CLINICAL RESEARCH STUDY

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Prevalence and Characteristics of Tinnitus among US Adults

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ABSTRACT

BACKGROUND: Tinnitus is common; however, few risk factors for tinnitus are known.

METHODS: We examined cross-sectional relations between several potential risk factors and self-reported tinnitus in 14,178 participants in the 1999-2004 National Health and Nutrition Examination Surveys, a nationally representative database. We calculated the prevalence of any and frequent (at least daily) tinnitus in the overall US population and among subgroups. Logistic regression was used to calculate odds ratios (OR) and 95% confidence intervals (CI) after adjusting for multiple potential confounders.

RESULTS: Approximately 50 million US adults reported having any tinnitus, and 16 million US adults reported having frequent tinnitus in the past year. The prevalence of frequent tinnitus increased with increasing age, peaking at 14.3% between 60 and 69 years of age. Non-Hispanic whites had higher odds of frequent tinnitus compared with other racial/ethnic groups. Hypertension and former smoking were associated with an increase in odds of frequent tinnitus. Loud leisure-time, firearm, and occupational noise exposure also were associated with increased odds of frequent tinnitus. Among participants who had an audiogram, frequent tinnitus was associated with low-mid frequency (OR 2.37; 95% CI, 1.76-3.21) and high frequency (OR 3.00; 95% CI, 1.78-5.04) hearing impairment. Among participants who were tested for mental health conditions, frequent tinnitus was associated with generalized anxiety disorder (OR 6.07; 95% CI, 2.33-15.78) but not major depressive disorder (OR 1.58; 95% CI, 0.54-4.62).

CONCLUSIONS: The prevalence of frequent tinnitus is highest among older adults, non-Hispanic whites, former smokers, and adults with hypertension, hearing impairment, loud noise exposure, or generalized anxiety disorder. Prospective studies of risk factors for tinnitus are needed.

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Tinnitus, derived from the Latin word *tinnire* meaning "to ring," is the perception of noise in the absence of an acoustic stimulus.[1] It is a common condition that is usually subjective, perceived only by the patient, and therefore diagnosis and monitoring rely on self-report.[2] Data from the 1996 National Health Interview Survey (NHIS) showed tinnitus was experienced by approximately 35-50 million adults in the US, with 12 million seeking medical care, and 2-3 million reporting symptoms that were severely debilitating.[3] Cases and proposed etiologies of tinnitus are clinically heterogeneous and, although several treatment options have been tried, no single cure exists for the condition.[4]

Patients who experience tinnitus often report significant associated morbidities. Lifestyle detriment, emotional difficulties, sleep deprivation, work hindrance, interference with social interaction, and decreased overall health have been attributed to tinnitus.[5-7] Although causative relations are yet unknown, patients with tinnitus can have increased risk for depression, anxiety, and insomnia.[5,8,9]

A limited number of risk factors for tinnitus have been suggested, the best described of which include increasing age, hearing loss, and loud noise exposure.[10,11] These asso-

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ciations merit further exploration in a large cohort. Furthermore, the relations between tinnitus and other demographic and health factors are minimally characterized in the current literature. Therefore, we examined the relation between tinnitus and several potential risk factors using data from the National Health and Nutrition Examination Survey (NHANES), a large nationally representative survey.

CLINICAL SIGNIFICANCE

- Tinnitus is a very common and potentially disabling condition, but few risk factors for its development are currently known.
- The relations between tinnitus and other demographic and health factors are minimally characterized in the current literature.
- Because tinnitus currently has no known cure, identifying potentially vulnerable groups and establishing potential risk factors in a large, nationally representative study is important for decreasing the burden of this condition.

METHODS

Study Population

Participants from the NHANES 1999-2000, 2001-2002, and 2003-2004 surveys were included in our study. NHANES provides nationally representative cross-sectional data on the health status of the civilian, non-institutionalized US population. After selection in a complex survey design, participants were interviewed and examined. The design of NHANES has been described previously.[12] Because older individuals, Mexican-Americans, and black individuals were intentionally over-represented, NHANES 1999-2004 were not simple random samples of the US population. Therefore, appropriate sample weights were used to obtain weighted regression estimates, and the final results of our analyses were generalizable to the US population.[12]

Exposure and Outcome Assessment

Questionnaire responses were used to compile the participants' general demographic and medical information. Participants were asked their age, self-identified race/ethnicity, and highest level of education achieved. They were asked if they smoked cigarettes currently, previously, or never. Participants were defined as having hypertension if they had been told by a health professional that they had hypertension or if they had a history of taking an antihypertensive medication. Similarly, they were defined as having diabetes mellitus if they had been told by a health professional that they had diabetes mellitus or if they had a history of taking a diabetes medication. Participants also were queried about the use of specific medications, including cholesterol-lowering medications. They were defined as having dyslipidemia if they reported taking a cholesterol-lowering medication. Body mass index measurement was calculated as weight in kilograms divided by the square of height in meters. Both the weight and height of participants were measured.

Subsamples of participants received additional testing and interviews. Audiometry was performed on half of all participants between the ages of 20 and 69 years (n = 5414). Hearing threshold testing was conducted on both ears of examinees at 7 frequencies (500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz). We defined low-mid frequency hearing impairment as a pure tone mean of >25 decibels at 500, 1000, or 2000 Hz in either ear.[13] We defined high frequency hearing impairment as a pure tone mean of >25 decibels at 3000, 4000, 6000, or 8000 Hz in either ear. The World Health Organization Composite Diagnostic Interview, Version 2.1, was administered to half of all participants between the ages of 20 and 39 years (n = 2265). Based upon responses to these interviews, a composite score was calculated for the presence or absence of a major depressive disorder and generalized anxiety disorder according to a predefined algorithm.[14]

Participants over the age of 20 years were asked questions about hearing and noise exposure. Tinnitus was defined as answering "yes" to the question, "In the past 12 months, have you ever had ringing, roaring, or buzzing in your ears?" This was followed by the question "How often did this happen?" Frequent tinnitus was defined as answering "almost always" or "at least once a day" to this question. To assess noise exposure, participants were asked about the presence or absence of exposure to loud leisure-time, leisure-time firearm, or occupational noise at least once in the past month.

Statistical Analyses

The prevalence of any and frequent tinnitus was calculated among participants with and without each potential risk factor. Logistic regression was performed with sex, age, race/ethnicity, education level, body mass index, smoking status, hypertension, diabetes mellitus, dyslipidemia, leisure-time noise exposure, leisure-time firearm noise exposure, and occupational noise exposure as covariates, and any or frequent tinnitus as the outcome. Low-mid frequency hearing impairment, high frequency hearing impairment, major depressive disorder, and generalized anxiety disorder were entered into the regression model in separate analyses of participants on whom these data were collected. Age and multivariable adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated using logistic regression models adjusted for potential confounders listed above. All *P*-values were 2-sided.

Data analysis was performed using SAS version 9.1 (SAS Institute Inc., Cary, NC) and SUDAAN version 9.0 (RTI International, Research Triangle Park, NC). Protocols to recruit and study participants of NHANES 1999-2004