Tests for assessing extended high-frequency hearing in humans: a scoping review

Lough, M., Plack, C.J. & Prendergast, G.
School of Health Sciences, The University of Manchester, UK

Aims

There is mounting research interest in assessing the highest frequency range of human hearing (8000 Hz - 20,000 Hz), particularly for diagnostic purposes. To facilitate future research into potential clinical applications, it is helpful to summarise what "extended high-frequency" (EHF) tests/methods/tools have been described to date, and to which other measures they have been compared.

A scoping review was undertaken to:

1. identify all tests/methods/tools for assessing EHF hearing in humans (besides EHF audiometry), and catalogue their use by study population;
2. determine whether there is sufficient evidence for undertaking a meta-analysis on associations between the various EHF tests, or between EHF tests and other non-audiometric measures.

Method

- The protocol was developed in accordance with the JBI methodology for scoping reviews (www.jbi.global/scoping-review-network) and was registered with the Open Science Framework. Database searches were carried out on 27 November 2023.
- Peer-reviewed quantitative analytical studies that adequately described an EHF test/method/tool applied to a living human study population were included.
- No exclusions were made based on geographical location, language, publication date or setting.

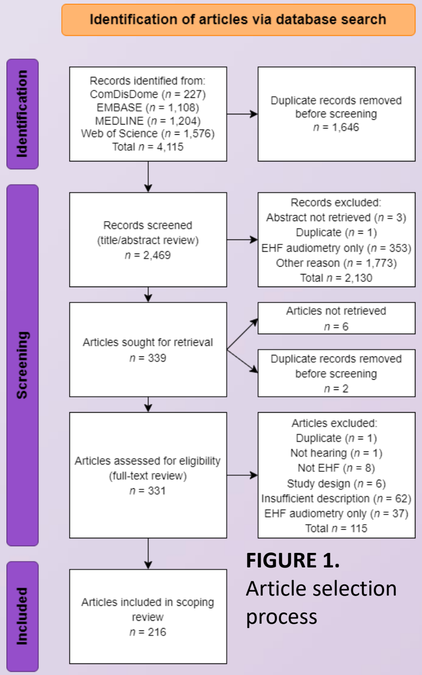
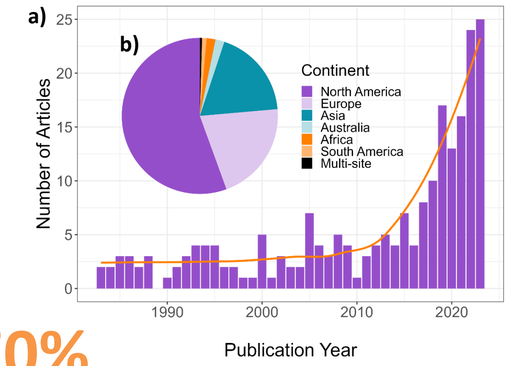


FIGURE 1. Article selection process

Results 1

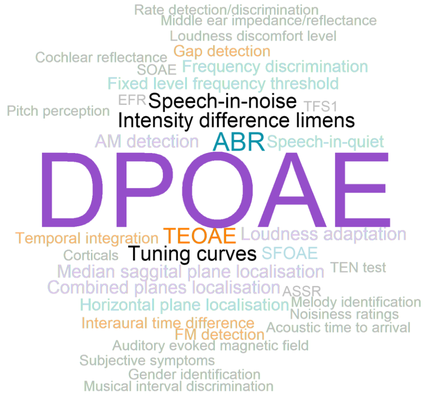
FIGURE 2. a) There has been a sharp increase in research outputs on EHF hearing since 2010. **b)** Study populations spanned 27 countries and six continents.



70%

of samples had "normal" hearing, but this was defined in different ways.

FIGURE 3. Thirty-seven unique EHF tests/methods/tools (besides EHF audiometry) were identified. EHF distortion product otoacoustic emissions (n = 71 articles), auditory brainstem responses (n = 10), and transient evoked otoacoustic emissions (n = 7) were most frequently used.



Results 2

FIGURE 4. Seventeen statistical comparisons (in 14 articles) were reported between one EHF test and another.

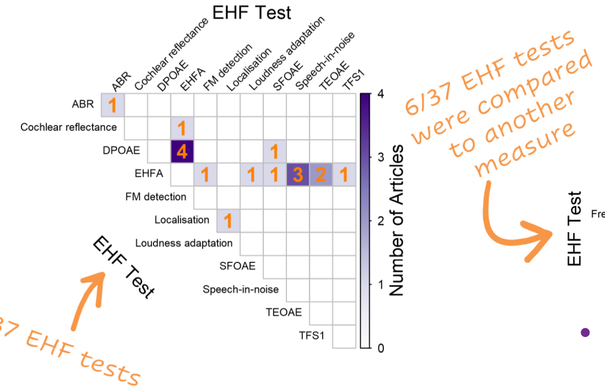
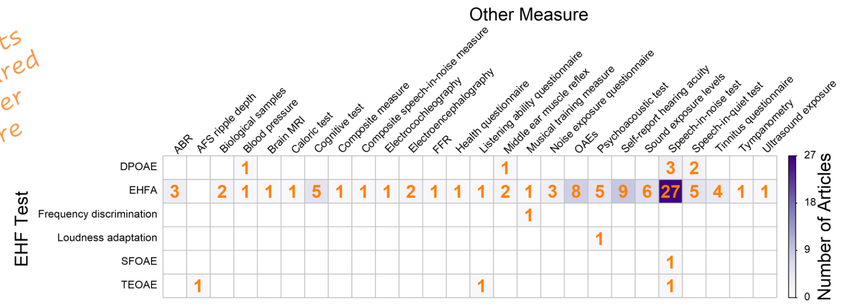


FIGURE 5. One hundred and twenty-six statistical comparisons (in 66 articles) were reported between an EHF test and another non-audiometric measure. EHF audiometry and speech-in-noise tests were compared the most.



- For EHF audiometry and speech-in-noise test comparisons, 16 different speech-in-noise tests were used, Digits-in-Noise (DIN) being the most reported (n = 9). For articles employing DIN, experimental methods were only consistent across a maximum of three studies.

Conclusions

To November 2023, the assessment of EHF hearing in peer-reviewed studies has most often been achieved by extending the frequency range of well-established clinical tests. A considerable number of other potentially useful tests and methods have been described, but these have received relatively little attention.

The relation between EHF audiometry and speech-in-noise perception has been investigated in 27 articles with mixed results, suggesting a meta-analysis would be valuable; however, it would likely be impeded by the heterogeneity in study design/methods.

To enhance our understanding of EHF hearing and how it can be utilised, further adequately powered empirical studies that clarify associations with EHF tests (particularly those that are under-researched) are warranted.

Manchester Centre for Audiology and Deafness

ABBREVIATIONS. ABR: auditory brainstem response; AFS: auditory fine structure; DPOAE: distortion product otoacoustic emissions (OAEs); EFR: envelope following response; EHFA: EHF audiometry; FFR: frequency following response; FM: frequency modulation; MRI: magnetic resonance imaging; SFOAE: stimulus frequency OAEs; SOAE: spontaneous OAEs; TEN: threshold equalizing noise; TEOAE: transient evoked OAEs; TFS1: temporal fine structure 1.

FUNDED BY
NIHR | National Institute for Health and Care Research