



U.S. Department of Veterans Affairs

Veterans Health Administration

Office of Research & Development

Epidemiology of Comorbid Hearing Loss and Tinnitus in a Military Population: Findings from the NOISE Study

James Schultz^{1,2}, Leah Barger^{1,2}, Samrita Thapa^{3,4}, Hannah Famili², Kaylani Abejar², Kelly Reavis^{3,4}

¹DoD Hearing Center of Excellence (HCE), Defense Health Agency, San Antonio, Texas

²The Geneva Foundation, Tacoma, Washington, 98402

³VA RR&D National Center for Rehabilitative Auditory Research (NCRAR), Veterans Affairs Portland Health Care System, Portland, Oregon, USA

⁴OHSU-PSU School of Public Health, Oregon Health & Science University, 3181 S.W. Sam Jackson Park Road, Portland, Oregon, USA, 97239



Introduction

Hearing loss (HL) and tinnitus are two of the most prevalent service-connected disabilities among U.S. military Veterans¹. Compared to civilians, military members have greater risk of HL and tinnitus due to occupational risk factors, including noise and chemical exposures. Though HL and tinnitus share common associated risk factors and have been correlated with adverse effects on overall well-being, few studies have explored the effects of comorbid HL and tinnitus compared to either condition alone. The Noise Outcomes in Servicemembers Epidemiology (NOISE) study is a multi-site longitudinal epidemiologic study that explores the impacts of military exposures on auditory function in Service members and Veterans over time.

Purpose: To measure the independent and comorbid prevalence and effects of HL and tinnitus on hearing outcomes in NOISE study participants.

Methods

Participants: n=987

- 441 active-duty Service members and 546 Veterans were recruited from two NOISE study sites
- Extensive audiometric and questionnaire data were collected for each participant

Exposure: Presence of Tinnitus and HL

- Hearing loss (yes/no): indicated if Pure Tone Average (PTA) ≥ 20 dB HL in both ears for any of the following groups:
 - Low frequencies (0.25, .5, 1, 2 kHz)
 - High frequencies (3, 4, 6, 8 kHz)
 - Extended high frequencies (9, 10, 11.2, 14 and 16 kHz)

Presence of tinnitus (yes/no) indicated by the Tinnitus Screener (TS) questionnaire³.

Participants placed into one of four exposure groups: 1) No tinnitus or HL, (NTHL), 2) tinnitus only (TO), 3) hearing loss only (HLO); or 4) comorbid tinnitus and HL (THL)

Outcomes: Questionnaires of auditory function and general disability included:

- Speech, Spatial and Qualities of Hearing Scale 12 (SSQ-12)⁴
- Hearing Handicap Inventory for Adults (HHIA) (yes/no)⁵
 - Hearing difficulty = score >18
- World Health Organization Disability Assessment Schedule (WHODAS 2.0)⁶

Results

Table 1: Participant characteristics by exposure groups for Service members and Veterans.

Service Members	NTHL	TO	HLO	THL	All
	n (%)	n (%)	n (%)	n (%)	n
Sex					
Men	108 (36.6)	53 (18)	50 (16.9)	84 (28.5)	295
Women	71 (48.6)	17 (11.6)	43 (29.5)	15 (10.3)	146
Age					
18-29	88 (59.9)	35 (23.8)	10 (6.8)	14 (9.5)	147
30-39	76 (42.7)	27 (15.2)	37 (20.8)	38 (21.3)	178
40+	15 (12.9)	8 (6.9)	46 (39.7)	47 (40.5)	116
Total	179 (41)	70 (16)	93 (21)	99 (22)	441
Veterans					
	NTHL	TO	HLO	THL	All
	n (%)	n (%)	n (%)	n (%)	n
Sex					
Men	113 (24.5)	124 (56.9)	65 (14.1)	160 (34.6)	462
Women	35 (41.7)	18 (21.4)	13 (15.5)	18 (21.4)	84
Age					
18-29	95 (43)	90 (40.7)	9 (4.1)	27 (12.2)	221
30-39	43 (27.4)	41 (26.1)	26 (16.6)	47 (29.9)	157
40+	10 (6)	11 (6.5)	43 (25.6)	104 (61.9)	168
Total	148 (27)	142 (26)	78 (14)	178 (33)	546

Figure 1: Results of logistic regression model for HHIA outcomes presented as odds ratio (filled circle) and 95% confidence interval (CI) (gray bar) for each exposure group (THL, HLO, TO) compared to the referent group (NTHL) for Service members and Veterans. Positive values suggest increased odds among those in the exposure groups compared to those without tinnitus and hearing loss. Results were adjusted for age and sex.

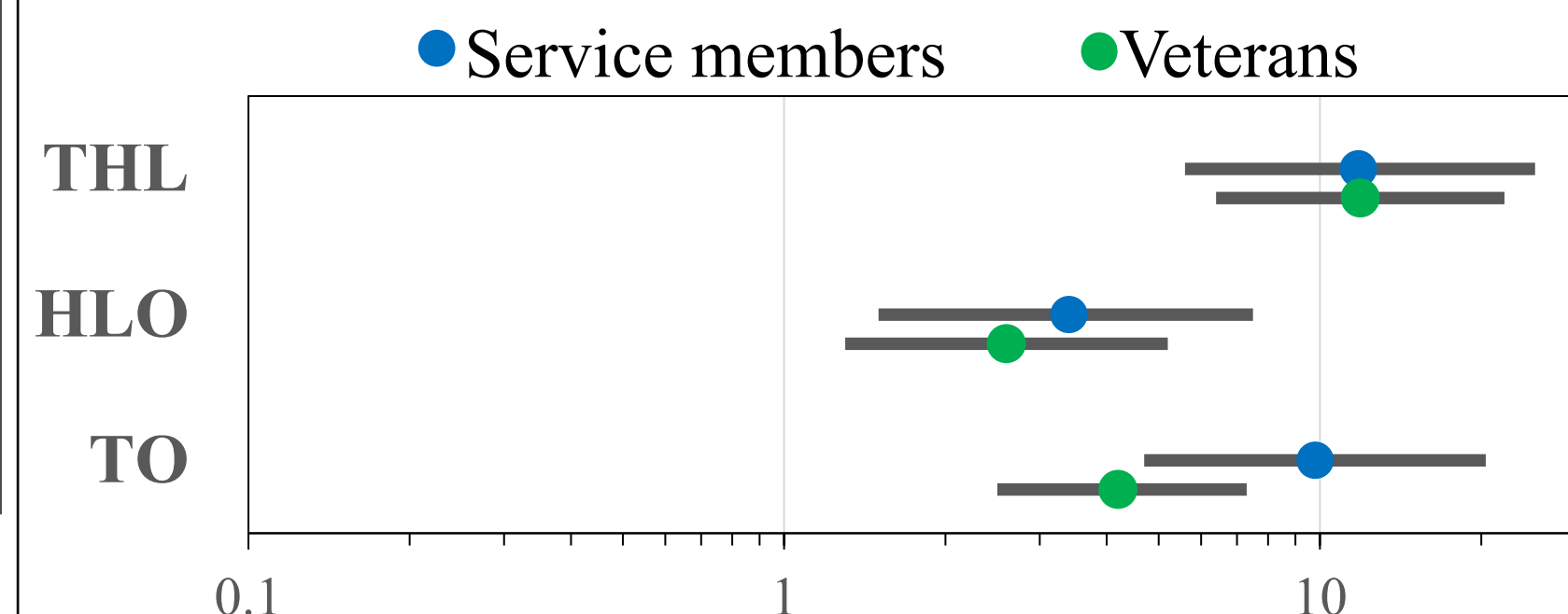


Table 2. Results of the regression models for SSQ-12 (including subscales) and WHODAS 2.0 presented as the parameter estimate, standard error (SE) and lower and upper 95% CI. NTHL exposure group was used for reference. The SSQ and WHODAS2.0 estimates can be interpreted as the mean difference in scores between those with tinnitus, HL or both and those who have neither. In the SSQ, lower scores indicate greater disability and in the WHODAS, greater scores indicate greater disability. Scores were adjusted for age and gender. Bold type indicates statistical significance.

Service members	Estimate	CI Lower	CI Upper
SSQ Total Score	TO	-1.4	-1.8
	HLO	-0.7	-1.2
	THL	-2.0	-2.5
SSQ Speech understanding subscale	TO	-1.7	-2.3
	HLO	-0.6	-1.2
	THL	-2.4	-3.0
SSQ Spatial aspects subscale	TO	-1.0	-1.5
	HLO	-0.7	-1.2
	THL	-1.6	-2.1
SSQ Sound quality subscale	TO	-1.3	-1.8
	HLO	-1.0	-1.5
	THL	-1.8	-2.3
WHODAS 2.0	TO	10.5	7.2
	HLO	4.2	0.9
	THL	9.3	6.0
Veterans			
	Estimate	CI Lower	CI Upper
SSQ Total Score	TO	-1.0	-1.5
	HLO	0.5	-1.1
	THL	-1.8	-2.3
SSQ Speech understanding subscale	TO	-1.1	-1.6
	HLO	-0.3	-1.0
	THL	-2.0	-2.6
SSQ Spatial aspects subscale	TO	-0.9	-1.4
	HLO	-0.6	-1.3
	THL	-1.7	-2.3
SSQ Sound quality subscale	TO	-1.0	-1.5
	HLO	-0.6	-1.2
	THL	-1.7	-2.2
WHODAS 2.0	TO	6.0	2.2
	HLO	3.2	-1.6
	THL	11.7	7.6

Discussion

- HL and tinnitus were both more prevalent in Veterans than in Service members
- Among both Service members and Veterans, most participants with hearing loss had comorbid tinnitus
- THL groups generally yielded the poorest SSQ, HHIA and WHODAS 2.0 outcomes among Service members and Veterans compared to HL or tinnitus alone
 - One exception appeared in the WHODAS 2.0 scores where the TO group reported worse scores than the THL group in Service members.
- Service members and Veterans with tinnitus only (TO) generally had poorer outcomes than those with HL only (HLO)
- Future research is needed to determine if tinnitus distress, severity and outcomes vary based on the severity and/or configuration of comorbid HL.
- Future studies could also inform causal factors associated with HL and tinnitus comorbidity.

References and Acknowledgements

- Veteran's Benefits Administration, 2021 (https://www.benefits.va.gov/REPORTS/abr/docs/2021_compensation.pdf)
- Henry J.A., Griest S.E., Blankenship C., Thielman E.J., Theodoroff S.M., Hammill T., Carlson K.F., Impact of Tinnitus on Military Service Members, *Military Medicine*, Volume 184, Issue Supplement_1, March-April 2019.
- Henry JA, Griest S, Austin D, Helt W, Gordon J, Thielman E, Theodoroff SM, Lewis MS, Blankenship C, Zaugg TL, Carlson K. Tinnitus Screener: Results From the First 100 Participants in an Epidemiology Study. *Am J Audiol*. 2016 Jun 1;25(2)
- Gatehouse S, Noble W. The Speech, Spatial and Qualities of Hearing Scale (SSQ). *Int J Audiol*. 2004 Feb;43(2)
- Newman CW, Weinstein BE, Jacobson GP, Hug GA. Test-retest reliability of the hearing handicap inventory for adults. *Ear Hear*. 1991 Oct;12(5):355-7
- Ustun TB, Chatterji S, Kostanjsek N, et al. Developing the World Health Organization Disability Assessment Schedule 2.0. *Bulletin of the World Health Organization*. 2010;88(11):815-823.

This work was supported by a Department of Defense Congressionally Directed Medical Research Program Investigator-Initiated Research Award (#PR121146), a Joint Warfighter Medical Research Program Award (#JW160036), and a U.S. Department of Veterans Affairs Rehabilitation Research and Development Service Research Career Scientist Award (#C9247S). This material is the result of work supported with resources and the use of facilities at the VA Rehabilitation Research and Development National Center for Rehabilitative Auditory Research (VA RR&D NCRAR Center Award; #C9230C) at the VA Portland Health Care System in Portland, Oregon, as well as the Department of Defense, Hearing Center of Excellence in San Antonio, Texas. These contents do not necessarily represent the views of the U.S. Department of Veterans Affairs, Department of Defense, or the United States Government. Poster presented at the Joint Defense Veterans Audiology Conference, March 6-8, Las Vegas, NV

