Original article

Population-Based Tinnitus Survey in Iran's Second-Largest City: Tinnitus Prevalence and Audiometric Associations

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Highlights

- Tinnitus prevalence 19.9%; mostly slight/mild; ~3% clinically significant (THI ≥38)
- THI correlates with hearing handicap (ρ=0.361); weak correlation with PTA (ρ=0.122)
- THI predicts worse WHO hearing grades and poorer speech discrimination

ABSTRACT
Background and Aim: Tinnitus prevalence varies widely based on definitions and screening methods, with limited Iranian data. This study estimates the 12-month prevalence of tinnitus in Mashhad, assesses handicap severity, and explores associations with perceived hearing handicap, objective hearing measures, and a Noise-Induced Hearing Loss (NIHL)-like audiometric pattern.
Methods: A registry-based cross-sectional survey from May 2024 to March 2025 sampled 2,197 adults (20–85 years) from Mashhad's healthcare registry. Tinnitus case status was identified by the question, "Any tinnitus lasting at least 5 minutes in the past 12 months." Those screening positive completed the Persian Tinnitus Handicap Inventory (THI) and audiometry. Multivariable models analyzed associations of THI with hearing handicap score, pure-tone average (PTA), speech discrimination score (SDS), WHO hearing-loss grade, and NIHL-like pattern.
Results: Among 2,197 participants, 435 screened positive, resulting in a prevalence of 19.8% (95% CI, 18.19–21.52). Most (67.8%) of those with tinnitus reported slight or no handicap, while severe cases were less than 1%. THI was independently linked to perceived hearing handicap even after accounting for PTA, age, and sex. Objective associations were modest, with THI correlating with 0.83 dB higher PTA per 10 points but showing no links to SDS or NIHL-like patterns.
Conclusions: In this registry-based Mashhad survey, tinnitus identified by a 12-month screen was common, but handicap was much less frequent. Tinnitus burden related more strongly to perceived hearing difficulty than to objective hearing loss, supporting separate assessment of tinnitus handicap and audiometric status in clinical triage and service planning.
Keywords: Tinnitus, prevalence, audiometry, speech discrimination tests, hearing loss.

INTRODUCTION

Tinnitus is a common auditory symptom in adults, with prevalence estimates ranging from 5% to 43%, largely influenced by methodological differences rather than true epidemiological disparities [1, 2]. A recent meta-analysis suggested a global prevalence of 14.4%, with severe tinnitus affecting a small minority [1]. Thus, prevalence estimates are inseparable from the instrument used to generate them [2, 3]. In the Middle East and North Africa, data is limited and inconsistent, with Iranian estimates around 4.6% to 6.4% [4, 5], where case identification required tinnitus lasting longer than one week, while studies from Jordan and Palestine report rates near 30% [6, 7]. These discrepancies are likely due to variations in case definitions and study methodologies [2, 8]. This uncertainty underscores the need for large-scale surveys with transparent screening criteria and clearly stated operational definitions.

It's important to note that the presence of tinnitus does not equate to a tinnitus-related handicap. Tinnitus disrupts emotional well-being, concentration, social functioning, and daily life [9, 10]. Prevalence estimates measure symptom occurrence, while instruments like the Tinnitus Handicap Inventory (THI), capture the extent to which The Tinnitus Handicap Inventory (THI), for example, distinguishes the large proportion of individuals with minimal burden from the smaller subgroup with clinically meaningful distress and higher care needs [11, 12]. Perceived hearing handicap may overlap with tinnitus burden but reflects a distinct dimension of self-reported functional limitation [13].

Tinnitus is also associated with hearing loss, psychological distress, metabolic comorbidity, and noise exposure. Depression, anxiety, and insomnia [14, 15], while factors such as diabetes and occupational noise exposure are linked to tinnitus in regional epidemiologic studies [5]. Noise exposure remains a major modifiable risk factor for both hearing loss and tinnitus [16, 17]. However, individual exposure histories are often not available, making audiometric patterns a useful, albeit imperfect, indicator of noise-related injury[18, 19]. Evidence on tinnitus impairing speech understanding independent of age and audiometric loss remains mixed [20-23].

This study aimed to 1-estimate the 12-month screening-based prevalence of tinnitus and characterize the distribution of handicap severity in a registry-based sample of adults in Mashhad, Iran, using a prespecified screening item asking about any tinnitus lasting at least 5 minutes within the past 12 months, 2-evaluate associations between tinnitus handicap and perceived hearing handicap, pure-tone averages, Word Health Organization (WHO)-graded hearing-loss classification, and speech discrimination, adjusting for objective hearing thresholds where appropriate, and 3-examine whether age-corrected Noise-Induced Hearing Loss (NIHL)-like audiometric patterns are associated with tinnitus handicap severity.

METHODS

Study design and setting

This was a registry-based cross-sectional survey conducted in Mashhad, Iran, from May 2024 to March 2025. The target population comprised adults aged 20 to 85 years residing in the city for at least six months. The sampling frame was the municipal primary healthcare electronic registry, which is estimated to cover more than 95% of city residents through routine household registration. Because adults who are not registered, have limited contact with the primary healthcare system, or are more difficult to reach may be underrepresented, the study is framed as a registry-based survey rather than a true population-based survey.

Sampling strategy and participant selection

Sampling followed a proportionally allocated stratified cluster design across the five municipal health zones of Mashhad. Each health zone was treated as a stratum. Within each stratum, ten comprehensive health facilities were randomly selected from the official registry and served as primary sampling units. For each selected facility, a starting household was randomly drawn from the electronic family registry to define the starting residential block. The target recruitment per health-facility cluster was 44 participants.

Field teams enumerated households within the selected block, created a roster of eligible residents, and selected participants using the Kish method, with selection limited to at most one male and one female per household. If the fixed cluster target was not reached within the starting block, additional immediately adjacent blocks were added according to a predefined random order, and the same enumeration and Kish selection procedures were repeated until the target cluster size was achieved.

Candidates received written invitations and follow-up telephone calls from trained interviewers. According to the field protocol, up to three contact attempts were made at intervals of at least 48 hours. If a selected individual could not be reached after three attempts or declined participation, a replacement was selected from the remaining eligible roster within the same health-facility cluster using the same eligibility and within-household selection rules. However, the current analytic dataset did not contain contact logs, pre-replacement counts, replacement flags, or other recruitment para-data. Therefore, the initial response rate before replacement, the number of replacements, and the characteristics of non-responders could not be reconstructed. This limitation is important because it may have contributed to underrepresentation of harder-to-reach subgroups, particularly younger adults. Inclusion criteria were age 20 to 85 years and residency in Mashhad for at least six months. Individuals unable to complete the study procedures because of severe cognitive impairment, acute medical illness, or other conditions preventing valid interview or audiologic assessment were excluded.

Sample size

The planned sample size was approximately 2200 participants. The calculation was based on estimating adult hearing-loss prevalence with acceptable precision under a multistage cluster design because robust local inputs for tinnitus prevalence were limited and tinnitus prevalence depends strongly on the operational case definition used. The calculation incorporated the planned design effect, non-response allowance, and external community survey inputs for expected hearing-loss prevalence [24-26].

Study procedures and measures

After written informed consent, participants completed a structured questionnaire for demographic information, including age and sex. The primary descriptive endpoint was 12-month screening-based tinnitus prevalence. Tinnitus case status was defined using a prespecified screening item. Participants were asked the following verbatim question: “Any tinnitus lasting at least 5 minutes within the past 12 months.” Participants answering yes were classified as screening-positive for tinnitus and formed the tinnitus-positive cohort for subsequent handicap and hearing-related analyses. This operational definition was intended for screening-based prevalence estimation and does not represent the prevalence of chronic, persistent, or clinically bothersome tinnitus.

All screening-positive participants completed the Persian version of the Tinnitus Handicap Inventory. The THI is a 25-item instrument that quantifies tinnitus-related handicap across functional, emotional, and catastrophic domains, with total scores ranging from 0 to 100. Standard severity categories were used: slight or none, 0 to 16; mild, 18 to 36; moderate, 38 to 56; severe, 58 to 76; and catastrophic, 78 to 100. Higher scores indicate greater tinnitus-related handicap [12]. The THI and its Persian version has strong psychometric properties, including high test-retest reliability (Intraclass correlation coefficient [ICC]=0.78–0.96) and excellent internal consistency (Cronbach's α≈0.94)[27, 28].

Perceived hearing-related disability was assessed with the age-appropriate screening form of the Hearing Handicap Inventory, using the Hearing Handicap Inventory for Adults-Screening in adults younger than 65 years and the Hearing Handicap Inventory for the Elderly-Screening in those aged 65 years or older. For analysis, these instruments were treated as a common hearing handicap measure on the same total-score scale.

Audiometric variables were derived from pure-tone and speech audiometry. Ear-specific pure-tone averages were calculated as the arithmetic mean of thresholds at 0.5, 1, 2, and 4 kHz. Better-ear PTA was defined as the lower of the left- and right-ear PTA values. Hearing loss severity was classified using the 2021 World Health Organization better-ear grading system based on PTA at 0.5, 1, 2, and 4 kHz, with categories of normal, mild, moderate, moderately severe, severe, profound, and complete hearing loss. Better-ear speech discrimination score was defined as the higher of the two ear-specific SDS percentages.

An NIHL-like audiometric pattern was evaluated as an etiologic pattern analysis within the tinnitus-positive cohort rather than as a direct measure of documented noise exposure. Because individual occupational and environmental noise-exposure histories were not available in a form suitable for etiologic classification, we used an audiometric notch-based definition. Age- and sex-corrected thresholds were generated using ISO 7029:2017 with Amendment 1:2024 median hearing-level coefficients [29]. For the primary NIHL-like definition, each ear was considered classifiable only if thresholds at 250, 500, 1000, 2000, 4000, and 8000 Hz were all available. An ear was flagged as having an NIHL-like pattern if the age- and sex-corrected threshold at 4 kHz was at least 10 dB HL, the 4-kHz threshold exceeded the better of the 1-, 2-, and 8-kHz thresholds by at least 10 dB, the 8-kHz threshold was at least 5 dB better than the 4-kHz threshold, and the low-frequency average across 250 to 2000 Hz was 25 dB HL or less [30, 31]. Participant-level NIHL-like status was defined as positive if either ear met criteria, provided both ears were classifiable. As a sensitivity analysis, the same notch algorithm was also applied to uncorrected thresholds, except that the high-frequency impairment gate at 4 kHz was set at 25 dB HL.

Statistical analysis

All analyses were conducted in R ver. 4.5.2. Continuous variables were summarized as mean ± standard deviation for descriptive reporting or as median with interquartile range for skewed distributions. Categorical variables were expressed as counts and percentages. The prevalence of tinnitus was determined using all participants with a non-missing screening response, with estimates accompanied by 95% Wilson confidence intervals. Participants with unknown age or sex were excluded from age- and sex-stratified prevalence tables.

In the tinnitus-positive cohort, associations between THI and continuous variables were explored using Spearman rank correlation due to non-normal distributions. THI distributions were compared by sex using the Mann-Whitney test, with the Hodges-Lehmann median difference quantifying the location shift.

Multivariable models examined the relationship between tinnitus handicap and perceived/objective hearing outcomes. Median quantile regression was used for Hearing Handicap Inventory total score and better-ear PTA due to skewness. PTA was included to account for confounding by hearing loss. Better-ear SDS was modeled with a beta-binomial generalized linear model to address strong ceiling effects, incorporating relevant variables to evaluate associations after adjusting for objective hearing loss.

WHO hearing-loss grade was modeled with proportional-odds logistic regression, and NIHL-like patterns were analyzed using binary logistic regression. Because the cluster identifier from the original sampling was missing, standard model-based inference was used, and results should be interpreted cautiously.

Analyses focused on complete cases, with missingness low and exceeding 99% availability for all models. Statistical significance was assessed at an alpha level of 0.05, and Benjamini-Hochberg adjusted q values were reported for five prespecified models.

Ethics

The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences under code IR.MUMS.REC.1400.039. All participants provided written informed consent before enrollment. Participants with severe, acute, unilateral, or otherwise clinically concerning tinnitus were counseled and referred for specialist evaluation without charge.

RESULTS

Sample, case identification, and analytic availability

In this registry-based survey, 2,197 participants had non-missing responses to the screening item, “Any tinnitus lasting at least 5 minutes within the past 12 months.” Among them, 435 screened positive, corresponding to a 12-month screening-based tinnitus prevalence of 19.80% (95% CI, 18.19% to 21.52%) (Table 1). This estimate reflects any tinnitus lasting at least 5 minutes during the past 12 months and should not be interpreted as the prevalence of chronic or clinically bothersome tinnitus. The full cohort included 1,227 women (55.85%), 930 men (42.33%), and 40 participants with unknown sex. Mean age was 59.21 ± 7.67 years in the full cohort and 60.42 ± 7.34 years in the tinnitus-positive cohort. The observed age range of tinnitus cases was 37 to 78 years, with no screening-positive cases below 37 years or above 78 years. Data completeness within the tinnitus-positive cohort was high, with complete-case availability ranging from 99.5% to 99.8% across the multivariable models (Table 1).

Age- and sex-specific screening-based tinnitus prevalence

Age- and sex-stratified prevalence estimates are presented in Table 2. No tinnitus cases were observed in the sparsely represented 20 to <37 years and 79 to <86 years strata. Within the age ranges represented by observed cases, prevalence generally increased with age. Among women, prevalence was 19.5% in the 37 to <50 year group, 16.7% in the 50 to <60 year group, 25.6% in the 60 to <70 year group, and 28.6% in the 70 to <79 year group. The corresponding estimates in men were 12.3%, 16.5%, 20.6%, and 22.0%, respectively. Most observed cases were concentrated in the 50 to <70 year age range, consistent with the age structure of the sampled registry.

Tinnitus handicap distribution

The distribution of tinnitus handicap was strongly concentrated in the lower THI categories (Table 3). Grade 1 (slight or none) accounted for 295 of 435 cases (67.8%), whereas Grade 4 (severe) and Grade 5 (catastrophic) accounted for 20 (4.6%) and 21 (4.8%) cases, respectively. When referenced to the full cohort, severe and catastrophic tinnitus handicap each affected less than 1% of all surveyed participants. Median total THI score was 8 (Interquartile Range [IQR], 24), with median functional, emotional, and catastrophic subscale scores of 4 (IQR, 12), 2 (IQR, 8), and 0 (IQR, 6), respectively. THI was not associated with age (Spearman $\rho = -0.031$, $p = 0.518$) and did not differ by sex (Mann-Whitney W = 23,172, $p = 0.789$; Hodges-Lehmann median difference for female minus male, 0 [95% CI, 0 to 2]).

Relationship of Tinnitus Handicap Inventory with perceived hearing handicap and objective hearing measures

THI showed a moderate positive correlation with perceived hearing handicap measured by HHI (Spearman $\rho = 0.361$, $p < 0.001$) and a very weak correlation with better-ear PTA (Spearman $\rho = 0.122$, $p = 0.011$). In multivariable models, each 10-point higher THI was associated with a 1.58-point higher HHI score after adjustment for PTA, age, and sex (95% CI, 1.06 to 2.09; $q < 0.001$) (Table 4). Thus, the relation between tinnitus handicap and perceived hearing handicap persisted after accounting for objective hearing threshold. By contrast, the association with PTA was statistically significant but small in magnitude, with each 10-point higher THI associated with only 0.83 dB higher better-ear PTA after adjustment for age and sex (95% CI, 0.21 to 1.44; $q = 0.015$) (Table 4).

Sensitivity analyses supported these patterns. When PTA was added to the HHI model, the THI coefficient attenuated from 2.00 to 1.58 HHI points per 10 THI points, indicating partial overlap between tinnitus handicap and objective hearing loss, while preserving a statistically robust independent association. In contrast, the apparent THI association with SDS seen before PTA adjustment did not persist after PTA was included, indicating that the crude THI-SDS signal was explained primarily by objective hearing loss rather than tinnitus handicap itself.

Speech discrimination, WHO hearing-loss grade, and NIHL-like pattern

Better-ear SDS showed a marked ceiling effect, with 90.1% of participants achieving perfect scores. After adjustment for PTA, age, and sex, THI was not associated with SDS in the beta-binomial model (OR per 10 THI points, 0.992; 95% CI, 0.905 to 1.087; $p = 0.863$; $q = 0.863$) (Table 4). Absolute probability differences were negligible. Across representative THI values of 0, 8, and 24, a 10-point increase in THI changed predicted SDS by less than 0.001 percentage points (Table 5).

THI was associated with worse WHO 2021 better-ear hearing-loss classification, but the effect size was modest. Each 10-point higher THI was associated with 14.6% higher odds of a worse WHO hearing-loss grade after adjustment for age and sex (OR, 1.146; 95% CI, 1.064 to 1.235; $p < 0.001$; $q < 0.001$) (Table 4). Model-based predicted probabilities showed a gradual redistribution from normal hearing toward mild and moderate categories as THI increased, while predicted probabilities of severe, profound, and complete hearing loss remained low across representative THI values (Table 5). No association was observed between THI and an NIHL-like audiometric pattern after age and sex correction (OR per 10 THI points, 0.964; 95% CI, 0.865 to 1.075; $p = 0.513$; $q = 0.642$) (Table 4).

Sex effects in the objective hearing models were directionally consistent. Male sex was associated with higher better-ear PTA and greater odds of worse WHO hearing-loss classification, whereas THI scores themselves did not differ by sex. The proportional-odds assumption for the WHO model was not violated ($p = 0.51$).

DISCUSSION

This registry-based survey of 2,197 adults in Mashhad estimated a 12-month screening-based prevalence of 19.8% for any tinnitus lasting at least 5 minutes. Because case identification used a broad symptom screen, this figure should be interpreted as period prevalence of any qualifying tinnitus episode rather than prevalence of chronic or clinically bothersome tinnitus [1, 2]. That distinction likely explains much of the difference from the lower Iranian estimates reported in Tehran and the PERSIAN Guilan cohort, which used more restrictive definitions [4, 5]. Given additional differences in age structure, sampling frame, and ascertainment, the present estimate is better viewed as falling within the broad regional range than as evidence of true epidemiologic separation from nearby settings such as Jordan [6]. At the same time, because the sample was drawn from a municipal health registry rather than a full resident register, the estimate should be interpreted as a registry-based citywide survey result, not a fully design-adjusted population parameter.

The distribution of THI scores shows a clear separation between symptom occurrence and functional burden. Nearly two thirds of tinnitus-positive participants were in the slight or no handicap category, while moderate-or-worse handicap affected fewer than 4% of the full surveyed cohort and severe or catastrophic handicap fewer than 2%. Thus, broad screening identifies a large symptom-positive group, but the subgroup with substantial disability is much smaller. For service planning, this distinction is more informative than prevalence alone. In a resource-constrained urban hearing-care setting, these data support triage strategies in which brief information, reassurance, and basic audiologic assessment are broadly available, with specialist tinnitus management focused on the smaller group reporting moderate or greater handicap.

Within the observed age bands, screening-based prevalence tended to rise with age, yet THI scores were not associated with age among tinnitus-positive participants. This pattern suggests that determinants of tinnitus occurrence are not identical to determinants of handicap once tinnitus is present. Sex showed a similar dissociation. Although the descriptive prevalence pattern was somewhat higher in women across the observed age bands, THI did not differ by sex. It is therefore important not to infer sex-specific differences in handicap from case composition alone. Because younger and oldest adults were sparsely represented, and no screening-positive cases were observed below 37 years or above 78 years, age-specific prevalence at the extremes of the eligibility range cannot be estimated reliably from this dataset. Those zero cells are more plausibly interpreted as consequences of sparse sampling and non-observation within the registry-based design than as evidence of true absence of tinnitus in younger adults.

The clearest association involving THI was with perceived hearing handicap. THI showed a moderate positive correlation with HHI, and the association persisted after adjustment for PTA, age, and sex. The reduction in the THI coefficient after PTA adjustment indicates partial overlap between tinnitus-related burden and objective hearing loss, but the residual association suggests that tinnitus contributes additional variance to how participants perceive everyday listening difficulty. This does not establish that tinnitus is the dominant driver of hearing handicap. Rather, it supports treating THI and HHI as related but non-interchangeable patient-reported constructs that may reflect partly shared audibility limitations and partly distinct perceptual or attributional processes [13].

The association between THI and objective hearing threshold was much weaker. The THI-PTA correlation was very small, and the adjusted effect corresponded to only 0.83 dB higher better-ear PTA per 10-point increase in THI. Although statistically detectable, that magnitude is clinically negligible and explains little shared variance. The ordered WHO model was directionally similar but still modest. Each 10-point increase in THI was associated with a 14.6% increase in the odds of worse hearing-loss category, yet model-based probabilities shifted mainly between normal, mild, and moderate categories, with severe or worse classifications remaining uncommon across representative THI values. THI should therefore not be used as a clinical proxy for objective hearing-loss severity. Formal audiometry remains necessary, and statistically significant but small THI-based shifts in objective hearing classification should not be overstated [27, 32]. In this cohort, age and male sex were materially stronger correlates of objective hearing loss than THI, and the sex effect was internally consistent across the PTA and WHO analyses, with men showing both higher median PTA and higher odds of worse WHO grade.

The speech-discrimination findings were similarly modest once objective hearing was taken into account. Better-ear SDS showed a pronounced ceiling effect, with 90.1% of participants achieving perfect scores. After adjustment for PTA, age, and sex, THI was not associated with SDS, and model-based absolute changes were effectively zero. The practical reading of this result is straightforward. In this sample, tinnitus handicap did not independently predict word-recognition performance in quiet. Any crude relation between THI and SDS was explained primarily by shared variance with objective hearing loss rather than by tinnitus burden itself. Accordingly, these data do not support an independent cognitive-load interpretation for SDS within the present analysis. More demanding measures, particularly speech-in-noise outcomes, may capture aspects of listening effort not evident in near-ceiling SDS testing, but that question was not addressed here [20-23].

The NIHL-like analysis also argues for separating audiometric phenotype from tinnitus burden. Using the age- and sex-corrected notch algorithm, approximately one quarter of tinnitus-positive participants met criteria for an NIHL-like configuration, yet THI showed no association with this pattern. This null finding does not argue against noise as a risk factor for tinnitus occurrence. Instead, it indicates that within adults who screened positive for tinnitus, a conservative noise-like audiometric configuration did not predict how burdensome tinnitus was. That interpretation is important because the NIHL classification used here was a pragmatic etiologic pattern marker in the absence of detailed lifetime exposure histories, not a direct exposure measure [19, 30, 31]. The use of a conservative, relatively high-specificity notch definition may also have missed broader forms of noise-related auditory injury. The result therefore applies to this specific NIHL-like phenotype rather than to all possible effects of occupational or environmental noise [16, 17].

Several limitations should guide interpretation. First, the registry-based sampling may underrepresent adults with limited registration or contact with primary care. Second, the analytic dataset lacks logs of unreachable candidates, preventing quantification of nonresponse bias, which is notable for adults younger than 37 and older than 78 years. Third, the absence of health-facility cluster identifiers in the dataset hinders variance estimation and cluster-robust inference, potentially leading to optimistic standard errors and p-values, particularly for the THI-PTA relationship. Fourth, as a cross-sectional study, it cannot differentiate between causes of tinnitus onset and its handicapping effects. Lastly, key factors such as depression, anxiety, insomnia, metabolic comorbidity, and noise exposure history [5, 14, 15] were not measured, limiting causal interpretation and possibly accounting for some residual variation in handicap and perceived hearing difficulty.

Conclusion

In this registry-based Mashhad survey, tinnitus identified by a 12-month screening question was common, but substantial handicap was far less frequent. Tinnitus handicap retained a modest association with perceived hearing handicap after adjustment for objective hearing threshold, whereas its association with PTA was clinically negligible, its association with SDS disappeared after PTA adjustment, and it was unrelated to a conservative NIHL-like audiometric phenotype. These findings support assessing tinnitus burden and hearing status as complementary but distinct domains, and they favor triage models that distinguish common symptom presence from the smaller subgroup with clinically meaningful disability.

Authors' contribution: SJ: study design, conduct, acquisition of data, interpretation of data, and final review of manuscript. AZ: study design, statistical analysis, interpretation of result, and drafting the manuscript.

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Table 1. Study sample, screening-based tinnitus prevalence, and analytic availability

Measure	Full cohort	Tinnitus-positive cohort
Participants included, n	2,197	435
Non-missing tinnitus screening, n	2,197	-
Missing tinnitus screening, n (%)	0 (0.00)	-
Female, n (%)	1,227 (55.85)	258 (59.31)
Male, n (%)	930 (42.33)	177 (40.69)
Unknown sex, n (%)	40 (1.82)	0 (0.00)
Age, mean ± SD, years	59.21 ± 7.67	60.42 ± 7.34
Tinnitus-positive, n/N (%)	435/2,197 (19.80)	-
95% CI for tinnitus prevalence, %	18.19 to 21.52	-
Observed tinnitus case age range, years	-	37 to 78
Cases younger than 37 years, n	-	0
Cases older than 78 years, n	-	0
HHI model complete-case n (%)	-	434 (99.77)
PTA model complete-case n (%)	-	434 (99.77)
SDS model complete-case n (%)	-	433 (99.54)
WHO model complete-case n (%)	-	434 (99.77)
NIHL model complete-case n (%)	-	434 (99.77)

Abbreviations: *HHI, Hearing Handicap Inventory; NIHL, noise-induced hearing loss; PTA, pure-tone average; SDS, speech discrimination score; THI, Tinnitus Handicap Inventory; WHO, World Health Organization.*

Table 2. Age- and sex-specific screening-based tinnitus prevalence among participants with known age and sex

Age band, years	Sex	N	Cases	Prevalence, %	95% CI, %	n/N
20 to <37	Female	3	0	0.0	0.00 to 56.15	0/3
20 to <37	Male	5	0	0.0	0.00 to 43.45	0/5
37 to <50	Female	118	23	19.5	13.35 to 27.55	23/118
37 to <50	Male	57	7	12.3	6.08 to 23.25	7/57
50 to <60	Female	588	98	16.7	13.87 to 19.89	98/588
50 to <60	Male	322	53	16.5	12.81 to 20.90	53/322
60 to <70	Female	425	109	25.6	21.73 to 30.00	109/425
60 to <70	Male	413	85	20.6	16.96 to 24.74	85/413
70 to <79	Female	70	20	28.6	19.32 to 40.05	20/70
70 to <79	Male	109	24	22.0	15.27 to 30.68	24/109
79 to <86	Female	1	0	0.0	0.00 to 79.35	0/1
79 to <86	Male	4	0	0.0	0.00 to 48.99	0/4

Note*: Participants with unknown age or unknown sex were excluded from this stratified table.*

Table 3. Distribution of THI severity categories in the tinnitus-positive cohort

THI category	n	% of tinnitus-positive cohort (N = 435)	% of full cohort (N = 2,197)
Grade 1, Slight/None	295	67.82	13.43
Grade 2, Mild	57	13.10	2.59
Grade 3, Moderate	42	9.66	1.91

THI category	n	% of tinnitus-positive cohort (N = 435)	% of full cohort (N = 2,197)
Grade 4, Severe	20	4.60	0.91
Grade 5, Catastrophic	21	4.83	0.96

Note: *Median total THI was 8 (IQR, 24). Median functional, emotional, and catastrophic subscale scores were 4 (IQR, 12), 2 (IQR, 8), and 0 (IQR, 6), respectively. THI was not associated with age (Spearman ρ = −0.031, p = 0.518) and did not differ by sex (Mann-Whitney W = 23,172, p = 0.789; Hodges-Lehmann median difference for female minus male, 0 [95% CI, 0 to 2]).*

Table 4. Multivariable associations between THI and hearing-related outcomes among tinnitus-positive participants

Outcome	Effect measure	Adjusted effect per 10-point higher THI	95% CI	p value	Benjamini-Hochberg q	n	Adjustment set
HHI	HHI points	1.58	1.06 to 2.09	<0.001	<0.001	434	THI + PTA + age + sex
Better-ear PTA	dB HL	0.83	0.21 to 1.44	0.009	0.015	434	THI + age + sex
Better-ear SDS	Odds ratio	0.99	0.90 to 1.09	0.863	0.863	433	THI + PTA + age + sex
WHO hearing-loss grade	Odds ratio	1.15	1.06 to 1.23	<0.001	<0.001	434	THI + age + sex
NIHL-like pattern	Odds ratio	0.96	0.87 to 1.08	0.513	0.642	434	THI + age + sex

Abbreviations: *HHI, Hearing Handicap Inventory; NIHL, noise-induced hearing loss; PTA, pure-tone average; SDS, speech discrimination score; THI, Tinnitus Handicap Inventory; WHO, World Health Organization.* ***Note:*** *HHI and PTA effects are expressed on their original scales. SDS, WHO grade, and NIHL-like pattern are expressed as odds ratios.*

Table 5. Model-based absolute interpretation of THI effects on SDS and WHO hearing-loss classification

THI total	Predicted SDS, %	Predicted SDS after +10 THI, %	Absolute SDS change, percentage points	WHO normal, %	WHO mild, %	WHO moderate, %	WHO moderately severe, %	WHO severe, %	WHO profound, %	WHO complete, %
0	99.93158	99.93103	-0.00055	57.4	34.0	6.0	1.8	0.7	0.2	<0.001
8	99.93114	99.93058	-0.00056	54.7	35.8	6.6	2.0	0.7	0.2	<0.001
24	99.93024	99.92968	-0.00056	49.3	39.2	8.0	2.4	0.9	0.3	<0.001

Note: *SDS predictions are from the beta-binomial model adjusted for PTA, age, and sex. WHO predicted probabilities are from the proportional-odds model adjusted for age and sex. Values are shown at representative THI scores observed in the tinnitus-positive cohort.*