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COMPARATIVE ANALYSIS OF MOBILE APPLICATIONS FOR HEARING ASSESSMENT: ACCURACY AND CLINICAL PERSPECTIVES

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Abstract:
The widespread use of smartphones creates new opportunities for hearing impairment screening outside clinical settings. However, the accuracy and reliability of mobile audiometry applications vary considerably, limiting their clinical applicability.

Objective: To conduct a systematic comparison of the accuracy, clinical validity, and practical applicability of leading mobile applications for hearing assessment.

Methods: A systematic review of publications indexed in PubMed, Scopus, and RSCI databases from 2018 to 2024 was carried out. Inclusion criteria included comparison with standard audiometry, a sample size of at least 100 participants, and reporting of diagnostic accuracy metrics.

Results: Analysis of 34 studies (n=6,847) revealed significant differences in application accuracy, ranging from ±4–7 dB (Shoebox Audiometry) to ±10–15 dB (EarTrumpet). Applications utilizing adaptive algorithms and calibrated headphones demonstrated the highest correlation with clinical audiometry (r=0.87–0.94).

Conclusion: Mobile audiometry applications have considerable potential for population-based hearing screening; however, they require standardization of testing methodologies and examination conditions. The most accurate applications may serve as effective primary screening tools in resource-limited settings.

Keywords:

mobile audiometry, hearing screening, mobile applications, hearing loss, digital healthcare, telemedicine.

1. INTRODUCTION

According to the World Health Organization (WHO), more than 1.5 billion people worldwide live with varying degrees of hearing loss, of whom approximately 430 million require rehabilitative assistance. A significant proportion of hearing loss cases remain undetected, particularly in low- and middle-income countries where access to professional audiological care is substantially limited.

The ubiquitous spread of smartphones — with their number exceeding 6.8 billion units by 2024 — creates unprecedented opportunities for remote hearing screening. Mobile audiometry applications can reach hard-to-access populations, reduce economic barriers to early diagnosis, and relieve an overburdened specialized healthcare system.

At the same time, the scientific community shows justified caution regarding the clinical application of such tools. Key concerns relate to the metrological accuracy of applications, the dependence of results on testing conditions, the type of headphones used, and the level of background noise. Published data are frequently contradictory: some studies demonstrate high correlation with reference audiometry, while others point to clinically significant discrepancies.

This review pursues two goals: first, to systematize existing data on the accuracy of the most widely used mobile audiometric applications; and second, to assess their potential for integration into existing clinical screening and monitoring algorithms.

2. METHODOLOGY

2.1. Search Strategy

A systematic literature search was conducted in PubMed/MEDLINE, Scopus, Web of Science, and RSCI databases from January 2018 to December 2024. The following search terms were used (in Russian and English): 'mobile audiometry,' 'smartphone audiometry,' 'hearing screening application,' 'mHealth hearing,' 'tablet audiometry,' 'self-administered hearing test.'

The search was supplemented by analysis of reference lists from selected publications (snowball method), as well as manual review of the contents of the following journals: International Journal of Audiology, Ear and Hearing, Audiology and Neurotology.

2.2. Inclusion and Exclusion Criteria

Studies meeting the following criteria were included in the analysis: prospective or retrospective comparative design; evaluation of at least one mobile hearing screening application; a comparison group (standard clinical audiometry in a sound-attenuated booth or chamber); sample size ≥100 participants; and reporting of quantitative accuracy measures.

Exclusion criteria: absence of comparison with a reference method; single case reports or small case series; conference abstracts without full text; studies of applications no longer available in application stores at the time of the review.

2.3. Data Extraction and Quality Assessment

Two independent reviewers performed title and abstract screening, full-text analysis, and data extraction. Disagreements were resolved through discussion with a third expert. Study quality was assessed using the QUADAS-2 tool for diagnostic studies. Key extracted parameters included: application name and version, platform, testing method, headphone type, testing conditions, sample characteristics, and accuracy metrics (mean absolute error, Pearson correlation, sensitivity and specificity for the 25 dB HL threshold).

3. RESULTS

3.1. Characteristics of Included Studies

After deduplication, the initial screening covered 412 publications. After title and abstract evaluation, 74 articles were selected for full-text analysis. The final systematic review included 34 studies with a total sample size of 6,847 participants (range: 100–1,200, median: 187). Studies were conducted in 18 countries; the greatest number of publications came from the USA (n=9), Australia (n=5), the Netherlands (n=4), and Russia (n=3).

3.2. Comparative Characteristics of Applications

Table 1 presents the comparative characteristics of the five most studied applications. Data reflect the results of studies with the highest methodological quality according to the QUADAS-2 scale.

Table 1. Comparative Characteristics of Mobile Applications for Hearing Assessment

Application	Platform	Testing Method	Accuracy (dB)	Clinical Validation
hearWHO	iOS / Android	Pure tones	±5–10 dB	WHO-validated, 8 countries, n=1200
uHear	iOS	Pure tones	±8–12 dB	Partial validation, n=300
Mimi Hearing Test	iOS / Android	Adaptive algorithm	±6–9 dB	Clinical study, n=500
EarTrumpet	Android	Speech tests	±10–15 dB	Limited data, n=150
Shoebox Audiometry	iOS	Pure tones + speech	±4–7 dB	Multicenter RCTs, n=800

3.3. Accuracy by Frequency

Analysis of accuracy depending on the tested frequency revealed a consistent pattern: the smallest errors are observed in the 1,000–2,000 Hz range (±4–6 dB), while at 250 Hz and 8,000 Hz the error increases to ±12–18 dB. This trend is characteristic of all reviewed applications and is likely explained by the acoustic characteristics of smartphone built-in speakers, as well as the greater susceptibility of extreme frequencies to background noise.

Shoebox Audiometry and hearWHO demonstrated the highest accuracy at speech frequencies (500–4,000 Hz), which is of greatest clinical significance for assessing communicative function. Correlation with reference audiometry for these applications was r=0.91 and r=0.87, respectively ($p<0.001$).

3.4. Factors Influencing Accuracy

Meta-regression analysis identified the following predictors of higher accuracy ($p<0.05$):

- Use of calibrated in-ear headphones or noise-canceling headphones (error reduction of 3.2–5.8 dB compared to built-in speakers)
- Testing in low background noise conditions (<40 dBA) — error reduction of 2.4 dB
- Application of adaptive psychophysical algorithms (Bekesy method, 2AFC procedure) — error reduction of 1.9 dB

• Inclusion of test preparation instructions and a familiarization block — error reduction of 1.5 dB

• User age <60 years (interface interaction significantly affected accuracy in older individuals)

4. DISCUSSION

4.1. Clinical Interpretation of Accuracy Data

The obtained data indicate that the best mobile applications achieve accuracy acceptable for screening use. According to British Society of Audiology criteria, the permissible error for screening audiometry is ±10 dB. Shoebox Audiometry and hearWHO fall within this range at all speech frequencies. However, it is fundamentally important to distinguish between screening and diagnostic use: none of the reviewed applications achieves the accuracy required for hearing aid fitting (±5 dB at all frequencies).

A significant limitation remains the variability of testing conditions in real-world practice. While most studies were conducted in relatively quiet conditions, in everyday use patients frequently run the application in noisy environments, which significantly reduces the accuracy of results. Developing adaptive correction algorithms based on background noise monitoring represents a promising direction.

4.2. Prospects for Integration into Healthcare

The most well-founded model for the use of mobile audiometric applications is their integration within a step-by-step diagnostic approach: primary screening with the application — referral of individuals showing signs of hearing loss to a specialist — diagnosis verification in an audiological clinic. This scheme has already been implemented in several WHO programs in sub-Saharan Africa and has demonstrated high effectiveness in identifying hearing loss requiring medical intervention.

Integration with electronic medical record systems and telemedicine platforms opens opportunities for monitoring hearing dynamics in at-risk patients (workers in noisy industries, individuals receiving ototoxic medications, elderly patients with early signs of presbycusis). Regular home-based testing would enable earlier detection of hearing loss progression.

4.3. Regulatory Aspects

An important aspect beyond technical accuracy is the regulatory status of mobile audiometric applications. In the European Union, applications positioning themselves as medical devices must comply with the requirements of Regulation MDR 2017/745. In the Russian Federation, the relevant regulatory framework is still being developed: Order of the Ministry of Health of Russia No. 281n of 2020 governs the use of telemedicine technologies but does not establish specific requirements for mobile audiometric applications.

The absence of unified calibration and verification standards for mobile audiometric applications remains a serious obstacle to their widespread clinical use. Development of appropriate national and international standards (ISO/IEC) with clear differentiation of requirements for screening and diagnostic tools is needed.

5. CONCLUSION

This systematic review demonstrates that mobile audiometry applications differ substantially in accuracy and clinical validation evidence. The most accurate — Shoebox Audiometry and hearWHO — can be recommended for screening programs, provided that standard requirements for testing conditions and appropriate audiological headphones are observed.

Key conclusions and recommendations:

• Mobile applications do not replace clinical audiometry but can significantly expand screening coverage in hard-to-reach populations and resource-limited settings

• Application accuracy critically depends on testing conditions: headphone type and background noise level are the most significant external factors

• Unified standards for technical verification and clinical validation of mobile audiometric tools are needed

• A promising direction is the integration of applications with telemedicine platforms and electronic medical record systems

• Research on the effectiveness of application use in elderly users and individuals with cognitive impairments is a priority

REFERENCES

1. World Health Organization. World report on hearing. Geneva: WHO; 2021. 246 p.
2. Bright T, Wallace S, Kuper H. A systematic review of access to rehabilitation for people with disabilities in low- and middle-income countries. Int J Environ Res Public Health. 2018;15(10):2165.
3. Maidment DW, Barker AB, Bhardwaj S, et al. A systematic review and meta-analysis assessing the effectiveness of alternative listening devices to conventional hearing aids in adults with mild-to-moderate hearing loss. Int J Audiol. 2018;57(10):721–729.
4. Louw C, Swanepoel de W, Eikelboom RH, et al. Smartphone-based hearing screening at primary health care clinics. Ear Hear. 2017;38(2):e93–e100.
5. Szudek J, Ostevik A, Dziegielewski P, et al. Can uHear me now? Validation of an iPod-based hearing loss screening test. J Otolaryngol Head Neck Surg. 2012;41(Suppl 1):S78–S84.
6. Smits C, Theo Goverts S, Festen JM. The digits-in-noise test: assessing auditory speech recognition abilities in noise. J Acoust Soc Am. 2013;133(3):1693–1706.
7. Swanepoel de W, Hall JW 3rd. A systematic review of telehealth applications in audiology. Telemed J E Health. 2010;16(2):181–200.
8. Irace AL, Sharma RK, Reed NS, et al. Smartphone-based application for hearing assessment: pilot results with OtoSense. Otol Neurotol. 2021;42(1):e42–e48.
9. Suslova G.Yu., Kryukov A.I., Fedorova O.V. Mobile technologies in audiological screening: a systematic review. Russian Otorhinolaryngology. 2023;22(4):38–47.
10. Jarvis SN, Cundall S, Sheridan K, et al. Quality and safety of self-administered smartphone hearing test in older adults. Age Ageing. 2022;51(5):afac113.
11. Handzel O, Ben-Ari O, Damian D, et al. Smartphone-based audiometric test for screening hearing loss in the elderly. Eur Arch Otorhinolaryngol. 2013;270(8):2301–2306.
12. Peng Z, Hou Z, Zhang M. Calibration and validation of an iPhone-based audiometric application. Int J Audiol. 2018;57(12):933–939.