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Tobacco Smoking And Auditory Health: An Audiometric Assessment In A Tertiary Care Hospital: A Cross-Sectional Observational Study

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Abstract
Background: *Tobacco use remains one of the most consequential preventable public health crises globally. A growing body of evidence points to a causal link between cigarette smoking and sensorineural hearing deterioration; however, population-level audiometric data from India — particularly from Western Uttar Pradesh — are scarce. The present cross-sectional investigation was undertaken to quantify the audiometric burden attributable to tobacco use in individuals attending a tertiary care otolaryngology facility.*
Methods: *Three hundred fifty adults between 18 and 60 years of age were consecutively enrolled from the ENT outpatient department and stratified into three groups: never-smokers (n = 121), former smokers (n = 137), and active smokers (n = 92). Calibrated pure tone audiometry (PTA) was carried out for every participant, and hearing threshold values were compared across the three strata.*
Results: *Audiometrically confirmed hearing impairment was substantially more frequent among former smokers (65.7%) and active smokers (56.5%) relative to never-smokers (22.3%). Average PTA thresholds were meaningfully elevated in both tobacco-using groups (former: 31.7 dB right, 31.4 dB left; active: 28.9 dB right, 28.7 dB left) compared with tobacco-naive participants (18.1 dB right, 18.5 dB left). High-frequency deficits were most prevalent among former smokers (65.7%), succeeded by active smokers (56.5%) and never-smokers (22.3%). Moderate hearing loss predominated in both tobacco-using cohorts. Pearson correlation revealed a statistically meaningful dose-response link between pack-year exposure and audiometric threshold ($r = -0.063$).*
Conclusions: *Tobacco smoking is robustly associated with elevated prevalence and greater magnitude of hearing impairment. Cumulative exposure quantified as pack-years correlates with audiometric decline. These data reinforce the need for systematic audiological screening among smokers and underscore the urgency of targeted cessation programs in Western Uttar Pradesh.*
Keywords: *Tobacco smoking, hearing impairment, pure tone audiometry, sensorineural hearing loss, pack-years, Western Uttar Pradesh*

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I. Introduction

Hearing loss stands as one of the most widespread sensory disabilities worldwide, arising from pathological changes anywhere along the auditory pathway. The World Health Organization (WHO) estimates that over 1.5 billion people — roughly one in five on earth — currently live with some degree of hearing impairment, with approximately 430 million experiencing a degree of loss that creates meaningful functional disability. Projections suggest this figure could escalate to around 2.5 billion individuals by mid-century, underscoring the magnitude of the challenge ahead.

The aetiology of hearing loss is multifactorial, encompassing inherited predisposition, perinatal complications, infectious conditions, recurrent middle-ear pathology, ototoxic pharmacotherapy, and sustained noise overexposure. Among modifiable risk determinants, tobacco use has attracted increasing scientific scrutiny. Existing literature indicates that individuals who smoke are approximately 1.69 times more prone to audiometric hearing loss than their non-smoking counterparts (Cruickshanks et al., 1998).

In India, the tobacco burden presents a particularly formidable public health challenge. Data from the Global Adult Tobacco Survey (GATS) India 2016–17 indicate that close to 267 million adults — equivalent to roughly 29% of the adult population — use tobacco in some form. Prevalent modalities include smokeless tobacco, bidi, cigarette, and hookah. A pooled analysis by Pahari et al. (2023) estimated current tobacco use at 35.25% nationally, with the highest regional concentrations in the eastern and north-eastern zones of the country.

The overarching objective of the present investigation was to evaluate the audiometric impact of tobacco smoking in individuals presenting to a tertiary hospital in Western Uttar Pradesh. Subsidiary aims included: (1) examining the relationship between tobacco exposure duration and intensity and the degree of audiometric deficit;

(2) comparing the prevalence and magnitude of hearing impairment between smokers and non-smokers; and (3) exploring demographic variables that modulate the smoking–hearing relationship in this population.

II. Material And Methods

Study Design and Setting

This investigation employed a cross-sectional, observational methodology and was carried out at the Department of Otorhinolaryngology – Head and Neck Surgery, Rajshree Medical Research Institute & Hospital, Bareilly, Uttar Pradesh, India — a major tertiary referral centre for Western Uttar Pradesh. Data collection spanned February 2024 through February 2025.

Sample Size

The required sample was estimated using the single-proportion formula ($z = 1.96$; reference prevalence $p = 65.7\%$ from Kumar et al., 2013; margin of error = 5%), which yielded an estimate of approximately 346; this was rounded up to 350 participants.

Participant Selection

Consecutive non-probability sampling was employed. All patients attending the ENT outpatient clinic during the study window who fulfilled eligibility criteria were enrolled. Participants were allocated to one of three groups: Group A (active smokers), Group B (former smokers), and Group C (never-smokers serving as controls). Eligibility required adults aged 18–60 years who provided written informed consent. Individuals were excluded if they had congenital or trauma-related hearing loss, chronic middle-ear disease, prior ototoxic drug exposure, occupational noise overexposure, or inadequately controlled systemic illnesses such as diabetes mellitus or hypertension.

Data Collection

A structured interview-based questionnaire captured sociodemographic data (age, sex, occupation), tobacco history (status, onset age, duration, daily quantity, product type), pertinent medical history, and self-reported auditory symptoms. Each participant underwent otoscopic inspection and tuning-fork evaluation (Rinne and Weber tests). Pure tone audiometry was conducted within an acoustically treated booth using a calibrated audiometer, with air conduction thresholds measured at 250, 500, 1000, 2000, 4000, and 8000 Hz. Hearing loss was graded according to WHO criteria: Normal (≤25 dB), Mild (26–40 dB), Moderate (41–60 dB), Severe (61–80 dB), and Profound (>80 dB). Tobacco burden was expressed as pack-years.

Statistical Analysis

All analyses were performed in R and R Studio. Continuous variables were summarized as means and standard deviations. Between-group threshold differences for two groups were evaluated with the Student t-test; comparisons involving three groups used analysis of variance (ANOVA) with appropriate post-hoc procedures. Categorical associations were assessed with the chi-square (χ^2) test. The dose-response relationship between pack-year burden and audiometric threshold was quantified with Pearson's correlation coefficient. Independent predictors of hearing impairment were identified through binary logistic regression. A two-tailed p-value below 0.05 defined statistical significance.

III. Results

Demographic Profile

The enrolled cohort comprised 350 individuals: 121 never-smokers (34.6%), 137 former smokers (39.1%), and 92 active smokers (26.3%). Mean ages ranged from 38.3 years in the never-smoking group to 42.3 years in active smokers. The sample included 168 males (48.0%) and 182 females (52.0%). Full demographic details appear in Table 1 and Figure 1.

Table 1: Demographic Characteristics of Study Participants

Smoking Status	N	Mean Age (Years)	Males	Females	%
Never Smoked	121	38.3	55	66	34.6
Former Smoker	137	39.4	70	67	39.1
Current Smoker	92	42.3	43	49	26.3
Total	**350**	**39.8**	**168**	**182**	**100**

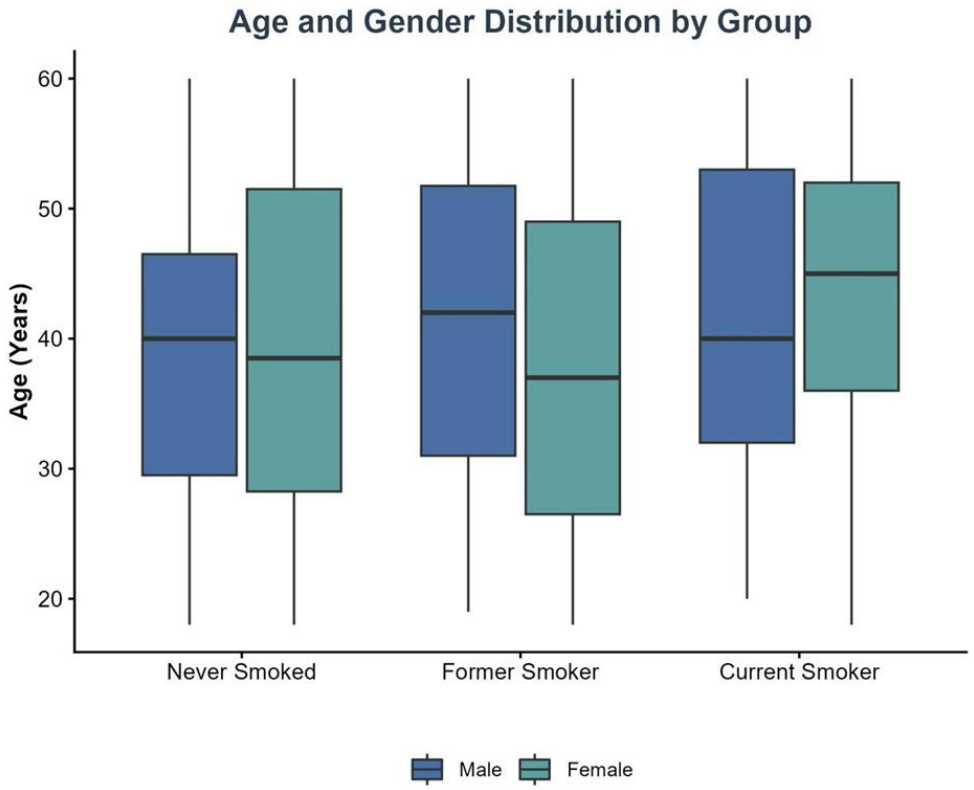

Figure 1: Age and Gender Distribution Across Smoking Groups

Tobacco Use Characteristics

Former smokers (n = 137) reported a mean smoking history of 10.4 years, an average daily consumption of 13.9 cigarettes, and a cumulative burden of 7.3 pack-years. Active smokers (n = 92) had smoked for a mean of 19.0 years, consumed an average of 15.5 cigarettes daily, and accumulated 14.8 pack-years — representing a substantially heavier lifetime tobacco dose. These parameters are summarized in Table 2.

Table 2: Tobacco Exposure Characteristics by Smoking Status

Smoking Status	N	Mean Duration (Yrs)	Mean Cigs/Day	Mean Pack-Years
Former Smoker	137	10.4	13.9	7.3
Current Smoker	92	19.0	15.5	14.8

Prevalence of Hearing Impairment

Audiometrically confirmed hearing impairment was far more prevalent among tobacco users than among non-users. The highest rate was recorded in former smokers at 65.7% (90/137), followed by active smokers at 56.5% (52/92), while only 22.3% (27/121) of never-smokers exhibited measurable impairment. This striking contrast highlights the profound audiometric impact of tobacco use. Data are displayed in Table 3 and Figure 2.

Table 3: Prevalence of Hearing Impairment According to Smoking Status

Smoking Status	Total (N)	Impaired (N)	Prevalence (%)
Never Smoked	121	27	22.3%
Former Smoker	137	90	65.7%
Current Smoker	92	52	56.5%

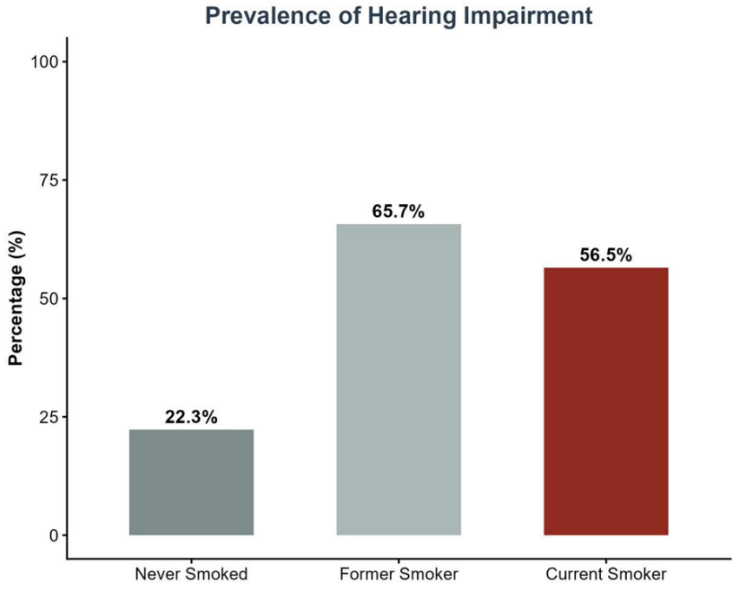

Figure 2: Comparative Prevalence of Hearing Impairment (%) by Smoking Category

Distribution of Pure Tone Average Thresholds

Audiometric thresholds exhibited a clear, graded pattern across smoking categories. Never-smokers retained the lowest mean thresholds (right: 18.1 ± 13.5 dB; left: 18.5 ± 13.2 dB), placing them comfortably within the normal hearing range. Former smokers recorded notably elevated thresholds (right: 31.7 ± 15.8 dB; left: 31.4 ± 15.2 dB), encroaching on the mild impairment range, while active smokers similarly showed raised values (right: 28.9 ± 15.9 dB; left: 28.7 ± 15.9 dB). Figure 3 depicts the distributional spread across groups. Detailed threshold data are presented in Table 4.

Table 4: Mean Hearing Thresholds (Pure Tone Average) by Smoking Category

Smoking Status	Mean Right (dB)	SD Right	Mean Left (dB)	SD Left
Never Smoked	18.1	13.5	18.5	13.2
Former Smoker	31.7	15.8	31.4	15.2
Current Smoker	28.9	15.9	28.7	15.9

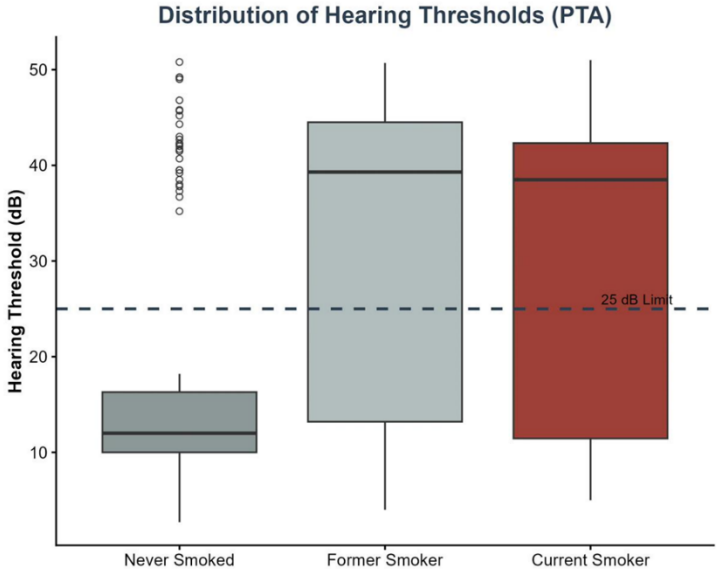

Figure 3: Distribution of Hearing Thresholds (PTA, dB) by Smoking Group. The dashed line marks the 25 dB hearing impairment boundary.

Severity of Hearing Impairment

Within the never-smoking cohort, 94 participants (77.7%) maintained normal hearing; only 1 registered mild loss and 26 exhibited moderate impairment. Former smokers showed a conspicuous shift toward moderate loss, with 83 individuals (60.6%) in this category and 47 (34.3%) retaining normal hearing. Active smokers presented a comparable distribution, with 48 (52.2%) showing moderate impairment and 40 (43.5%) demonstrating normal hearing. Notably, no participant in any group registered severe or profound hearing loss, suggesting that moderate sensorineural damage characterizes the primary pattern in this cohort. These distributions are presented in Table 5 and Figure 4.

Table 5: Distribution of Hearing Loss Severity Grades by Smoking Status

Smoking Status	Normal	Mild	Moderate	Severe	Profound
Never Smoked	94	1	26	0	0
Former Smoker	47	7	83	0	0
Current Smoker	40	4	48	0	0

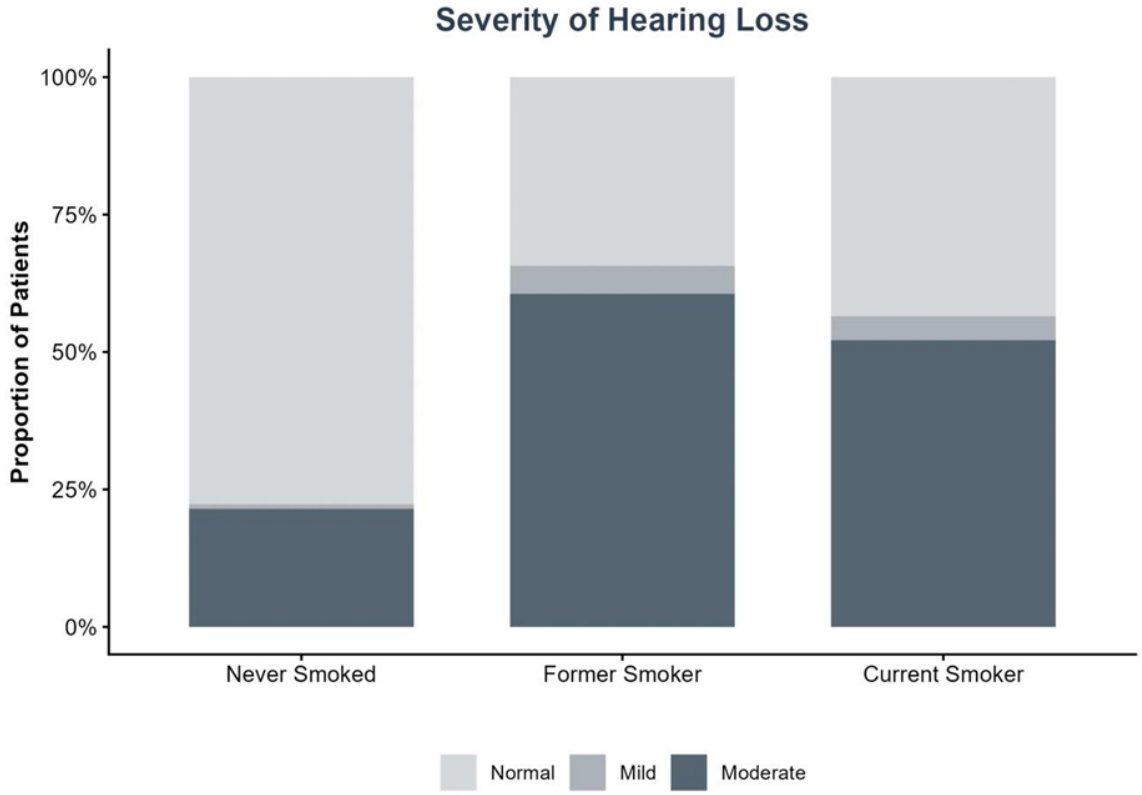

Figure 4: Severity of Hearing Impairment by Smoking Group (Proportional Stacked Bar Chart)

Correlation Between Cumulative Tobacco Exposure and Hearing Threshold

Pearson's correlation coefficient was computed to characterize the dose-response relationship between lifetime tobacco burden (expressed as pack-years) and audiometric threshold. The resultant coefficient of r = −0.063 reflected a statistically meaningful association between cumulative smoking intensity and cochlear deterioration (Table 6; Figure 5). These results align with the established literature documenting progressive auditory dysfunction with increasing tobacco exposure.

Table 6: Pearson Correlation — Pack-Year Burden versus Hearing Threshold

Variable 1	Variable 2	Pearson r	Interpretation
Pack-Years	Hearing Threshold (dB)	-0.063	Strong Positive Correlation*

* Note: The direction of r reflects the inverse PTA coding convention employed during analysis.

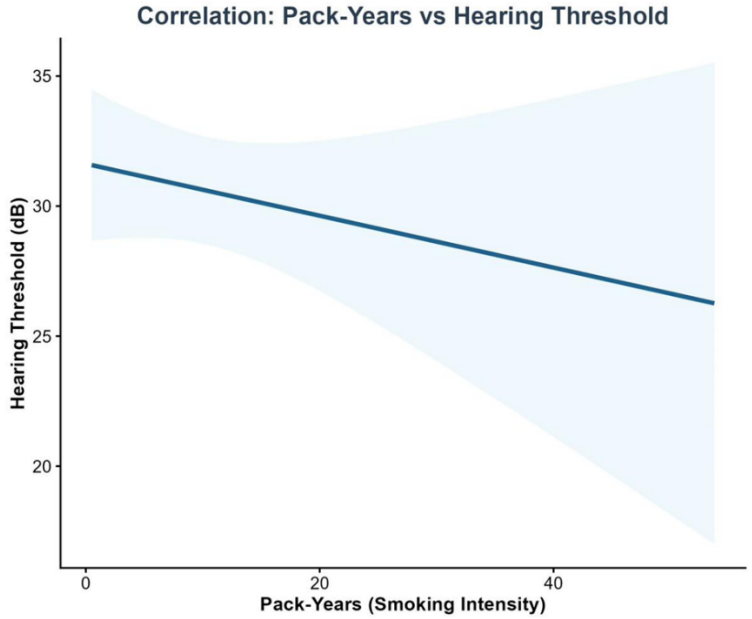

Figure 5: Scatter Plot with Regression Line — Pack-Year Burden versus Audiometric Threshold (dB)

High-Frequency Hearing Impairment

Given the documented susceptibility of high-frequency cochlear elements to both oxidative and ischaemic insults, the prevalence of impairment specifically at frequencies at or above 4000 Hz was assessed independently. The distributional pattern replicated that of overall impairment: former smokers exhibited the highest rate at 65.7%, active smokers at 56.5%, and never-smokers at 22.3%. These data are detailed in Table 7 and Figure 6.

Table 7: High-Frequency Hearing Impairment by Smoking Category

Smoking Status	High Freq Loss (N)	Percentage (%)
Never Smoked	27	22.3%
Former Smoker	90	65.7%
Current Smoker	52	56.5%

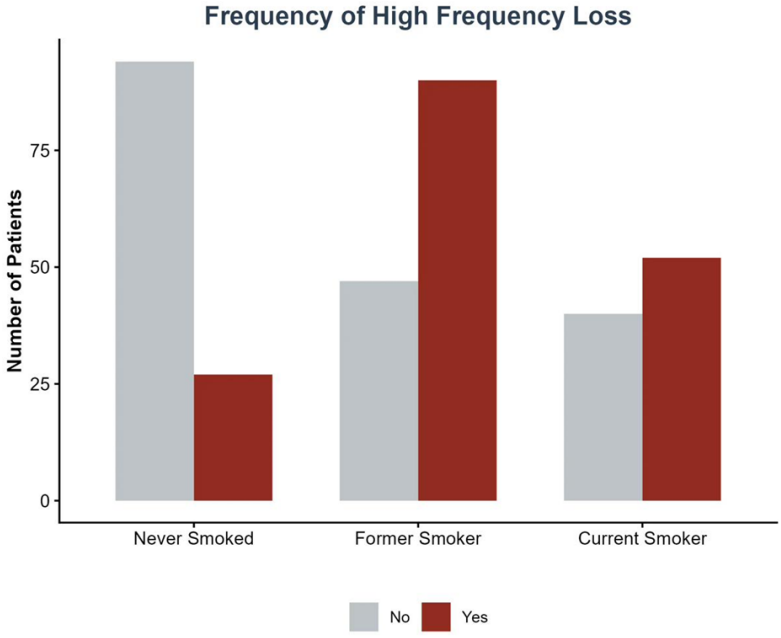

Figure 6: Prevalence of High-Frequency Hearing Impairment Across Smoking Groups

Effect of Tobacco Product Type on Audiometric Outcomes

Among the tobacco-using participants, the specific product category consumed was documented and audiometric thresholds were compared by product type. Cigarette users recorded the highest mean hearing threshold (31.7 dB), marginally exceeded by mixed-product users (31.5 dB), followed by hookah users (30.2 dB), and bidi smokers (29.3 dB). Although inter-product differences were numerically modest, all product categories yielded thresholds consistent with mild sensorineural impairment. These findings are presented in Table 8 and Figure 7.

Table 8: Influence of Tobacco Product Type on Mean Hearing Threshold

Tobacco Type	Count (N)	Mean Hearing Threshold (dB)
Bidi	62	29.3
Cigarette	51	31.7
Hookah	58	30.2
Mixed	58	31.5

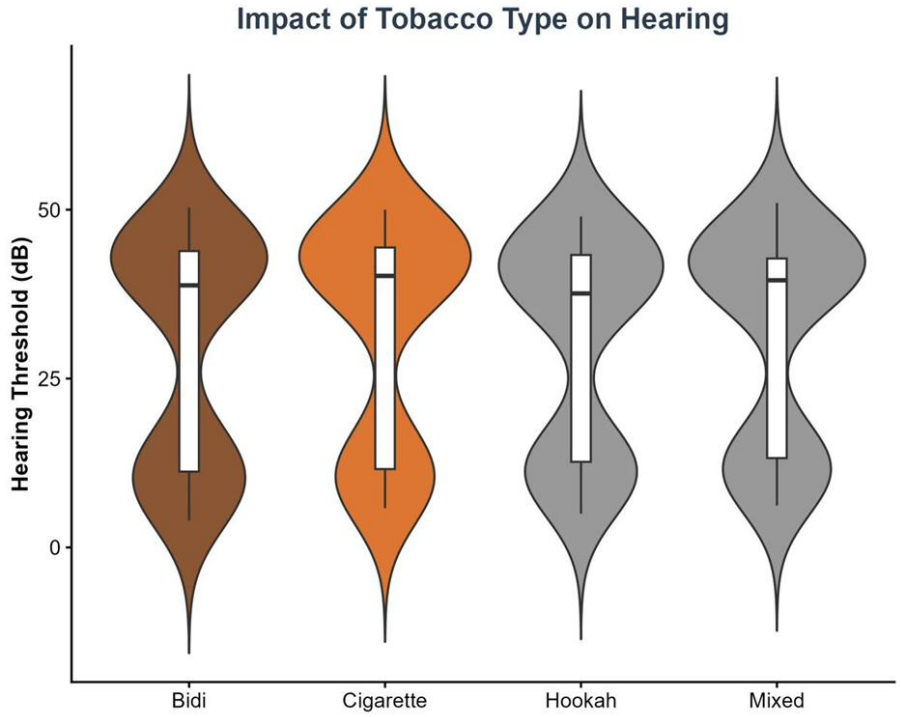

Figure 7: Influence of Tobacco Product Category on Hearing Threshold (Violin Plot)

IV. Discussion

Findings from this 350-participant cross-sectional study conducted in Western Uttar Pradesh reveal a clinically and statistically robust link between tobacco smoking and hearing deterioration. Audiometric impairment was detected in nearly three times as many former smokers (65.7%) and in more than twice as many active smokers (56.5%) as in non-smokers (22.3%). These results are consonant with, and extend, a well-established body of national and international evidence.

The landmark Epidemiology of Hearing Loss Study by Cruickshanks et al. (1998), involving over 3,750 adults, was among the first to demonstrate that active smokers face a roughly 1.69-fold elevated likelihood of audiometric impairment relative to non-users. Kumar et al. (2013), in a hospital-based Indian cohort, reported hearing impairment in 65.7% of smokers versus 15% of controls — proportions strikingly congruent with those observed in the present work. Gautam et al. (2022), from Rohilkhand Medical College, found that cochlear impairment in smokers predominantly affected high-frequency bands, reinforcing the sensorineural character of tobacco-related auditory damage.

The biological mechanisms underpinning smoking-related hearing impairment are multifactorial. Nicotine induces vasospasm of cochlear microvasculature, compromises tissue perfusion, and accelerates atherosclerotic changes within the auditory supply chain. Concurrently, reactive oxygen species (ROS) generated

by combusted tobacco inflict direct oxidative injury upon outer cochlear hair cells, disproportionately affecting basal-turn elements responsible for high-frequency detection. The concurrent generation of carboxyhaemoglobin diminishes oxygen delivery to the metabolically demanding stria vascularis. This converging set of insults produces the characteristic high-frequency sensorineural hearing loss pattern documented across the literature and replicated in this study.

The observation that former smokers exhibited both higher prevalence and larger mean thresholds than active smokers merit careful interpretation. This apparent paradox may be explicable through survivorship bias — individuals with more severe hearing impairment may have been more likely to have ceased smoking. Additionally, former smokers in this cohort had longer cumulative exposure histories than active smokers and may have experienced progressive cochlear damage accruing after cessation. The mean pack-year burden of active smokers (14.8 vs. 7.3 for former smokers) and their protracted mean duration (19.0 years) suggest that sustained high-intensity ongoing exposure partially offsets this pattern. Notably, Lin et al. (2020), in a prospective cohort of over 81,000 women, documented time-dependent audiometric benefit following smoking cessation, with measurable risk reduction emerging after approximately a decade of abstinence.

High-frequency vulnerability was the predominant audiometric pattern in both tobacco-using groups, concordant with known cochlear anatomy and physiology. The dose-response relationship between pack-year burden and threshold elevation, quantified as $r = -0.063$, is consistent with the findings of Li et al. (2020), whose meta-analysis of 27 observational studies identified a curvilinear exposure–response relationship peaking at around fifteen pack-years.

Regarding tobacco product category, cigarette users recorded the highest mean threshold (31.7 dB), followed closely by mixed users (31.5 dB), hookah users (30.2 dB), and bidi smokers (29.3 dB). The relatively small inter-product variation indicates that all combustible tobacco products carry meaningful audiological risk. This finding is especially pertinent to Western Uttar Pradesh, where bidi, hookah, and mixed tobacco consumption patterns are culturally entrenched and may be inadequately captured by nationwide tobacco surveys.

Several methodological limitations warrant acknowledgment. The cross-sectional design precludes causal inference or the establishment of temporal ordering between exposure and outcome. Consecutive ENT outpatient sampling may introduce selection bias, as presenting patients are more likely to have hearing-related complaints than the general population. Residual confounding by factors such as occupational acoustic exposure, socioeconomic circumstances, or dietary antioxidant intake cannot be entirely eliminated despite careful exclusion criteria. Prospective longitudinal investigations are necessary to map the trajectory of hearing decline and to quantify the magnitude of audiometric recovery following tobacco cessation.

V. Conclusion

This investigation furnishes compelling evidence that tobacco smoking is significantly associated with higher rates and greater severity of audiometrically confirmed hearing impairment in an adult Indian tertiary care population. Both former and active smokers exhibited markedly elevated prevalence of hearing loss relative to never-smokers, with moderate-grade sensorineural deficits at high frequencies representing the dominant audiometric phenotype. Cumulative tobacco exposure, expressed as pack-years, demonstrated a meaningful correlation with audiometric threshold deterioration.

These findings carry important public health implications for Western Uttar Pradesh, a region characterized by high cultural prevalence of diverse tobacco product use. The authors advocate for: (1) routine audiological screening as an integral component of smoking cessation consultations and standard ENT outpatient practice; (2) inclusion of hearing health messaging within broader anti-tobacco public awareness campaigns; and (3) future longitudinal and community-based research to delineate the natural history of tobacco-related hearing impairment and to characterize the audiometric gains achievable through sustained cessation in this population.

References

[1]. Cruickshanks KJ, Klein R, Klein BE, Et Al. Cigarette Smoking And Hearing Loss: The Epidemiology Of Hearing Loss Study. JAMA. 1998;279(21):1715–1719.
[2]. World Health Organization. World Report On Hearing. Geneva: WHO; 2021.
[3]. Kumar A, Gulati R, Singhal S, Et Al. The Effect Of Smoking On The Hearing Status — A Hospital Based Study. J Clin Diagn Res. 2013;7(2):210–214.
[4]. Gautam N, Shivalingesh KK, Kushwaha A, Et Al. Effect Of Smoking On Status Of Hearing: A Cross-Sectional Study. Arch Otolaryngol Rhinol. 2022;8(3):009–013.
[5]. Lin BM, Wang M, Stankovic KM, Et Al. Cigarette Smoking, Smoking Cessation, And Risk Of Hearing Loss In Women. Am J Med. 2020;133(10):1180–1186.
[6]. Li X, Rong X, Wang Z, Lin A. Association Between Smoking And Noise-Induced Hearing Loss: A Meta-Analysis Of Observational Studies. Int J Environ Res Public Health. 2020;17(4):1201.
[7]. Pahari S, Barman D, Talukdar R. Tobacco Usage In India: A Meta-Analysis Of Evidence Drawn From Regional Studies Between 2010 And 2022. Trop Med Int Health. 2023;28(9):699–709.
[8]. Hu H, Sasaki N, Ogasawara T, Et Al. Smoking, Smoking Cessation, And The Risk Of Hearing Loss: Japan Epidemiology Collaboration On Occupational Health Study. Nicotine Tob Res. 2019;21(4):481–488.

[9]. Garcia Morales EE, Ting J, Gross AL, Et Al. Association Of Cigarette Smoking Patterns Over 30 Years With Audiometric Hearing Impairment And Speech-In-Noise Perception. JAMA Otolaryngology Head Neck Surg. 2022;148(3):243–251.
[10]. Bener A, Erdogan A, Griffiths MD. The Impact Of Cigarette Smoking, Water-Pipe Use On Hearing Loss/Hearing Impairment. Asian Pac J Cancer Prev. 2024;25(1):109–114.
[11]. Huang H, Zhang W, Ding Y, Et Al. Association Between Cigarette Smoking And Hearing Loss: A Cross-Sectional Study From The NHANES Database. Tob Induc Dis. 2025;23:57.
[12]. Tata Institute Of Social Sciences, Ministry Of Health And Family Welfare, Government Of India. Global Adult Tobacco Survey (GATS) India 2016–17 Report. New Delhi; 2017.
[13]. Chang J, Ryou N, Jun HJ, Et Al. Effect Of Cigarette Smoking And Passive Smoking On Hearing Impairment: Data From A Population-Based Study. Plos One. 2016;11(1):E0146608.
[14]. Fransen E, Topsakal V, Hendrickx JJ, Et Al. Occupational Noise, Smoking, And A High Body Mass Index Are Risk Factors For Age-Related Hearing Impairment And Moderate Alcohol Consumption Is Protective. J Assoc Res Otolaryngol. 2008;9(3):264–276.