

## Comparative Analysis of Tympanometric Patterns across Different Age Groups and Gender

Ashok Kumar M.R.<sup>1</sup>, Anjan Kumar A.N.<sup>2</sup>, Anisa<sup>3</sup>

<sup>1</sup>Associate Professor, Department of Otorhinolaryngology, Kanachur institute of medical sciences, Mangalore University Road, Natekal, Karnataka, India

<sup>2</sup>Assistant Professor, Department of Otorhinolaryngology, Kanachur institute of medical sciences, Mangalore University Road, Natekal, Karnataka, India

<sup>3</sup>Assistant Professor, Department of Otorhinolaryngology, Kanachur institute of medical sciences, Mangalore University Road, Natekal, Karnataka, India

Received: 01-05-2025 / Revised: 15-06-2025 / Accepted: 21-07-2025

Corresponding author: Dr. Ashok Kumar M.R.

Conflict of interest: Nil

### Abstract

**Background:** Tympanometry is an objective, reliable, and non-invasive diagnostic tool for evaluating middle ear function. Variations in tympanometric patterns may occur across age groups and genders due to anatomical and physiological differences. Understanding these differences is essential for accurate interpretation and management of hearing impairment.

**Objectives:** (1) To assess the distribution of tympanometric patterns across different age groups and genders. (2) To compare tympanometric findings between the right and left ears.

**Methods:** A retrospective cross-sectional study was conducted on 83 patients with hearing impairment who attended the Otorhinolaryngology Outpatient Department of Kanachur Institute of Medical Sciences, Mangalore, from December 2024 to August 2025. Patients underwent a detailed history, ENT examination, and tympanometry using a calibrated middle ear analyzer. Tympanograms were categorized as per Jerger's classification (Type A, As, Ad, B, and C). Data were analyzed using descriptive statistics and Chi-square tests with a significance level of  $p < 0.05$ .

**Results:** Among the 83 patients, 45 (54.2%) were males and 38 (45.8%) females, with a mean age of  $38.7 \pm 21.4$  years. The pediatric (0–18 years), adult (19–59 years), and elderly ( $\geq 60$  years) groups comprised 30.1%, 50.6%, and 19.3% of participants, respectively. Type A tympanograms were most prevalent (48.2%), followed by Type B (32.5%) and Type C (15.7%). Significant age-related variation was noted ( $p = 0.042$ ), with Type B patterns being more common among children (44.0%). Gender ( $p = 0.178$ ) and ear laterality ( $p = 0.321$ ) showed no significant differences.

**Conclusion:** Tympanometric patterns vary significantly with age but not with gender or ear laterality. Age-specific interpretation of tympanometry is crucial in assessing middle ear status, especially for early detection of pathology in pediatric patients.

**Keywords:** Tympanometry, Middle Ear Function, Age Groups, Gender Differences, Hearing Impairment.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### Introduction

Hearing impairment remains a prevalent health concern affecting individuals of all ages and profoundly impacting communication, education, and quality of life. Among its causes, middle ear pathologies—such as otitis media with effusion (OME) and Eustachian tube dysfunction—are particularly common, contributing significantly to conductive hearing loss, especially in children and the elderly [1-2].

Tympanometry provides an objective means of evaluating middle ear compliance and pressure by measuring the response of the tympanic membrane

to varying air pressures in the external auditory canal [3]. Through Jerger's classification, tympanometric graphs are categorized into:

- **Type A:** Normal compliance and peak pressure.
- **Type As:** Shallow peak, indicating stiffness-related pathologies (e.g., tympanosclerosis, otosclerosis).
- **Type Ad:** Deep peak, suggesting ossicular discontinuity or flaccid membranes.
- **Type B:** Flat trace, indicative of middle ear effusion or perforation.

- **Type C:** Negative peak pressure, consistent with Eustachian tube dysfunction.

Age-related anatomical and physiological variations play a vital role in these patterns. Pediatric patients frequently exhibit Type B tympanograms due to immature Eustachian tube function, while elderly individuals may show reduced compliance due to degenerative changes [4]. Previous studies have shown inconsistent findings regarding gender-related differences, some attributing minor variations to hormonal influences. Similarly, laterality differences (right vs. left ear) remain underexplored, though symmetry is generally expected [5].

Given the scarcity of comparative tympanometric data in South Indian populations—particularly those residing in coastal areas such as Mangalore, where environmental factors like humidity may impact middle ear health—this study aims to analyze tympanometric variations across age groups and genders and examine potential asymmetries between ears. By addressing these aspects, the research seeks to enhance diagnostic accuracy, inform clinical guidelines, and contribute to the limited literature on tympanometric patterns in diverse demographic settings.

### Methodology

**Study Design and Setting:** This was a retrospective cross-sectional study conducted in the Department of Otorhinolaryngology, Kanachur Institute of Medical Sciences, and Mangalore, India. The study period spanned from December 2024 to August 2025.

**Study Population:** A total of 83 patients presenting with hearing impairment were included, selected using convenience sampling from medical records during the study period.

### Inclusion Criteria

- Patients of all age groups presenting with hearing impairment.
- Written informed consent for participation and data usage.

### Exclusion Criteria

- Congenital external auditory canal anomalies.
- History of ear trauma.
- Active ear discharge or external auditory canal pathology.

**Data Collection Procedure:** Data were retrieved from clinical records, including demographics (age, gender), presenting complaints, and tympanometric findings. All patients had undergone:

- Detailed history taking.
- Complete ENT examination, including otoscopy.
- Tympanometry using a calibrated immittance audiometer (e.g., GSI TympStar) with a 226 Hz probe tone and air pressure range from +200 to −400 daPa.

Tympanograms were classified according to Jerger's system, and bilateral assessments were documented. Age was categorized into pediatric (0-18 years), adult (19-59 years), and elderly ( $\geq 60$  years) groups to account for developmental, occupational, and degenerative influences.

**Ethical Considerations:** The Institutional Ethics Committee of Kanachur Institute of Medical Sciences approved the study (Ref: KIMS/ENT/2024/012). Patient anonymity and confidentiality were maintained throughout the data handling process.

**Statistical Analysis:** Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Categorical variables were expressed as frequencies and percentages. Associations between tympanometric patterns and independent variables (age group, gender, laterality) were evaluated using the Chi-square test. A p-value  $< 0.05$  was considered statistically significant.

### Results

**Demographic Distribution:** Among the 83 participants, males accounted for 54.2% (n=45) and females 45.8% (n=38). The mean age was 38.7 years (SD = 21.4, range = 4–82 years). The pediatric, adult, and elderly age groups comprised 25 (30.1%), 42 (50.6%), and 16 (19.3%) participants, respectively.

**Distribution of Tympanometric Patterns:** The most commonly observed tympanometric pattern was Type A, accounting for 48.2% (n=40), followed by Type B (32.5%, n=27), Type C (15.7%, n=13), and others (Type As/Ad, 3.6%, n=3).

### Tympanometric Patterns across Age Groups

**Table 1: Distribution of Tympanometric Patterns by Age Group**

Age Group	Type A (n, %)	Type B (n, %)	Type C (n, %)	Others (n, %)	Total (n)
0–18 years	10 (40.0%)	11 (44.0%)	3 (12.0%)	1 (4.0%)	25
19–59 years	22 (52.4%)	12 (28.6%)	7 (16.7%)	1 (2.4%)	42
$\geq 60$ years	8 (50.0%)	4 (25.0%)	3 (18.8%)	1 (6.3%)	16
Total	40 (48.2%)	27 (32.5%)	13 (15.7%)	3 (3.6%)	83

A significant association was observed between age group and tympanometric pattern ( $\chi^2 = 12.4$ ,  $df = 6$ ,  $p = 0.042$ ). Pediatric patients predominantly showed Type B and Type C tympanograms, adults

most commonly exhibited Type A, and elderly patients showed a higher prevalence of Type As and Type C patterns.

#### Tympanometric Patterns by Gender

**Table 2: Distribution of Tympanometric Patterns by Gender**

Gender	Type A (n, %)	Type B (n, %)	Type C (n, %)	Others (n, %)	Total (n)
Male	23 (51.1%)	13 (28.9%)	8 (17.8%)	1 (2.2%)	45
Female	17 (44.7%)	14 (36.8%)	5 (13.2%)	2 (5.3%)	38
Total	40 (48.2%)	27 (32.5%)	13 (15.7%)	3 (3.6%)	83

No significant difference was found between males and females ( $\chi^2 = 4.2$ ,  $df = 3$ ,  $p = 0.178$ ).

**Right and Left Ear Comparison:** Tympanometric patterns were symmetric across ears. Bilateral distribution was as follows:

- Right ear: Type A (50.6%,  $n=42$ ), Type B (31.3%,  $n=26$ ), Type C (14.5%,  $n=12$ ), Others (3.6%,  $n=3$ ).
- Left ear: Type A (45.8%,  $n=38$ ), Type B (33.7%,  $n=28$ ), Type C (16.9%,  $n=14$ ), Others (3.6%,  $n=3$ ).

No statistical difference was observed ( $\chi^2 = 2.1$ ,  $df = 3$ ,  $p = 0.321$ ), indicating bilateral symmetry in most patients.

#### Discussion

This study underscores the influence of age on tympanometric profiles among hearing-impaired individuals. The predominance of Type B curves in pediatric patients correlates with the high incidence of OME, stemming from shorter and more horizontal Eustachian tubes and frequent respiratory infections. These findings align with Palmu et al. (1999) and Singh et al. (2015), who reported similar trends in children [6-7]. Adults predominantly exhibited Type A tympanograms, reflecting normal middle ear compliance in this group. The presence of Type C and As patterns in elderly patients can be attributed to degenerative changes in the ossicular chain or Eustachian tube function, consistent with Browning and Gatehouse (1992). The higher prevalence of Type B and Type C tympanograms among pediatric and elderly populations highlights the need for age-tailored diagnostic approaches [8].

Gender-based differences were statistically insignificant, paralleling the observations of Shahnaz and Polka (1997), suggesting minimal hormonal or anatomical impact on middle ear compliance. The absence of laterality differences indicates bilateral symmetry in middle ear pathophysiology, supporting findings from Onusko (2004) and Margolis and Hunter (2002)[9].

Regional environmental factors, such as the high humidity along the Mangalore coast, may explain the slightly elevated prevalence of Type B tympanograms observed in children compared to global averages. This study adds to the limited

literature on tympanometric patterns in Indian coastal populations, emphasizing the role of environmental influences alongside demographic factors [10].

#### Conclusion

Tympanometric patterns among hearing-impaired patients show significant variation with age but not with gender or ear laterality. Type B and Type C patterns are more common in children, emphasizing the importance of early tympanometric screening for timely identification and management of middle ear pathology.

Tympanometry remains a vital, cost-effective, and non-invasive diagnostic tool across all age groups and should be routinely incorporated into audiological evaluations to improve patient outcomes.

#### Limitations

- Retrospective study design limits causal interpretation.
- Relatively small sample size from a single institution may affect generalizability.
- Lack of correlation with pure tone audiometry or clinical diagnosis.
- Exclusion of cases with active otorrhea may have underestimated acute pathologies.

**Acknowledgments:** I thank all the faculty, teaching and non-teaching staff and the administration Department of Otorhinolaryngology, Kanachur institute of medical sciences, Mangalore, India for granting permission to carry out the research work.

**Data Availability:** All datasets generated or analyzed during this study are included in the manuscript.

#### References

1. Jerger J. Clinical experience with impedance audiometry. *Arch Otolaryngol.* 1970;92(4): 311–324.
2. Onusko E. Tympanometry. *Am Fam Physician.* 2004;70(9):1713–1720.

3. Palmu A, et al. Tympanometric findings in otitis media. *Pediatr Infect Dis J.* 1999; 18(12):1110–1115.
4. Browning GG, Gatehouse S. The prevalence of middle ear disease in the adult British population. *Clin Otolaryngol Allied Sci.* 1992; 17(4):317–321.
5. Singh A, et al. Tympanometric patterns in Indian school children. *Indian J Otolaryngol Head Neck Surg.* 2015;67(2):123–128.
6. Katz J, Chasin M, English K, Hood LJ, Tillery KL. *Handbook of Clinical Audiology.* 7th ed. Wolters Kluwer; 2015.
7. Margolis RH, Hunter LL. Tympanometry: Basic principles and clinical applications. *Otolaryngol Clin North Am.* 2002;35(3):475–488.
8. Bluestone CD, Klein JO. *Otitis Media in Infants and Children.* 4th ed. PMPH-USA; 2007.
9. Shahnaz N, Polka L. Standard and multifrequency tympanometry in normal and otosclerotic ears. *Ear Hear.* 1997;18(4):326-341.
10. Rosenfeld RM, et al. Clinical practice guideline: otitis media with effusion (update). *Otolaryngol Head Neck Surg.* 2016;154(1 Suppl):S1-S41.