

Multimorbid Military TBI, PTSD, and Tinnitus in a Veteran Cohort

Kelly M Reavis PhD^{1,2}, Leslie Grush AuD¹, James A Henry PhD^{1,3}, Sarah M Theodoroff PhD^{1,3}, Wendy Helt MA¹, Anneka Sonstroem BA³, Kathleen Carlson PhD^{1,2,4}

¹VA RR&D, National Center for Rehabilitative Auditory Research, VA Portland Health Care System, Portland, OR, ²OHSU-PSU School of Public Health, OR Health & Science University, Portland, OR, ³Department of Otolaryngology, OR Health & Science University, Portland, OR, ³DoD Hearing Center of Excellence, Defense Health Agency, San Antonio, TX, ⁴VA HSR&D, Center to Improve Veteran Involvement in Care, VA Portland Health Care System, Portland, Oregon

Introduction

- Traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) are prevalent conditions among military Veterans
- Separately, TBI and PTSD are associated with tinnitus
- Q1:** Is the combined presence of TBI & PTSD associated with greater prevalence of tinnitus than either condition alone?
- TBI, PTSD, and tinnitus are associated with poorer functional outcomes
- Q2:** To what extent does the co-occurrence of TBI and PTSD affect functioning among individuals with tinnitus?

Methods

Participants (n=597)

- Veterans enrolled in the Noise Outcomes In Service members Epidemiology (NOISE) study¹

Exposure

- Military TBI history defined using American Congress of Rehabilitation Medicine criteria²
- PTSD defined using the Primary Care-PTSD-4 screening questionnaire³

Q1. Outcome

- Tinnitus defined using the Tinnitus Screener⁴
 - Lasting longer than 2-3 minutes
 - Always or frequently present

Q2. Functional Outcome

- Tinnitus impacts on daily living activities
- WHO Disability Assessment Schedule (WHODAS)⁵
 - higher score = greater disability

Statistical Analysis

- Q1.** Individual and joint effects of TBI and PTSD on the prevalence of tinnitus were examined using logistic regression - multiplicative and additive interactions
- Q2.** Descriptive analysis reporting counts and percentages (categorical data) or median and interquartile range (continuous data)

Results (Q1) – Independent and Joint Associations of TBI and PTSD on Tinnitus

Study Sample

- 85% men
- 71% non-Hispanic white
- 71% age between 18-39
- 40% deployed 2+ times

Exposure

- Neither TBI nor PTSD (n=310) 52%
- TBI Only (n=65) 11%
- PTSD Only (n=132) 22%
- Both TBI and PTSD (n=90) 15%

Outcome: Tinnitus prevalence 58% (349/597)

Table 1. Multivariable logistic regression model results

	Total n	Tinnitus		Multivariable Model† OR (95% CI)
		Yes n (%)	No n (%)	
No TBI or PTSD	310	143 (46%)	167 (54%)	Ref
TBI Only	65	46 (71%)	19 (29%)	2.3 (1.2-4.4)
PTSD Only	132	84 (64%)	48 (36%)	2.1 (1.3-3.3)
TBI and PTSD	90	76 (84%)	14 (16%)	5.2 (2.7-10.3)

†Model adjusted for sex, age, race/ethnicity, marital status, education, service branch, component and duration, blast, and number of deployments.

Results (Q2) – Multimorbid TBI and PTSD on Functioning among Veterans with Tinnitus

Table 2. Functional outcomes among those with tinnitus. Data are counts and percentages unless noted otherwise. Bold font indicates noteworthy increase in prevalence of difficulty compared to tinnitus only.

Functional Outcome (Impacts of tinnitus on...)		Tinnitus Only (n=143)	TBI & Tinnitus (n=46)	PTSD & Tinnitus (n=84)	TBI, PTSD, & Tinnitus (n=76)	Total (n=349)
		n (%)	n (%)	n (%)	n (%)	n (%)
Change Jobs	NO	138 (96.5)	44 (97.8)	80 (98.8)	71 (94.7)	333 (96.8)
	YES	5 (3.5)	1 (2.2)	1 (1.2)	4 (5.3)	11 (3.2)
Change Lifestyle	NO	108 (75.5)	30 (66.7)	63 (77.8)	49 (65.3)	250 (72.7)
	YES	35 (24.5)	15 (33.3)	18 (22.2)	26 (34.7)	94 (27.3)
Frequent Rests	NO	135 (94.4)	41 (91.1)	68 (84.0)	61 (81.3)	305 (88.7)
	YES	8 (5.6)	4 (8.9)	13 (16.0)	14 (18.7)	39 (11.3)
Reduced Time	NO	132 (92.3)	40 (88.9)	66 (81.5)	56 (74.7)	294 (85.5)
	YES	11 (7.7)	5 (11.1)	15 (18.5)	19 (25.3)	50 (14.5)
Accomplish less	NO	125 (87.4)	38 (84.4)	64 (79.0)	53 (70.7)	280 (81.4)
	YES	18 (12.6)	7 (15.6)	17 (21.0)	22 (29.3)	64 (18.6)
Not careful	NO	130 (90.9)	42 (93.3)	65 (80.2)	50 (66.7)	287 (83.4)
	YES	13 (9.1)	3 (6.7)	16 (19.8)	25 (33.3)	57 (16.6)
Limited work	NO	128 (89.5)	42 (93.3)	69 (85.2)	55 (73.3)	294 (85.5)
	YES	15 (10.5)	3 (6.7)	12 (14.8)	20 (26.7)	50 (14.5)
Difficulty performing work	NO	120 (83.9)	30 (66.7)	59 (72.8)	39 (52.0)	248 (72.1)
	YES	23 (16.1)	15 (33.3)	22 (27.2)	36 (48.0)	96 (27.9)
Need assistance	NO	135 (94.4)	38 (84.4)	70 (86.4)	64 (85.3)	307 (89.2)
	YES	8 (5.6)	7 (15.6)	11 (13.6)	11 (14.7)	37 (10.8)
WHODAS median, interquartile range		7.6 (2.1-16.0)	12.5 (6.3 - 22.9)	22.8 (11.8 - 31.3)	27.1 (18.8-37.5)	15.3 (5.6 – 27.1)

Discussion

- Both history of probable TBI and a positive screen for PTSD were independently associated with tinnitus
- Weak additive interaction
 - May correspond to biologic synergy
- Interventions targeting TBI and/or PTSD treatment may reduce the number of individuals with tinnitus
- Descriptively, compared to individuals with only tinnitus, those with positive screen for PTSD and tinnitus reported difficulty across a range of functional outcomes
- High percentage (25-48%) of individuals with probable TBI, positive screen for PTSD, and tinnitus report functional limitations/difficulties

Interdisciplinary approach involving audiologists and mental health providers is warranted to best meet the complex needs of Veterans with multimorbid military TBI, PTSD, and tinnitus.

References

- Henry JA, Griest S, Reavis KM, Grush L, Theodoroff SM, Young S, Thielman EJ, Carlson KF (2021). Noise Outcomes in Servicemembers Epidemiology (NOISE) study: Design, methods, and baseline results. *Ear and Hearing*, 42(4), 870-85.
- The Management of Concussion/mTBI Working Group (2009). VA/DoD Clinical Practice Guideline for Management of Concussion/Mild Traumatic Brain Injury (mTBI). http://www.healthquality.va.gov/guidelines/Rehab/mtbi/concussion_mtbi_full_1_0.pdf
- Prins A, Ouimette P, Kimerling R, Cameron RP, Hugelshofer DS, Shaw-Hegwer J... Sheikh JI (2003). The primary care PTSD screen (PC-PTSD): Development and operating characteristics. *Primary Care Psychiatry*, 9(1), 9-14.
- Henry JA, Griest S, Austin D, Helt W, Gordon J, Thielman E, ... Carlson K (2016). Tinnitus Screener: Results From the First 100 Participants in an Epidemiology Study. *American Journal of Audiology*, 25(2), 153-160.
- Ustun TB, Chatterji S, Kostanjsek N, Rehm J, Kennedy C, Epping-Jordan E... Pull C (2010). Developing the World Health Organization Disability Assessment Schedule 2.0. *Bulletin of the World Health Organization*, 88(11), 815-823.

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, Scottsdale, AZ February 24-26, 2022.