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Tympanometric Profiles of Indian Geriatric Population

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Abstract: ***Tympanometry is an important measure which assess the function of the middle ear. There is a critical need to profile tympanometric parameters in older Indian adults to establish age and ethnicity-specific normative data for accurate assessment of middle ear function in this population. The present study evaluated tympanometric parameters in 102 Indian older adults (aged 50–92 years), with equal numbers of males and females. Results showed no significant differences between genders for any tympanometric value, indicating similar middle ear function across males and females in this population. The findings highlight the importance of establishing age- and ethnicity-specific normative data for accurate middle ear assessment in older adults.***

Keywords: Tympanometry, Indian, older adults, middle-ear immittance

1. Introduction

Audiological evaluations generally aid in gathering reliable information regarding the status of an individual's auditory mechanism and functional hearing efficiency. Tympanometry is one such fundamental audiometric assessment that offers crucial quantitative data on the ear canal's volume, the middle ear system's motility, and the presence of fluid in the middle ear (ONUSKO, 2004).

Tympanometry is a clinically objective technique that can be utilized to evaluate middle ear function. It consists of three key parameters: static acoustic admittance (Ytm), expressed in millimhos (mmho), reflects the mobility of the tympanic membrane (TM); tympanometric peak pressure (TPP), which represents the pressure at which the TM moves freely; and ear canal volume (ECV), defining the volume of air between the TM and the ear canal opening (Margolis & Heller, 1987). However, Margolis and Heller's (1987) normative data, while foundational, did not account for potential variations in tympanometric outcomes related to age and gender, which may influence clinical interpretation.

Tympanometry aids in the early detection of middle and external ear disorders (Carmo, Costa & Momensohn-Santos, 2013). According to Rosowski and Wilber (2015), tympanometry measures changes in the acoustic immittance of the middle ear by varying ear canal pressure. Immittance includes impedance (Z), the resistance to sound, and admittance (Ytm), its reciprocal (Ytm = 1/Z), which reflects the ease of sound transmission (Hunter & Shahnaz, 2014). These values depend on TM sound absorption or reflection, making tympanometry reliable for evaluating middle ear health. Tympanometric width (TW) estimates the shape of the tympanogram and slope near the peak (Joo, Kim, Lee, Cho & Kim, 2003).

Middle ear pressure variation across different ranges of air pressures shows the tympanogram which is measured in Ytm (mmho), and its shape may vary due to middle ear pathology. The widely used Liden-Jerger classification, introduced by Liden (1969) and Jerger (1970), categorizes tympanograms based on peak height and position.

Tympanometric parameters (ECV, Ytm, TPP, TW) can be influenced by factors such as gender, ethnic background, age, and ear asymmetry, highlighting the necessity of population-specific norms. Type A tympanograms show normal middle ear function; Type B tympanograms show middle ear pathologies or TM perforation if the ECV is significant; and Type C tympanograms show negative pressure, which is frequently found in sinus congestion or late ear infections.

Studies over the years have explored tympanometric norms across age, gender, and ethnicity. Gedik Toker, Kuru, Özbay, Akbıyık, Aksakal, and Bal (2024) found significant age-related differences in tympanometric values, with no differences between ears, likely due to growth and anatomical changes. Stuart, Tomaszewski, and Engelhardt (2021) also reported no interaural asymmetries in young Caucasian adults but noted lower Ytm and ECV in females than males.

Wiley, Cruickshanks, Nondahl, Tweed, Klein, and Klein (1996) found older adults had lower Peak Ytm, higher ECV, and narrower TW compared to Margolis and Heller (1987) norms. Lower TW and greater Peak Ytm and ECV were seen in males than in females. Wan and Wong (2002) found lower Peak Ytm, broader TW, and more favorable TPP in southern Chinese young adults compared to Caucasian data (Roup, Wiley, Safady & Stoppenbach, 1998).

Manchaiah, Durisala, and Marimuthu (2017) found that older Chinese adults had narrower TW and lower peak Ytm than younger groups, with males showing slightly larger ECV. In contrast, Sinha, Neupane and, Gururaj (2021) reported no age effects on static Ytm, ECV, and TPP in the Indian population. Thus, the need for ethnic-specific normative data for accurate diagnosis has been emphasized. Given the lack of tympanometric norms for older Indian adults, the present study aims to establish and analyze normative values for ages

50 to 90, investigating gender effects on Ytm, ECV, TPP, and TW.

2. Need of the study

Age-related changes in middle ear structures affect tympanometric measurements, making it essential to understand these variations in older adults. While many studies exist on tympanometric norms, there is a lack of data specific to older adults in India. Current norms are mostly based on younger or non-Indian populations and may not reflect the unique characteristics of Indian elders. Establishing normative values for this group will improve diagnostic accuracy, helping clinicians differentiate normal aging from pathology and enhancing hearing care for older Indian adults.

3. Methodology

Aim:
The current study aimed to profile tympanometric values in 102 Indian older adults (aged 50–92 years) and compare gender differences between males and females.

Participants: A total of 102 older Indian adults (51 males and 51 females), aged between 50 and 92 years (mean age = 64.48 years; standard deviation [S.D] = 9.32), were randomly selected to participate in the study.

Inclusion criteria:
Normal hearing sensitivity in one or both ears and sensorineural hearing loss with an air-bone conduction gap of 10 dB or less in at least one ear.

Exclusion criteria:
Presence of impacted cerumen or debris, structural deformities of the external or middle ear, clinical signs of middle ear pathology, and history of recent ear surgery. Only ears that met the inclusion criteria were included in the tympanometric analysis.

Procedure:
All participants underwent pure-tone air and bone conduction audiometry using a well-calibrated diagnostic audiometer compliant with American National Standards Institute (ANSI) standards. Testing was conducted in a sound-treated room with noise levels within permissible limits. Audiometric thresholds were established at octave frequencies from 250 Hz to 8000 Hz using standard procedures. Tympanometry was conducted using a well calibrated clinical tympanometer (equipped with a 226 Hz probe tone). The following tympanometric parameters were recorded for each ear such as Ytm, ECV, TPP and TW.

Statistical analysis:
The collected data were summarized by using Descriptive Statistics: frequency, percentage; mean, and S.D. The Independent sample "t" test was used to compare ECV, admittance, pressure, and gradient; between males and females. The p-value < 0.05 was considered as significant. Data were analyzed by using the SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10.

4. Result and discussion

4.1 Table

Table shows the comparison of age according to gender

		Mean	S.D.	"t"	p value
Age (Years)	Male	66.25	9.30	1.95	0.054
	Female	62.71	9.09		

("t" = Independent sample "t" test)

The Independent sample "t" test was used to compare age according to gender. There was no statistically significant difference ($p > 0.05$) in age between males and females.

4.2 Table

Table shows the normative values for ECV, Ytm, TPP, and TW

		Normative values
ECV	Left	1.40 to 1.59
	Right	1.33 to 1.52
Admittance (YTM)	Left	0.71 to 0.89
	Right	0.72 to 0.87
Pressure (TPP)	Left	-14.08 to -6.72
	Right	-9.71 to -2.66
Gradient (TW)	Left	51.81 to 56.87
	Right	51.87 to 58.20

Above table summarizes the normative values for ECV, Ytm, TPP, and TW, reported separately for the left and right ears in the geriatric population.

4.3 Table

Table shows the ccomparison of ECV, Ytm, TPP, and TW between males and females

		n	Mean	S.D.	"t"	p value
ECV Left	Male	44	1.40	0.35	-1.34	0.186
	Female	40	1.53	0.55		
ECV Right	Male	40	1.34	0.44	-0.75	0.455
	Female	43	1.43	0.57		
Left admittance (YTM)	Male	44	0.77	0.37	-0.27	0.787
	Female	40	0.80	0.49		
Right admittance (YTM)	Male	40	0.81	0.36	-0.47	0.641
	Female	43	0.86	0.51		
Left pressure (TPP)	Male	44	-8.61	17.68	0.02	0.982
	Female	40	-8.70	16.82		
Right pressure (TPP)	Male	40	-6.67	19.58	0.03	0.980
	Female	43	-6.79	21.84		
Left gradient (TW)	Male	42	51.98	11.43	-0.95	0.347
	Female	40	54.53	12.98		
Right gradient (TW)	Male	40	55.93	13.75	0.45	0.658
	Female	43	54.49	15.53		

("t" = Independent sample "t" test)

The independent sample t-test was used to compare ECV, Ytm, TPP, and TW according to gender. The results indicated no statistically significant differences ($p > 0.05$) between males and females in either right or left ear measurements of ECV, Ytm, TPP, and TW. This suggests that tympanometric values were comparable across genders in the geriatric population.

4.4 Discussion

The aim of the study was to profile tympanometric values in Indian older adults aged 50–92 years and examine gender differences. The findings from the current research indicate that there were no significant differences in tympanometric values between male and female participants. This aligns with Sinha et al. (2021), who also found no gender or age effects in Indian adults, suggesting these measures remain stable across genders. In contrast, Stuart et al. (2021) reported lower Ytm and ECV in females than males in young Caucasian adults. This difference may be due to age or ethnic factors. Similarly, the findings from Wiley et al. (1996) also showed lower Ytm, narrower TW and higher ECV, in comparison to the younger population. The current findings are closer to those of Manchaiah et al. (2017) in older Chinese adults, who also observed narrower TW and lower Ytm with age. Type A tympanogram, indicating normal middle ear function, was the most frequently observed tympanogram type in the study. This suggests some similarities among Asian populations in tympanometric patterns. Overall, the results highlight the need for ethnic- and age-specific norms.

5. Summary and Conclusion

Tympanometry is a fundamental audiometric assessment that provides crucial quantitative data on ear canal volume, middle ear motility, and the presence of fluid in the middle ear (Onusko, 2004). A total of 102 participants (51 males and 51 females) were tested. Results from the present study shown no significant differences in ECV, Ytm, TPP, and TW values between both genders and it aligns with the previous Indian research by Sinha et al. (2021) but differ from studies on Caucasian and Chinese populations that reported age and gender effects. This underscores the need for age- and ethnicity-specific normative data to ensure accurate middle ear evaluation in older adults.

5.1 Limitation:

- Limited sample size
- Random selection of the participants

5.2 Future direction

- A comparative study on different age groups can be done
- Comparison of other ethnic or regional groups
- The sample size can be increased

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