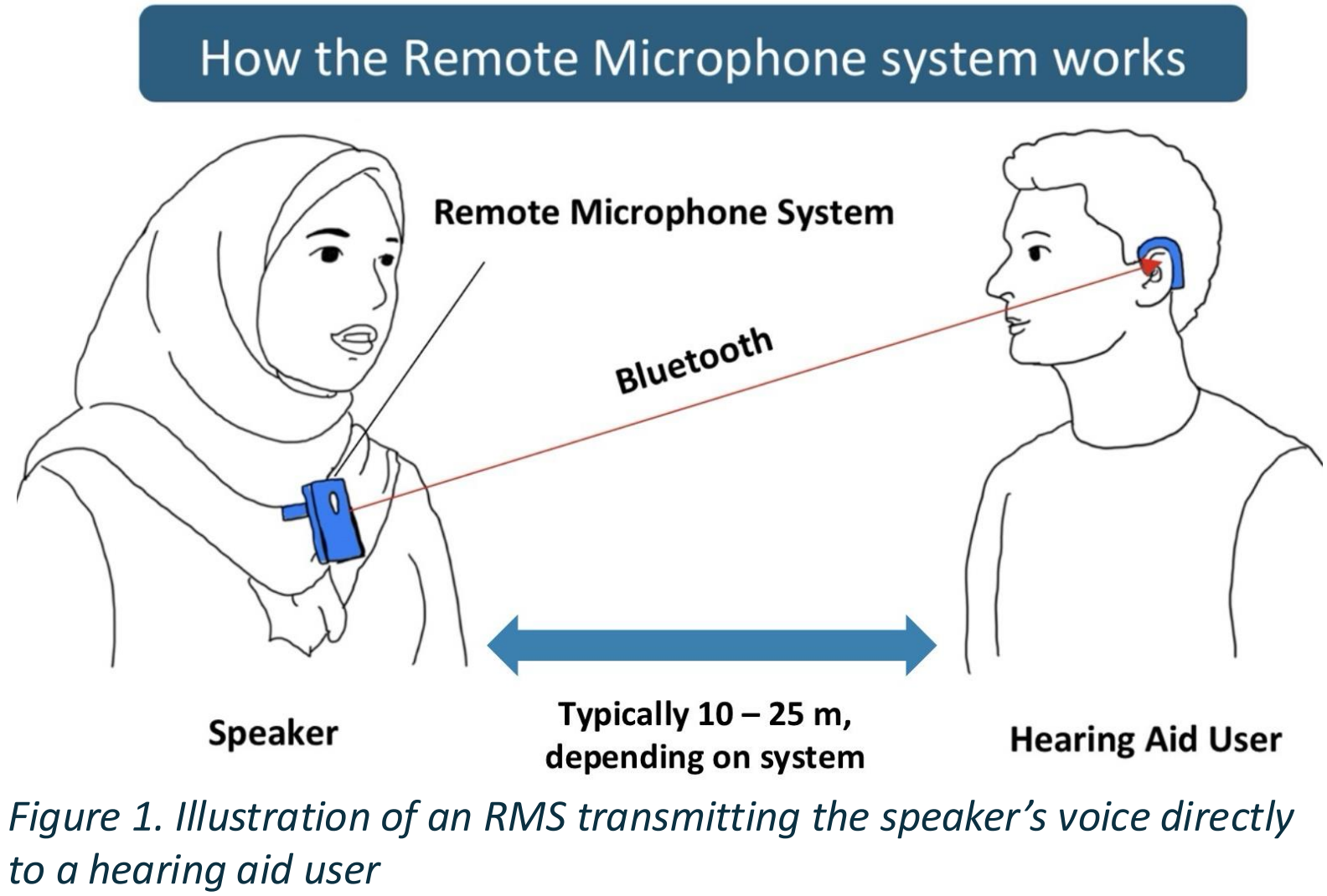


Introduction

Adults with sensorineural hearing loss (SNHL) frequently experience difficulty understanding speech in complex listening environments, particularly in background noise, despite appropriately fitted hearing aids (Glyde et al., 2011; NICE, 2023).

Hearing aids incorporate technologies such as digital noise reduction and directional microphones; however, they cannot fully restore the frequency, temporal and spatial processing deficits associated with SNHL (Bentler and Chiou, 2006; Choi and Rhee, 2025). Consequently, difficulty understanding speech may persist in noisy and complex listening environments (NICE, 2023).

Remote microphone systems (RMS) transmit the speaker’s signal directly to the listener’s hearing aids, improving the effective signal-to-noise ratio (SNR) and reducing the effects of background noise, distance and reverberation (Walker et al., 2019; Zanin et al., 2024).



Previous studies have reported improved speech recognition with RMS compared with hearing aids alone, particularly under challenging listening conditions. However, evidence varies according to RMS technology, study design, outcome measures and listening conditions (Wolfe et al., 2015; Chen et al., 2021; Zanin et al., 2024).

Aim:
To map the evidence regarding RMS efficacy, outcome measures and technical factors influencing performance in adult hearing-aid users.

Methods

Study design:
A scoping review guided by the Arksey and O’Malley (2005) framework and Joanna Briggs Institute (JBI) guidance. The reporting followed PRISMA-ScR (Tricco et al., 2018).

Search strategy:
A three-step search strategy was undertaken across Ovid, PubMed and Leeds Library.

Search terms were structured using the Population-Concept-Context (PCC) framework and combined using controlled vocabulary, free-text terms and Boolean operators (AND/OR) (Khalil et al., 2024).

Eligibility:

Included:

- Adults aged ≥18 years with SNHL
- Hearing aid users
- RMS intervention, including FM and digital adaptive systems such as Roger
- Measurable relevant outcomes relating to RMS use

Excluded:

- Paediatric populations
- Cochlear implant users
- Non-RMS technologies
- No relevant measurable outcomes

Study selection & appraisal:
Records were screened by title and abstract, followed by full-text assessment against the predefined criteria.

Methodological quality was assessed using CASP checklists. The CASP systematic review checklist was applied to Maidment et al. (2018), while adapted CASP criteria were used for the controlled experimental studies.

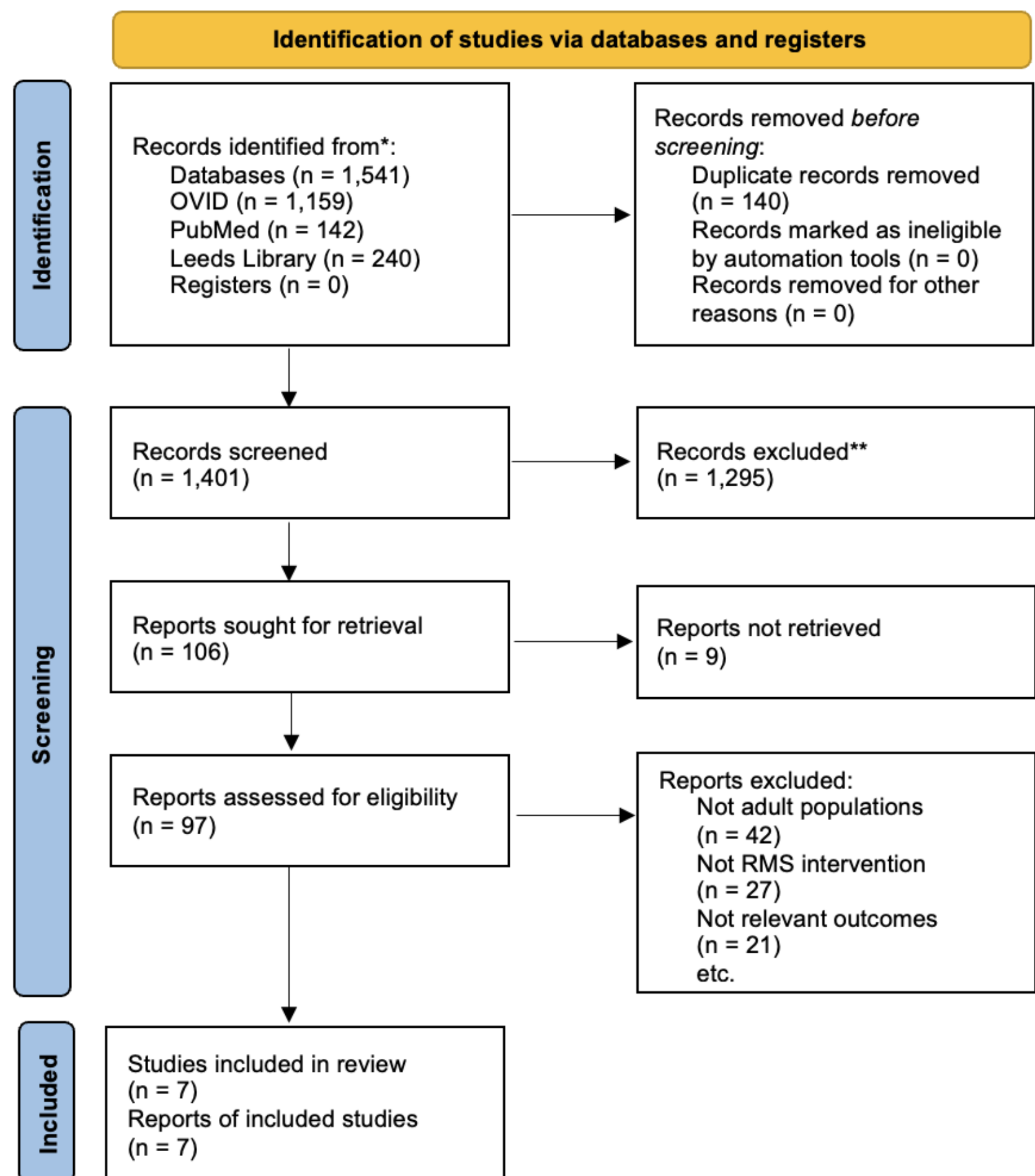


Figure 2. PRISMA flow diagram of study identification, screening, eligibility assessment and inclusion.

Results

Evidence base:
7 studies published between 2015-2025 were included. **6 quantitative experimental studies and 1 systematic review** (Maidment et al., 2018; Chen et al., 2021; Courtois et al., 2018; Wagener et al., 2018; Wolfe, 2018; Wolfe et al., 2015; Zanin et al., 2024).

7
Included studies

2015-2025
Publication period

15-40
Participants in quantitative studies

6
Countries represented

Studies conducted across Australia, UK, China, USA, Switzerland and Germany, with one unspecified location.

Methodological quality (CASP):

Study	CASP Quality
Zanin et al. (2024)	Moderate-High
Maidment et al. (2018)	High
Chen et al. (2021)	Moderate-High
Wolfe (2018)	Moderate
Wolfe et al. (2015)	Moderate
Courtois et al. (2018)	Moderate
Wagener et al. (2018)	Moderate

Table 1. Methodological quality of included studies (CASP).

RMS technologies included:

- FM systems
- Digital adaptive systems, including Roger
- Wireless microphone systems

Overall quality: moderate
Common limitations included small sample sizes, controlled laboratory settings rather than real-world environments, limited reporting of participant characteristics, and variability in study design and reporting.

Variation was identified in transmission type, microphone configuration and integration with hearing aids.

Speech-in-noise outcomes:

All included studies reported objective speech-in-noise (SIN) outcomes, most commonly speech recognition thresholds (SRTs), percentage-correct scores and signal-to-noise ratio (SNR) measures.

RMS use was consistently associated with improved speech-in-noise performance compared with hearing aids alone. Greater benefits were observed under more challenging conditions, particularly at lower SNRs and greater speaker-to-listener distances.

Objective measures dominated the evidence base:

- Speech recognition thresholds (SRTs)
- Percentage-correct word scores
- Performance across different SNRs
- Dual-task listening
- Hearing Aid Speech Perception Index (HASPI)

Patient-reported / real-world outcomes

- less consistently evaluated
- Most studies conducted in controlled laboratory or clinical environments

Key findings:
RMS consistently improved speech-in-noise performance compared with hearing aids alone, with greater benefits observed in more challenging listening conditions.

Conclusions

Across the mapped evidence, RMS use was consistently associated with improved speech-in-noise performance, with greater benefits observed under challenging listening conditions, particularly at lower SNRs and greater speaker-to-listener distances (Chen et al., 2021; Maidment et al., 2018; Wolfe et al., 2015; Zanin et al., 2024).

Interpretation is limited by small sample sizes, methodological variability and the predominance of controlled laboratory research.

Real-world effectiveness and patient-reported benefits remain less well established than objective laboratory outcomes (Maidment et al., 2018; Wagener et al., 2018; Zanin et al., 2024).

Further research should prioritise larger, longitudinal studies in ecologically valid listening environments, using standardised objective and patient-reported outcome measures.

References

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

Bentler, R. and Chiou, L.-K. 2006. Digital noise reduction: An overview. *Trends in Amplification*. 10(2), pp.67–82.

Chen, J., Wang, Z., Dong, R., Fu, X., Wang, Y. and Wang, S. 2021. Effects of wireless remote microphone on speech recognition in noise for hearing aid users in China. *Frontiers in Neuroscience*. 15.

Choi, C.-H. and Rhee, C.-K. 2025. Cochlear hearing loss and the current use of hearing aids. *Korean Journal of Audiology*. 3(2), pp.111–122.

Courtois, G., Lissek, H., Estoppey, P., Oesch, Y. and Gigandet, X. 2018. Effects of Binaural Spatialization in Wireless Microphone Systems for Hearing Aids on Normal-Hearing and Hearing-Impaired Listeners. *Trends in Hearing*. 22, 233121651775354

Glyde, H., Hickson, L., Cameron, S. and Dillon, H. 2011. Problems hearing in noise in older adults. *Trends in Amplification*. 15(3), pp.116–126.

Khalil, H., Campbell, F., Dania, K., Pollock, D., Munn, Z., Welsh, V., Saran, A., Hoppe, D. and Tricco, A.C. 2024. Advancing the methodology of mapping reviews: A scoping review. *Research Synthesis Methods*. 15(3). doi:10.1002/jrsm.1694.

Maidment, D.W., Barker, A.B., Xia, J. and Ferguson, M.A. 2018. A systematic review and meta-analysis assessing the effectiveness of alternative listening devices to conventional hearing aids in adults with hearing loss. *International Journal of Audiology*. 57(10), pp.721–729.

NICE 2023. *Management in primary care*. NICE. [Online]. Available from: <https://cks.nice.org.uk/topics/hearing-loss-in-adults/management/management-in-primary-care/>.

Tricco, A.C., Lillie, E., Zarin, W., O’Brien, K.K., Colquhoun, H., Levac, D., Moher, D., Peters, M.D.J., Horsley, T., Weeks, L., Hempel, S., Akl, E.A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M.G., Garritty, C., Lewin, S., Godfrey, C.M., Macdonald, M.T., Langlois, E.V., Soares-Weiser, K., Moriarty, J., Clifford, T., Tunçalp, Ö. and Straus, S.E. 2018. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*. 169(7), pp.467–473.

Wagener, K.C., Vormann, M., Latzel, M. and Müller, H.E. 2018. Effect of hearing aid directionality and remote microphone on speech intelligibility in complex listening situations. *Trends in Hearing*. 22, 233121651880494.

Walker, E.A., Curran, M., Spratford, M. and Roush, P. (2019). Remote microphone systems for preschool-age children who are hard of hearing: access and utilization. *International Journal of Audiology*. 58(4), pp.200–207. doi:https://doi.org/10.1080/14992027.2018.1537523.

Wolfe, J. 2018. *Evaluation of modern remote microphone technologies*. AudiologyOnline. [Online]. Available from: <https://www.audiologyonline.com/articles/evaluation-modern-remote-microphone-technologies-23681>.

Wolfe, J., Morais Duke, M., Schäfer, E., Jones, C., Müller, H.E., John, A. and Hudson, M. 2015. Evaluation of performance with an adaptive digital remote microphone system and a digital remote microphone audio-streaming accessory system. *American Journal of Audiology*. 24(3), pp.440–450.

Zanin, J., Vaisberg, J., Swann, S. and Rance, G. 2024. Evaluating benefits of remote microphone technology for adults with hearing loss using behavioural and predictive metrics. *International Journal of Audiology*. 64, pp.1–9.