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Tinnitus and Its Risk Factors in African Americans: The Jackson Heart Study

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Abstract

Objective—To describe the prevalence of reported tinnitus and tinnitus handicap in the all African-American Jackson Heart Study (JHS) cohort, with assessment of the relationship to cardiometabolic risk and depression.

Study Design—Prospective cohort study

Methods—Audiologic data were obtained from a sample of 1,314 participants of the JHS. Reported tinnitus was assessed dichotomously (Yes/No) by interview and with the Tinnitus Handicap Inventory (THI). The statistical relationship of reported tinnitus and tinnitus handicap to various cardiometabolic risks (i.e., hypertension and waist circumference) and Center for Epidemiologic Studies Depression scale (CES-D) was assessed with logistic and gamma regression procedures.

Results—Tinnitus was found to be a highly prevalent condition (29.5%), with an additionally high rate of individuals who report at least slight tinnitus handicap (35%). Hypertension (β=1.344; CI=1.015, 1.780; p=0.039) and waist circumference (β=1.009, CI=1.001, 1.018; p=0.021) were found to have a statistically significant relationship with THI score, depending on the level of covariate adjustment. Depression, as measured by the CES-D, was found to have a statistically significant relationship with both reported tinnitus (OR=1.051; CI=1.030, 1.072; p<0.001) and THI score (β=1.029; CI=1.013, 1.047; p=0.001), which persisted for all levels of covariate adjustment in statistical models.

Conclusions—Tinnitus was found to be highly prevalent in the JHS and certain measures of cardiometabolic risk are weakly related to both reported tinnitus and level of tinnitus handicap. A consistent relationship between depression and tinnitus/level of tinnitus handicap was observed.

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Introduction

It is estimated that nearly 30 million Americans have chronic tinnitus.[1] Tinnitus is a heterogeneous phenomenon and prevalence estimates differ according to the definition of tinnitus, severity/impact on quality of life, assessment, and population demographics/characteristics.[2] Epidemiologic studies such as the National Health and Nutrition Examination Survey (NHANES) and Epidemiology of Hearing Loss Study report tinnitus prevalence ranging from 4 to 30%.[1,3,4,5,6] Although tinnitus has a high prevalence, severe or problematic tinnitus is estimated to occur in only 1–7% of the US population.[1,5]

The association between hearing loss and tinnitus is well known and supported throughout the literature.[1,6,7] Increasing age and noise exposure, which are strongly predictive of sensorineural hearing loss are also predictive of tinnitus.[2,3,4,5] Previous studies have shown differences in prevalence of tinnitus between males and females; however, results are conflicting. There are also race/ethnicity variations in the report of tinnitus, with African Americans reporting lower prevalence of tinnitus and hearing loss.[4,,8,9] Cardiometabolic factors have also been associated with tinnitus. A meta-analysis performed in 2015 of 19 studies showed a significant association between hypertension and tinnitus.[10] Yet, other studies report an association between hypotension and worsening congestive heart failure and tinnitus.[11,12] One study reported an association between nighttime blood pressure and tinnitus.[13] In addition, stress, decreased sleep, hyperlipidemia, osteoarthritis, rheumatoid arthritis, asthma, diabetes, thyroid disease, hypertension, increased BMI, increased neck circumference, anxiety, and depression have been shown to be associated with increased reported tinnitus.[4,10,14,15,16]

African Americans present an intriguing paradox, where epidemiological studies show higher prevalence of cardiometabolic disease and associated risk factors, but they show lower prevalence of hearing loss and tinnitus compared to other race/ethnicity groups.[4,8,9] Interestingly, African Americans with cardiometabolic disease are more likely to report depression, which may further influence tinnitus report and handicap.[17] However, the majority of these studies examining risk factors and tinnitus were performed in Caucasian and Asian populations or provided limited insight into race/ethnicity differences.

Given the potential relationship of sensorineural hearing loss to various cardiometabolic risks, it stands that tinnitus, which is strongly and positively correlated with sensorineural hearing loss, may have a similar, if not stronger, relationship with those same cardiometabolic risks. This is arguable as tinnitus has been found to be a reliable indicator of sub-clinical cochlear damage, often occurring before hearing loss is detected with conventional audiometry.[18] The goal of the present study is to assess the prevalence of tinnitus in the Jackson Heart Study (JHS), an African-American cohort, and to test the association between cardiometabolic risk and depression with reported tinnitus/tinnitus handicap.

Materials and Methods

The hearing and tinnitus data that are summarized in this report were collected as part of an ancillary study of the JHS, called the "Hearing Status of the Jackson Heart Study Cohort (NIH 5-RO1-DC008371-01)." The study protocol was approved by the institutional review boards (IRBs) of the following institutions: University of Mississippi Medical Center, Jackson State University, and Tougaloo College. All participants provided written informed consent.

Study Sample

Audiologic assessments were performed during a 7-year period, from 2008 to 2014. All clinician investigators performing audiologic assessments were Mississippi state licensed audiologists. The participants who were enrolled in the hearing study represent a convenience sample of "healthy" volunteers of the JHS cohort (N = 5,302). The total number of participants with complete hearing, tinnitus, demographic and cardiometabolic risk data was 1,314. The hearing ancillary study sample did not significantly differ from the JHS cohort in regards to age, education, cardiometabolic factors, but was slightly less male in composition.

Questionnaires

Each participant was given a 9-item, binary (yes/no), "hearing health" questionnaire that was administered by interview. Individuals who were unclear of what it means to have "a hearing problem," or "tinnitus," were counseled to improve their understanding and to increase the reliability of their answers. Individuals who answered "yes" to the question: "Do you have tinnitus (ringing, buzzing, "crickets" or other sound) in your ears?" were labeled as having "reported tinnitus." Though this question did not probe the perceived timeframe of onset nor the characteristics of the tinnitus, individuals who answered in the affirmative were given the Tinnitus Handicap Inventory[19] (THI). This instrument probes three distinct aspects of tinnitus handicap, including the self-perceived emotional, functional, and catastrophic aspects.[19] Total score ranges from 0–100: 0–16=slight or no handicap, 18–36= mild handicap, 58–76= severe handicap, 78–100= catastrophic handicap. Two tinnitus variables were considered in our analysis: the report of tinnitus and the tinnitus handicap as captured by the THI. A THI score of > 16 was considered clinically significant tinnitus, reporting at least a mild handicap. This allowed us to examine predictors of tinnitus and factors that influence handicap reported by participants with tinnitus.

Audiometry and Tympanometry

All audiologic assessments, including pure-tone and speech audiometry, as well as tympanometry, were performed using a protocol that has been previously described.[20] From pure-tone audiometric results, a pure-tone average (PTA4) of 500, 1000, 2000, and 4000 Hz was calculated for each ear, and averaged between the ears (bilateral PTA4=BiPTA4). This average of four frequencies was used as a descriptive statistic as well as a covariate adjuster in statistical models. The PTA4 has been shown to have a strong positive correlation with the index of speech recognition and is sensitive to high frequency impairments.[21]

Risk Factors and Covariate Assessment

Participant demographics and cardiometabolic risks were assessed by the JHS across three exam phases: Exam 1= 2000–2004, Exam 2= 2005–2008, and Exam 3= 2009–2013. When possible, data were taken from Exam 2 and Exam 3, as this corresponded most closely with the years of the ancillary hearing study. However, some analyses are performed using data obtained from years that preceded the hearing study (Exam 1, and part of Exam 2), which is a limitation of the study. Age was determined by the date hearing was assessed. Education levels were categorized into three levels: 1) less than high school, 2) equal to high school, and 3) greater than high school. Noise exposure was determined by self-report on the "hearing health questionnaire," as described above. Income was classified as poor or affluent based on reported family income. Participants were classified as "poor" if family income was < 3.5 times the poverty level and "affluent" if family income was ≥ 3.5 times the poverty level.

Body mass index (BMI) was calculated as weight (kg)/height (m).[2] Waist circumference was measured in centimeters. Blood pressure data were obtained from the JHS second exam phase. Two blood pressure measurements were made in mm/hg. A net average of the first and second systolic and diastolic blood pressure measurements was used.

Hypertension was defined as blood pressure greater than 140/90 mmHg (per JNC 7), self-report of hypertension, or use of antihypertensive medication in the previous two weeks. Diabetes was defined as fasting glucose of 126 mg/dL or greater, random glucose of 200 mg/dL or greater, self-report of diabetes mellitus, or hypoglycemic medication use. A medication survey was also taken during Exam 2. Participants were asked to record all medications, including dosage and frequency.

Venipuncture performed at Exam 2 examinations measured HbA1c, LDL, HDL, and triglycerides values. HbA1c was calculated using the Glycated Hemoglobin Test, which measures the average blood glucose level for the past 2 to 3 months and is determined by measuring the percentage of glycated hemoglobin.[22] HDL, LDL and triglycerides were assessed after 8 hours of fasting time.

Physical activity was assessed in the study as it has been shown to be predictive of hearing loss.[20] The physical activity questionnaire was administered by home interview at the time of Exam 1. The questionnaire was derived from modifications to the Baecke/Atherosclerosis Risk in Communities (ARIC) physical activity survey.[23,24] The questionnaire was validated with repeat testing, 24-hour accelerometer counts, and 3 days of pedometer counts.[25,26] Physical activity (PA) was simplified into three categories: "Poor Health" = 0 minutes of moderate or vigorous PA, "Intermediate Health" = >0 and <150 minutes of moderate, or >0 and <75 minutes of vigorous PA, "Ideal Health" = ≥150 minutes of moderate, or ≥75 minutes of vigorous PA.

Depression was assessed in Exam 1 and represents the total depressive symptoms score obtained from the Center for Epidemiologic Studies Depression scale (CES-D), which is a standardized self-report depression scale consisting of twenty questions focused on mood.

Responses are graded using a 0–3 scale; possible scores range from 0–60, with scores over 16 indicating greater levels of depression.[27]

Statistical Analysis

Descriptive analyses were used to asses and compare the differences in participant demographic characteristics, cardiometabolic risks, and hearing measures by tinnitus group (Group1= no reported tinnitus, Group 2= reported tinnitus). Continuous data are described using mean (standard deviation) and categorical data are described using n (%). Logistic models were used to examine the association between cardiometabolic risks and depression scale with reported tinnitus, as assessed with the binary “hearing health” questionnaire. Potential covariates, such as age, sex, education level, as well as hearing (PTA4 averaged between the ears) and reported noise exposure, were assessed for their impact on statistical models. Gamma regression was used to model THI score and logistic regression was used to model binary THI, which was determined by using test score of 16 as the cut-off (slight or no handicap ≤ 16). Same sets of covariates were adjusted. All analyses were performed using Stata 14.0 (StataCorp. 2015. College Station, TX: Stata Corp, LP). Statistical significance was defined as $P<0.05$.

Results

Participant characteristics are given in Table 1, which include demographic, audiologic, cardiometabolic, and depression risk independent variables, given for the whole group, and with comparisons of these participant characteristics made between two groups created from the dataset: Group 1=No (Reported) Tinnitus, and Group 2= (Reported) Tinnitus. Prevalence of reported tinnitus was 29.5%, which is approximately a third (388 of the total 1314) of the participants in the study. Of the participants who reported tinnitus, 35.4% were found to have clinically significant tinnitus handicap (THI > 16). Overall, we note that the tinnitus group, compared to the non-tinnitus group, was more likely to be older, female, and to have lower household income and a lower education level. They were also more likely to have reported noise exposure, and worse hearing (by PTA4). Cardiometabolic risks were generally found to be equally prevalent between the two groups; however, the tinnitus group did have a higher frequency of hypertension and included participants who were more likely to be taking blood pressure lowering medications and/or diuretics. The tinnitus group also contained more participants who were characterized as having poor health determined by physical activity level. Depression score was also higher in the tinnitus group.

Multivariate Regression

Reported Tinnitus—Logistic regression was used to examine relationships between cardiometabolic risk factors and reported tinnitus. Data are given for three levels of covariate adjustment in Table 2: Model 1=unadjusted, Model 2=adjusted for age, sex and education, and Model 3=adjusted for age, sex, education, hearing level (PTA4) and reported noise exposure. For the unadjusted model, hypertension (OR=1.444; CI=1.111,1.875; p=0.006), use of blood pressure lowering (OR=1.416; CI=1.101,1.821; p=0.007), diuretic (OR=1.427; CI=1.124, 1.811; p=0.004) and statin medications (OR=1.318; CI=1.019,1.705; p=0.036) were significantly associated with reported tinnitus. Additionally, “ideal health,’ as

determined by physical activity level (OR=0.646; CI=0.467, 0.894; p=0.008) was negatively associated with reported tinnitus, whereas depression (OR=1.056; CI=1.038, 1.075; p<0.001) was positively associated with reported tinnitus. However, with covariate adjustment for age, sex and education (Model 2) and with additional adjustment for hearing and reported noise exposure (Model 3), only the depression variable (OR=1.051; CI=1.030, 1.072; p<0.001) was significantly associated with reported tinnitus.

Tinnitus Handicap—Scores from the THI were categorized into 2 groups: Group1=THI score ≤ 16 (indicating little to no handicap), and Group2=THI score > 16 (indicating at least slight handicap). Table 3 shows the relationship between cardiometabolic risk factors and depression with the THI categories, using logistic regression. We note that depression is the only variable significantly associated with the THI categories in the unadjusted model (Model 1; OR=1.059; CI=1.029, 1.089; p<0.001); however, for Model 2 and Model 3, depression, along with hypertension, were found to be significantly associated with the THI categories (p<0.05). We note that the odds ratio for hypertension with THI category is strong, such that, among participants with any reported tinnitus, having hypertension increases the odds of having at least slight tinnitus handicap by 82.5% (OR=1.825; CI=1.015, 3.281; p=0.044), independent from the effect of age, sex, education, hearing level (by PTA4 averaged between the ears) and reported noise exposure.

The relationship of cardiometabolic risk factors and depression with the THI score as a continuous variable were examined with gamma regression (Table 4). Results were found to be similar to those in Table 3, where the THI is given as a categorical variable with a clinical cut-off score. In Table 4, for the unadjusted model, only waist circumference (β=1.009; CI=1.002, 1.016; p=0.012) and depression (β=1.027; CI=1.013, 1.041; p<0.001) were found to be significantly associated with THI score. For model 2, waist circumference and depression continued to be significantly associated; however, hypertension (β=1.344; CI=1.015, 1.780; p=0.039) was also significant. For model 3, similar to model 1, only waist circumference (β=1.009; CI=1.001, 1.017; p=0.025) and depression (β=1.029; CI=1.013, 1.047; p=0.001) were found to be significant. Of these two variables, depression had the most robust predictor value of THI score, such that for every unit increase in depression score, the THI score increased 2.9%, independent from the effect of age, sex, education, hearing level (by PTA4 averaged between the ears) and reported noise exposure.

Discussion

The goal of the study was to assess the prevalence of tinnitus in the JHS and to test the association between cardiometabolic risks and depression with reported tinnitus and tinnitus handicap. In the way of prevalence, 29.5% of the participants in our study reported tinnitus. This is higher than data on African Americans in the NHANES, which is 18.3% for “any” tinnitus, and 3.4% for “frequent” tinnitus. This difference between the JHS and the NHANES tinnitus prevalence rates could be the result of one or more factors. During the JHS tinnitus assessment, an audiologist performed the interview. This interaction, as opposed to only a paper handout/survey, may have allowed participants to better understand what is meant by “tinnitus” and may have increased the number of “yes” answers. Our question did not specify a period during which the “ringing” occurred; some studies use a

more distinctive period during their assessment (e.g., one month). Also, our study group was comprised of generally older participants, and was comprised of more females (70%) than males. Tinnitus, similar to hearing loss, is related to advanced age[4] and it has been shown that females are more likely to report tinnitus,[14] which was observed in our results. Although the prevalence of reported tinnitus in the JHS was higher compared to previous prevalence data reported in African Americans, our results are within the range of reported tinnitus across all ethnicities from the NHANES, which is closer to 30%.[1,3,4,5,6] Of interest, our study group reported a high prevalence of at least slight tinnitus handicap, which was 35% of those who reported any tinnitus, and 10% of the whole group. This is greater than the estimation of "problematic tinnitus" for the US population, which is 1–7%.[1,5]

The association of cardiometabolic risk with reported tinnitus was not observed and the association to tinnitus handicap (THI) was found to be generally weak, though statistically significant. For the most conservative models, which involve covariate adjustment for participant demographic characteristics, as well as hearing loss and reported noise exposure (Model 3), hypertension was strongly "predictive" of THI category and waist circumference was weakly "predictive" of THI score. In other words, cardiometabolic risk was not associated with prevalence of tinnitus, but was associated with handicap of participants with tinnitus.

The lack of a relationship between cardiometabolic variables with odds of reported tinnitus in adjusted models is inconsistent with other cohort studies in non-African American cohorts.[14,15] The paradox of lower tinnitus and hearing loss prevalence despite higher prevalence of cardiometabolic risk factors and disease in African Americans is supported by our findings. It has been suggested that melanocyte content within the inner ear, which is higher in African Americans compared to Causasians, may decrease susceptibility to hearing loss, and with decreased hearing loss, decreased prevalence of tinnitus.[9,28] Melanocytes are located in the stria vascularis of the cochlea and are referred to as intermediate cells. The cells play a vital role in the potassium-recycling pathway, which serves to maintain the endocochlear potential, a high cellular potential necessary for the mechanotransduction process of hearing. Melanocytes also play a putative role in hearing protection by acting as free-radical scavengers and metal ion chelators, protecting against oxidative injury and maintaining calcium homeostatsis.

A tertiary concern for our study was the relationship of depression with tinnitus/tinnitus handicap. We found that depression was a statically significant "predictor" of reported tinnitus and level of tinnitus handicap for all three models of covariate adjustment. A recent systematic review of twenty articles on the relationship of tinnitus and depression showed a positive association between these variables.[29] One explanation for this relationship is that individuals who are likely to report high tinnitus handicap, such as on the THI, are prone to catastrophic ideation, which is an aspect of the THI questionnaire, as previously described.

There are some distinct limitations with our study that can affect the generalization of results to the larger population. Firstly, our study group was comprised entirely of African Americans. As studies have demonstrated that there are differences in the prevalence of tinnitus and hearing loss among racial groups,[4] we cannot compare our findings directly to

the larger, racially and ethnically diverse population. Also, the results presented in this report were obtained cross-sectionally, such that audiologic variables, such as hearing and tinnitus, were obtained at a different point-in-time than cardiometabolic or depression variables. This further limits any assumption of cause and effect. More research needs to be conducted that assesses these relationships longitudinally, such that cardiometabolic risk, and depression, are measured during the same period as hearing and tinnitus, with a repeat measure separated by one or more years. One future goal is to arrive at an explanation of how certain changes in cardiometabolic /cardiovascular function can directly affect the cochlea and associated structures in the brain, leading to the perception of tinnitus and difficulties in hearing and why African Americans may be less susceptible to these effects.

Conclusion

In summary, our results show that tinnitus is a highly prevalent condition in the JHS and that it is problematic for a substantial number of our participants with 35% of those reporting tinnitus having THI scores consistent with clinically significant handicap. Though cardiometabolic risk factors were not associated with report of tinnitus, they were found to be associated with tinnitus handicap. In other words, African Americans in our cohort may have lower prevalence of tinnitus compared to non-African American cohorts, but those that do have tinnitus have a high report of clinically significant tinnitus that is associated with cardiometabolic factors. Depression was found to be associated with the presence of reported tinnitus and level of tinnitus handicap, and this was found to be a robust and consistent finding, independent from all levels of covariate adjustment.

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Table 1

Participant characteristics and differences by reported tinnitus sub-group.

Characteristics		Total	No Tinnitus	Tinnitus	*p-value*
		N=1314	**N=926(70%)**	**N=388(30%)**	
Demographics					
Age, mean(SD)		61.8 (11.5)	61.1 (11.5)	63.3 (11.1)	**0.002**
Male, n(%)		396 (30%)	297 (32%)	99 (26%)	**0.018**
Years of Education, n(%)					
	High school	225 (20%)	136 (16%)	89 (29%)	**<0.001**
	> High school	918 (80%)	696 (84%)	222 (71%)	**<0.001**
Income, n (%)					
	Poor	124 (11%)	74 (9%)	50 (15%)	**<0.001**
	Affluent	405 (36%)	309 (38%)	96 (29%)	**<0.001**
Audiologic Risk					
Noise exposure, n(%)		387 (29%)	237 (26%)	150 (39%)	**<0.001**
Bilateral PTA4, mean(SD)		20.5 (10.9)	19.4 (10.2)	23.4 (11.8)	**<0.001**
THI, mean(SD)		16.1 (17.2)		16.1 (17.2)	
THI cat, n(%)					
	<=16	244 (65%)		244 (65%)	
	>16	134 (35%)		134 (35%)	
Cardiometabolic Risk					
Hypertension, n(%)		886 (67%)	603 (65%)	283 (73%)	**0.006**
Blood pressure med, n(%)		825 (63%)	560 (61%)	265 (68%)	**0.007**
Diuretic med, n(%)		607 (47%)	403 (44%)	204 (53%)	**0.003**
Diabetes, n(%)		343 (26%)	235 (25%)	108 (28%)	0.345
Diabetes med, n(%)		264 (20%)	175 (19%)	89 (23%)	0.093
HbA1c, mean(SD)		6.0 (1.1)	6.0 (1.2)	6.0 (1.1)	0.922
LDL, mean(SD)		122.6 (36.5)	123.2 (36.6)	121.1 (36.2)	0.341
HDL, mean(SD)		54.5 (15.2)	54.4 (15.2)	54.5 (15.3)	0.898
Triglyceride, mean(SD)		103.3 (81.6)	101.0 (82.0)	108.9 (80.4)	0.114
Statin meds, n(%)		374 (29%)	248 (27%)	126 (33%)	**0.035**

Characteristics		Total	No Tinnitus	Tinnitus	*p-value*
		N=1314	**N=926(70%)**	**N=388(30%)**	
SBP, mean(SD)		126.5 (18.1)	126.8 (18.3)	125.9 (17.7)	0.437
DBP, mean(SD)		74.2 (9.9)	74.4 (10.0)	73.9 (9.6)	0.473
Waist, mean(SD)		102.1 (15.6)	101.7 (15.3)	103.2 (16.2)	0.115
BMI, mean(SD)		32.2 (6.9)	32.1 (6.7)	32.6 (7.2)	0.278
Physical Activity, n(%)					
	Ideal Health	262 (20%)	196 (21%)	66 (17%)	**0.002**
Depression, mean(SD)		10.9 (8.1)	9.8 (7.2)	13.6 (9.4)	**<0.001**

Group characteristic given as a total and by sub-groups based on reported tinnitus. Categorical measures given as number(percent) and continuous measures given as mean(standard deviation). P-values show statistical test for differences between sub-groups. Level of significance set to 0.05. PTA4=four-frequency pure tone average, THI=tinnitus handicap inventory, THI cat=tinnitus handicap inventory score category, HbA1c=glycated hemoglobin, LDL=low density lipoprotein, HDL=high density lipoprotein, SBP=systolic blood pressure, DBP=diastolic blood pressure, BMI=body mass index.

Table 2

Logistic regression of cardiometabolic and depression variables with reported tinnitus.

Variable		Model 1	Model 2	Model 3
Hypertension		1.444 **p=0.006** (1.111,1.875)	1.273 p=0.115 (0.943,1.719)	1.259 p=0.146 (0.923,1.717)
Blood Pressure Medication		1.416 **p=0.007** (1.101,1.821)	1.224 p=0.172 (0.916,1.636)	1.231 p=0.174 (0.912,1.661)
Diuretic Medication		1.427 **p=0.004** (1.124,1.811)	1.281 p=0.078 (0.972,1.687)	1.285 p=0.084 (0.967,1.707)
Statin Medication		1.318 **p=0.036** (1.019,1.705)	1.232 p=0.171 (0.913,1.663)	1.247 p=0.162 (0.915,1.699)
Diabetes		1.137 p=0.345 (0.871,1.486)	0.995 p=0.973 (0.733,1.349)	1.016 p=0.923 (0.741,1.392)
HbA1c		0.995 p=0.922 (0.896,1.105)	0.951 p=0.413 (0.842,1.073)	0.954 p=0.465 (0.842,1.082)
LDL		0.998 p=0.341 (0.995,1.002)	0.998 p=0.240 (0.994,1.002)	0.998 p=0.207 (0.994,1.001)
HDL		1.001 p=0.898 (0.993,1.008)	0.998 p=0.616 (0.988,1.007)	0.998 p=0.668 (0.988,1.008)
Triglycerides		1.001 p=0.125 (1.000,1.003)	1.001 p=0.305 (0.999,1.002)	1.001 p=0.282 (0.999,1.003)
Depression		1.056 **p<0.001** (1.038,1.075)	1.056 **p<0.001** (1.036,1.076)	1.051 **p<0.001** (1.030,1.072)
Waist Circumference		1.006 p=0.115 (0.999,1.014)	1.006 p=0.136 (0.998,1.015)	1.004 p=0.316 (0.996,1.013)
Physical Activity	Intermediate Health	0.659 **p=0.003** (0.502,0.865)	0.758 p=0.075 (0.559,1.029)	0.829 p=0.243 (0.605,1.136)
	Ideal Health	0.646 **p=0.008** (0.467,0.894)	0.858 p=0.397 (0.603,1.222)	0.905 p=0.593 (0.629,1.303)

The relationship of group characteristics with reported tinnitus given as odds ratios with 95% confidence interval. Level of significance set to 0.05. Model 1: unadjusted. Model 2: adjusted for age, sex, education. Model 3: adjusted for age, sex, education, bilateral PTA4, and reported noise exposure. HbA1c=glycated hemoglobin, LDL=low density lipoprotein, HDL=high density lipoprotein.

Table 3

Logistic regression of cardiometabolic and depression variables by THI category.

Variable		Model 1	Model 2	Model 3
Hypertension		1.334 p=0.242 (0.823,2.163)	1.873 **p=0.032** (1.055,3.325)	1.825 **p=0.044** (1.015,3.281)
Blood Pressure Medication		1.313 p=0.249 (0.827,2.087)	1.680 p=0.062 (0.975,2.895)	1.614 p=0.092 (0.925,2.815)
Diuretic Medication		1.430 p=0.101 (0.933,2.192)	1.571 p=0.075 (0.955,2.582)	1.535 p=0.099 (0.923,2.554)
Statin Medication		0.995 p=0.982 (0.635,1.558)	1.006 p=0.983 (0.587,1.723)	0.932 p=0.803 (0.537,1.619)
Diabetes		1.273 p=0.310 (0.798,2.030)	1.428 p=0.199 (0.829,2.461)	1.538 p=0.133 (0.877,2.698)
HbA1c		1.019 p=0.853 (0.837,1.240)	1.065 p=0.571 (0.856,1.325)	1.041 p=0.726 (0.832,1.303)
LDL		1.004 p=0.179 (0.998,1.010)	1.006 p=0.103 (0.999,1.013)	1.006 p=0.088 (0.999,1.013)
HDL		1.000 p=0.979 (0.986,1.014)	1.012 p=0.158 (0.995,1.030)	1.014 p=0.123 (0.996,1.032)
Triglycerides		1.002 p=0.239 (0.999,1.004)	1.001 p=0.312 (0.999,1.004)	1.002 p=0.278 (0.999,1.005)
Depression		1.059 **p<0.001** (1.029,1.089)	1.063 **p<0.001** (1.028,1.099)	1.067 **p<0.001** (1.031,1.104)
Waist Circumference		1.013 p=0.064 (0.999,1.026)	1.013 p=0.102 (0.997,1.028)	1.011 p=0.163 (0.996,1.027)
Physical Activity	Intermediate Health	0.821 p=0.420 (0.507,1.327)	0.775 p=0.371 (0.443,1.355)	0.794 p=0.435 (0.444,1.418)
	Ideal Health	0.693 p=0.235 (0.378,1.270)	0.676 p=0.259 (0.343,1.335)	0.640 p=0.212 (0.318,1.290)

The relationship of group characteristics with THI score category (≤16, and >16) given as odds ratios with 95% confidence interval. Level of significance set to 0.05. Model 1: unadjusted. Model 2: adjusted for age, sex, education. Model 3: adjusted for age, sex, education, bilateral PTA4, and reported noise exposure. THI=tinnitus handicap inventory, HbA1c=glycated hemoglobin, LDL=low density lipoprotein, HDL=high density lipoprotein.

Table 4

Gamma linear regression of cardiometabolic and depression variables by THI score.

Variable		Model 1	Model 2	Model 3
Hypertension		1.126 p=0.337 (0.884,1.434)	1.344 **p=0.039** (1.015,1.780)	1.301 p=0.064 (0.985,1.717)
Blood Pressure Medication		1.104 p=0.407 (0.874,1.393)	1.207 p=0.167 (0.924,1.576)	1.161 p=0.270 (0.890,1.515)
Diuretic Medication		1.124 p=0.295 (0.903,1.398)	1.177 p=0.205 (0.915,1.514)	1.149 p=0.274 (0.896,1.473)
Statin Medication		0.973 p=0.818 (0.773,1.225)	0.987 p=0.925 (0.754,1.292)	0.985 p=0.913 (0.754,1.287)
Diabetes		1.010 p=0.937 (0.793,1.285)	1.079 p=0.595 (0.814,1.431)	1.155 p=0.320 (0.869,1.535)
HbA1c		1.009 p=0.857 (0.913,1.116)	1.033 p=0.585 (0.920,1.160)	1.019 p=0.749 (0.908,1.144)
LDL		1.000 p=0.925 (0.997,1.003)	1.001 p=0.630 (0.998,1.004)	1.001 p=0.552 (0.998,1.004)
HDL		1.000 p=0.915 (0.993,1.006)	1.004 p=0.313 (0.996,1.013)	1.005 p=0.256 (0.997,1.013)
Triglycerides		1.001 p=0.408 (0.999,1.002)	1.001 p=0.360 (0.999,1.002)	1.001 p=0.185 (0.999,1.003)
Depression		1.027 **p<0.001** (1.013,1.041)	1.029 **p=0.001** (1.012,1.046)	1.029 **p=0.001** (1.013,1.047)
Waist Circumference		1.009 **p=0.012** (1.002,1.016)	1.009 **p=0.021** (1.001,1.018)	1.009 **p=0.025** (1.001,1.017)
Physical Activity	Intermediate Health	0.953 p=0.701 (0.744,1.220)	0.921 p=0.584 (0.687,1.235)	0.951 p=0.740 (0.710,1.276)
	Ideal Health	0.873 p=0.378 (0.645,1.181)	0.872 p=0.435 (0.618,1.230)	0.887 p=0.493 (0.630,1.249)

The relationship of group characteristics with THI score, given as Gamma Regression coefficient (β) with 95% confidence interval. Level of significance set to 0.05. Model 1: unadjusted. Model 2: adjusted for age, sex, education. Model 3: adjusted for age, sex, education, bilateral PTA4, and reported noise exposure. THI=tinnitus handicap inventory, HbA1c=glycated hemoglobin, LDL=low density lipoprotein, HDL=high density lipoprotein.