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Tympanometric Patterns of Children with Allergic Rhinitis Treated at a Tertiary Health Institution

Ayotunde James Fasunla, MBChB, FWACS, FMCORL[1], Julius Olowo Ijitola, MBBS, FWACS, FMCORL[1], and Onyekwere George Nwaorgu, MBBS, FWACS, FMCORL[1]

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Abstract

Objectives. To determine the prevalence of otitis media with effusion (OME) and compare patterns of tympanogram between children with and without allergic rhinitis in Ibadan, Nigeria.

Study Design. A case-control study of children (2-7 years) with AR from May 2015 to March 2016.

Setting. Tertiary hospital.

Subjects and Methods. Consecutive 86 children with AR and 86 healthy controls (nonallergic) participated in the study. A structured questionnaire was administered to parents or caregivers of the participants to obtain relevant sociodemographic and clinical information. Diagnosis of AR was by symptomatology and nasal cytology. Both groups had ear, nose, and throat examination and tympanometric evaluation. OME was diagnosed according to Jerger's tympanometric patterns.

Results. The mean ± SD ages of cases and controls were 3.80 ± 1.72 and 3.78 ± 1.71 years, respectively. All cases presented with watery nasal discharge, bouts of sneezing, and nasal itching. The duration of AR symptoms was 18 ± 13 months. Among cases and controls, Jerger's type A tympanogram was the most common pattern, while type C was the least common. Thirty-nine (45.3%) children with AR had OME, as compared with 8 (9.3%) controls, and the difference was statistically significant ($P < .001$; odds ratio = 8.090; 95% CI = 3.48-18.79).

Conclusion. Prevalence of OME was significantly high among children with AR. Jerger's type B and C tympanograms were more common among children with AR than the healthy pediatric population. This background information supports the need for routine tympanometric evaluation of children with AR.

Keywords

allergic rhinitis, children, nasal cytology, otitis media with effusion, tympanometry

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Allergic rhinitis (AR) is an IgE-mediated type 1 hypersensitivity reaction of nasal mucosa in response to an antigenic substance (allergen).[1,2] It is a common disorder among children. In Nigeria, the prevalence of AR among children with asthma was 39.2%.[3] No study has reported the prevalence of AR in the general pediatric age group in the country. Many factors may predispose already genetically predisposed individuals to AR, including family history of allergy, overcrowding, dusty environment, air-conditioned rooms, and so on.[1] Recent evidence suggested that the disorder is relatively more common among children of affluent parents who live in purportedly hygienic environments.[4-6] The symptomatology of AR includes clear mucoid nasal discharge, itching, bouts of sneezing, and nasal obstruction,[7] which are reversible either spontaneously or following the use of antiallergic medications. These symptoms are precipitated by exposure to allergens, with hypersensitivity to multiple antigens more common than hypersensitivity to a single antigen.[8]

[1]Department of Otorhinolaryngology, University College Hospital and College of Medicine, University of Ibadan, Ibadan, Nigeria

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Corresponding Author:
Ayotunde James Fasunla, MBChB, FWACS, FMCORL, Department of Otorhinolaryngology, University College Hospital, Queen Elizabeth Road, Ibadan, 200212, Oyo State, Nigeria.
Email: ayofasunla@yahoo.com

The allergic inflammation of nasal mucosa readily spreads to involve contiguous and distant organs, such as eustachian tube, middle ear, and upper and lower airways. AR has a strong association with asthma, atopic dermatitis, conjunctivitis, nasal polyps, and sleep disorder.[2,9-11] It can also cause a dysfunctional eustachian tube with resultant otitis media with effusion (OME).[12,13] The burden of AR is significant and includes loss of school, absence from work, and economic loss. Furthermore, the presence of OME in a child may affect his or her hearing,[14,15] thereby causing delayed speech and language development as well as poor academic performance at school. It may also affect one's social interaction with peers in the environment because of difficulty in communication. Many children have been wrongly labeled stubborn and abused, especially when they failed to carry out instructions.

Some developmental sequelae of OME, particularly deficits in reading ability, can persist into late childhood and the early teens.[16] It is therefore important to promptly identify children with AR with OME and manage their cases to reduce the burden of hearing loss. Therefore, the aim of this study was to determine the prevalence of OME among children with AR and describe the different patterns of tympanograms seen among children in Ibadan, Nigeria.

Materials and Methods

This case-control study included children (2-7 years old) with AR treated at the University College Hospital, Ibadan. The clinical diagnosis of AR was based on the presence of watery nasal discharge and at least 1 of excessive bout of sneezing, nasal obstruction, and nasal itching for a minimum of 3 to 4 weeks following onset of symptoms[17-20] and was further confirmed with nasal cytology (nasal smear for eosinophils).[21,22] The control group comprised healthy children from the University College Hospital Staff School without features of allergy and rhinosinusitis. None of the participants had symptoms or signs of acute otitis media.

The Ethics Review Committee of the joint University of Ibadan–University College Hospital approved the study. Informed consent was also obtained from the parents or caregivers of the participants.

Data Collection Procedure

Structured Questionnaire. The questionnaire was administered to the parents or caregivers of the participants to obtain data on sociodemographics, symptoms, duration of AR, and comorbidities. The skin, eyes, ear, nose, and throat were examined. Children with earwax had it removed, but those with ear discharge and/or perforated tympanic membrane as well as features of adenoid vegetation (confirmed by lateral postnasal radiograph) were excluded from the study.

Nasal Smear for Eosinophils. Under adequate illumination, the anterosuperior part of the inferior turbinate was swabbed, smeared on a glass slide, processed, and examined microscopically at the Department of Pathology, University College Hospital, for the presence of eosinophils or other inflammatory cells. The presence of at least 5 eosinophilic cells under the high-power field of a light microscope was diagnostic of AR.[21-23]

Tympanometry. Tympanometry was performed with a Welch Allyn Autotymp (TM 262, version 4, 2008), manufactured and calibrated by Welch Allyn (Skaneateles Falls, New York) to standards per the International Organization for Standardization, with a probe tone frequency of 226 Hz (sound pressure level, +200 to −400 daPa). Tympanogram was then classified according to modified Jerger's classification.[24] In this study, type B or C tympanogram was diagnostic of OME.

Data Analysis and Presentation. Data collected were collated and inputted into SPSS 17 (IBM, Chicago, Illinois) for analysis. Frequencies, percentages, and cross tabulations were used to summarize qualitative variables. Differences among categorical variables were analyzed with the chi-square test, while Student's *t* test was used to analyze difference among continuous variables. A P value $<.05$ was accepted to be statistically significant.

Results

A total 172 children were studied, including 86 children with AR (male: n = 58, 67.4%; female: n = 28, 32.6%) and 86 controls (male: n = 59, 68.6%; female: n = 27, 31.4%). The age of the patients with AR ranged from 2 to 7 years (mean ± SD, 3.80 ± 1.72 years), and the age of the controls ranged from 2 to 7 years (3.78 ± 1.71 years).

The mean duration of AR symptoms was 18 ± 13 months. All the children with AR presented with watery nasal discharge, nasal obstruction, and nasal itching (frequent rubbing of the nose). Only 57 (66.3%) children with AR presented with an excessive bout of sneezing. Comorbidities among the participants with AR included bronchial asthma (n = 28, 32.6%), allergic dermatitis (n = 30, 34.9%), and allergic conjunctivitis (n = 15, 17.4%; **Table 1**). There was a significant association of AR with bronchial asthma (P = .033), allergic dermatitis (P = .002), and allergic conjunctivitis (P = .007).

Table 1. Comorbidities of Allergic Rhinitis among the Cases.

Comorbidity	Cases, n (%)	*P* Value
Bronchial asthma	28 (32.6)	.033
Allergic dermatitis	30 (34.9)	.002
Allergic conjunctivitis	15 (17.4)	.007

There was a significant difference in the family history of atopy between the groups (**Table 2**).

Among the cases and controls, Jerger's type A tympanogram was the most common pattern in both ears, while type C was the least common, as shown in **Table 3**.

Thirty-nine (45.3%) participants with AR had OME, as compared with 8 (9.3%) controls, and the difference was

Table 2. Family History of Atopy among the Cases and Controls.[a]

Allergic Disorder	Cases	Controls	*P* Value
Bronchial asthma	61 (70.9)	11 (12.8)	.0001
Allergic dermatitis	26 (30.2)	8 (9.3)	.0001
Allergic rhinitis	38 (44.2)	12 (14.0)	.0001
Allergic conjunctivitis	22 (25.6)	9 (10.5)	.001

[a]Values are presented as n (%).

Table 3. Pattern of Tympanograms among the Cases and Controls.[a]

Ear: Tympanogram	Cases	Control	χ^2	*P* Value
Right ear			21.3	<.001
Type A	57 (66.3)	82 (95.4)		
Type B	23 (26.7)	2 (2.3)		
Type C	6 (7.0)	2 (2.3)		
Left ear			20.8	<.001
Type A	52 (60.5)	83 (96.5)		
Type B	24 (27.9)	2 (2.3)		
Type C	10 (11.6)	1 (1.2)		

[a]Values are presented as n (%).

Table 4. Prevalence of OME among the Participants.[a]

OME	Cases	Control	Odds Ratio	McNemar	95% CI	*P* Value
Unilateral	15 (17.4)	8 (9.3)	8.09	26.3	3.48-18.79	<.001
Bilateral	24 (27.9)	0 (0.0)				
None	47 (54.7)	78 (90.7)				

Abbreviation: OME, otitis media with effusion.
[a]Values are presented as n (%).

statistically significant ($P < .001$; odds ratio = 8.090; 95% CI = 3.48-18.79), as shown in **Table 4**.

Discussion

This present study clearly showed that OME occurred more among the participants with AR than the age- and sex-matched healthy (nonallergic) controls. To the best of our knowledge, this study is the first to investigate the pattern of tympanometry among children with AR in Nigeria. The prevalence of OME (45.3%) in the present study was higher than that cited in similar pediatric studies: 32.8% by Alles et al[25] and 39% in a Copenhagen study.[26] The reason for the observed difference is unknown but may be associated with the genetic makeup and environmental differences of the studied population. The present study found that children with AR have >8 times the chance of developing OME ($P < .001$; odds ratio = 8.090; 95% CI = 3.48-18.79). The Copenhagen cohort study reported 3-fold chances of children with AR developing OME as compared with the unaffected child population. The higher prevalence of OME among children with AR may not be unconnected with the inflammatory process in the nasal mucosa, which spreads easily to involve the mucosa of the eustachian tube and middle ear cleft, thereby resulting in eustachian tube dysfunction and OME.

The male preponderance of AR in this study is similar to what the literature has reported.[3] Although allergic disorder majorly affects a single organ, it could affect >1 organ, resulting in more severe effects. The comorbidities reported in this study—allergic dermatitis, bronchial asthma, and allergic conjunctivitis—are similar to what other studies on AR have reported.[17,19,27,28] Positive family history of atopy has been documented as a recognized risk factor for the development of AR,[28] as corroborated by the finding in this study where more cases than controls had a family history of atopy.

The pattern of tympanogram recorded in this study included Jerger's tympanogram types A, B, and C, similar to what similar studies have reported.[29,30] Tympanogram type A was the most common in this study and was usually found in a healthy middle ear cleft. However, it could also be found at the early stage of OME. This study had a higher proportion of cases with a type B pattern than a type C pattern. Tympanogram type C indicates dysfunction in the eustachian tube, while type B implies the presence of effusion in the middle ear cleft or the restriction of tympanic membrane mobility. The higher proportion of children with type B than type C may not be unconnected with the fact that the disease process of OME usually starts with blockage of the eustachian tube by mucosa edema or a plug of thick, tenacious mucus.

AR manifests with excessive bouts of sneezing, nasal mucous secretion, and edematous swelling of the mucosal lining of nasal cavity, nasopharynx, and eustachian tube.[12] The pathogenesis of OME and hearing loss in children with AR is associated with dysfunction of the eustachian tube when partially or completely obstructed by a mucous plug or mucosal edema. In this situation, air within the middle ear cleft is absorbed by the mucous membrane and is not replaced, resulting in negative middle ear pressure. The sustained negative pressure results in a retracted tympanic membrane and eventual secretion and retention of fluid within the middle ear space resulting in OME. OME has a negative effect on the auditory process, with a consequent clinical manifestation as conductive hearing loss.[12]

The 2016 updated clinical practice guideline for diagnosing OME from the American Academy of Otolaryngology—Head and Neck Surgery Foundation recommends the use of pneumatic otoscopy to document the presence of OME in children before tympanometry, as well as to assess for OME among children with otalgia, hearing loss, or both.[31] Unfortunately, this was not done in this study due to the nonavailability of a functioning pneumatic otoscope at the time. Nevertheless, the tympanometry done confirmed OME in the children. None of the participants had otalgia, and caregivers did not lodge complaints of hearing loss on their wards. However, the focus of the study did not include

documentation on speech delay, which is the sequela of OME. The presence of nasal eosinophilia alone to confirm AR in this study is inadequate, as this can also be found in non-AR with eosinophilia syndrome. However, allergen skin testing, which can distinguish AR from non-AR with eosinophilia syndrome, could not be done due to funding and, thus, the difficulty in procuring allergen test kits.

Conclusion

The prevalence of OME in this study was 45.3%. Three tympanometric patterns as described by Jerger were seen, but the abnormal patterns (types B and C) were more common for children with AR than the healthy pediatric population. Medical practitioners should be aware of the possible association of AR with OME and hence incorporate routine tympanometric evaluation into the management protocol for children with AR to detect and treat OME early.

Author Contributions

Ayotunde James Fasunla, study concept and design, data collection, analysis and interpretation of data, manuscript drafting, revision and final draft approval of the manuscript; **Julius Olowo Ijitola**, study design and conduct, submitted proposal for ethical approval, data collection, analysis and interpretation, writing of the manuscript, revision and final draft approval; **Onyekwere George Nwaorgu**, study concept and design, data interpretation, manuscript review for contribution to knowledge and correction, and final draft approval.

Disclosures

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References

1. Pawankar R, Mori S, Ozu C, Kimura S. Overview on the pathomechanisms of allergic rhinitis. *Asia Pac Allergy*. 2011; 1:157-167.
2. Varshney J, Varshney H, Dutta SK, Hazra A. Comparison of sensory attributes and immediate efficacy of intranasal ciclesonide and fluticasone propionate in allergic rhinitis: a randomized controlled trial. *Indian J Pharmacol*. 2012;44:550-554.
3. Falade AG, Ige OM, Yusuf BO, Onadeko MO, Onadeko BO. Trends in the prevalence and severity of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema. *J Natl Med Assoc*. 2009;101:414-418.
4. Davies R, Rusznak C, Devalia J. Why is allergy increasing? Environmental factors. *Clin Exp Allergy*. 1998;28(suppl 6):8-14.
5. Skoner DP. Allergic rhinitis: definition, epidemiology, pathophysiology, detection, and diagnosis. *J Allergy Clin Immunol*. 2001;108(1):S2-S8.
6. Wright AL, Holberg CJ, Halonen M, Martinez FD, Morgan W, Taussig LM. Epidemiology of physician-diagnosed allergic rhinitis in childhood. *Pediatrics*. 1994;94:895-901.
7. Togias A. Unique mechanistic features of allergic rhinitis. *J Allergy Clin Immunol*. 2000;105:S599-S604
8. Stone KD. Atopic diseases of childhood. *Curr Opin Pediatr*. 2003;15:495-511.
9. Lavie P, Gertner R, Zomer J, Podoshin L. Breathing disorders in sleep associated with ''microarousals'' in patients with allergic rhinitis. *Acta Otolaryngol*. 1981;92:529-533.
10. Young T, Finn L, Kim H; University of Wisconsin Sleep and Respiratory Research Group. Nasal obstruction as a risk factor for sleep-disordered breathing. *J Allergy Clin Immunol*. 1997; 99:S757-S762.
11. Bousquet J, Van Cauwenberge P, Khaltaev N; Aria Workshop Group; World Health Organisation. Allergic rhinitis and its impact on asthma. *J Allergy Clin Immunol*. 2001;108(5):S147-S334.
12. Schilder AG, Zielhuis GA, Straatman HS, van den Broek P. An epidemiological approach to the etiology of middle ear disease in the Netherlands. *Eur Arch Otorhinolaryngol*. 1992; 249:370-373.
13. Bernstein JM. Role of allergy in eustachian tube blockage and otitis media with effusion: a review. *Otolaryngol Head Neck Surg*. 1996;114:562-568.
14. Moore DR, Hartley DE, Hogan SC. Effects of otitis media with effusion (OME) on central auditory function. *Int J Pediatr Otorhinolaryngol*. 2003;67(suppl 1):S63-S67.
15. Ogisi FO. Impedance screening for otitis media with effusion in Nigerian children. *J Laryngol Otol*. 1988;102:986-988.
16. Bennett KE, Haggard MP, Silva PA, Stewart IA. Behaviour and developmental effects of otitis media with effusion into the teens. *Arch Dis Child*. 2001;85:91-95.
17. Ologe FE, Adebola SO, Dunmade AD, Adeniji KA, Oyejola BA. Symptom score for allergic rhinitis. *Otolaryngol Head Neck Surg*. 2013:148:557-563.
18. Mösges R. The increasing prevalence of allergy: a challenge for the physician. *Clin Exp Allergy Rev*. 2002;2:13-17.
19. Bauchau V, Durham SR. Prevalence and rate of diagnosis of allergic rhinitis in Europe. *Eur Respir J*. 2004;24:758-764.
20. Vanna AT, Yamada E, Arruda LK, Naspitz CK, Solé D. International Study of Asthma and Allergies in Childhood: validation of the rhinitis symptom questionnaire and prevalence of rhinitis in school children in Sao Paulo, Brazil. *Paediatr Allergy Immunol*. 2001;12:95-101.
21. Lans DM, Alfano N, Rocklin R. Nasal eosinophilia in allergic rhinitis and non-allergic rhinitis: usefulness of the nasal smear in the diagnosis of allergic rhinitis. *Allergy Proc*. 1989;10:275-280.
22. Takwoingi Y, Akang E, Nwaorgu G, Nwawolo C. Comparing nasal secretion eosinophilia count with skin sensitivity test in allergic rhinitis in Ibadan, Nigeria. *Acta Otolaryngol*. 2003; 123:1070-1074.
23. Mullarkey MF, Hill JS, Webb DR. Allergic and non-allergic rhinitis: their characterization with attention to the meaning of nasal eosinophilia. *J Allergy Clin Immunol*. 1980;65:122-126.
24. Jerger J. Clinical experience with impedance audiometry. *Arch Otolaryngol*. 1970;92:311-324.
25. Alles R, Parikh A, Hawk L, Darby Y, Romero JN, Scadding G. The prevalence of atopic disorders in children with chronic otitis media with effusion. *Pediatr Allergy Immunol*. 2001;12: 102-106.

26. Bisgaard H. The Copenhagen Prospective study on Asthma in Childhood (COPSAC): design, rationale, and baseline data from a longitudinal birth cohort study. *Ann Allergy Asthma Immunol*. 2004;93:381-389.
27. Min YG, Choi BY, Kwon SK, et al. Multicenter study on the prevalence of perennial allergic rhinitis and allergy-associated disorders. *J Korean Med Sci*. 2001;16:697-701.
28. Dold S, Wjst M, von Mutius E, Reitmeir P, Stiepel E. Genetic risk for asthma, allergic rhinitis, and atopic dermatitis. *Arch Dis Child*. 1992;67:1018-1022.
29. Holt R, Watkins TM, Yoder MG. Assessment of tympanometry in abnormalities of the tympanic membrane. *Am J Otolaryngol*. 1982;3:112-116.
30. Baldwin M. Choice of probe tone and classification of trace patterns in tympanometry undertaken in early infancy. *Int J Audiol*. 2006;45:417-427.
31. Rosenfeld RM, Shin JJ, Schwartz SR, et al. Clinical practice guideline: otitis media with effusion (update). *Otolaryngol Head Neck Surg*. 2016;154:201-214.