Headache and Nasal Dysfunction in Children

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Abstract

Headaches in pediatric patients can be related to primary (essential) and secondary (symptomatic) causes. This study investigates the correlation between nasal dysfunction, specifically mucociliary clearance impairment and structural anomalies, and cephalalgia in children, with a focus on allergic rhinitis and rhinopathy. A total of 2,262 children aged 5 to 10 years were screened. Clinical evaluation included evaluation of headache history, nasal patency, mucociliary clearance function, and the presence of structural anomalies such as septal deviation or adenoidal hypertrophy. A significant association was found between nasal dysfunction and headache. Children with impaired mucociliary clearance, nasal obstruction, or structural abnormalities demonstrated a higher prevalence of cephalalgia compared to those with normal nasal function. Allergic rhinitis was frequently observed among patients who reported recurrent headaches. Altered nasal dysfunction appears to be an important and potentially underrecognized contributor to pediatric headache. These findings highlight the need for comprehensive Ear Nose Throat evaluation in children with recurrent and unexplained cephalalgia.

Keywords: headache, child, mucociliary clearance, allergic rhinitis, adenoids

1. Introduction

Headache is one of the most common neurological complaints in childhood and represents a significant cause of absenteeism at school, reduced academic performance, and a poor quality of life.[1] Pediatric headaches are broadly classified into primary (hemicranial) forms, such as migraine and tension-type headaches, and secondary (non-hemicranial) forms resulting from identifiable underlying conditions. Although primary headaches have been extensively investigated, secondary causes, particularly those related to sinonasal pathology, remain underrecognized in daily clinical practice.[2,3]

The nasal cavity plays a critical role in airway conditioning, humidification, filtration, and immunological defense. Proper mucociliary clearance ensures the removal of inhaled particles and pathogens, thus maintaining sinonasal homeostasis.[4] Disruption of this system, whether due to allergic inflammation, infection, or structural abnormalities such as septal deviation and turbinate hypertrophy, can lead to chronic mucosal edema, impaired ventilation of the paranasal sinuses, and altered nasal airflow dynamics.[5,6]

Allergic rhinitis is highly prevalent in the pediatric population and is characterized by IgE-mediated inflammation of the nasal mucosa.[7] Beyond typical symptoms such as rhinorrhea, nasal obstruction, and sneezing, allergic rhinitis may also contribute to systemic and neurological manifestations, including headache.[2] However, the precise mechanisms linking nasal dysfunction to cephalalgia are not fully understood. The proposed mechanisms include hypoxia secondary to chronic nasal obstruction, hypercapnia, impairment of cerebral microcirculation, trigeminal nerve irritation, and the release of algogenic-type inflammatory mediators.[8]

In addition to allergic inflammation, structural abnormalities—such as adenoid hypertrophy, nasal septum deviation, turbinate hypertrophy, and nasal substenosis—can further compromise nasal airflow and mucociliary function.[6,8] These alterations can promote sinus ventilation impairment and mucosal congestion, which can serve as triggers for headache episodes.

Given the multifactorial etiology of pediatric headaches, it is essential to evaluate potential otorhinolaryngological contributors. The present study aims to investigate the relationship between nasal dysfunction, specifically altered mucociliary clearance and structural abnormalities, and cephalalgia in children, with particular attention to the role of allergic sensitization and rhinopathy.

2. Material and methods

2.1. Study design and population

This retrospective observational study was conducted between January 2020 and 2026. Children were recruited consecutively during routine outpatient visits. Although a subset of patients underwent subsequent clinical follow-up within practices, only baseline clinical data were included in the present analysis. Accordingly, the study was designed as a cross-sectional observational investigation evaluating the association between nasal dysfunction and recurrent headache in children.

A total of 2,262 children aged 5–10 years were initially screened using a standardized questionnaire investigating headache characteristics, symptom frequency, symptom duration, family history of allergy, and otorhinolaryngological disorders. Following application of the eligibility criteria, 1,323 children were enrolled in the final analysis. Inclusion criteria consisted of availability for complete otorhinolaryngological examination, allergy testing, nasal functional assessment, and parental informed consent. Children with known neurological disorders, chronic systemic diseases, previous diagnosis of primary headache under active neurological follow-up, or incomplete clinical records were excluded.

Among the enrolled participants, 126 children reported recurrent headache episodes and constituted the cephalalgia group, whereas the remaining 1,197 children served as the control group.

This study was approved by the Scientific Research Ethics Committee of Adana City Training and Research Hospital. (approval no:81/2026) and conducted in accordance with the 2013 Helsinki Declaration. Informed consent, in terms aggreed within these approvals, was given by parent on behalf of each child or adolescent before his or her participation at the time of clinical assessments.

2.2. Headache assessment

Headache status was evaluated using a standardized pediatric questionnaire completed by parents or legal guardians. Recurrent headaches are defined as repeated headache episodes occuring over time, with symptom-free periods between attacks. Whenever sufficient clinical information was available, headache characteristics were retrospectively classified according to the International Classification of Headache Disorders, Third Edition (ICHD-3).[9] The terms “hemicranial” and “non-hemicranial,” used in the original database, were retained for historical consistency and correspond approximately to migraine-like and non-migraine headache patterns, respectively.

2.3. Clinical and ENT evaluation

All participants underwent a comprehensive otorhinolaryngological examination that included anterior rhinoscopy, nasal endoscopy, assessment of adenoid and tonsillar hypertrophy, evaluation of nasal septum deviation, and assessment of inferior turbinate hypertrophy. Nasal endoscopy was performed using a pediatric flexible endoscope (Olympus Medical Systems, Tokyo, Japan). Particular attention was paid to structural abnormalities, mucosal edema, the presence of secretions, and signs of chronic rhinopathy.

Children presenting with clinical suspicion of chronic sinonasal disease underwent radiological evaluation of the paranasal sinuses. Given the young age of the pediatric patients, radiography was performed to minimize radiation exposure.

2.4. Allergy assessment

All participants underwent skin prick testing for common inhalant allergens according to standardized procedures. A positive result was defined as a wheal diameter exceeding 3 mm compared with the negative control.

2.5. Nasal functional assessment

Nasal airflow was assessed by active anterior rhinomanometry using Rhino-Comp 4000 rhinomanometer (Homoth Medizinelektronik GmbH &Co. KG, Hamburg, Germany). Nasal conductance was calculated and expressed as liters per minute per millimeter of water pressure (LPM/mmH_2O) for both nasal cavities.

Mucociliary clearance was evaluated using both the charcoal transport test and the saccharin test according to established pediatric protocols. Transport time was recorded in minutes from placement of the test substance until detection within the nasopharynx. Normal pediatric reference values were considered to be 8 ± 3 minutes for the charcoal test and 13 ± 2 minutes for the saccharin test.

2.6. Immunological assessment

Secretory immunoglobulin A (Ig A) concentrations were measured in nasal secretions collected under standardized conditions. Measurements were performed using an enzyme-linked immunosorbent assay (ELISA) and results were expressed as mg/100 mL.

2.7. Statistical analysis

All statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution. Categorical variables were expressed as frequencies and percentages. Normality and variance homogeneity were assessed using the Kolmogorov–Smirnov, Shapiro–Wilk, and Levene tests. Group comparisons were performed using the independent samples t-test or Mann–Whitney U test for continuous variables and the chi-square test or Fisher’s exact test for categorical variables. Correlations were evaluated using Pearson’s or Spearman’s correlation coefficients as appropriate. p-value below 0.05 was considered statistically significant.

3. Results

A total of 2,262 children were initially screened using the standardized questionnaire. After application of the inclusion and exclusion criteria, 1,323 children were enrolled in the study and completed all clinical, allergological, and nasal functional assessments. Among these participants, 126 children (9.5%) reported recurrent headache episodes and constituted the cephalalgia group, whereas 1,197 children (90.5%) served as controls.

The demographic and clinical characteristics of the study population are presented in Table 1. No significant differences in age or sex distribution were observed between the two groups.

Age distribution analysis demonstrated that non-migraine headache patterns were more frequently observed in younger children, whereas migraine-like headache patterns tended to increase with age.

Skin prick testing revealed positive sensitization to at least one inhalant allergen in 64% of children with recurrent headache, whereas 36% of children in the cephalalgia group had negative skin prick test results. Despite the relatively high prevalence of allergen sensitization, no statistically significant association was found between skin prick test positivity and the presence of recurrent headache.

Otorhinolaryngological evaluation identified several structural and inflammatory sinonasal abnormalities among children with headache. Nasal septal deviation was observed in 26.2% of cases, inferior turbinate hypertrophy in 35.9%, and mucosal secretions suggestive of chronic rhinopathy in 37.9%. Radiological assessment of children with suspected sinonasal disease demonstrated multiple sinus opacification in 88% of cases, single sinus opacification in 4.3%, maxillary sinus opacification in 5.4%, and normal radiographic findings in 2.1%.

Nasal conductance values were significantly lower in children with headache than in controls. ($p<0.04$) Mean left-sided nasal conductance was 0.40 ±0.4 LPM/mmH_2O in the cephalalgia group compared with 0.90 ± 0.5 LPM/mmH_2O in controls. Mean right-sided nasal conductance was 0.55 ± 0.5 LPM/mmH_2O in children with headache and 0.85 ± 0.4 LPM/mmH_2O in controls.

Mucociliary transport time was prolonged in children with headache. The mean transport time was 27 ± 3 minutes in the cephalalgia group compared with 20 ± 4 minutes in controls, indicating significantly impaired mucociliary clearance among symptomatic children.

Analysis of nasal secretions demonstrated lower secretory IgA concentrations in the headache group. Mean secretory IgA levels were 35 ± 3 mg/100 mL in children with headache and 42 ± 3 mg/100 mL in controls. This difference reached statistical significance. ($p<0.05$)

4. Discussion

The present retrospective observational study investigated the relationship between recurrent headache and nasal dysfunction in a large pediatric population. The findings demonstrated significant associations between headache

and several indicators of impaired nasal function, including reduced nasal conductance, prolonged mucociliary clearance, structural sinonasal abnormalities, and lower concentrations of secretory IgA in nasal secretions.

One of the most relevant findings was the significantly reduced nasal conductance observed in children with recurrent headache. Nasal obstruction may impair physiological airflow, promote mouth breathing, and contribute to sleep fragmentation and reduced sleep quality. Previous studies have suggested that chronic nasal obstruction may influence headache occurrence through altered oxygenation, impaired sleep, and activation of trigeminal sensory pathways.[10,11] Although the present study cannot establish causality, the observed association supports the hypothesis that nasal airflow impairment may represent a clinically relevant factor in children presenting with recurrent headache.

The prolonged mucociliary transport time observed in the cephalalgia group provides additional evidence of altered nasal physiology. Efficient mucociliary clearance plays a fundamental role in maintaining sinonasal homeostasis by removing inhaled particles, pathogens, and inflammatory debris. Impairment of this defense mechanism may result in mucus retention and persistent low-grade inflammation of the nasal mucosa. Such inflammatory changes may contribute to headache symptoms through local release of inflammatory mediators and stimulation of trigeminal nociceptive pathways.[11]

Structural abnormalities of the nasal cavity were frequently identified among children with headache. Septal deviation and inferior turbinate hypertrophy were common findings and may contribute to mechanical narrowing of the nasal airway. Previous studies have proposed that mucosal contact points and altered airflow dynamics may activate trigeminal sensory receptors and potentially contribute to facial pain and headache symptoms. [11,12,13] The present findings are consistent with this hypothesis and suggest that careful otorhinolaryngological evaluation should be considered in pediatric patients with recurrent headache.

An additional finding of interest was the lower concentration of secretory IgA observed among children with headache. Secretory IgA represents a key component of mucosal immunity and contributes to protection against pathogens and environmental antigens. Reduced levels may reflect impaired local immune defense and increased susceptibility to chronic mucosal inflammation. Although the exact mechanisms remain unclear, this observation supports the concept that immunological factors may participate in the complex interaction between sinonasal dysfunction and headache.

In contrast, allergen sensitization itself was not significantly associated with headache occurrence. Although a substantial proportion of children with headache demonstrated positive skin prick test results, statistical analysis failed to identify a significant relationship between sensitization and cephalalgia. This finding suggests that positive allergy testing alone should not be interpreted as evidence of a causal relationship between allergy and headache. Rather, the functional and structural consequences of chronic nasal disease may be more relevant than allergen sensitization itself. [14]

Several limitations should be acknowledged. First, the cross-sectional nature of the study precludes any conclusions regarding temporal relationships or causality. Second, headache severity, disability, quality of life, and

educational impact were not systematically assessed using validated questionnaires. Third, radiological assessment was performed using plain sinus radiography, which reflected standard clinical practice during the period of data collection but differs from contemporary diagnostic recommendations.

Despite these limitations, the study benefits from a large pediatric sample and comprehensive otorhinolaryngological assessment. The findings highlight the potential importance of evaluating nasal function in children presenting with recurrent headache and support further investigation of the relationship between sinonasal disease and pediatric cephalalgia.

Future prospective studies should incorporate validated headache classifications, quality-of-life measures, contemporary imaging techniques, and objective biomarkers of inflammation and trigeminovascular activation. Such investigations may help clarify whether early diagnosis and treatment of nasal dysfunction influence headache outcomes over time.

In conclusion, this retrospective observational study identified significant associations between recurrent headache and several markers of nasal dysfunction in children, including reduced nasal conductance, prolonged mucociliary clearance, structural sinonasal abnormalities, and lower levels of secretory IgA. Although allergen sensitization was common among children with headache, no statistically significant association was observed between positive skin prick test results and headache occurrence.

Because of the cross-sectional design, the present findings should be interpreted as associations rather than evidence of causation. Nevertheless, the results suggest that comprehensive otorhinolaryngological evaluation may provide clinically relevant information in children presenting with recurrent headache. Future prospective and longitudinal studies are required to determine whether early identification and treatment of nasal dysfunction may influence headache frequency, severity, and long-term outcomes.

Authors' contributions

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Declarations

All data generated or analyzed in the study are included in this article. The data are available on request.

The authors have no conflicts of interest to declare.

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Abbreviations

ICHD-3 International Classification of Headache Disorders

LPM Liter per meter

mmH_2O Milimeters of water

ELISA Enzyme-linked immunosorbent assay

Ig Immunoglobulin

mg Miligram

mL Mililiter

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Table 1 Clinical and sinonasal findings in children with and without headache

Parameter	**Children with headache**	**Children without headache**
Skin Prick Test	Positive 64% Negative 36%	
Headache type by age	Hemicranial 8-10 years Non-hemicranial 6-8 years	
Sinonasal abnormalities	Deviated septum 26.2% Turbinate hypertrophy 35.9% Mucosal secretion 37.9%	
Radiographic findings	Clouding multiple sinuses 88% Clouding one-sinus 4.3% Maxillary-darkening 5.4% Transparency 2.4%	
Nasal conductance	Left:0.40 Right:0.55	Left:0.90 Right: 0.85
Mucociliary clearance (min)	27	20
Secretory Ig A (mg/100 mL)	35±3	42±3