

Increased Healthcare Utilization in Patients with Tinnitus

Mingee Kim^{1*},
David R. Friedland¹,
Jazzmyne A. Adams¹,
Masoud Khani²,
Jake Luo²

ABSTRACT

Background: Tinnitus, characterized by a perception of sound in the absence of external stimuli, is a condition impacting millions of Americans. Recent international research revealed that patients with tinnitus had significantly increased healthcare utilization. That study did not control for age, a significant cofactor in health utilization. The present study uses a local US adult database and controls for age to assess the reproducibility and generalizability of the observed correlation.

Methods: This retrospective study included 6,236 tinnitus patients, and 6,236 age, sex, and race matched controls, from a mid-west academic health system. Healthcare utilization parameters were assessed within one year before and after the initial tinnitus diagnosis. Odds ratios with 95% confidence intervals were calculated for categorical analyses and Student t-test used for continuous variables.

Results: Despite demographic and clinical equivalency between tinnitus and control populations, patterns of increased healthcare utilization were seen among individuals with tinnitus. Tinnitus patients had a mean of 8.57 primary care consultations compared to 1.04 for controls ($p < .001$). Tinnitus patients had a mean of 5.34 hospitalizations compared to 0.58 for controls ($p < .001$). Furthermore, tinnitus patients had a mean difference of 10.58 more new drug prescriptions and 23.02 more diagnoses of other conditions compared to controls ($p < .001$).

Conclusions: Higher health care utilization is noted among a US cohort of patients with a tinnitus diagnosis when controlling for age, sex, and race. Further work is needed to identify whether increased medical comorbidities lead to tinnitus perception; or whether tinnitus heralds impending medical conditions and poorer overall health.

Keywords: Tinnitus, Comorbidities, Health care utilization, Primary health care, Hearing loss, Health services.

¹Department of Otolaryngology and Communication Sciences, Medical College of Wisconsin, Milwaukee WI, USA

²Department of Health Informatics, Zilber College of Public Health, University of Wisconsin-Milwaukee, Milwaukee WI, USA

***Send correspondence to**

Mingee Kim

Department of Otolaryngology and Communication Sciences, Medical College of Wisconsin, Milwaukee WI, USA, E-mail: mingkim@mcw.edu

Paper submitted on Oct 20, 2024; and Accepted on Nov 15, 2024

INTRODUCTION

Tinnitus, characterized by a perception of sound in the absence of external stimuli, is a prevalent condition impacting millions of Americans. Approximately 10% of the United States adult population experiences some form of tinnitus, with 5 million experiencing a chronic form of the disease and 2 million finding it debilitating^{1,2}. Tinnitus exhibits variability in both auditory experiences and associated comorbidities with medical, behavioral health, pharmacological and social factors associated with disease severity.

Comorbidities, such as anxiety, depression, and sleep disturbances, have been associated with tinnitus, as reported in a study using the 2007 U.S. National Health Interview Survey (NHIS)³. Further studies investigated the correlation between chronic tinnitus and phantom auditory pain, revealing a strong association between the severity of tinnitus and insomnia, anxiety, and depression, similar to patients with chronic pain^{4,5}. Using data from the U.S. National Health and Nutrition Examination Survey (NHANES), Shargardsky et al. noted a significant association between smoking, hypertension, and tinnitus, emphasizing a potential contribution of vascular disease to tinnitus etiology⁶.

The relationship between tinnitus and significant medical comorbidities raises questions as to whether tinnitus patients utilize greater healthcare resources or, conversely, whether patients requiring evaluation and treatment for multiple medical conditions are more likely to suffer from tinnitus. Indeed, a 2018 study from the Netherlands revealed that patients diagnosed with tinnitus had significantly increased healthcare utilization, experiencing, on average, four more primary care consultations and 1.2 more drug prescriptions compared to individuals without a tinnitus diagnosis⁷.

A significant cofactor in health utilization, as well as the development of tinnitus, is age. While the Netherlands report controlled for age and gender through binary logistic regression, their tinnitus and non-tinnitus cohorts were distinctly different with respect to these demographics⁷. Specifically, over 80% of the tinnitus group were 40 years or older, compared to 67% of the non-tinnitus group. In addition, slightly more than half of the tinnitus group were males compared to less than half being male in the non-tinnitus group. The present study uses a local U.S. adult database along with age, gender, and race matched controls so as to further explore the correlation between healthcare utilization and a diagnosis of tinnitus.

METHODS

This project was performed under OTO Clinomics, a comprehensive platform for retrospective electronic health record investigations, with approval by our local IRB (PRO00045896). The Clinical Research Data Warehouse

(CRDW) of the Center for Biomedical Informatics of the Clinical and Translational Science Institute of Southeast Wisconsin (UL1TR001436) houses a JupyterHub enabled mirror of the hospital Electronic Health Record (EHR). EHR data is updated weekly and augmented by data from the US Census, Social Security Death Master File, and system-specific clinical data such as genetic testing, ECG results, and audiometry results.

Within the JupyterHub environment, all patients with a diagnosis of tinnitus by ICD code (ICD9: 388.30, 388.31, 388.32; ICD10: 93.1, 93.11, 93.12, 93.13, 93.19) between 2012 and 2022 were identified. The date of tinnitus diagnosis for each patient was considered time zero (T0). On a patient-to-patient basis, a control group without a diagnosis of tinnitus at a similar T0 was created that was identically matched for age, sex, and race. The medical record of tinnitus and control patients was then interrogated for 1 year prior (T-1) and 1 year after (T+1) T0 for numbers of ambulatory clinic visits, numbers of hospitalizations, medications taken during this 2-year period, new medication prescriptions during this time, procedures performed between T-1 and T+1, and number of other medical diagnoses within this time period.

Categorical comparisons between tinnitus and control populations were performed by chi-square analyses with calculation of odds ratios, 95% confidence intervals and p-values. Numerical continuous variable comparisons between study and control groups were performed by two-tailed t-test with calculation of the t-statistic and p-value. Significance was set at p-value of <.05. All statistical tests were performed within the JupyterHub environment using R (4.3).

RESULTS

There were 6,236 patients identified with a diagnosis of tinnitus between 2012 and 2022. An age, sex, and race matched cohort of 6,236 patients without a diagnosis of tinnitus at time 0 were also identified. The tinnitus and control populations had identical average age (56.7 years [95% CI: 47.8, 67.0]), proportion of males (47.34%), and proportions of White, Black, and Asian patients (85.74%, 9.36%, 1.19% respectively). In both groups, the majority of patients were non-Hispanic or Latino; 96.60% in the tinnitus group and 93.62% in the control group.

Differences in insurance status were observed, with a higher percentage of tinnitus patients having public (51.17% vs. 45.85%; OR=1.238 (CI: 1.15, 1.33), p<.001) or private insurance (39.18% vs. 28.26%; OR=1.635 (CI: 1.52, 1.76), p<.001), fewer noted as self-paying (0.30% vs. 21.86%; OR=.011 (CI: .01, .02), p<.001) or having other forms of insurance (0.47% vs. 2.85%; OR=.159 (CI: .11, .24), p<.001), and more tinnitus patients with unknown insurance status (8.88% vs. 1.19%; OR=8.119 (CI: 6.35, 10.38), p<.001) compared to the control group. Overall, however, the vast majority of patients in groups, 90.9% of the tinnitus group and 77.0% of control patients, had some form of healthcare insurance.

Clinically, there were no statistically significant differences in BMI (30.56 vs 30.53) or blood pressure: systolic (128.05 vs 126.27 mmHg), diastolic (74.41 vs 75.50 mmHg) (Table 1). Despite the demographic and clinical similarity, consistent patterns of increased healthcare utilization were seen among individuals with tinnitus. Patients with tinnitus had a mean of 8.57 primary care consultations within the two years surrounding the tinnitus diagnosis compared to 1.04 visits for patients without tinnitus ($p < .001$). Similarly, tinnitus patients had a mean of 5.34 hospitalizations compared to 0.58 hospitalizations for patients without tinnitus ($p < .001$). Furthermore, patients diagnosed with tinnitus had a significant mean difference of 10.58 more new drug prescriptions and 23.02 more diagnoses of other conditions compared to individuals without tinnitus ($p < .001$) (Table 2).

Given the notably higher rate of any medical diagnosis in the tinnitus group as compared to the control group, further analysis was performed for the systems and disciplines involved in these diagnoses. Expectedly, there was a significantly greater likelihood of patients in the tinnitus group being seen for otolaryngologic disorders directly related to tinnitus, such as sensorineural hearing loss and hearing aid encounters, than the control group (OR=29.58 [CI: 25.98, 33.68], $p < .001$). Likewise, conditions such as temporomandibular joint disorders

which our otolaryngology practice commonly notes in association with tinnitus showed higher prevalence among the tinnitus group (OR=5.38 [CI: 3.63, 7.96], $p < .001$). Given that otolaryngologists, through review of systems and secondary chief complaints, would also likely identify tinnitus more commonly than other disciplines, we saw higher odds of having any otolaryngologic condition among the tinnitus cohort than in the controls (OR=8.99 [CI: 8.19, 9.87], $p < .001$). This included conditions such as chronic rhinitis, dizziness, dysphonia, and sinus disorders (Table 3).

Other medical conditions also saw greater prevalence among the tinnitus group as compared to controls. There was a significantly greater likelihood of having a cancer diagnosis within the 2-year period surrounding a tinnitus diagnosis than in those without tinnitus (OR=6.22 [CI: 5.50, 7.03], $p < .001$). Similarly, higher odds of cardiovascular disorders, pulmonary conditions, general gastroenterology problems, urologic disorders, and musculoskeletal disorders were noted (Table 3). Behavioral health issues are commonly noted in patients with troublesome tinnitus and, while there were higher odds of depression diagnoses among those with tinnitus, the odds were not as robust as that seen for other medical disorders (OR=4.35 [CI: 3.86, 4.89], $p < .001$).

Table 1: Baseline Demographics of Matched Individuals with and without Tinnitus Diagnosis.

	Tinnitus		Control		Odds Ratio	95% CI	P-value
Number of patients	6236		6236				
Mean Age	56.7	[47.75,67]	56.7	[47.75,67]			
Sex	N	%	N	%			
Male	2952	47.34%	2952	47.34%	1	(0.93, 1.07)	1
Female	3284	52.66%	3284	52.66%	1	(0.93, 1.07)	1
Race							
White or Caucasian	5347	85.74%	5347	85.74%	1	(0.90, 1.11)	1
Black or African American	584	9.36%	584	9.36%	1	(0.89, 1.13)	1
Other	118	1.89%	118	1.89%	1	(0.77, 1.29)	1
Asian	74	1.19%	74	1.19%	1	(0.72, 1.38)	1
Unknown	58	0.93%	58	0.93%	1	(0.69, 1.44)	1
American Indian or Alaska Native	21	0.34%	21	0.34%	1	(0.55, 1.83)	1
Patient Refused	17	0.27%	17	0.27%	1	(0.51, 1.96)	1
Multiracial	14	0.22%	14	0.22%	1	(0.48, 2.10)	1
Native Hawaiian or Other Pacific Islander	3	0.05%	3	0.05%	1	(0.20, 4.96)	1
Ethnicity							
Not Hispanic or Latino	6024	96.60%	5838	93.62%	1.94	(1.63, 2.30)	<.001
Hispanic or Latino	151	2.42%	209	3.35%	0.72	(0.58, 0.88)	<.01
Unknown	21	0.34%	104	1.67%	0.2	(0.12, 0.32)	<.001
Patient Refused	27	0.43%	22	0.35%	1.23	(0.70, 2.16)	0.567
Missing Data	13	0.21%	63	1.01%	0.21	(0.11, 0.37)	<.001
Insurance							
Public	3191	51.17%	2859	45.85%	1.24	(1.15, 1.33)	<.001
Private	2443	39.18%	1762	28.26%	1.64	(1.52, 1.76)	<.001
Self-pay	19	0.30%	1363	21.86%	0.01	(0.01, 0.02)	<.001
Other	29	0.47%	178	2.85%	0.16	(0.11, 0.24)	<.001
Unknown	554	8.88%	74	1.19%	8.12	(6.35, 10.38)	<.001

Table 2: Healthcare Utilization Among Individuals with Tinnitus Diagnosis Compared to Controls.

	Tinnitus		Control		P-value
	Mean	[0.25,0.75]	Mean	[0.25,0.75]	
Numerical					
Number of clinic visits	8.57	[2,12]	1.04	[0,0]	<.001
Number of hospitalizations	5.34	[0,5]	0.58	[0,0]	<.001
Medications +/- 1 year					
New medication in this time frame	12.89	[1,14]	2.31	[0,0]	<.001
Total number of medications	26.83	[5,36]	15.58	[2,18]	<.001
New medication after diagnosis (T0)	9.91	[0,10]	1.33	[0,0]	<.001
Diagnoses of Other Conditions					
Number of diagnoses	40.36	[14,54]	17.24	[4,21]	<.001

Table 3: Healthcare Utilization Among Individuals with Tinnitus Diagnosis Compared to Controls.

Category	Tinnitus (n)	Control (n)	Odds Ratio	95% CI	P-value
ENT Disorders Related to Hearing Loss or Tinnitus	3633	281	29.578	(25.98, 33.68)	<.001
ENT Disorders NOT Related to Hearing Loss or Tinnitus	3302	694	8.987	(8.19, 9.87)	<.001
Primary Care Wellness Visits	2801	589	7.818	(7.08, 8.63)	<.001
Cardiovascular/Cardiac/ Cerebrovascular	1292	216	7.283	(6.28, 8.45)	<.001
Rheum/Ortho/Misc	2263	464	7.086	(6.36, 7.89)	<.001
General Skin Care	1867	356	7.058	(6.26, 7.96)	<.001
Pulmonary	445	68	6.97	(5.39, 9.02)	<.001
Urology	1235	222	6.69	(5.77, 7.75)	<.001
Cancers	1653	342	6.216	(5.50, 7.03)	<.001
General GI	1855	430	5.717	(5.11, 6.39)	<.001
Disorders Associated with Tinnitus that ENT or Audiology May Check For	158	30	5.378	(3.63, 7.96)	<.001
Mood Disorders Associated with Worse Tinnitus	1408	392	4.348	(3.86, 4.89)	<.001

DISCUSSION

Higher healthcare utilization was observed among patients diagnosed with tinnitus when compared to controls. This U.S.-based study not only corroborates the findings of Rademaker et al. but also strengthens the correlation by developing an age, sex, and race matched control group. Although tinnitus symptoms are often mild, tinnitus patients tend to utilize healthcare services more frequently, which could be attributed to more severe symptoms, better access to medical services, a lower health status, or a combination of these factors⁸. This pattern was supported by our finding that patients diagnosed with tinnitus had a significantly greater number of primary care ambulatory visits compared to controls. This difference is more substantial than the findings of a study on U.S. veterans, which reported a mean of 2.9 visits to primary health care for those with tinnitus compared to a mean of 2.2 visits for veterans without tinnitus over a five-year period⁹. Moreover, our results are consistent with recent international research, indicating significantly increased primary care consultations among patients with tinnitus diagnoses⁷.

One aspect to consider is the patient complaint threshold in healthcare utilization patterns. Patients who have a lower threshold for evaluating their tinnitus symptoms may also have a decreased threshold for addressing other health issues. This pattern was demonstrated by the increased likelihood of diagnoses for non-urgent concerns such as general skin care. Raj-Koziak et al.

suggest that tinnitus patients may have a lower pain threshold following sound exposure, which could lead to increased healthcare-seeking behavior¹⁰. Numerous studies highlight a significant association between chronic pain and tinnitus, which suggests that these patients may have a lower threshold or heightened sensitivity, leading to increased healthcare utilization^{4,5,11}.

Differences in access to healthcare, particularly in terms of insurance coverage, can significantly impact the variations in healthcare utilization between tinnitus patients and controls. Patients diagnosed with tinnitus demonstrated a higher likelihood of having healthcare insurance (public and private) compared to controls. While this difference may impact our outcome measures, it should be noted that over 75% of both groups were insured, and thus the magnitude of difference in healthcare utilization would not be explained solely by insurance rates. Access to ambulatory care is crucial in evaluating tinnitus symptoms, and disparities in insurance coverage may exacerbate differences in healthcare utilization¹²⁻¹⁴. These findings highlight an association between insurance coverage and healthcare utilization patterns, which suggests that the true impact and prevalence of tinnitus may be greater than currently estimated.

In the context of comorbidities associated with tinnitus, our study found that patients diagnosed with this condition have a significant increase in new drug prescriptions. This correlation aligns with our observation of a higher prevalence of comorbidities among tinnitus patients.

Around the time of diagnosis, these patients also exhibited higher rates of hospitalizations, potentially due to the management of associated comorbidities such as cancer, cardiovascular, and pulmonary diseases. Our study identified a higher likelihood of having cancer diagnoses among the tinnitus group, aligning with studies that indicate a higher prevalence of hearing loss among U.S. adult cancer survivors¹⁵. Furthermore, tinnitus patients showed increased risk of cardiovascular and pulmonary comorbidities, which corresponds with observations by Friedland et. al regarding low-frequency hearing loss and risk of cardiovascular events as well as the HUNT study on long-term hearing loss related to Chronic Obstructive Pulmonary Disease (COPD)¹⁶⁻¹⁸. Major comorbidities may also contribute to stress-related exacerbation of tinnitus symptoms and management, consistent with observed correlations between tinnitus and mood disorders³. However, further research is needed to fully understand these complex relationships.

This study reveals a unique aspect of tinnitus care, as there are limited investigations on increased healthcare utilization in patients with tinnitus in primary care settings in the U.S. While this phenomenon has been infrequently reported in relation to cost of care, comorbidity prevalence, and other risk factors, the sparse existing literature highlights the importance of this report in expanding our understanding of potential healthcare needs and the burden of disease in this patient population.

Limitations of the study include a sample comprised of an adult population from a mid-west academic health system, limiting its national representation. Reliance on diagnosis codes may overlook individuals experiencing tinnitus in the control group without a formal diagnosis. In addition, the retrospective analysis limits control over exposure factors, precluding the establishment of causality. It also cannot be definitively concluded that patients sought care specifically for tinnitus, only that a tinnitus diagnosis was documented along with their higher overall healthcare utilization. Future investigation may include a deeper analysis of comorbidities and potential etiological links to tinnitus, analysis of referral data, and the inclusion of a larger U.S. cohort.

CONCLUSION

Patients diagnosed with tinnitus exhibit increased healthcare utilization across multiple domains, even when controlling for age, sex, and race. The role of a tinnitus diagnosis in the increased utilization of health resources is unclear with further study needed to identify whether the correlation represents access, patient threshold for complaint, or clinically correlated medical conditions.

REFERENCES

1. Käll A, Tammelin M. Validering av den svenska versionen av Tinnitus Functional Index (TFI-SE) som ett utfallsmått- en mixed-methods studie.2023.

2. National Institute on Deafness and Other Communication Disorders. Quick Statistics about Hearing. 2023.
3. Bhatt JM, Bhattacharyya N, Lin HW. Relationships between tinnitus and the prevalence of anxiety and depression. *Laryngoscope*. 2017;127(2):466-9.
4. Folmer RL, Griest SE, Martin WH. Chronic tinnitus as phantom auditory pain. *Indian J Otolaryngol Head Neck Surg*. 2001;124(4):394-400.
5. Tonndorf J. The analogy between tinnitus and pain: a suggestion for a physiological basis of chronic tinnitus. *Hear Res*. 1987;28(2-3):271-5.
6. Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics of tinnitus among US adults. *Am J Med*. 2010;123(8):711-8.
7. Rademaker MM, Stegeman I, Hooiveld M, Stokroos RJ, Smit AL. Patients with tinnitus use more primary healthcare compared to people without tinnitus. *Sci Rep*. 2021 Aug 27;11(1):17299..
8. Buczek W. Hospital utilization and expenditures in a Medicaid population. *Health Care Financ Rev*. 1989;11(1):35-47.
9. Carlson KF, Gilbert TA, O'Neil ME, Zaugg TL, Manning CA, Kaelin C, et al. Health care utilization and mental health diagnoses among veterans with tinnitus. *Am J Audiol*. 2019;28(1S):181-90.
10. Raj-Koziak D, Gos E, Kutyba J, Skarzynski H, Skarzynski PH. Decreased sound tolerance in tinnitus patients. *Life*. 2021;11(2):87.
11. Ausland JH, Engdahl B, Oftedal B, Steingrimsdóttir ÓA, Nielsen CS, Hopstock LA, et al. Tinnitus and associations with chronic pain: The population-based Tromsø Study (2015–2016). *PLoS One*. 2021;16(3):e0247880.
12. Narita RE. Consumption of Healthcare Services in the United States: The Impact of Health Insurance. *J Risk Financ Manag*. 2023;16(5):277.
13. Batts S, Stankovic KM. Tinnitus prevalence, associated characteristics, and related healthcare use in the United States: a population-level analysis. *Lancet Public Health*. 2024;29.
14. Min T, Yeo J, Lee YS, Kim SY, Lee D, Ha IH. Trends of medical service utilization for tinnitus: Analysis using 2010–2018 health insurance review and assessment service national patient sample data. *Int J Healthc*. 2022;10(8): 1547.
15. Wang Q, Jiang C, Wen C, Xie H, Li Y, Zhang Y, et al. Subjective and Objective Hearing Loss Among US Adult Cancer Survivors. *JAMA Otolaryngol Head Neck Surg*. 2023;149(12):1101-10.
16. Aarhus L, Sand M, Engdahl B. COPD and 20-year hearing decline: The HUNT cohort study. *Respir Med*. 2023;212:107221.
17. Biswas R, Genitsaridi E, Trpchevska N, Lugo A, Schlee W, Cederroth CR, et al. Low evidence for tinnitus risk factors: A systematic review and meta-analysis. *JARO*. 2023;24(1):81-94.
18. Friedland DR, Cederberg C, Tarima S. Audiometric pattern as a predictor of cardiovascular status: development of a model for assessment of risk. *Laryngoscope*. 2009;119(3):473-86.