Becker AB, Gendreau-Reid LF, Simons FE. Nasal patency in children with allergic rhinitis: correlation of objective and subjective assessments. Ann Allergy Asthma Immunol. 1995;74: 237-40.
36. Wamboldt MZ, Fritz G, Mansell A, McQuaid EL, Klein RB. Relationship of asthma severity and psychological problems in children. J Am Acad Child Adolesc Psychiatry. 1998;37:943-50.