



Demographics and clinical features predictive of allergic versus non-allergic rhinitis in children aged 6–18 years: A single-center experience of 1535 patients



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ABSTRACT

Background: Chronic rhinitis (CR) is one of the most common causes accounting for lost-school days, absenteeism and resource utilization in pediatric patients. Distinction between common causes of CR, allergic (AR) and non-allergic rhinitis (NAR), based upon clinical features is critical, especially in primary care settings or facilities with lack of allergen sensitivity testing, as management strategies differ considerably. The current study elucidates clinical factors, particularly facial features associated with AR and NAR using a large cohort.

Methods: In a retrospective cohort analysis of pediatric patients aged 6–18 years, we assessed patient demographics, clinical symptoms, and signs associated with allergic rhinitis using multivariable regression techniques.

Results: Overall, 1490 patients (mean age: 10.11 ± 3.31 years; 48% female; 69% AR and 31% NAR) were included in the study. In multivariable regression analysis, major clinical features associated with AR were: sneezing (OR: 3.53; 95% CI: 2.35–5.32; $p < 0.001$), rhinorrhea (OR: 1.77; 95% CI: 1.18–2.66; $p = 0.006$), nasal itching (OR: 17.88; 95% CI: 11.92–26.83; $p < 0.001$), horizontal nasal crease (OR: 5.09; 95% CI: 1.29–20.01; $p = 0.020$) and conjunctivitis (OR: 4.66; 95% CI: 3.28–6.62; $p < 0.001$). On the contrary, we noted presence of Dennie-Morgan fold (OR: 1.67; 95% CI: 1.11–2.56; $p = 0.014$), moderate to severe persistent or intermittent symptoms to be likely associated with NAR than AR.

Conclusion: In pediatric patients presenting with symptoms of rhinitis, facial hallmarks serve as an adjunct to sensitivity testing in establishing a diagnosis as well as differentiating between NAR from AR, albeit individualized upon patient history and clinical features.

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1. Introduction

Rhinitis is a common clinical condition affecting pediatric population and often acknowledged as the leading cause for lost-school days, absenteeism and resource utilization in children aged 6–12 years [1–4]. Characterized by numerous nasal symptoms such as rhinorrhea, obstruction or congestion, itching, post-nasal drip and sneezing [5], the underlying pathology is attributed to an inflammatory process afflicting the nasal mucosa due to allergic or non-allergic causes [6]. Although allergic rhinitis (AR) is the most

common form, it has significant overlap in clinical symptomatology with non-allergic rhinitis (NAR). Due to pertinent differences in management strategies between the two, it is critical to differentiate between patients with AR and NAR. While NAR can follow a more prolonged course, avoidance of mere offending allergen can often lead to remission of symptoms in patients with AR, with or without administration of allergen immunotherapy. Allergen sensitivity tests provides remarkable distinction across the two entities [7]. However, its availability is limited to tertiary care centers and fairly low percentage of community centers. In most instances, especially primary care settings, diagnosis of rhinitis and differentiation between AR and NAR relies mainly upon patient history, clinical symptoms and physical findings, notably facial features [8,9].

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Several studies on rhinitis are focused upon comparative effectiveness of various therapeutic modalities such anti-histaminics versus corticosteroids in patients with AR and NAR. Despite the significance of remarkable physical findings in diagnosis of rhinitis, limited studies have assessed these differences based upon facial features across AR and NAR in a comprehensive fashion [10–16]. Most studies are based upon relatively smaller sample size, and thus limited to inherent selection bias. Considering paucity of literature on the diagnostic utility of facial features in distinguishing patients with AR from NAR, we conducted a retrospective review of our institutional data to investigate demographic and clinical characteristics across pediatric age groups diagnosed with AR and NAR. Based upon our data, we employed robust methodology to report association of demographics and clinical features associated with AR and NAR.

2. Material and methods

2.1. Study protocol and patient population

A retrospective cohort analysis of pediatric patients aged 6–18 years referred to our Department, between January 2014 through January 2016 for evaluation of chronic rhinitis was performed. Approval from the Institutional Review Board was sought prior to initiation of the study.

2.2. Data extraction and management

A review of medical records on all eligible patients was performed independently by 2 authors (I.L. and C.A.) Relevant information on a pre-coded datasheet such as patient demographics (age and gender), presenting symptomatology (sneezing, rhinorrhea, nasal itching, and obstruction), facial features as elicited on examination (shiners, horizontal nasal crease, allergic salute, conjunctivitis, mouth breathing or Dennie-Morgan (DM) infraorbital fold), skin prick test (SPT) were extracted. Standard clinical definitions for shiner, horizontal nasal crease, allergic salute, conjunctivitis, and DM folds that are well-described in otolaryngology literature were used [14]. Classification and severity grading of rhinitis was performed based upon the Allergic Rhinitis and its Impact on Asthma (ARIA) criteria such as intermittent (mild or moderate-severe) or persistent (mild or moderate-severe) rhinitis [17]. Nasal symptom severity (NSS) scores for individual symptoms were extracted from the files that were derived based upon a 4-point Likert scale ranging from 0 to 1 (0 = no symptom, 1 = mild, 2 = moderate, 3 = severe). This was primarily performed by cross-examining patients or when deemed necessary, to minimized the loss of 'compliance' (e.g. difficulty understanding some concepts or questions, emotional state especially for younger children) throughout the assessment, we invite parents to participate in the assessment even only with the presence, without interfere in any form with the independent children's response, or only to provide details or explanations which can contributed to increased reliability of their children's responses.

The total NSS score was computed based upon the sum of individual symptom scores for sneezing, rhinorrhea, nasal itching and obstruction [18].

Patients were categorized as having AR or NAR based upon history and results from the SPT [19]. The SPT was based upon examination of wheal 15–20 min following administration of a standard panel of locally present aeroallergens (see Appendix A, Table A.1) with histamine (10 mg/ml) and glycerinated saline used as positive and negative controls respectively. Development of wheal of size ≥ 3 mm based upon glycerinated saline response as measured by the mean of maximal and minimal diameter was

considered a positive SPT [19]. A patient with rhinitis with a history of allergic symptoms congruent with a positive SPT was diagnosed as having AR, while a negative SPT along with overlapping symptoms was diagnosed as having NAR [12].

Stringent quality measures were implemented through all phases of data extraction and management. This included timely check to ensure completeness and accuracy. A cross-over review of individually collected data was performed. In case of conflict surrounding a data variable, resolution was sought with re-review of medical records, followed by discussion and mutual consensus.

2.3. Primary outcome (endpoint)

Primary outcome of interest was to investigate factors associated with AR and NAR.

2.4. Statistical analysis

Descriptive and inferential statistics were used for analysis. Categorical variables are presented as frequencies and proportions, while metric variables are reported as mean $\pm$ SD, or median as appropriate. Differences in proportions for categorical variables across patients with AR and NAR are analyzed using the Pearson's χ^2 test. For metric values, we first assessed the distribution using numerical (Shapiro-Wilk test) and visual methods (histograms, Q-Q plots, stem-and-leaf plots), and subsequently assessed differences in the means across these variables using the independent samples *t*-test or the non-parametric Mann-Whitney *U* test as appropriate.

To identify factors associated with AR, we constructed a multi-variable logistic regression model by adjusting for patient age, gender, clinical symptoms (sneezing, rhinorrhea, nasal itching, and obstruction) and signs (shiner, horizontal nasal crease, allergic salute, conjunctivitis, mouth breathing, and Dennie Morgan fold), ARIA classification (moderate or severe intermittent, mild persistent, moderate or severe persistent with mild intermittent as the reference value), and total NSS score. Age and total NSS score were metric variables in the model, while all others were categorical (see Appendix A, Fig. A.1).

Based on the model in the variables, we propose the calculation of predicted probability (*p*) for allergic rhinitis in patients aged 6–18 years of age using the following equation:

$$p = \frac{1}{1 + e^{-(c + \sum_{i=1}^n (a_i b_i))}}$$

where *c* = constant; *n* = variables in the model; *a* = model parameter, defined as the natural logarithm of the odds; and *b* assumes value of either 0 or 1 for binomial variables or actual value for quantitative variable.

Regression diagnostics was performed. To assess model validity or its discriminatory ability between NAR and AR from the derived estimates, *c*-statistics or the area under the receiver operative characteristic (ROC) curve was computed [20]. A value of 0.5 denotes no discriminatory ability of the model, while higher area under the curve (AUC) depicts a better discriminatory ability. Additionally, model calibration was assessed by Hosmer-Lemeshow goodness-of-fit test (*p* > 0.05). As a part of sensitivity analysis of our derived regression estimates, we corrected *c*-statistics for overfitting bias using 1000-bootstrapped samples. As these estimates are similar to our primary model, are not being reported separately. All statistical tests were 2-tailed, and a type I error set at 5% was deemed of statistical significance. All analysis was performed using SPSS version 24.0 (IBM Corp, Armonk, NY).

3. Results

3.1. Patient population and demographics

Of the 1535 patients presenting to our clinic during the study period, 45 (2.9%) were excluded owing to incomplete medical records as reflected during the data-extraction phase. Overall, 1490 paediatric patients were included for analysis with a mean age of 10.11 ± 3.31 years (median: 9 years), and approximately 48% were female. Of these, 1029 (69%) were diagnosed as having AR while the remainder 461 (31%) had NAR. A relative difference in the mean age of patients across the AR and NAR groups was noted (10.41 vs 9.46 ; $p < 0.001$). However, no difference in gender predilection was observed across patients presenting with chronic rhinitis (Female: 47% vs 50%; $p = 0.300$) (Table 1).

3.2. Clinical symptomatology and facial features

The patients diagnosed as AR and those with NAR had notable differences in presenting symptomatology and facial features. In comparison to patients with NAR, patients with AR had significantly higher proportion of nasal itching (34% vs 87%; $p < 0.001$) and sneezing (51% vs 67%; $p < 0.001$) as their presenting symptoms. No differences were noted for nasal obstruction (82% vs 78%; $p = 0.079$) or rhinorrhea (61% vs 59%; $p = 0.572$) amongst these patients. Based upon ARIA classification, patients with AR were more likely to have mild symptoms, either intermittent (30% vs 16%; $p < 0.001$) or persistent (35% vs 23%; $p < 0.001$) as compared to NAR patients. Likewise, patients with NAR were likely to present with moderate or severe intermittent symptomatology (37% vs 10%; $p < 0.001$). Remarkable differences were observed in terms of total mean NSS scores in patients with AR and NAR (5.45 ± 2.32 vs 4.46 ± 1.83 ; $p < 0.001$). Differences in NSS scores were evident across individual symptomatology with higher proportion of patients with AR eliciting highest NSS score for nasal itching (19.2% vs 2.0%; $p < 0.001$). On the contrary, higher proportion of patients with NAR demonstrated low NSS nasal itching score (65.9% vs 12.6%; $p < 0.001$ for NSS = 0 and 22.8 vs 18.0; $p = 0.031$ for NSS = 1) with respect to patients with AR. A similar trend was observed for sneezing (Table 1).

Higher proportion of specific facial signs such as the presence of horizontal nasal crease (28% vs 4%; $p < 0.001$), allergic salute (30% vs 5%; $p < 0.001$), and conjunctivitis (46% vs 16%; $p < 0.001$) was observed in patients with AR. No differences were observed with the presence of shiner (46% vs 45%; $p = 0.775$), mouth breathing (52% vs 49%; $p = 0.335$) or Dennie-Morgan folds (18% vs 17%; $p = 0.638$) in these patients. An overview of clinical characteristics of patients included in the study is depicted in Table 1.

3.3. Regression model derivation

In a multivariable regression analysis, we assessed factors such as patient demographics, clinical symptoms, and signs associated with allergic rhinitis. With reference to NAR, our data suggested advancing age (OR: 1.12; 95% CI: 1.07–1.18; $p < 0.001$) and clinical symptoms such as sneezing (OR: 3.53; 95% CI: 2.35–5.32; $p < 0.001$), rhinorrhea (OR: 1.77; 95% CI: 1.18–2.66; $p = 0.006$), nasal itching (OR: 17.88; 95% CI: 11.92–26.83; $p < 0.001$) to be associated with AR. On the contrary, higher total NSS was less likely associated with AR (OR: 0.73; 95% CI: 0.63–0.85; $p < 0.001$). Additionally, presence of horizontal nasal crease (OR: 5.09; 95% CI: 1.29–20.01; $p = 0.020$) or conjunctivitis (OR: 4.66; 95% CI: 3.28–6.62; $p < 0.001$) were more likely associated with AR as opposed to NAR. On the contrary, presence of Dennie-Morgan fold was more predictive of NAR (OR: 1.67; 95% CI: 1.11–2.56; $p = 0.014$)

than AR. On the basis of ARIA classification, patients with AR had lesser likelihood of having either moderate to severe intermittent (OR: 0.09; 95% CI: 1.11–2.56; $p < 0.001$) or persistent (OR: 0.34; 95% CI: 0.19–0.59; $p < 0.001$) symptoms (Fig. 1).

Based on our model, the predicted probability (p) for a patient having AR can be calculated using the following equation: $\ln [p/(1-p)] = -1.726 + [0.113 * \text{Age in years (6–18 years)}] + [1.262 * \text{sneezing}] + [0.572 * \text{rhinorrhea}] + [2.884 * \text{nasal itching}] + [1.627 * \text{horizontal crease}] + [1.540 * \text{conjunctivitis}] - [0.519 * \text{Dennie-Morgan folds}] - [2.439 * \text{moderate/severe intermittent ARIA}] - [1.081 * \text{moderate/severe persistent}] - [0.312 * \text{total NSS}]$.

The discriminatory ability of our model was good: sensitivity 80.05% (95% CI: 75.8–83.9), specificity 87.14% (95% CI: 85.01–89.08), positive likelihood ratio 6.23 (95% CI 5.29–7.32), negative likelihood ratio 0.23 (95% CI 0.19–0.28) and AUC value of 0.893 ± 0.01 SE (95% CI: 0.874–0.911; $p < 0.001$) (Fig. 2). The model demonstrated good calibration as assessed by Hosmer-Lemeshow test ($p = 0.144$).

4. Discussion

4.1. Current work

Predominant facial features such as allergic salute, shiner and horizontal crease are known to be associated with AR; however validation in a large cohort is essential [7]. In the current study involving approximately 1500 patients, we investigated demographics and facial features across pediatric patients with AR and NAR. In a regression analysis, we quantified the association of several factors, notably facial features associated with AR with respect to NAR. Appropriate methodology was employed to derive the reported associations. To account for validity of our model, we computed the c-statistics which demonstrated excellent accuracy with AUC approximately to 0.90. Additionally, these associations were further internally validated in a sensitivity analysis using bootstrapped replacement samples. Considering the overlapping features in patients with NAR with AR, diagnosis based upon facial features congruent with clinical symptoms in the absence of confirmatory antigen or allergen sensitivity test is critical not only in establishing diagnosis but also to direct treatment strategies. Diagnosis based upon facial hallmarks are particularly imperative in primary care settings or in facilities with lack of allergen sensitivity. The utility of prompt diagnosis is gaining further momentum as the increasing prevalence of AR is shaping into a public health concern, affecting up to 40% children during lifetime [17,21,22].

4.2. Pertinent factors associated with rhinitis: comparison with literature

In a large cohort involving 1186 Danish participants aged between 14 and 44 years, Malgaard and colleagues described characteristics associated with AR and NAR. Female sex (OR 2.05; 95% CI: 1.31–3.20; $P = 0.002$), persistent symptoms for 4 weeks prior to presentation (OR 1.88, 95% CI: 1.23–2.89; $p = 0.003$), especially recurrent headaches (OR 1.94, 95% CI: 1.12–3.37; $p = 0.019$) were more likely associated with NAR. On the contrary, Malgaard et al. observed airway hyper-reactivity, food allergy, and treatment with anti-histaminics were associated with AR than NAR. The authors noted no differences across common symptomatology such as nasal congestion ($p = 0.901$) and rhinorrhea ($p = 0.278$) as seen in patients with rhinitis. Similarly, in a larger cohort involving 1511 adult patients with chronic rhinitis, Di Lorenzo and colleagues reported several clinical and laboratory parameters that may aid in diagnosis of AR. A complete allergic evaluation including skin prick test, blood and nasal eosinophilic evaluation, assessment of nasal symptoms

Table 1
Characteristics of patients with chronic rhinitis included in the study (N = 1490).

Characteristics	Allergic rhinitis N = 1029	Non-allergic rhinitis N = 461	Overall N = 1490	P value
Age, in years				
Mean $\pm$ SD	10.41 $\pm$ 3.41	9.46 $\pm$ 2.32	10.11 $\pm$ 3.31	<0.001
Median	10	9	9	–
Range	6–18	6–18	6–18	–
Gender, n(%)				
Male	541 (52.6)	229 (49.7)	770 (51.7)	0.300
Female	488 (47.4)	232 (50.3)	720 (48.3)	
Symptoms, n(%)				
Sneezing	690 (67.1)	236 (51.2)	926 (62.1)	<0.001
Rhinorrhea	609 (59.2)	280 (60.7)	889 (59.7)	0.572
Nasal itching	899 (87.4)	157 (34.1)	1056 (70.9)	<0.001
Nasal obstruction	805 (78.2)	379 (82.2)	1184 (79.5)	0.079
Signs, n(%)				
Shiners	468 (45.5)	206 (44.7)	674 (45.2)	0.775
Horizontal nasal crease	286 (27.8)	20 (4.3)	306 (20.5)	<0.001
Allergic salute	309 (30.0)	23 (5.0)	334 (22.4)	<0.001
Conjunctivitis	472 (45.9)	75 (16.3)	547 (36.7)	<0.001
Mouth breathing	530 (51.5)	225 (48.8)	755 (50.7)	0.335
Dennie-Morgan infraorbital folds	189 (18.4)	80 (17.4)	269 (18.1)	0.638
ARIA, n(%)				
Mild intermittent	306 (29.7)	74 (16.1)	380 (25.5)	<0.001
Moderate/Severe intermittent	103 (10.0)	171 (37.1)	274 (18.4)	<0.001
Mild persistent	358 (34.8)	106 (23.0)	464 (31.1)	<0.001
Moderate/Severe persistent	262 (25.5)	110 (23.9)	372 (25.0)	0.509
NSS Grading				
NSS sneezing				
0	337 (32.8)	225 (48.8)	562 (37.7)	<0.001
1	328 (31.9)	65 (14.1)	393 (26.4)	<0.001
2	202 (19.6)	120 (26.0)	322 (21.6)	0.006
3	162 (15.7)	51 (11.1)	213 (14.3)	0.017
NSS rhinorrhea				
0	417 (40.5)	181 (39.3)	598 (40.1)	0.646
1	297 (28.9)	73 (15.8)	370 (24.8)	<0.001
2	177 (17.2)	125 (27.1)	302 (20.3)	<0.001
3	138 (13.4)	82 (17.8)	220 (14.8)	0.028
NSS nasal itching				
0	130 (12.6)	304 (65.9)	434 (29.1)	<0.001
1	185 (18.0)	105 (22.8)	290 (19.5)	0.031
2	509 (49.5)	43 (9.3)	552 (37.0)	<0.001
3	205 (19.9)	9 (2.0)	214 (14.4)	<0.001
NSS obstruction				
0	224 (21.8)	82 (17.8)	306 (20.5)	0.079
1	302 (29.3)	91 (19.7)	393 (26.4)	<0.001
2	307 (29.8)	144 (31.2)	451 (30.3)	0.586
3	196 (19.0)	144 (31.2)	340 (22.8)	<0.001
Total NSS score				
Mean $\pm$ SD	5.45 $\pm$ 2.32	4.46 $\pm$ 1.83	5.14 $\pm$ 2.23	<0.001
Median	5	4	5	–

Statistically significant results are highlighted in bold.

via a visual analog scale (VAS) was performed. Similar to our analysis, the authors reported sneezing [OR 4.09; 95% CI: 2.78–6.00], nasal itching or pruritus [OR 3.84; 95% CI: 2.60–5.67] and conjunctivitis [OR 4.49; 95% CI: 2.86–7.05] to be strongly associated with AR. Contrary to our findings, the authors note advancing age to be less likely associated with AR [OR 0.97; 95% CI: 0.96–0.98]. However, this difference could be attributed to the heterogeneity across the two cohorts in terms of age, with our cohort restricted to pediatric patients. To elicit conspicuous

anatomical abnormality subsequent to an allergic exposure usually requires 2 seasons, thus limiting an allergic response within first 2–3 years following birth [5,23]. Based on this analogy, we excluded patients less than 6 years of age. However, by age 4, over quarter of children are atopic and more sensitized to inhaled allergens compared to food allergens (19% vs 3.5%) [5,24]. Consistent with pediatric literature [5,25], we noted increasing age in pediatric patients associated with AR [OR: 1.12; 95% CI: 1.07–1.18; $p < 0.001$]. Interestingly, Di Lorenzo noted clinical responsiveness to anti-

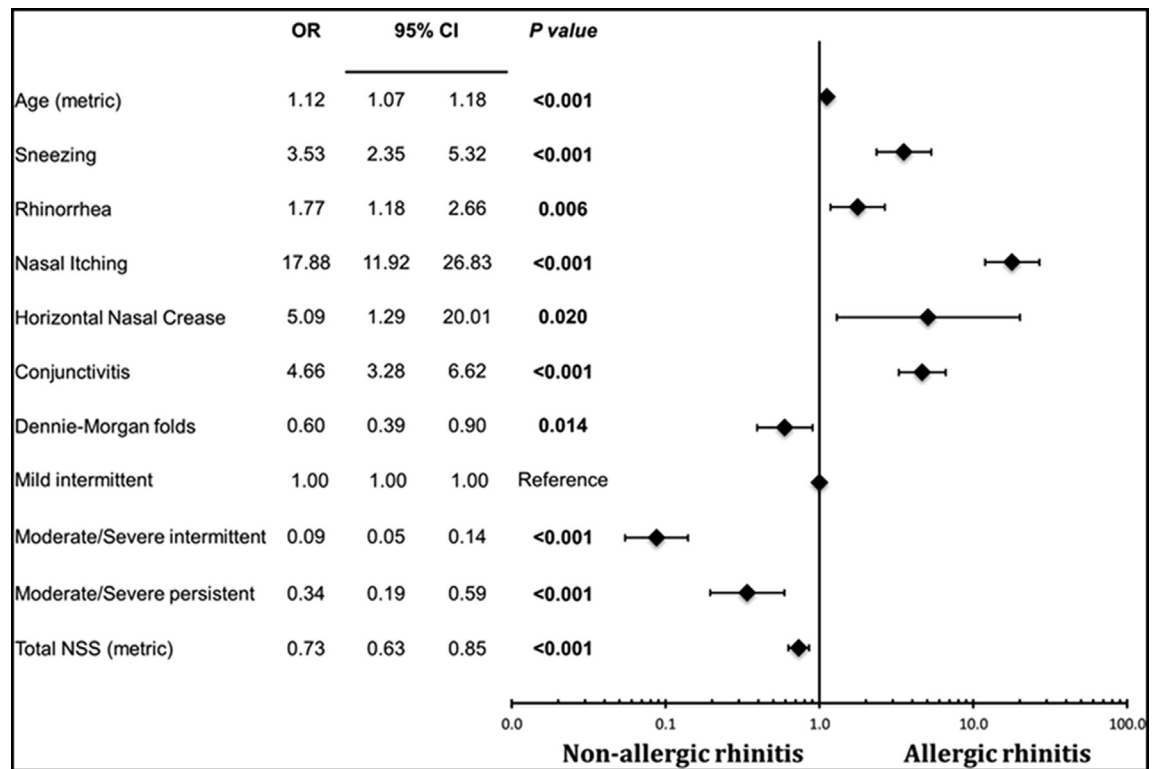


Fig. 1. Multivariable regression model demonstrating factors associated with both allergic and non-allergic rhinitis.

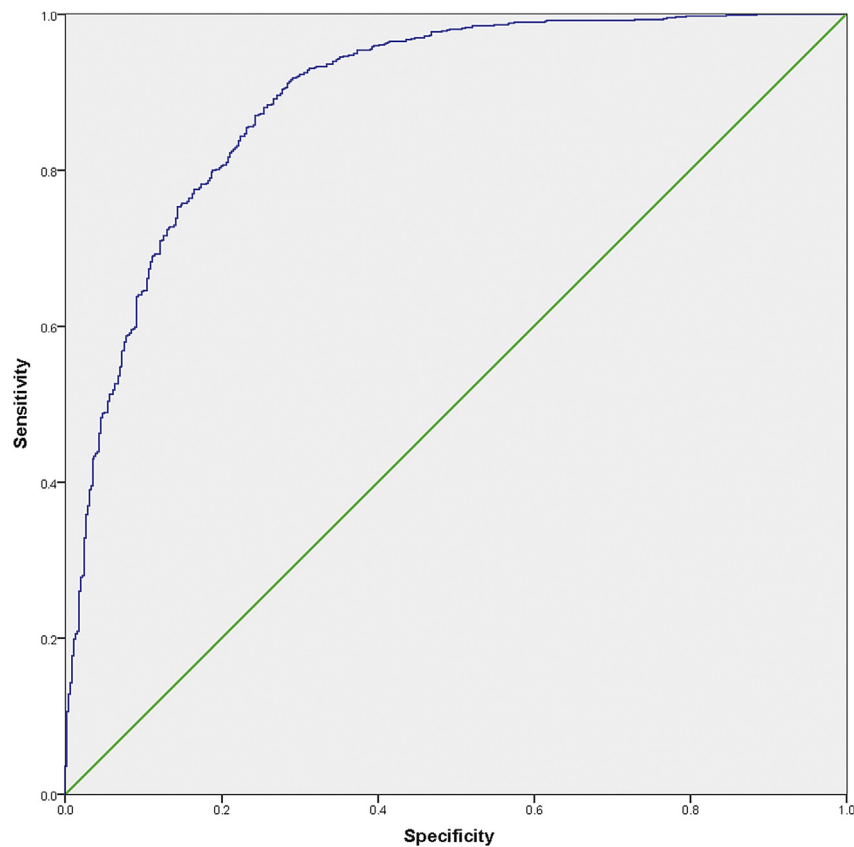


Fig. 2. Receiver operating characteristic (ROC) curve of the study predictive model.

histamine medications [OR 22.59; 95% CI: 13.79–37.00], nasal eosinophil counts [OR 1.14; 95% CI: 1.10–1.18] and PNIF [OR 1.01; 95% CI: 1.00–1.01] to be associated with AR. Unfortunately, our study did not explore the association of laboratory findings including PNIF and eosinophilic evaluation and was more focused on elucidating facial hallmarks that may lead to diagnosis. In an attempt to define predictive factors that could potentially aid in differentiation of AR from NAR in primary health care settings relating to pediatric population, Topal et al. analyzed 472 patients aged between 6 and 18 years that were diagnosed with chronic rhinitis [14]. Similar to our cohort, the authors noted patients in the NAR group to be relatively younger compared with patients with AR (years: 10 vs 11; $p = 0.042$), with a significant proportion of patients in the latter presenting with nasal symptomatology (74% vs 58%; $p = 0.002$) and conjunctivitis (41% vs 23%; $p < 0.001$). Based on regression analysis, the authors demonstrated an association of seasonality, responsiveness to anti-histaminics, sneezing and moderate/severe rhinitis with AR. However, most of these analyses precluded a comprehensive evaluation of relevant facial signs as seen in chronic rhinitis such as shiners, allergic salute, DM folds, and horizontal nasal crease.

Patients with AR are plausibly known to present with allergic salute due to intense nasal itching and obstruction associated with it. This habitual gesture as seen in patients with AR involves pushing the tip of the nose upwards and backwards with the palm, thus propping the air passages temporarily open, and relieves itching [26]. As a consequence of repeated external manipulation, patients with AR often elicit a horizontally pigmented, hyper or hypo, crease localized at the junction of middle and lower third of the bridge of the nose [27,28]. In our cohort, higher proportion of patients with AR presented with allergic salute (30% vs 5%; $p < 0.001$) and horizontal crease (28% vs 4%; $p < 0.001$) as compared to patients with NAR. In a regression analysis adjusted for various patient demographics and clinical features, we noted patients with AR to be associated with sneezing (OR: 3.53; 95% CI: 2.35–3.52; $p < 0.001$), rhinorrhea (OR: 1.77; 95% CI: 1.18–2.66; $p = 0.006$), and nasal itching (OR: 17.88; 95% CI: 11.92–26.83; $p < 0.001$) compared to patients with NAR. Relating to facial features, patients with AR had higher likelihood to elicit horizontal nasal crease (OR: 5.09; 95% CI: 1.29–20.01; $p = 0.020$) and conjunctivitis (OR: 4.66; 95% CI: 3.28–6.62; $p < 0.001$) while lower likelihood for DM folds (OR: 0.60; 95% CI: 0.39–0.90; $p = 0.014$) compared to NAR. Correlating the predominant symptoms specific to itching or sneezing in conjunction with the presence of horizontal crease or conjunctivitis can aid in the diagnosis of AR, albeit tailored upon patient history and clinical judgment. Another critical aspect of facial feature correlated with AR is the presence of suborbital dark-brown circles (shiners) due to venous congestion [29]. However, we noted no difference with respect to “allergic shiner” across the two cohorts (46% vs 45%; $p = 0.775$).

4.3. Non-specific features

Non-specific features associated with AR are sleep-disordered breathing, fatigue, malaise, behavioral issues, hearing defects and cognitive decline [7,10,30]; however not analyzed in the current study owing to its rarity and low clinical significance.

4.4. Study limitations

The current study is subjected to some limitations. Residual confounding and confounding by indication could have impacted some of the observed associations. Lack of nasal endoscopy or imaging evaluation to determine the type of nasal obstruction limited our assessment to identify the cause of obstruction such as

adenoid vegetation or other causes. Another aspect to consider is that we separated AR and NAR patients only by the presence or absence of a positive SPT. Measuring specific IgE could have strengthened this separation, though both serum sIgE tests and SPT are sensitive and they have similar diagnostic properties. In our study, although allergy skin prick tests were performed in all children with rhinitis to categorize them into AR and NAR, certain proportion of patients with NAR might have an underlying local AR (LAR) with undetected systemic atopy. Future studies could utilize allergological target organ evaluation by quantifying nasal specific IgE antibodies and/or a nasal allergen provocation test response with the suspected allergen to exclude localized mucosal allergic response. Considering the observational design of our study, causality cannot be predicted. Despite these limitations, the current study based upon a large sample size provides a baseline assessment of factors associated with AR and NAR.

5. Conclusion

Appropriate patient selection is critical in treating chronic rhinitis. In pediatric patients, facial hallmarks can be used as an adjunct to sensitivity testing in establishing a diagnosis as well as differentiating between NAR from AR. Based on our cohort, we determine presence of clinical symptoms such as sneezing, rhinorrhea, and nasal itching, and prominent facial features such as presence of horizontal nasal crease or conjunctivitis to be more likely associated with AR than NAR. On the contrary, infra-orbital DM folds, moderate/severe intermittent or persistent symptoms of rhinitis are predictive of NAR. Although these observed associations were derived from a large cohort and using appropriate methodology, diagnosis and treatment strategies should be individualized based upon history and presentation, clinical symptomatology and signs.

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Conflict of interests

None.

Appendix A. Supplementary data

Supplementary data related to this chapter can be found at <http://dx.doi.org/10.1016/j.ijporl.2017.04.044>.

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Appendix A - Supplementary data

Demographics and clinical features predictive of allergic versus non-allergic rhinitis in children aged 6-18 years: A single-center experience of 1535 patients

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Table A. 1: Allergen testing in Skin Prick Test (SPT) ‡

Sr No	CATEGORY	
1.	Grass	Phleum pratense Dactila glomerara Festuca elator Lolium perenne Poe pratensis
2.	Weeds	Mugwort (Artemisia vulgaris)
3.	Pellitory of the wall or sticky weed	Parietaria judaica Salsola kali
4.	Trees	Birch- Olea europea, Cupressus
5.	House dust mite	Dermatophagoides pteronyssinus Dermatophagoides farinae
6.	Moulds	Alternaria alternata Cladosporium erbarium Aspergillus fumigatus
7.	Animal dander	Cats Dogs

‡ Locally present aero-allergen in *Stallergenes, Antony, France*

Figure A.1: Forest plot demonstrating association of all covariates adjusted in the log-binomial multivariable regression model with allergic rhinitis. Odds ratios, along with 95% confidence intervals are reported

