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Original Investigation

Prevalence, Severity, Exposures, and Treatment Patterns of Tinnitus in the United States

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IMPORTANCE Tinnitus is a common problem for millions of individuals and can cause substantial negative effects on their quality of life. A large epidemiologic study of tinnitus and its management patterns in the US adult population is lacking.

OBJECTIVES To quantify the epidemiologic features and effect of tinnitus and to analyze the management of tinnitus in the United States relative to the 2014 American Academy of Otolaryngology–Head and Neck Surgery Foundation (AAO-HNSF) clinical practice guidelines.

DESIGN, METHODS, AND PARTICIPANTS This cross-sectional analysis of the representative 2007 National Health Interview Survey (raw data, 75 764 respondents) identified a weighted national sample of adults (age, ≥ 18 years) who reported tinnitus in the preceding 12 months. Data were collected in November 2014 at the University of California, Irvine, and Harvard Medical School.

MAIN OUTCOMES AND MEASURES In addition to quantifying prevalence, severity, duration, and regularity of tinnitus, specific data regarding noise exposure and tinnitus management patterns during health care visits were analyzed.

RESULTS Among an estimated (SE) 222.1 (3.4) million US adults, 21.4 (3.4) million (9.6% [0.3%]) experienced tinnitus in the past 12 months. Among those who reported tinnitus, 27% had symptoms for longer than 15 years, and 36% had nearly constant symptoms. Higher rates of tinnitus were reported in those with consistent exposure to loud noises at work (odds ratio, 3.3; 95% CI, 2.9-3.7) and during recreational time (odds ratio, 2.6; 95% CI, 2.3-2.9). Years of work-related noise exposure correlated with increasing prevalence of tinnitus ($r = 0.13$; 95% CI, 0.10-0.16). In terms of subjective severity, 7.2% reported their tinnitus as a big or a very big problem compared with 41.6% who reported it as a small problem. Only 49.4% had discussed their tinnitus with a physician, and medications were the most frequently discussed recommendation (45.4%). Other interventions, such as hearing aids (9.2%), wearable (2.6%) and nonwearable (2.3%) masking devices, and cognitive behavioral therapy (0.2%), were less frequently discussed.

CONCLUSIONS AND RELEVANCE The prevalence of tinnitus in the United States is approximately 1 in 10 adults. Durations of occupational and leisure time noise exposures correlated with rates of tinnitus and are likely targetable risk factors. Management options suggested by the recently published AAO-HNSF guidelines were followed infrequently.

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Tinnitus is a symptom characterized by the perception of sound in the absence of an external stimulus.¹ If persistent and intolerable or sufficiently bothersome, tinnitus can cause functional impairment in thought processing, emotions, hearing, sleep, and concentration,¹ all of which can substantially and negatively affect quality of life.² Tinnitus is a common problem for millions of people; epidemiologic studies³⁻⁷ have reported its prevalence to range in from 8% to 25.3% of the US population. Population-based studies conducted in other nations have found a similar prevalence of tinnitus, ranging from 4.6% to 30%.⁸⁻¹²

Given its high prevalence and effect on quality of life, the American Academy of Otolaryngology-Head and Neck Surgery Foundation (AAO-HNSF) recently published its first-ever, multidisciplinary, evidence-based clinical practice guidelines to provide clinicians a framework for managing tinnitus.¹³ In addition to outlining a suggested workup for persistent tinnitus, the authors provided recommendations for and against various treatment options, including education and counseling, sound therapy, cognitive behavioral therapy (CBT), medications, dietary supplementation, and acupuncture, among others.

To achieve targeted improvement in tinnitus management relative to the AAO-HNSF guidelines, we analyzed data from the 2007 Integrated Health Interview Series. The Integrated Health Interview Series is a project funded by the National Institutes of Health to supplement the National Health Interview Survey (NHIS), a household-based, personal-interview survey administered by the US Census Bureau and Centers for Disease Control and Prevention since 1957. The NHIS serves as the largest source of health information in the US civilian population. The information is collected from trained interviewers via a personal household interview. The sample is chosen at random, and starting in 2006, the minority population was oversampled to allow for more precise estimation of the socioeconomically mixed US population.

In 2007 only, the Integrated Health Interview Series survey asked respondents numerous questions about tinnitus symptoms, including inquiries about treatment strategies offered by their health care professionals. These data represent the national trends in the management of tinnitus before the formulation of the recent guidelines referenced above. They may serve as a benchmark for the state of tinnitus counseling and treatment during this time and, by comparing and contrasting the survey results with the AAO-HNSF guidelines, we can identify and address deficiencies and areas for improvement. Thus, in the present study, we extracted data from this survey to (1) determine the prevalence, duration, frequency, and severity of and common risk factors for tinnitus symptoms and (2) report common interventions for tinnitus discussed by physicians with symptomatic patients. We then compared these survey results with the AAO-HNSF recommendations to identify areas of potential improvement in the management of tinnitus and to guide future studies after the implementations of the guidelines.

Methods

Adult responses in the household-based 2007 NHIS were analyzed as aggregated in the Integrated Health Interview Series.¹⁴

Key Points

Question How are the epidemiologic features and management of tinnitus before the implementation of the 2014 American Academy of Otolaryngology-Head and Neck Surgery Foundation clinical practice guidelines on tinnitus quantified?

Findings Results from this cross-sectional analysis indicated that in 9.6% of respondents experienced tinnitus in the past year, 36.0% of whom had nearly constant symptoms. Fewer than half of the patients had discussed their problem with a physician, who most commonly provided medications for management of tinnitus.

Meaning The national prevalence of tinnitus is approximately 1 in 10 adults, who were typically not treated in accordance with recent guidelines.

Data were collected in November 2014 and analyzed at the University of California, Irvine, and Harvard Medical School, Boston, Massachusetts. The study protocol was reviewed and deemed exempt from review by Partners Committee on Clinical Investigations because it analyzes publicly available, de-identified data that do not require informed consent.

Previous studies^{15,16} have used the NHIS to describe the epidemiology of various otologic conditions in the United States. However, in 2007, the NHIS contained a specific module that assessed multiple tinnitus-related variables, including the presence or absence of tinnitus, the duration, frequency, and perceived severity of the problem, and health care-seeking behaviors with respect to the tinnitus and treatments offered. The responses were obtained by trained interviewers via household surveys. Questions asked were typically simple, for example: "In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?" The answer choices included options ranging from "not a problem" to "a small/moderate/big/very big problem," as well as declining to answer. Because these responses were collected through a rigorous, interview-based process, we presume that the questions were understood, unbiased, and appropriately guided by the interviewers. In addition to tinnitus variables, respondents were queried on noise exposure at work and during recreational time. When surveying work noise exposure, interviewers defined loud environments as those in which one must speak in a raised voice to be heard. In an effort to maintain uniformity, several particular recreational time activities, including the use of gardening and workshop tools, machinery, motorcycles and other motor engines, loud household appliances, MP3 players, and concert attendance, among others, were queried.

Corresponding responses were extracted for adult patients (aged ≥ 18.0 years). Data were imported into SPSS software (version 22.0; SPSS, Inc) for analysis. We determined the prevalence of self-reported tinnitus with various factors that further characterized the tinnitus symptom, including duration, frequency, and severity. These data were used to determine the associations between the prevalence of tinnitus and noise exposures. Thereafter, the proportion of respondents who discussed their tinnitus with their physician and the proportions who subscribed to various remedies for their tinnitus were also calculated. We applied sample design weights to

the raw sample size to obtain representative statistics for the national population in the United States. Overall data are reported as means and their associated SEs for the weighted national sample. Statistical comparisons were conducted with χ^2 tests, with significance set at $P = .05$. We used the Pearson product moment correlation test to measure correlation between 2 variables when reported.

Results

Among an estimated 222.1 (3.4) million adults (raw number, 75 764), 21.4 (3.4) million adults (9.6% [0.3%]) had experienced tinnitus in the past 12 months. When asked about the duration of symptoms, 56.1% of respondents with tinnitus experienced the problem for longer than 5 years, and 27.0% had symptoms for longer than 15 years. Adults who had experienced tinnitus in the prior 12 months were significantly older than those who did not have tinnitus (mean age, 53.1 vs 45.0 years; mean difference, 8.1 years; 95% CI, 7.2-9.0 years). In addition, those individuals with more severe symptoms tended to be older, with a direct correlation seen between increased tinnitus severity and increased age ($r = 0.08$; 95% CI, 0.04-0.13) (Figure). Furthermore, tinnitus tended to be more prevalent in men (10.5%) than women (8.8%; mean difference, 1.8%; 95% CI, 0.9%-2.7%), with no significant differences in severity between the 2 groups. Men were more likely than women to discuss tinnitus with their physician (52.8% vs 48.0%; mean difference, 4.8%; 95% CI, 0.5%-9.1%) (Table 1).

Of those who reported experiencing tinnitus, 36.0% reported having nearly constant symptoms, 15.0% had noticeable symptoms at least once a day, 14.6% had noticeable symptoms at least once a week, and the remainder had symptoms less than weekly. Regarding subjective severity, 7.2% believed tinnitus to be a big or a very big problem; 20.2%, a moderate problem; and 41.6%, a small problem. The remaining 31.0% was not bothered by tinnitus. When asked about when they noticed the symptoms, 38.4% noted their tinnitus at bedtime.

Among all respondents, 25.0% reported a history of regular loud noise exposure at work, with duration of such exposure reported as 0 to 2 years by 27.7%, 3 to 14 years by 38.0%, and 15 or more years by 34.3%. Those with a history of regular noise exposure at work had a 19.2% prevalence of tinnitus compared with 6.8% for those without (odds ratio, 3.3; 95% CI, 2.9-3.7). Furthermore, we found an associated increase in the prevalence of tinnitus based on number of years exposed to work noise, including 0 to 2 years with a tinnitus preva-

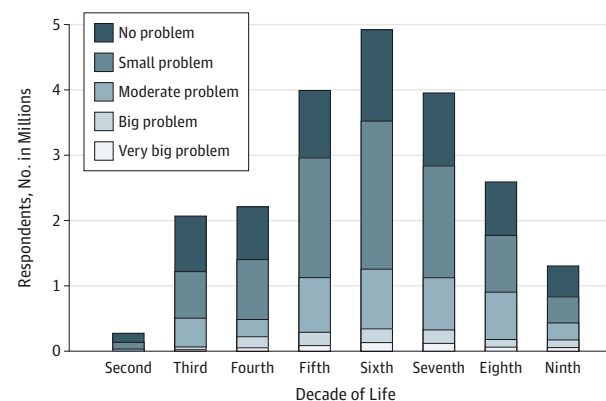
lence of 12.9%, 3 to 14 years with a prevalence of 18.0%, and 15 or more years with a prevalence of 25.7% ($r = 0.13$; 95% CI, 0.10-0.16) (Table 2). A significant number of adults also reported exposure to loud recreational noise at least once a month (22.7%). The prevalence of tinnitus for those with monthly exposure to loud noise in leisure time was 17.1% compared with 7.4% for those without such exposure (odds ratio, 2.6; 95% CI, 2.3-2.9).

Of those who experienced tinnitus, only about half had discussed their problem with a physician (49.4%). The various options discussed according to guidelines and alternative therapies discussed with patients but not included in the guidelines are described in Table 3. The responses indicated that most patients (84.8%) had never tried any form of remedy. Compared with the recommendations elaborated by the AAO-HNSF tinnitus guidelines, our data indicate that medical therapy was the most commonly discussed topic, whereas CBT was the least common.

Discussion

Tinnitus can be a severely debilitating problem, and numerous risk factors have been associated with the development of tinnitus. Those with a hearing impairment have a higher risk

Figure. Subjective Severity of Tinnitus Symptoms by Age



Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents). A direct correlation is seen between subjective perception of increased tinnitus severity and increased age ($r = 0.083$; 95% CI, 0.042-0.125).

Table 1. Sex Stratification of Tinnitus Symptoms

Tinnitus Symptom	Population in Millions (%) ^a		P Value ^b
	Men	Women	
During past year	11.3 (10.5)	10.1 (8.8)	<.001
Extent of problem			
None	3.6 (31.7)	3.0 (30.2)	.11
Small or moderate	6.9 (61.1)	6.3 (62.5)	
Big or very big	0.8 (7.2)	0.7 (7.2)	
Discussed with physician	6.0 (52.8)	4.8 (48.0)	.04

^a Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

^b Calculated using χ^2 tests.

Table 2. Rates of Tinnitus Among Those Reporting Regular Occupational Loud Noise Exposure and in Relation to Reported Duration of Noise Exposure

Occupational Loud Noise Exposure	Population in Millions (%) ^a	Tinnitus Prevalence, %	P Value ^b
Regular			
No	156.7 (75.0)	6.8	<.001
Yes	52.2 (25.0)	19.2	
Duration, y			
0-2	14.3 (27.7)	12.9	<.001
3-14	19.7 (38.0)	18.0	
>15	17.8 (34.3)	25.7	

^a Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

^b Calculated using χ^2 tests.

Table 3. Treatment Options Discussed With Physicians Among Respondents Reporting Tinnitus

Type of Therapy Discussed	Population in Millions (%)
Included in AAO-HNSF guidelines	
Medications	1.45 (45.4)
Hearing aids	0.30 (9.2)
Nutritional supplements	0.25 (7.8)
Stress reduction methods	0.21 (6.7)
Music treatment	0.13 (4.0)
Tinnitus retraining therapy	0.10 (3.0)
Biofeedback therapy	0.09 (2.8)
Wearable masking device	0.08 (2.6)
Nonwearable masking device	0.07 (2.3)
CBT	0.01 (0.2)
All	2.68 (83.8)
Not included in AAO-HNSF guidelines	
Psychiatric therapy	0.01 (0.3)
Surgical transection of auditory nerve	0.04 (1.2)
Alternative medicine	0.12 (3.9)
Other	0.94 (29.5)
All	1.11 (34.9)

Abbreviations: AAO-HNSF, Academy of Otolaryngology–Head and Neck Surgery Foundation; CBT, cognitive behavioral therapy.

^a Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

for tinnitus, and the associated increase in risk depends on the severity of hearing impairment.^{5,12,17,18} Furthermore, the risk for tinnitus is elevated in people with a history of head injury, depressive symptoms, target shooting, arthritis, use of nonsteroidal anti-inflammatory medications,^{5,19} hypertension, and smoking.⁷ In addition, individuals with intolerable tinnitus often have higher rates of anxiety, depression, low self-esteem, and poor quality of life compared with those without tinnitus.^{12,20-23} Moreover, tinnitus is the most common service-related disability among veterans, with more than 1.1 million US veterans receiving disability payments for intolerable tinnitus in 2013.²⁴

Wide ranges of tinnitus prevalence have been reported from previous studies, possibly the result of variations in survey questioning and statistical methods. Most studies^{3-12,25} found that the prevalence of tinnitus in adults ranged from 8% to 30%. Although our reported prevalence among adults in the United States reporting tinnitus symptoms in the prior 12 months is on the lower end of the range,

the study that reported the highest prevalence of tinnitus (30%) limited their survey population to adults older than 55 years.¹² This restriction likely contributed to the relatively higher prevalence rate.

We also found that more men than women reported tinnitus, which is consistent with previously published findings.^{26,27} In addition and similar to other large epidemiologic studies in the United States, tinnitus severity directly correlated with age.^{4,7,27,28} However, we also see in this cohort that although the prevalence of tinnitus increased with age, it decreased in the older populations, beginning in the seventh decade of life, and this change is reported elsewhere (Figure).^{6,7}

Loud noise exposure has been consistently linked to increased odds of hearing loss.^{1,5,7,26} In particular, the risks of occupational noise exposure have been associated with the development of tinnitus symptoms.^{10,25,27,29-31} In contrast, the Beaver Dam Offspring Study⁵ failed to demonstrate an association between occupational noise exposure and the prevalence or incidence of tinnitus. In our sampled cohort, most of the respondents denied regular loud noise exposure at work or during leisure hours and did not experience 1 episode of loud noise exposure at work in the prior 12 months. However, among the respondents with regular occupational noise exposure, the prevalence of tinnitus was higher than in those without such exposure, and the rates of tinnitus increased with the reported duration of occupational noise exposure (Table 2). A similar association was seen among adults who reported monthly exposure to loud noise during leisure time. The data suggest that although most of the respondents do not have regular exposure to loud noise at work or during leisure time, tinnitus occurs at much higher rates during regular exposure to environments with loud noise, which are furthermore correlated with duration of noise exposure.

The AAO-HNSF guidelines are intended to address the treatment of the subset of patients with tinnitus and symptom persistence for at least 6 months, which constitutes a large portion of our study cohort. Most of the respondents in our survey noted symptoms for longer than 12 months. However, independent of symptom duration, most of the respondents with tinnitus believed their symptoms to be “not a problem” or only “a small problem.” Similarly, 55.5% of respondents in the Blue Mountains Hearing Study²⁶ reported their symptoms to be mild. Thus, for many patients with chronic tinnitus, the severity of symptoms may actually be tolerable, and they may not require any intervention.

Patients with intolerable and bothersome tinnitus often experience sleep disturbance and poor quality of life, which can lead to mental distress, worsened anxiety and depression symptoms, and disability.^{7,20-23} Despite this evidence, we found that most respondents had not discussed their problem with a physician, and many more had never tried any form of remedy. These figures are similar to those reported in the Blue Mountains Hearing Study,¹² where only 37% sought help despite 50% of participants reporting a tinnitus problem for 6 years or more. Similar to our cohort, only 6% of patients reporting tinnitus in their study received a form of treatment.¹²

Of note and in the present study, fewer than 1 in 4 patients who discussed their tinnitus symptoms with their physician received management recommendations in concordance with the current AAO-HNSF guidelines. As seen in Table 3, the most commonly discussed intervention for tinnitus management was medical therapy. Although the treatment of comorbid mood disorders with psychoactive medications has been shown in some studies to reduce the severity of tinnitus,^{32,33} the AAO-HNSF recommends that clinicians should not use medical therapy, including antidepressants, anticonvulsants, and intratympanic medications, for routine management of tinnitus. Anxiolytics are also not recommended owing to the lack of consistent benefit and the potential for adverse effects. The recommendation against medical therapy is primarily owing to insufficient data from clinical trials and meta-analyses to reliably demonstrate a reduction in the perception of tinnitus.¹³

Although evaluation for a hearing aid for patients with hearing loss and tinnitus was recommended in the AAO-HNSF guidelines,¹³ we found that this topic was rarely discussed (Table 3). A hearing aid-like device can be used to deliver sound therapy, which may provide respite from tinnitus. Although conclusive evidence behind the efficacy of sound therapy in the treatment of tinnitus is lacking,³⁴ the AAO-HNSF guidelines encourage clinicians to regularly present it as an option for patients with persistent and bothersome tinnitus, given that adverse effects and potential harm are minimal to nonexistent.¹³ Moreover, masking sound therapy can be delivered in the form of wearable and nonwearable appliances and can provide some benefit to patients with tinnitus, but our results show that these therapeutic management strategies were infrequently discussed with our respondents seeking medical advice (Table 3).

Tinnitus symptoms can also lead to sleep, concentration, and emotional difficulties,³⁵ for which CBT has been shown to be beneficial.^{36,37} Cognitive behavioral therapy aims to restructure distressful and dysfunctional thoughts that lead to cognitive distortions into a more effective response to stressors. These techniques promote habituation and adaptive behaviors that may improve tinnitus tolerance, depression scores, and quality of life without directly affecting the severity or volume of tinnitus.³⁷ However, the evidence supporting or refuting the effectiveness of CBT in improving tinnitus-specific quality of life is considered to be generally insufficient in some large reviews, mostly secondary to inconsistent study methods and lack of high-powered studies.³⁸ Regardless, although CBT is a favored recommendation in the AAO-HNSF guidelines for the

management of bothersome tinnitus and the good-practice guidelines of the Department of Health in the United Kingdom,³⁸ CBT was rarely discussed with our cohort during physician-patient conversations regarding tinnitus (Table 3). Cognitive behavioral therapy can furthermore be combined with education and counseling via informational brochures and self-help books, as well as stress management techniques, to provide effective management strategies for tinnitus. Unfortunately, as seen in Table 3, these adjunctive therapies were seldom discussed with patients who presented to a physician with tinnitus symptoms.

The AAO-HNSF recommended against dietary supplements, such as *Ginkgo biloba*, melatonin, and zinc, among others, given the preponderance of harm over clear benefit demonstrated in randomized clinical trials for any dietary supplement.¹³ Nevertheless, nutritional supplementation was more often discussed than nearly every other recommended intervention listed in Table 3. In addition, unconventional and unproven strategies, such as surgical transection of the auditory nerve and alternative medicine, were also discussed with patients (Table 3).

Tinnitus-related disability has been reported to be among the most common of chronic conditions and in some populations even more prevalent than back and neck pain, knee problems, and diabetes mellitus.²⁴ The negative effect on quality of life due to chronic tinnitus is well-established, and, similar to chronic daily headache³⁹ and low back pain,⁴⁰ has been reported to adversely affect all 5 measures of validated health-related quality of life surveys, including mobility, self-care, performance of usual activities, pain and/or discomfort, and anxiety and/or depression.⁴¹ Moreover, mood disorder comorbidity among individuals with tinnitus has been reported to be as high as 60% to 80%^{42,43} and can lead to increases in measures of tinnitus annoyance.⁴⁴ Similar findings are also seen in other common conditions, such as chronic pain. Prevalence of major depressive disorder among patients with chronic pain has been reported to be more than 50%,⁴⁵ and low back pain is also associated with higher rates of depression, anxiety, and sleep disorders.⁴⁶

Our study has several strengths and limitations. The data are derived from a national database that represents a large and diverse sampling of the general population. In addition, each person is chosen in a way that they have a known nonzero probability of selection. All 50 states and the District of Columbia are surveyed, and since 2006, the survey oversamples black, Hispanic, and Asian populations to more precisely estimate the health characteristics of the country's minority population. Furthermore, to our knowledge, this study is also the first to report the epidemiologic data on the treatments for tinnitus discussed by physicians with their patients. However, the data analyzed herein were extracted from the 2007 NHIS and may therefore not reflect the current tinnitus management practices of physicians nationally. Consequently, and with more recent public awareness and education about hearing loss and tinnitus, a higher percentage of patients with tinnitus may be receiving management recommendations in line with the AAO-HNSF guidelines than reported herein. In addition, because 2007 was the first year tinnitus-related information was avail-

able, future studies can be directed toward changes in tinnitus management patterns. Last, owing to the retrospective nature of this study, the potential for recall bias from the respondents exists, because they may have forgotten the details of or failed to fully understand the discussion of tinnitus and management recommendations from their health care professionals.

Conclusions

The analysis of responses from 75 764 US adults, representing a sample of more than 220 million people, confirms that tinnitus is prevalent in the general adult population. Re-

ported rates of tinnitus are significantly higher in those with regular exposure to noisy environments at work and during leisure time. The recent guidelines published by the AAO-HNSF provide a logical framework for clinicians treating these patients, but the current results indicate that most patients may not be offered management recommendations consistent with the suggested protocol. With the newly published guidelines from the AAO-HNSF, otolaryngologists may play a greater role in addressing this issue, not only with treating their patients accordingly, but also in educating other physicians and health care professionals. Future work can be directed to show changing patterns in tinnitus management before and after the implementation of these guidelines.

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Study concept and design: Bhatt, Bhattacharyya.
Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: All authors.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Bhatt, Bhattacharyya.

Administrative, technical, or material support: Lin, Bhattacharyya.

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