

Ethnic variations and risk factors associated with pneumatisation in chronic otitis media: A morphological analysis

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Abstract

Objective: To identify socioeconomic and clinical factors associated with chronic otitis media and hearing loss.

Method: The cross-sectional study was conducted at PNS Shifa Hospital, Karachi, from January 1 to June 30, 2024, and comprised patients of either gender aged 10-75 years having chronic otitis media in one ear. A detailed past medical and surgical history was obtained along with demographic data and history of bilateral chronic otitis media disease. Evaluation of chronic otitis media was done by using high-resolution computed tomography of temporal bone pneumatisation. Data was analysed using SPSS 27. Chi-square test was applied.

Results: Of the 46 patients with mean age 40.96 ± 15.613 years (range: 12-72 years), 32(69.6%) were male 14(30.4%) were female. Chronic otitis media was found more prevalent in males. Out of 46, 24(52.2%) patients were Punjabis. Hypopneumatisation was found in 27 out of 46 and hearing loss was found in 28 out of 46 (60.9%). They were found to be significantly associated with chronic otitis media ($p=0.001$ and $p=0.048$) respectively. Out of 46, 32 (69.6%) belonged to rural areas\

and 14 (30.4%) belonged to the urban areas. Hearing loss was associated with low socioeconomic status ($p=0.04$). A total of 31 (67.4%) patients were illiterate and 15 (32.6%) were literate..

Conclusion: Chronic otitis media was found to be a leading cause of avoidable deafness. Early identification of COM can lessen the burden of the disease.

Keywords: Hearing loss, Ethnicity, Middle ear infection, Otitis media, Temporal bone, social class, Low socioeconomic status, Urban population, Rural population, Hearing loss. (JPMA 76: 1664; 2026)

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Introduction

A tympanic membrane perforation^{1,2} accompanied by otorrhea is known as chronic suppurative otitis media (CSOM), and it is also characterised by the presence or absence of cholesteatoma.¹ Chronic otitis media (COM) is an inflammatory condition that results in cholesteatoma, tympanosclerosis, retraction and permanent or long-term perforation of the middle ear and tympanic membrane.³ The majority of the disease burden is borne by the developing world even though CSOM, with or without cholesteatoma^{2,3} is a major source of illness worldwide.

According to a study, CSOM affects between 65 million and 330 million people³ results in 28,000 deaths per year, and has a burden of >2 million disability-adjusted life years.¹ COM is influenced by socioeconomic^{2,4} and environmental⁵ factors, including immunity⁶ that might affect treatment outcomes, severity and susceptibility.

In Pakistan, the prevalence of COM is reported to be 6%.^{3,7} Over 2.2 million cases of otitis media with effusion are

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identified each year in the United States, where 60% of children are estimated to have acute otitis media (AOM) before the age of three.⁶ In order to lower the prevalence of CSOM in the community, public health measures may need to focus on a variety of risk factors⁷ associated with COM.

Different groups have different healthcare utilisation trends. Black children were more prone than white children, for instance, to use hospital emergency rooms (ERs) and outpatient departments (OPDs) rather than doctor's clinics.⁸ It is still not fully known what causes these differences, and developing solutions to give every child an equal chance to receive the care they require needs a deeper comprehension of the factors causing inequities.⁹

Important national and international studies have emphasised the effects of variables like race, socioeconomic status (SES), education and access to healthcare on general health.¹⁰ Racial and cultural stereotypes and misconceptions about financial capacity, surgical desire, postoperative care and other aspects may affect referral and treatment choices at every stage.⁹

Although, a large number of risk factors for COM have been identified, modern studies that take into account a large number of putative determinants and confounders

collectively are scarce.⁴ One article emphasised the necessity of precisely defining risk factors for the development of CSOM. Recognition of risk factors for CSOM plays an important role in disease prevention and reduction of related morbidity and mortality, because addressing the risk factors may lessen the burden of the disease and its recurrence in children with CSOM.⁷

Additionally, Pakistan has a relatively low literacy rate, and, due to ignorance and illiteracy, people increasingly turn to quacks for the treatment of their illnesses. Many handle these issues without even consulting a specialist.¹¹ Such carelessness can ultimately lead to variety of complications. According to a study, the complications of COM can be extra-cranial, like sub-periosteal abscess, inflammation of labyrinth and mastoid, and facial paralysis, while intracranial complications include thrombosis of lateral sinus, abscess of brain, sub- and extra-dural abscess and inflammation of meninges.¹²

The current study was planned to identify socioeconomic and clinical factors associated with COM and hearing loss.

Patients and Methods

The cross-sectional (morphological) study was conducted at PNS Shifa Hospital, Karachi, from January 1 to June 30, 2024. The sample was raised using purposive sampling technique from among the patients who were referred for high-resolution computed tomography (HRCT). After approval from the institutional ethics review committee, the sample size was calculated using an OpenEpi calculator¹³ on the basis of prevalence noted in literature:⁷ The formula used was: $n = [DEFF * Np(1-p)] / [(d^2 / Z^2 * 1 - \alpha / 2 * (N-1) + p * (1-P))]$.

COM was evaluated through detailed otoscopic examination and diagnosis was confirmed by consultant

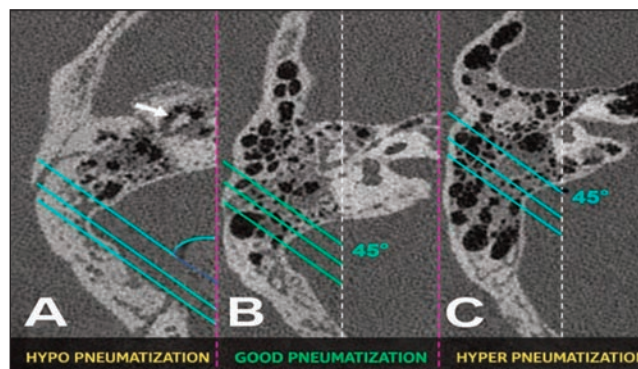


Figure-2: High-resolution computed tomography (HRCT) of a patient showing hypo (A), good (B) and hyper pneumatisation (C) with right-ear chronic otitis media (COM).

ear-nose-throat (ENT) specialists. Those included were patients of either gender aged 10-75 years having COM in one ear. The consent forms were signed by the individuals aged >18 years, while assent forms were signed by those aged <18 years. Those excluded were individuals outside the specific age group, and those having any traumatic temporal bone history or surgery or any abnormality related to the ear. Patients with bilateral COM were also excluded. A detailed past medical and surgical history was obtained. After taking down demographic data and clinical history, COM was evaluated. The procedure followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) flow¹⁴ (Figure 1).

HRCT temporal bone pneumatisation evaluation was done using a multidetector CT scanner while the head was in neutral alignment and the patient was lying down. Using HRCT algorithm, thin-section axial images (0.5-0.6mm) were produced, followed by coronal and sagittal reconstructions. The total scan time ranged 30-60 seconds, and the images were examined using Vitrea software.

The pneumatisation was categorised into three classes: hypo-pneumatisation when the pneumatisation was located anteromedially at the most anterior point and the most lateral aspect of the sigmoid sinus; good pneumatisation when the pneumatisation reached the area located between the two arbitrary lines drawn at both the most lateral aspect and the most posterior point of the sigmoid sinus; and hyper-pneumatisation when the pneumatisation reached posterolaterally beyond a line drawn at the most posterior point of the sigmoid sinus¹⁵ (Figure 2).

Data was analysed using SPSS 27. Data was expressed, as appropriate, in terms of either frequencies and percentages or mean $\pm$ standard deviation. Association between categorical variables were assessed using chi-square and Fisher exact test. $P < 0.05$ was considered significant.

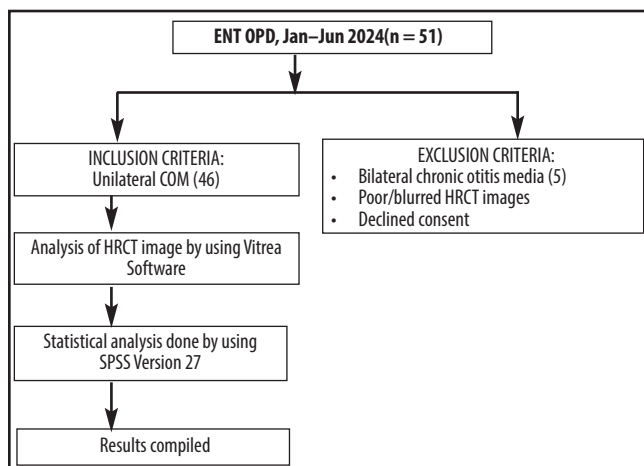


Figure-1: Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) flow diagram.

Table-1: Demographic and clinical characteristics of the subjects (n=46).

Variable	COM Present [n(%)]
Gender	
Male	32 (69.6)
Female	14 (30.4)
Ethnicity	
Punjabi	24 (52.2)
Urdu speaking	11 (24)
Balochi	4 (8.6)
Seraiki	4 (8.6)
Sindhi	1 (2.2)
Pathan	1 (2.2)
Hazara	1 (2.2)
Pneumatisation	
Hypo	27 (58.8)
Good	12 (26.1)
Hyper	7 (15.1)
Hearing Loss	
Present	28 (60.9)
Absent	18 (39.1)
Residence	
Urban	14 (30.4)
Rural	32 (69.6)
Education	
Literate	15 (32.6)
Illiterate	31 (67.4)
Socioeconomic status	
Low	20 (43.5)
Middle	18 (39.1)
High	8 (17.4)

COM: Chronic Otitis Media.

Results

Of the 46 patients with mean age 40.96 ± 15.613 years (range: 12-72 years), 32(69.6%) were male 14(30.4%) were female ($p > 0.05$). Punjabi ethnicity was the most common 24(52.2%). The most prevalent pneumatisation pattern was hypo-pneumatisation 27(58.8%). Majority of the participants 28(60.9%) had hearing loss. The majority of participants lived in rural areas 32(69.6%), 3(67.4%) were illiterate, 20(43.5%) had low SES. (Table 1).

Hypo-pneumatisation of the mastoid bone and hearing loss were observed exclusively in patients with COM (Table 2). Hearing loss was found to be associated with low SES (Table 3). Mastoiditis was found as a complication in (2.17%) patient.

Discussion

The current sample had a male preponderance which was most likely because males are given more importance in Pakistani society. However, one study among children in the United States found that younger children were most affected and older-aged children were at a greater risk of

Table-2: The association of chronic otitis media (COM) with demographic variables.

Variable	Hypo (n)	Good (n)	Hyper (n)	COM Present (n)	p-value
Gender					
Male	14	7	11	32	0.152
Female	9	4	1	14	
Ethnicity					
Punjabi	20	8	2	24	0.104
Balochi	2	1	0	11	
Sindhi	0	1	0	4	
Seraiki	2	0	1	4	
Urdu speaking	9	0	2	1	
Hazara	0	0	1	1	
Pathan	1	0	0	1	
Pneumatisation					
COM Present	25	2	0	12	0.001*
Healthy	9	4	6	7	
Hearing Loss					
COM Present	29	3	3	28	0.048*
Healthy	5	3	3	18	
Residence					
Urban	3	6	5	14	0.030*
Rural	20	8	4	32	
Education					
Literate	8	2	5	15	0.054
Illiterate	25	4	2	31	

Table-3: The association of hearing loss with age, gender and socioeconomic status (SES).

Socioeconomic Status	Hearing Loss	Hearing Loss Present (n)	Total Absent (n)	p-value
Age (years)				
0-20	4	3	7	0.52
21-40	12	9	21	
41-60	10	4	14	
>60	2	2	4	
Gender				
Male	20	12	32	0.95
Female	8	6	14	
SES				
Low (20)	15 (75%)	5 (25%)	20	0.04*
Middle (18)	10 (55.6%)	8 (44.4%)	18	
High (8)	3 (37.5%)	5 (62.5%)	8	

* $p < 0.05$.complications.⁸

The current study found that Punjabi population suffered most with the disease. One of the possible reasons could be that the centre/hospital selected for sample collection was most frequently visited by the Punjabi population as it was a navy-based hospital and majority of the panelled staff reporting there were from Punjabi ethnicity. One study⁸ found a significant higher prevalence of OM with non-Hispanic population compared to the Hispanic ones. One retrospective cohort study found that tympanostomy tube (TT) placement was most commonly done in white children, followed by non-Hispanic blacks, Hispanics and

the lowest in the Asian population.⁹

Hypo-pneumatisation and hearing loss was more prevalent in the current study. Similar results for hypo-pneumatisation^{3,15} and hearing loss^{6,16,17} have been reported by earlier studies in Pakistan. However, hearing loss was not present with a high incidence in some studies.^{18,19}

The current study had the majority of sample belonging to rural areas. One study concluded that COM was found to be more prominent in the rural population compared to the urban.¹ However, other studies¹⁷ showed that urban population was most commonly affected. Moreover, the current study did not find any significant association between rural and urban population, suggesting that COM is a widespread disease, not localised to a particular population, so healthcare facilities should be available to both urban and rural populations, and awareness related to ear hygiene can play an important role.

In the current study, majority of COM patients had not completed their education up to matriculation. However, an earlier study reported that COM was more commonly present in those holding a bachelor's degree compared to high school graduates.²⁰

The current study found unilateral COM diseased ear to be more common. Similar results were observed in a study in Lodhran.²¹ However, in contrast, one study in Saudi Arabia found more bilateral cases of CSOM.²² Majority of the current patients had low SES, but one study²⁰ reported higher middle class representation in its sample.

The current study did not find a significant association of gender and ethnicity with COM. One case-control study in Auckland concluded that Asian ethnicity was not associated with COM.⁴ Another study in Nepal determined the severity of the disease, and found no significant association between ethnicity and COM severity with respect to the presence or absence of cholesteatoma.² However, the current study did not determine COM severity. A cross-sectional study in the United States found no significant association between OM and ethnicity.⁸

The current study found a significant association between hypo-pneumatisation and COM. Earlier studies^{3,15} in Pakistan also reported similar results.

In the current study, there was an association of hearing loss with COM, irrespective of the type and severity. A study in Lahore concluded that there was moderate hearing loss in patients with COM.¹⁸ Studies conducted in Abbottabad¹⁷ and Karachi⁶ found that sensorineural hearing loss^{17,23} was most commonly found in COM.¹⁷ The current study also

found that hearing loss was the most common presenting complaint regardless of pain. COM had no significant association with residence, education status and laterality of the disease.

The current study found no association of hearing loss with age and gender which was in line with an earlier study done in Karachi.¹⁹ The current study found significant association between SES and hearing loss, which was also reported earlier.²⁴

In the current study, there was only one patient with mastoiditis. However, compared to other nations, Saudi nationality has been found associated with a higher incidence of acute mastoiditis.^{20,25}

In terms of limitations, the current study may have been affected by selection bias. Also, the study had a small sample size. Multicentre studies with large sample sizes are recommended.

Conclusion

COM was found to be a leading cause of avoidable deafness. Since unilateral diseased ear were common, it can be said that one ear is not linked with the other.

Disclaimer: The text is based on an academic thesis.

Conflict of Interest: None.

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References

1. Ruffin WC, Crouch JB, Burruss CP, Bush ML. Sociodemographic factors and health care utilisation in pediatric chronic suppurative otitis media. *Laryngoscope* 2023;133:700-5. doi: 10.1002/lary.30213.
2. Qian ZJ, Rehkopf DH. Association between social disadvantage and otitis media treatment in US children with commercial insurance. *JAMA Otolaryngol Head Neck Surg* 2023;149:7-14. doi: 10.1001/jamaoto.2022.3560.
3. Azmat H, Mahar Y, Qamar A, Younus A. Association of mastoid pneumatisation with chronic otitis media: a comparative study. *Pak J Med Sci* 2025;41:3437-42. doi: 10.12669/pjms.41.12.12217.
4. Walker RE, Bartley J, Flint D, Thompson JM, Mitchell EA. Determinants of chronic otitis media with effusion in preschool children: a case-control study. *BMC Pediatr* 2017;17:1-9. doi: 10.1186/s12887-016-0767-7.
5. Geng R, Wang Q, Chen E, Zheng QY. Current understanding of host genetics of otitis media. *Front Genet* 2020;10:1395. doi: 10.3389/fgene.2019.01395.
6. Ali Zaidi SS, Pasha HA, Suhail A, Qureshi TA. Frequency of sensorineural hearing loss in chronic suppurative otitis media. *J Pak Med Assoc* 2016;66(Suppl 3):s42.
7. Heward E, Saeed H, Bate S, Rajai A, Molloy J, Isba R, et al. Risk factors associated with the development of chronic suppurative otitis media in children: systematic review and meta-analysis. *Clin Otolaryngol* 2024;49:62-73. doi: 10.1111/coa.14152.
8. Chang JE, Shapiro NL, Bhattacharyya N. Do demographic disparities exist in the diagnosis and surgical management of otitis media? *Laryngoscope* 2018;128:2898-901. doi: 10.1002/lary.27396.

9. Shi Y, Heien HC, Orvidas LJ, Sangaralingham LR, Halbauer M, Warner DO, et al. Racial and Ethnic Disparities in Otolaryngology Office Visit and Tympanostomy Tube Placement in Children with Otitis Media. *Laryngoscope* 2024;134:3846-52. doi: 10.1002/lary.31380.
10. Jabbour J, Robey T, Cunningham MJ. Healthcare disparities in pediatric otolaryngology: a systematic review. *Laryngoscope* 2018;128:1699-713. doi: 10.1002/lary.26995.
11. Akram S, Khan MA, Rehman A, Malik KZ, Afridi JA. Comparison of prevalence of various ENT diseases and hearing impairment among children of government schools versus private schools of Mardan. *J Fatima Jinnah Med Univ* 2020;14:170-5. doi: 10.37018/pjdw8445.
12. Sharma N, Jaiswal AA, Banerjee PK, Garg AK. Complications of chronic suppurative otitis media and their management: a single institution 12 years' experience. *Indian J Otolaryngol Head Neck Surg* 2015;67:353-60. doi: 10.1007/s12070-015-0836-5.
13. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version: 3.01. [Online] 2013 [Cited 2026 July 16]. Available from URL: https://www.openepi.com/Menu/OE_Menu.htm
14. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med* 2007;4:e296. doi: 10.1371/journal.pmed.0040296.
15. Han SJ, Song MH, Kim J, Lee WS, Lee HK. Classification of temporal bone pneumatisation based on sigmoid sinus using computed tomography. *Clin Radiol* 2007;62:1110-8.
16. Liaqat N, Qadri JA, Din IU, Ali Z, Baseer A. Association of chronic otitis media with rhinologic and otologic variations: a high-resolution computed tomography study. *F1000Research* 2025;14:793.
17. Usman F, Babar M, Shinwari WU, Nagra SR, Ahmed SA. Otitis media with persistent inflammation is a common cause of sensorineural hearing loss. *Pak J Med Health Sci* 2022;16:884. doi: 10.53350/pjmhs22168884.
18. Aziz BA, Riaz NA, Rehman A, Malik MI, Malik KI. Colligation of hearing loss and chronic otitis media. *Pak J Med Health Sci* 2021;15:1817. doi: 10.53350/pjmhs211581817.
19. Anwar Z, Afaq SA, Bhatti MI, Dogar MR, Mahmood M, Anwar A, et al. Demographical variations of sensory neural hearing loss in chronic suppurative otitis media patients at JPMC Karachi. *Pak J Med Health Sci* 2023;17:294. doi: 10.53350/pjmhs2023175294.
20. Alkhars OA, Althamin MA, Alolyani AN, Aljumaah AS, Alkhayat EM, Altalhi RA, et al. Identifying risk factors and complications associated with acute otitis media in paediatric patients in Saudi Arabia: a cross-sectional analysis. *J Adv Trends Med Res* 2024;1:149-55. doi: 10.4103/ATMR.ATMR_67_24.
21. Hussain A, Ali I, Mushtaq AB, Hussain J, Khan TH, Afzal M, et al. Prevalence of allergic indicators in patients with chronic otitis media: a case-control study. *Pak J Health Sci* 2024;5:134-8. doi: 10.54393/pjhs.v5i11.1907.
22. Alshehri AM, Alhelali SN, Alzahrani AA, Mohammed A, Alqhtani MB, Alqahtani MM, et al. Risk factors of otitis media in children, Asser region: a case-control study. *Bahrain Med Bull* 2021;43.
23. Ali S, Khan MS, Zahid L. Common causes of hearing impairment among children less than 8 years of age in district Bahawalpur, Punjab, Pakistan. *J Pak Med Assoc* 2022;72:1607-11. doi: 10.47391/JPMA.3879.
24. Pérez-Herrera LC, Peñaranda D, Moreno-López S, Otoya-Tono AM, Gutiérrez-Velasco L, García JM, et al. Associated factors, health-related quality of life, and reported costs of chronic otitis media in adults at two otologic referral centers in a middle-income country. *PLoS One* 2020;15:e0244797. doi: 10.1371/journal.pone.0244797.
25. Alshehri S, Alahmari KA. Pediatric acute mastoiditis in Saudi Arabia: demographic insights, clinical profiles, and prognostic factors. *Children (Basel)* 2024;11:402. doi: 10.3390/children11040402.

Author Contribution:

HA: Responsible for integrity of the research, set parameters, writing and editing.

YM: Generally supervised the research.

AQ: Final approval.

JZ: Helped in designing the study.

AY: Data interpretation and reviewed the results.

AM: Helped in collection of clinical and non-clinical data.