

INTRODUCTION

Recreational sound exposure through personal listening devices (PLDs) is a public health concern for adolescents, particularly with prolonged listening at high levels (*Vogel et al., 2007; Dillard et al., 2022*).

Conventional pure tone audiometry (PTA; 0.25–8 kHz) may not detect all early auditory changes. Extended high frequency (EHF) audiometry and otoacoustic emissions (OAEs) assess higher frequency thresholds and cochlear outer hair cell function, respectively (*Hoth and Baljić, 2017; Lough and Plack, 2022*).

Variation in assessment methods and outcomes leaves uncertainty about the most sensitive approach for detecting early changes in adolescent PLD users.



Over 1 billion

Young people aged 12–35 are at risk of hearing loss from unsafe listening.

WHO, 2019

RESULTS

5

Studies were included
3 cross sectional
1 case control
1 systematic review

4

Primary studies assessed PTA and EHF

1

Primary study assessed OAEs

PTA
Mixed findings

Abnormal thresholds were similar in users and non-users: **14.9% vs 13.0%** (p = 0.8802; Sulaiman et al., 2015). Kumar et al. (2017) found differences at **3, 4 and 6 kHz** (p < 0.05). Mourad (2020) reported normal conventional thresholds.

EHF
More consistent threshold elevations

Higher exposure was associated with elevated thresholds at **11.2, 12.5, 14 and 16 kHz** (Sulaiman et al., 2015). Kumar et al. (2017) reported differences across **9–16 kHz**. EHF elevations were also reported by Sulaiman et al(2013), Mourad (2020) and Jiang et al. (2016).

OAEs
Reduced amplitudes despite normal PTA

One primary study assessed TEOAEs. Amplitudes were lower in PLD users (**p < 0.05**) despite normal conventional thresholds; emission presence did not differ significantly (Mourad, 2020). **Secondary evidence:** The included systematic review also reported EHF threshold elevations and reduced OAE amplitudes (Jiang et al., 2016).

Exposure measurement
Exposure was mainly self-reported. Two studies also measured listening output objectively (Sulaiman et al., 2013; 2015).

Assessment gap
No primary study included ABR or speech-in-noise testing, limiting assessment of neural and functional outcomes.

BEYOND THE CONVENTIONAL AUDIOGRAM

EHF audiometry and OAEs provided additional information beyond PTA. Variation in testing protocols and outcomes prevented a firm conclusion about the most sensitive method.

CONCLUSION

EHF threshold elevations and reduced OAE amplitudes were reported despite normal conventional thresholds, suggesting that PTA alone may underestimate early auditory changes associated with PLD exposure.

Next steps
Track change over time
Longitudinal adolescent studies with objectively measured listening exposure.

Standardise EHF for clinical use
Improve consistency in EHF testing protocols and reference values to support clinical interpretation and evaluate its role in early detection.

Safe listening education remains an important prevention priority (Vogel et al., 2007)

REFERENCES:

Arksey, H. and O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, **8**(1), 19–32.

Critical Appraisal Skills Programme (2018). *CASP checklists*. Available at: <https://casp-uk.net/casp-tools-checklists/>

Dillard, L.K. et al. (2022). Prevalence and global estimates of unsafe listening practices in adolescents and young adults: a systematic review and meta-analysis. *BMJ Global Health*, **7**(11), e010501.

Elmazoska, I. et al. (2024). Associations between recreational noise exposure and hearing function in adolescents and young adults: a systematic review. *Journal of Speech, Language, and Hearing Research*, **67**(2), 688–710.

Hoth, S. and Baljić, I. (2017). Current audiological diagnostics. *GMS Current Topics in Otorhinolaryngology – Head and Neck Surgery*, **16**, Doc09.

Jiang, W. et al. (2016). Daily music exposure dose and hearing problems using personal listening devices in adolescents and young adults: a systematic review. *International Journal of Audiology*, **55**(4), 197–205.

Kumar, P. et al. (2017). Extended high frequency audiometry in users of personal listening devices. *American Journal of Otolaryngology*, **38**(2), 163–167.

Lough, M. and Plack, C.J. (2022). Extended high-frequency audiometry in research and clinical practice. *The Journal of the Acoustical Society of America*, **151**(3), 1944–1955.

Mourad Abd El-Mawgoud, S. (2020). Personal audio devices and the risk of hearing loss in young adults. *Electronic Physician*, **12**(1), 7662–7667.

Peters, M.D.J. et al. (2020). Updated methodological guidance for the conduct of scoping reviews. *JBIM Evidence Synthesis*, **18**(10), 2119–2126.

Sulaiman, A.H., Seluakumaran, K. and Husain, R. (2013). Hearing risk associated with the usage of personal listening devices among urban high school students in Malaysia. *Public Health*, **127**(8), 710–715.

Sulaiman, A.H., Husain, R. and Seluakumaran, K. (2015). Hearing risk among young personal listening device users: effects at high-frequency and extended high-frequency audiogram thresholds. *The Journal of International Advanced Otolaryngology*, **11**(2), 104–109.

Tricco, A.C. et al. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of Internal Medicine*, **169**(7), 467–473.

Vogel, I. et al. (2007). Young people's exposure to loud music: a summary of the literature. *American Journal of Preventive Medicine*, **33**(2), 124–133.

World Health Organization (2019). *New WHO-ITU standard aims to prevent hearing loss among 1.1 billion young people*. Available at: <https://www.who.int/news/item/12-02-2019-new-who-itu-standard-aims-to-prevent-hearing-loss-among-1.1-billion-young-people>

AIM

To map the audiological assessment methods used in adolescent PLD exposure studies, examine their reported findings and identify methodological gaps.

METHODS

Study design
A Scoping review mapped assessment methods and evidence gaps across studies with varied tests, age ranges and outcomes. Guided by Arksey and O'Malley (2005) and PRISMA-ScR guidance (Tricco et al., 2018).

Search strategy
PubMed/MEDLINE, CINAHL and Google Scholar were searched. PCC informed terms combined adolescents, PLDs and hearing assessment using Boolean operators, MeSH terms and truncation. Filters included English, humans and birth –18 years. 2000-2025 searched.

Eligibility
Relevant mixed age and young adult studies were considered because adolescent only evidence was limited or combined within the study (Peters et al., 2020)

Included

- Recreational PLD exposure
- Quantitative audiological studies
- PTA, EHF, OAE's, ABR or speech in noise

Excluded

- Occupational /environmental noise
- Ineligible populations; pre-existing hearing loss or auditory processing disorders
- Non peer reviewed work or case reports
- Self report without audiological testing

Study selection and appraisal

Selection was documented in a PRISMA flow diagram. An adapted CASP checklist evaluated study strengths, limitations and potential bias (CASP, 2018).

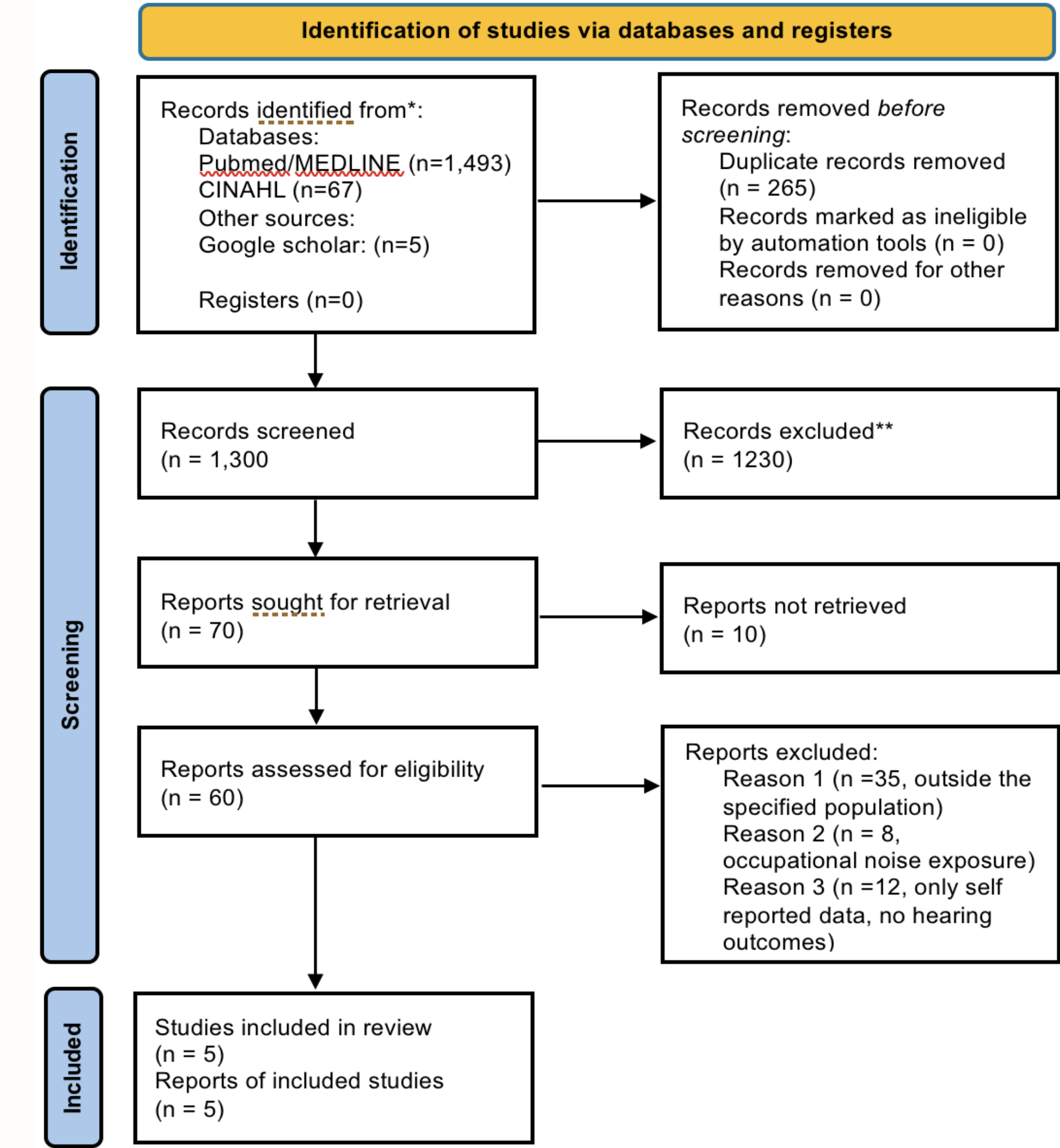


Figure 1. PRISMA flow diagram of study selection.