



# Non-otologic Medical Conditions Associated with Hearing Loss and Tinnitus in Veterans

Leslie D. Grush, AuD<sup>1</sup>, Kelly M. Reavis, PhD, MPH<sup>1,2</sup>, Susan E. Griest, MPH<sup>1</sup>, Samrita Thapa, MPH<sup>1,3</sup>, Wendy J. Helt, MA<sup>1</sup>, James A. Henry, PhD<sup>1,3</sup>, Sarah M. Theodoroff, PhD<sup>1,3</sup>

<sup>1</sup>National Center for Rehabilitative Auditory Research, Portland, OR; <sup>2</sup>Oregon Health & Science University, OHSU-PSU School of Public Health, Portland, OR; <sup>3</sup>Oregon Health & Science University, Department of Otolaryngology/Head & Neck Surgery, Portland, OR



## Introduction

Hearing loss and tinnitus are common in Veterans, which is typically attributed to noise exposure during military service. However, non-otologic medical conditions are also known to contribute to auditory dysfunction. Associations between medical conditions and auditory dysfunction are currently not well described for young individuals or for Veterans. These associations may be especially important in Veterans, for whom chronic medical conditions are more prevalent<sup>1</sup>.

Data presented are from the NOISE (Noise Outcomes in Service members Epidemiology) study<sup>2</sup>, a longitudinal, epidemiologic study of relationships between military exposures and hearing health outcomes in Veterans and Service members. This analysis explores associations between comorbidities (count and specific disease) and auditory dysfunction in a sample of Veterans recently separated from military service.

## Methods

Cross-sectional analysis of 487 Veterans separated from military service (received DD-214 form) within ~2.5 years

### Exposures

Non-otologic physical health conditions self-reported on medical history questionnaire<sup>4</sup> (heart disease, high blood pressure, stroke, emphysema or asthma, arthritis/rheumatism, diabetes, thyroid problem, kidney disease, cancer, and sleep disorder)

Primary exposure: total comorbidity count; associations with individual comorbidities were also explored

### Outcomes

**Hearing loss (HL)** defined as pure tone average (PTA) >20 dB hearing level, averaged between ears, for the following frequency ranges:

- Low frequency (LF): 0.25, 0.5, 1, 2 kHz
- High frequency (HF): 3, 4, 6, 8 kHz
- Extended high frequency (Ext HF): 9, 10, 11.2, 12.5, 14, 16 kHz

**Tinnitus** determined by the Tinnitus Screener<sup>3</sup>

- Tinnitus: constant or intermittent tinnitus
- No tinnitus: occasional or temporary tinnitus, or no tinnitus

### Covariates

- Military noise exposure captured by Lifetime Exposure to Noise & Solvents Questionnaire<sup>5</sup> (LENS-Q)

- Additional covariates reported on demographic questionnaire, medical questionnaire, Blast and Traumatic Brain Injury (TBI) questionnaire<sup>6</sup>

### Statistical Analysis

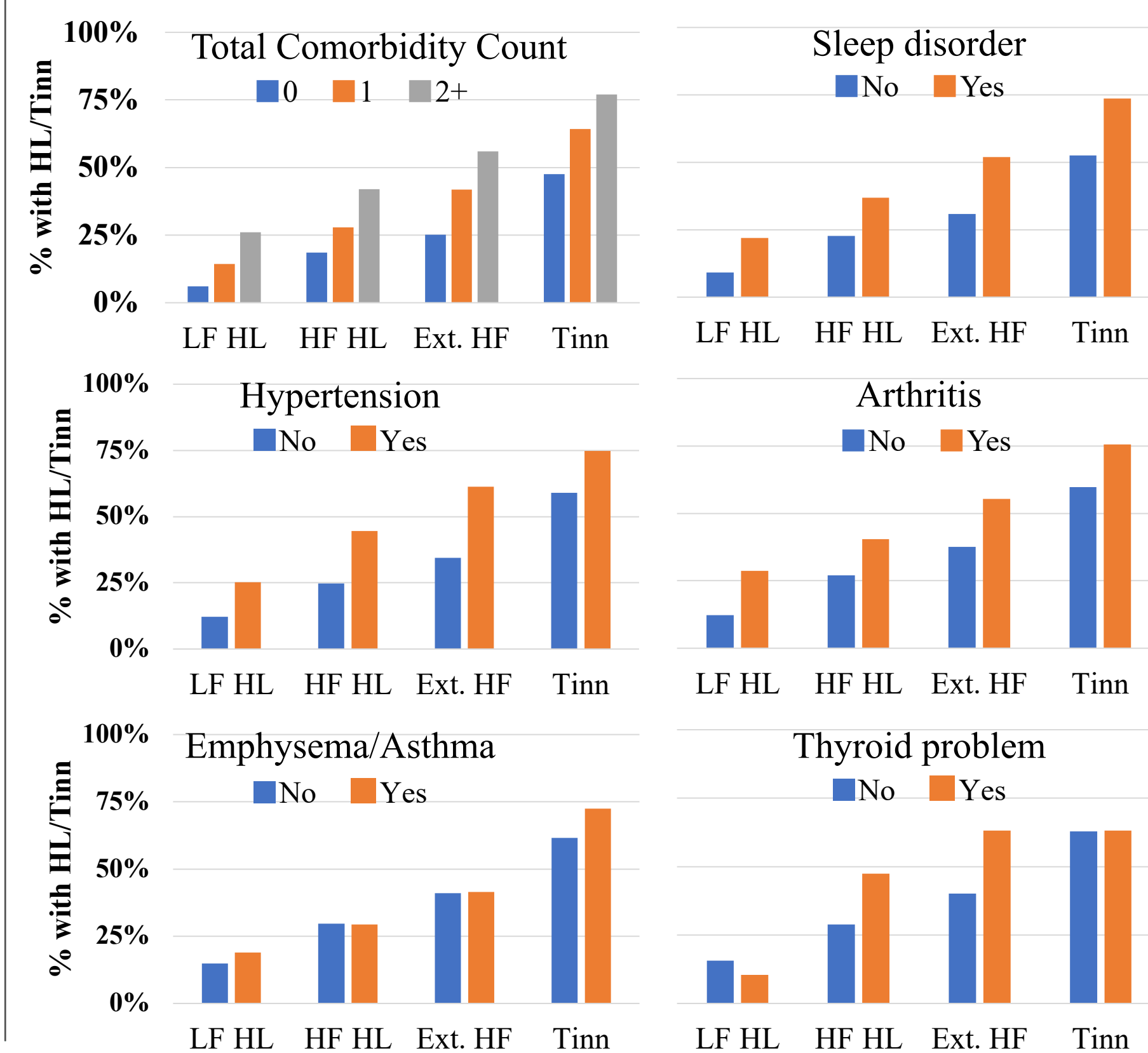
- Bivariable and multivariable logistic regression models were used to estimate odds ratios (OR) and 95% confidence intervals (CI).
- Minimally adjusted models included: age, gender, and military noise exposure.
- Fully adjusted models included the above and: race/ethnicity, education, marital status, smoking, alcohol disorder, and military characteristics (years of service, branch, blast, chemical exposure, and TBI severity)
- Results reported for medical conditions reported by >10 subjects.

## Results

### Sample Demographics

- Mean Age: 34.2 yrs
- Sex: 86% Male
- Branch: 52% Army
- Years of Service: 61% with <10 yrs
- Race/Ethnicity: 78% White, non-Hispanic

**Figure 1:** Percentage of subjects with LF, HF, Ext. HF HL, and tinnitus (Tinn) by total self-reported comorbidity count and by history of each medical condition.



**Table 1: Regressing auditory outcomes on comorbidity count.** OR and 95% CIs displayed. **Bold text** indicates statistically significant associations.

	Unadjusted	Minimally adjusted	Fully adjusted
<b>1 comorbidity</b>	OR (95% CI)	OR (95% CI)	OR (95% CI)
Tinnitus	<b>2.0 (1.3-3.1)</b>	<b>1.9 (1.2-3.1)</b>	1.6 (0.9-2.6)
LF HL	<b>2.6 (1.2-5.8)</b>	<b>2.5 (1.1-5.4)</b>	2.3 (1.0-5.3)
HF HL	1.7 (1.0-2.9)	1.5 (0.9-2.7)	1.4 (0.7-2.5)
Ext. HF HL	<b>2.1 (1.3-3.4)</b>	<b>2.2 (1.3-3.9)</b>	1.8 (1.0-3.5)
<b>2 or more comorbidities</b>			
Tinnitus	<b>3.7 (2.3-5.9)</b>	<b>3.5 (2.2-5.8)</b>	<b>2.4 (1.4-4.2)</b>
LF HL	<b>5.6 (2.7-11.5)</b>	<b>4.2 (2.0-8.9)</b>	<b>3.2 (1.4-7.4)</b>
HF HL	<b>3.3 (2.0-5.4)</b>	<b>2.0 (1.1-3.4)</b>	1.5 (0.8-2.7)
Ext. HF HL	<b>3.8 (2.4-6.1)</b>	<b>2.1 (1.2-3.6)</b>	1.4 (0.7-2.7)

**Table 2: Regressing auditory outcomes on individual comorbidities.** OR and 95% CIs displayed. **Bold text** indicates statistically significant associations.

	Unadjusted	Minimally adjusted
	OR (95% CI)	OR (95% CI)
<b>Sleep disorder</b>		
Tinnitus	<b>2.5 (1.7-3.7)</b>	<b>2.5 (1.7-3.8)</b>
LF HL	<b>2.8 (1.7-4.7)</b>	<b>2.5 (1.5-4.4)</b>
HF HL	<b>2.0 (1.3-3.0)</b>	1.6 (1.0-2.5)
Ext. HF HL	<b>2.4 (1.7-3.5)</b>	<b>2.1 (1.4-3.4)</b>
<b>Hypertension</b>		
Tinnitus	<b>2.1 (1.3-3.3)</b>	<b>1.8 (1.1-3.0)</b>
LF HL	<b>2.4 (1.4-4.1)</b>	1.7 (0.9-2.9)
HF HL	<b>2.4 (1.6-3.8)</b>	1.3 (0.8-2.2)
Ext. HF HL	<b>3.0 (2.0-4.6)</b>	1.3 (0.8-2.2)
<b>Arthritis/rheumatism</b>		
Tinnitus	<b>2.1 (1.2-3.5)</b>	<b>2.0 (1.2-3.5)</b>
LF HL	<b>2.9 (1.7-5.0)</b>	<b>2.4 (1.4-4.3)</b>
HF HL	<b>1.8 (1.2-2.9)</b>	1.3 (0.8-2.2)
Ext. HF HL	<b>2.1 (1.3-3.2)</b>	1.2 (0.7-2.1)
<b>Emphysema or asthma</b>		
Tinnitus	1.6 (0.9-3.0)	1.7 (0.9-3.1)
LF HL	1.3 (0.7-2.7)	1.4 (0.7-2.9)
HF HL	1.0 (0.5-1.8)	1.1 (0.5-2.1)
Ext. HF HL	1.0 (0.6-1.8)	1.2 (0.6-2.3)
<b>Thyroid problem</b>		
Tinnitus	1.0 (0.4-2.6)	1.0 (0.4-2.6)
LF HL	0.6 (0.1-2.8)	0.4 (0.1-2.0)
HF HL	2.2 (0.9-5.6)	1.7 (0.6-5.0)
Ext. HF HL	2.6 (1.0-6.6)	1.8 (0.5-5.9)

## Discussion

We found greater auditory dysfunction among Veterans with non-otologic comorbidities compared to Veterans without comorbidities while controlling for important potential confounders, including noise exposure.

- Compared to Veterans without any comorbid health conditions, Veterans with two or more comorbid conditions were **three times as likely** to have low frequency hearing loss and greater than **twice as likely** to report tinnitus
- Borderline significant associations were found for reporting one comorbid condition and low and extended high frequency hearing loss
- Sleep disorder, hypertension, and arthritis were associated with tinnitus; sleep disorder and arthritis were associated with hearing loss

Findings suggest it may be appropriate for Veterans with non-otologic comorbidities to have an audiologic evaluation. Future work is needed to determine if these associations are also found in Service members and to examine longitudinal data to assess stability of associations over time.

## References

- 1) Schult TM, Schmunk SK, Marzolf JR, Mohr DC. (2019). The health status of Veteran employees compared to civilian employees in Veterans Health Administration. *Military Medicine*, 184(7-8), e218-e224.
- 2) Henry JA, Griest S, Reavis KM, et al. (2020; e-pub ahead of print). Noise Outcomes in Servicemembers Epidemiology (NOISE) Study: Design, methods, and baseline results. *Ear Hear*.
- 3) Henry JA, Griest S, Austin D, et al. (2016). Tinnitus Screener: Results from the first 100 participants in an epidemiology study. *Am J Audiol*, 25(2):153-160.
- 4) Johnson RM. The masking of tinnitus. In: Vernon JA, ed. *Tinnitus Treatment and Relief*. Needham Heights: Allyn & Bacon; 1998:164-186.
- 5) Griest SE, Bramhall NF, Reavis KM, et al. (2021; in press). Development and initial validation of the Lifetime Exposure to Noise and Solvents Questionnaire (LENS-Q) in US Service members and Veterans. *Am J Audiol*.
- 6) Department of Veterans Affairs, Veterans Health Administration. (2010, March 8). *Screening and Evaluation of Possible Traumatic Brain Injury in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) Veterans*. [https://www.va.gov/optometry/docs/VHA\\_Directive\\_2010-012\\_Screening\\_and\\_Evaluation\\_of\\_Possible\\_TBI\\_in\\_OEF-OIF\\_Veterans.pdf](https://www.va.gov/optometry/docs/VHA_Directive_2010-012_Screening_and_Evaluation_of_Possible_TBI_in_OEF-OIF_Veterans.pdf)

## Acknowledgements

The U.S. Army Medical Research Acquisition Activity, 820 Chandler Street, Fort Detrick MD 21702-5014 is the awarding and administering acquisition office. Work supported by the Office of the of Defense, the Assistant Secretary of Defense for Health Affairs, Joint Warfighter Medical Research Program (W81XWH-17-1-0020) and a U.S. Department of VA RR&D Research Career Scientist Award (#C9247S). This material is the result of work supported with resources and the use of facilities at the VA RR&D NCRAR (#C9230C) at the VAPORHCS. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the Department of the Army, Department of Defense, Department of Veterans Affairs, or the U.S. Government. Poster presented at the American Auditory Society Annual Meeting (online), March 5, 2021.