NOISE EXPOSURE AND HEARING PROTECTION BEHAVIORS IN NASHVILLE'S LIVE-MUSIC DISTRICT

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BACKGROUND

- No safety standards exist for recreational noise exposure, unlike occupational settings.
- Music venues often exceed 100 dBA for hours, surpassing the 15-minute occupational exposure limit at that level.
- On Nashville's Lower Broadway, peak levels up to 131 dBA have been recorded, capable of causing permanent hearing damage.
- Hearing protection (earplugs) can prevent noise-induced hearing loss (NIHL).
- However, only 8% of U.S. adults report consistent earplug use at entertainment venues.

AIM

- To understand patrons' on-site estimates of noise levels and safe exposure times with simultaneous sound measurement in music venues.

Hypotheses:

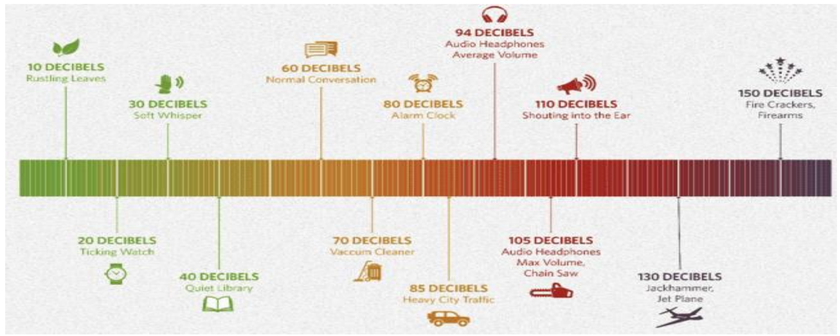
- A decibel chart educational tool (Figure 1) would improve the accuracy of noise level estimation.
- Patterns of music venue engagement would be associated with hearing protection behaviors.

METHODS

- We surveyed adult patrons on Lower Broadway in Nashville, TN:

(1) NOISE LEVELS	(2) SAFE EXPOSURE DURATION	(3) MUSIC LEVEL ATTITUDES
Loudness in dB scale & Loudness in Likert scale	Duration in minutes	Perception of loudness & Ideal music volume
(5) HEARING SYMPTOMS	**(4) HEARING PROTECTION BEHAVIORS**	**(6) EARPLUG DISTRIBUTION**
Frequency & Specification	Frequency & Specification	Receptiveness to free earplugs

Figure 1: Decibel chart educational tool



RESULTS

70 participants total (median age = 28 yrs, 46.5% female, 64% consumed alcohol). Median recorded sound levels of 95 dBA Leq.

(1) NOISE LEVELS
Median decrease of 20.0 dBA in absolute error between estimated and actual noise level after educational tool (p<00001) (Table 1).

(2) SAFE EXPOSURE DURATION
Nonsignificant trend of overestimating safe exposure duration at 95dBA by 10.4 minutes (IQR:-49 to 330, p=0.066

(3) MUSIC LEVEL ATTITUDES
68% rated volume on Lower Broadway as loud. 77% believed volume would affect hearing. 61% did not believe music venues should reduce maximum volume.

(5) HEARING SYMPTOMS
65% reported hearing issues after music venue attendance. Most common symptoms were ringing in the ears and muffled hearing.

(4) HEARING PROTECTION BEHAVIORS
75% reported never using earplugs at music venues. Frequent attendees (>1/month) had significantly higher odds of prior earplug use (aOR: 6.33, 95% CI: 1.27-31.62) (Figure 3).

(6) EARPLUG DISTRIBUTION
43% accepted free earplugs when offered. Most common reason for refusal was perceived lack of need. Univariable analysis found significant predictors (Figure 2).

Table 1: Effect of Educational Intervention on Noise Estimation

	Median Difference (IQR)	P-value
Noise Level Perception Error Before Education	-14.50 (-80 to 5.75)	0.030
Noise Level Perception Error After Education	3.50 (-10.75 to 16.50)	0.119
Absolute Reduction in Noise Level Estimation Error After Education	20.00 (0.00 to 70.00)	**<0.00001**

Figure 2: Univariable Analysis of Predictors for Free Earplug Acceptance

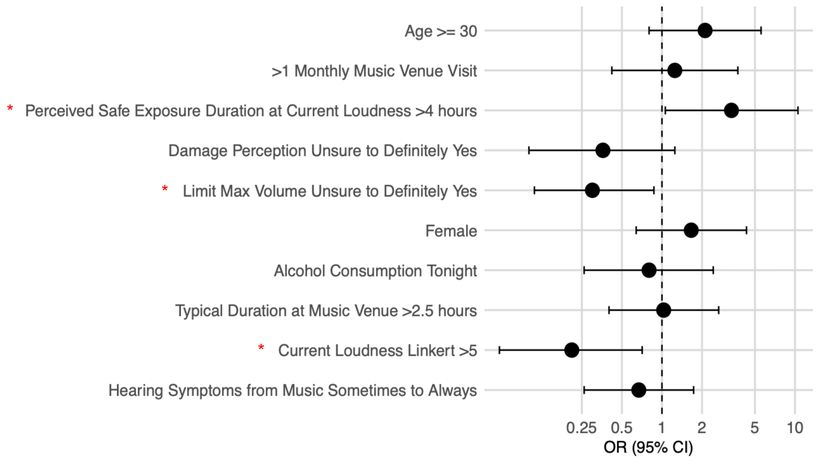
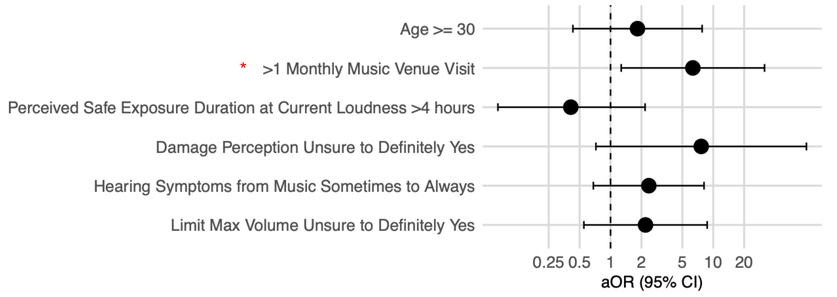


Figure 3: Multivariable Analysis of Predictors for Prior Earplug Use



DISCUSSION

- Lower Broadway noise level consistent with music venues across the globe but lower than previously reported for Broadway venues.
- Many patrons are at increased risk for NIHL due to increased exposure time.
- Educational tool increased accuracy in estimating noise.
- Despite recognizing loud noise levels and hearing loss symptoms, most patrons preferred loud volumes and did not use hearing protection.

Limitations to our study include:

- Measurement errors from smartphone application.
- Reliability bias from unvalidated survey items.
- Social desirability and recall bias from self-reported responses.
- Selection bias as participation was based on convenience.
- Limited generalizability from small sample size and single geographic setting.

This project demonstrates the potential for on-site tools in recreational settings that balance autonomy and safety to increase awareness.

REFERENCES

NIOSH. *Criteria for a Recommended Standard: Occupational Noise Exposure Revised Criteria 1998.* Cincinnati, OH: DHHS (NIOSH) Publication No. 98-126; 1998.

Beach EF, Gilliver M, Williams W. A snapshot of young adults' noise exposure reveals evidence of "binge listening." *Appl Acoust.* 2014; 77:71-75. doi:10.1016/j.apacoust.2013.10.004

Tittman SM, Yawn RJ, Manzoor N, Dedmon MM, Haynes DS, Rivas A. No shortage of decibels in Music City: Evaluation of noise exposure in urban music venues. *Laryngoscope.* 2021; 131(1):25-27. doi:10.1002/lary.28556

Eichwald J, Scinicariello F, Telfer JL, Carroll YI. Use of personal hearing protection devices at loud athletic or entertainment events — United States, 2018. *MMWR Morb Mortal Wkly Rep.* 2018; 67(41):1151-1155. doi:10.15585/mmwr.mm6741a4

American Academy of Otolaryngology–Head and Neck Surgery. *Block Out the Noise.* Published 2025. Accessed September 8, 2025. https://www.entnet.org/about-us/campaigns/better-hearing-speech-month/block-out-the-noise/