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Exploring the User Requirement Features in a Hearing Aid Selection Mobile Application According to Audiologists in Saudi Arabia

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Abstract

Background: Hearing loss is a common impairment affecting millions worldwide. Despite availability of various hearing aid options and features, selecting most suitable hearing aid that meets patient's communication needs and provides the best quality of life remains a challenge. This study aims to explore audiologists' perceptions regarding user requirement features that should be incorporated into the design of a hearing aid selection mobile application.

Methods: This study was cross-sectional. A validated web-based questionnaire was electronically distributed. We included audiologists with at least one-year experience in hearing aid prescription/selection in Saudi Arabia. We administered a survey of 22 closed-ended questions divided into three categories: participant demographics, features, and perceptions regarding the mobile application.

Results: Data analysis was performed using the SPSS program to summarize the responses. In this study, 118 responses were collected. Individuals who were not audiologists (n=26) and had less than one year of experience (n=22) were excluded. Additionally, approximately 20 incomplete responses were excluded to maintain dataset integrity, resulting in a refined dataset of 51 responses. Participants' responses were categorized into three categories: essential, nice to have, and features suggested by participants. The essential features identified included pricing information, hearing aid trials, compatibility with different smartphones/operating systems, connecting with other users, insurance coverage, compatibility with hearing aid accessories, live chat features, and multi-language support.

Conclusion: The outcomes of this study are to automate the hearing aid selection process, improve selection accuracy, provide wider accessibility, and improve patient satisfaction. With this platform, both audiologists and clients will be able to make more informed decisions and save time and effort by using this application as opposed to the conventional process.

Keywords: Hearing aid, Hearing aid Selection, Features, M-Health, Application.

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1. Introduction

The term "hearing loss" refers to the inability to hear as well as someone with normal hearing, which means thresholds of 20 dB or better in both ears [1]. There are various degrees of hearing loss (HL), including mild, moderate, moderately severe, severe, and profound, and it can be unilateral or bilateral. HL can be classified into three types: conductive hearing loss, which is caused by a blockage or obstruction in the outer ear or middle ear; sensorineural hearing loss, which results from damage to the inner ear (cochlea) or auditory nerve; and mixed hearing loss; a combination of both types.

The first line of treatment for hearing loss is typically a hearing aid unless medical treatment is indicated [2]. Many of these consequences can be reduced with timely intervention, such as hearing aid (HA) [3, 4]. A hearing aid is an electronic device used to amplify sound for people with hearing loss. It works by capturing sound through a microphone, processing it through an amplifier, and then delivering the amplified sound to the ear [5]. The benefits of hearing aids are numerous, as they can improve communication, enhance social interaction, and even reduce the risk of cognitive decline [5, 6].

Hearing aid features are essential elements that determine hearing aid properties. Even though these features differ in their description, they can still be classified based on their purpose. For instance, single microphone noise reduction (NR) concepts may be used to enhance the speech-to-noise ratio and comfort of listening [7]. However, manufacturers now introduce new hearing aid technology as proprietary "concepts" that combine multiple features, complicating comparing hearing aid features across vendors. These concepts are specific to each manufacturer and are not easily understood by the general public [8].

Depending on the patient's hearing profile and limitations experienced, advanced features might be necessary for some patients. In contrast, basic features could be more cost-effective and beneficial for others. Despite this, there are no scientifically supported guidelines to help practitioners determine when to recommend technology with basic features and when to recommend technology with premium features [9]. In the absence of independent research, practitioners are primarily dependent on unverified manufacturer claims regarding the benefits of hearing aids when making recommendations for their patients [9]. Audiologists face challenges in selecting the most suitable hearing aid (HA) from a variety of models from vendors due to the complexity of HA devices, limited time spent with patients, and limited access to the latest technologies. Cost can also be a barrier, especially for those without insurance coverage. Technological advances in HAs often arrive faster than accurate fitting methods, making it crucial for audiologists to stay updated [10].

The fourth industrial revolution is transforming healthcare by utilizing mobile health (mHealth)

models, such as smartphones and wearable devices, to improve patient care, reduce costs, and enhance access to health services. Education and information are crucial services, and audiological counseling is a powerful tool for communication [3]. Platforms for peer interaction are essential for audiological interventions. Mobile apps have transformed audiological care and accessibility, offering flexibility and amplification profiles computed from audiograms [11]. Computational audiology has the potential to address global hearing loss challenges, using machine learning and data mining techniques to generate diagnostic and therapeutic inferences [12]. With the advent of smartphones, audiology will become more accessible, providing a solid foundation for developing a mobile application that uses ML to recommend the most suitable hearing model and features [3].

Machine learning can be used to assist in selecting hearing aids, making the process more accurate, accessible, and efficient. This technology can be particularly beneficial for individuals in rural areas who struggle to travel to hearing aid vendors or audiologists' offices. A machine learning platform can suggest the most suitable hearing aid model and features based on audiogram and patient data, leading to personalized recommendations and higher patient satisfaction. ML algorithms can also improve accuracy, save time and effort, and provide continuous improvement. Accessibility can be enhanced, reaching a wider range of individuals with hearing loss. This study aims to explore audiologists' perception of user requirements for a hearing aid selection mobile application in Saudi Arabia.

2. Subjects and Methods

A survey was developed to discover the features that need to be included in a hearing aid selection mobile application. This application will improve, assist, and guide Audiologists and hearing aid users so that they can make informed decisions when choosing the best hearing aid model/features.

2.1 Study design and setting

This study was done through a web-based questionnaire that was electronically distributed to all Audiologists in Saudi Arabia.

2.2 Study Subjects:

Inclusion criteria: Audiologists with a minimum of 1 year experience in hearing aid prescription/selection in Saudi Arabia.

Exclusion criteria: Audiologists with less than one year experience in hearing aid prescription/selection in Saudi Arabia.

2.3 Study Design:

The design of this study is cross-sectional. A validated web-based questionnaire was electronically distributed among the targeted population to address the aim of the study.

2.4 Sample Size:

Since the population is unknown, the Epitools - Epidemiological Calculators website (https://epitools.ausvet.com.au/oneproportion) was used to identify the sample size. The sample size was 385, with an Estimated true proportion of 0.5, a 5% margin of error, and a confidence level of 95%. A convenient web-based sampling technique was used in this study in order to obtain a representative sample for the target population. There were 118 participants in this survey, of whom 78% (92 participants) were audiologists and 22% (26 participants) were not audiologists. Participants' experience with hearing aid selection and prescription ranged from less than one year (23.3%, n =21), one to two years (20%, n=18), two to five years (26.6%, n=24), and more than five years (30%, n=27). Participants with less than one year of experience (23.3%, n=21) or who were not Audiologists (22%, n=26) were excluded from the study.

Furthermore, an additional filtering step was implemented to ensure the data's integrity and relevance for analysis. It was necessary to exclude approximately 20 responses due to incompleteness, in which participants answered only the first two questions of the survey. The incomplete responses were considered insufficient for comprehensive data analysis. The final dataset was refined to encompass a remaining count of 51 responses. This refined set of responses constituted the basis for subsequent analysis, ensuring that the data set is representative of experienced audiologists and sufficiently comprehensive to provide meaningful insights and conclusions.

2.5 Data Collection Methods, Instruments Used, Measurements, Data Management, and Analysis Plan:

This study is designed to explore the audiologist's perception regarding the user requirement features that should be included in the design of the hearing aid selection mobile application to help them make better decisions and save their time and effort.

2.6 The Research Tool:

A total of 22 questions are included in this tool, which are grouped into three categories: participant demographics, participant preferences regarding what features should be included in the mobile application, and participant perceptions. The last question of the survey asked the participants if they had any additional features that were not included in the survey.

2.7 Tool Validation:

The tool was validated in two steps:

Content validity: The initial version of the questionnaire was reviewed by three experts with a Doctorate of Audiology degree and over five years of experience in hearing aid selection/prescription. Based on their recommendations, inclusion and exclusion criteria were adjusted, and answer options were refined to ensure comprehensiveness and accuracy to avoid potential omissions. Additionally, one question was eliminated based on unanimous recommendations from all three experts.

Pilot testing: Before broader distribution, the final revised version was administered to five audiologists meeting the inclusion criteria to assess statement accuracy and wording clarity. The necessary rewording and adjustments were made based on feedback.

The tool's reliability was evaluated by measuring its internal consistency using Cronbach's alpha for each of the three sections (Demographics, Features, Perceptions) to ensure that all questions under the same section measure the same construct or characteristic. The Cronbach's alpha for the "Demographics" section was 0.57, indicating a moderate internal consistency. The Cronbach's alpha for the "Features" section was 0.92 and 0.87 for the "Perceptions" section, both indicating a high internal consistency (20).

2.8 Statistical analysis

After data cleaning, the responses were analyzed using the Statistical Package for the Social Sciences (SPSS) program to identify patterns and summarize the results. Responses were summarized using descriptive statistics, particularly counts and percentages.

3. Results

The questionnaire was conducted through the SurveyMonkey platform and distributed among Audiologists to investigate what features they find crucial in a mobile hearing aid selection application. The study involved Audiologists with varying levels of experience in hearing aid selection/prescription.

In terms of difficulty selecting the most appropriate hearing aid style, model, and features among different manufacturers, difficulties were reported as very frequently (1.96%, n=1), frequently (13.72%, n=7), occasionally (54.9%, n=28), rarely (27.45%, n=14), and never (1.96%, n=1). As far as the time spent on the hearing aid selection process, responses vary from less than five minutes (29.41%, n=15), five to fifteen minutes (41.17%, n=21), fifteen to thirty minutes (23.53%, n=12), thirty to sixty minutes (5.88%, n=3) to more than sixty minutes (0%). Furthermore, a total of 94.12% of respondents (n=48) indicated that they have never used mobile applications for hearing aid selection, while only 5.88% (n=3) indicated

that they had used mobile applications such as My Phonak, Oticon ON, Resound Smart, Starkey Inspire System, Oticon Companion, and Oticon ON. It should be noted that those apps are used for hearing aid programming and sound adjustments rather than for hearing aid selection. Participants' demographics and experience are summarized in Table1.

Table (1) Demographic Data of the Study Groups

Years of experience in hearing aid selection/prescription	**STATICS**
Less than 1 year	(23.3%, n =21)
1 to 2 years	(20%, n =18)
2 to 5 years	(26.6%, n=24)
More than 5 years	(30%, n=27)
Hearing aid selection challenges: frequency of difficulties	
Very frequently	(1.96%, n=1)
Frequently	(13.72%, n=7)
Occasionally	(54.9%, n=28)
Rarely	(27.45%, n=14)
Never	(1.96%, n=1)
Time typically spent on hearing aid selection process	
less than 5 minutes	(29.41%, n=15)
5 to 15 minutes	(41.17%, n=21)
15 to 30 minutes	(23.53%, n=12)
30 to 60 minutes	(5.88%, n=3)
More than 60 minutes	(0%)
History of mobile app usage for hearing aid selection	
No	(94.12%, n=48)
Yes	(5.88%, n=3)

Among these factors are degree of hearing loss (100%, n=51), configuration of hearing loss (92.16%, n=47), Age (92.16%, n=47), Type of hearing loss (86.27%, n=44), Cosmetic preferences (86.27%, n=44), Dexterity (80.39%, n=41), Lifestyle (80.39%, n=41), Budget (68.63%, n=35), Smartphone usage and its brand (49.02%, n=25) as well as Employment status (41.18%, n=21).

In response to inquiries about the hearing aid features they believe clients are most interested in, audiologists provided the following responses: Noise reduction (82.35 %, n=42), Speech enhancement (78.43 %, n=40), Wireless connectivity (74.51 %, n=38), Feedback suppression (72.55%, n=37), Water resistance (72.55%, n=37), Volume control (70.59%, n=36), Rechargeable batteries (64.71%, n=33), Directionality (58.82%, n=30), Wind suppression (58.82, n=30), and Number of channels (49.02%, n=25).

In terms of the importance of the features that should be included in the mobile application, participants offered a variety of perspectives. The availability of an app in multiple languages was considered very important by a significant majority of participants (78.43%, n=40), important by 17.65% of respondents (n=9), somewhat important by 3.92% of respondents (n=2), and not important by (0%) of respondents. Furthermore, 68.63% (n=35) of participants rated compatibility with various types of smartphones and operating systems as a very important feature of the mobile application, while 27.45% (n=14) rated it as important, 3.92% (n=2) rated it somewhat important, and none viewed it as unimportant (0%) (Table2).

In addition, the availability of information regarding hearing aid insurance coverage is highly important to 54.90% (n=28), important to 37.25% (n=19), somewhat important to 7.84% of respondents (n=4), and no respondents indicated it as unimportant (0%). Regarding the feature of providing information about available/compatible hearing aid accessories, 50.98% (n=26) considered it very important, 35.29% (n=18) as important, 13.73% (n=7) as somewhat important and not important (0%). Moreover, adding information about the vendor's ability to offer hearing aid trials was considered very important by 49.02% (n=25), important by 29.41% (n=15), somewhat important by 15.69% (n=8), and not important by 5.88% (n=3) (Table2).

Table (2) Importance of various features in hearing aid selection mobile application.

Features	Very important	Important	Somewhat important	Not important
Availability in multiple languages	(78.43%, n=40)	(17.65%, n=9)	(3.92%, n=2)	(0%)
Compatibility with different types of smartphones and operating systems	(68.63%, n=35)	(27.45%, n=14)	(3.92, n=2)	(0%)
Information about hearing aid insurance coverage	(54.90%, n=28)	(37.25% , n=19)	(7.84%, n=4)	(0%)
Information about available/compatible hearing aid accessories	(50.98%, n=26)	(35.29%, n=18)	(13.73%, n=7)	(0%)
Information on whether the vendor offers hearing aid trials	(49.02%, n=25)	(29.41%, n=15)	(15.69%, n=8)	(5.88%, n=3)
Pricing information	(39.22%, n=20)	(33.33%, n=17)	(19.61%, n=10)	(7.84%, n=4)
Live chat with an Audiologist	(45.1%, n=23)	(39.22%, n=20)	(13.73% , n=7)	(1.96%, n=1)
Connecting with other hearing aid users	(33.33%, n=17)	(23.53%, n=12)	(33.33%, n=17)	(9.80%, n=5)
Reviews and ratings from other hearing aid users	(33.33%, n=17)	(45.10%, n=23)	(11.76%, n=6)	(9.80%, n=5)

Furthermore, the availability of pricing information for different hearing aid models was considered a very important feature by 39.22% (n=20) of the respondents. However, 33.33% (n=17) considered it important, 19.61% (n=10) as somewhat important, and 7.84% (n=4) as not important. Nevertheless, 45.1% of respondents (n=23) considered live chat consultation with an Audiologist to be very important, 39.22% (n=20) as important, 13.73 % (n=7) as somewhat important, and only 1.97% (n=1) deemed it unimportant. In evaluating the feature of connecting with other hearing aid users, responses were distributed as follows: 33.33% (n=17) rated it very important, 23.53% (n=12) as important, 33.33% (n=17) as somewhat important, and 9.80% (n=5) as not important (Table2).

On the other hand, the feature of providing reviews and ratings from other hearing aid users was rated very important by 33.33% (n=17), important by 45.10% (n=23), somewhat important by 11.76% (n=6), and not important by 9.80% (n=5) (Table2).

As part of our study, we evaluated participants' perceptions of a hearing aid selection mobile application. Specifically, we inquired about their willingness to use a hearing aid selection platform incorporating Machine Learning technology. The responses were distributed as follows: Very likely (33.33%, n=7), Likely (23.53%, n=12), Somewhat likely (25.49%, n=13), and Not likely (17.65%, n=9). Additionally, we explored participants' willingness to recommend the hearing aid mobile application, yielding the following results: Very likely (39.22%, n=20), Likely (43.14%, n=22), Somewhat likely (13.73%, n=7), and Not likely (3.92%, n=2) (Table3).

Table (3) Perceptions regarding the hearing aid selection mobile application.

Likelihood	Very likely	Likely	Somewhat likely	Not likely
Likelihood of **using** a hearing aid selection platform	(33.33%, n= 7)	(23.53%, n= 12)	(25.49%, n= 13)	(17.65%, n= 9).
Likelihood of **recommending** to other audiologists/clients a hearing aid selection platform	(39.22%, n=20)	(43.14%, n= 22)	(13.73%, n=7)	(3.92%, n=2)
Likelihood of a hearing aid selection platform being **helpful** for **Audiologists**	(31.37%, n= 16)	(37.25%, n= 19)	(27.45%, n= 14)	(3.92%, n= 2)
Likelihood of a hearing aid selection platform being helpful for **clients**	(33.33%, n= 17)	(35.29%, n= 18)	(21.57%, n= 11)	(9.8%, n= 5)

Furthermore, when participants were inquired about the perceived usefulness of the mobile app for Audiologists in facilitating the hearing aid selection process, responses were categorized as Very likely (31.37%, n=16), Likely (37.25%, n=19), Somewhat likely (27.45%, n=14), and Not likely (3.92%, n=2).

Moreover, participants' opinions on the likelihood of the mobile app being helpful for clients in the hearing aid selection process were obtained as follows: Very likely (33.33%, n=17), Likely (35.29%, n=18), Somewhat likely (21.57%, n=11), and Not likely (9.8%, n=5) (Table3).

4. Discussion

This study found that over half of the participants (54.90%, n=27) encountered occasional difficulty selecting the most appropriate hearing aid style, model, and features among various manufacturers. Moreover, regarding the time allocated to the hearing aid selection process, 41.18% (n=21) spent between 5 and 15 minutes, while 23.53% (n=12) spent between 15 and 30 minutes. This suggests that a substantial amount of time is spent primarily on this process during patient visits.

We investigated the most common client-related factors Audiologists consider when recommending hearing aid. Among the most prevalent factors were the degree of hearing loss (100.00%, n=51), the configuration of hearing loss (92.16%, n=47), the age (92.16%, n=47), the type of hearing loss (86.27%, n=44), cosmetic preferences (86.27%, n=44), lifestyle (80.39%, n=41), dexterity (80.39%, n=41), and budget (68.63%, n=35).

These factors are crucial for designing and developing a hearing aid selection mobile application to provide more personalized recommendations.

Furthermore, participants mentioned "use of eyeglasses" and "client expectations" as other client-related factors.

In addition, participants were asked about the hearing aid functions they believed clients were most interested in. Common responses included noise reduction (82.35%, n=42), speech enhancement (78.43%, n=40), wireless connectivity (74.51%, n=38), feedback suppression (72.55%, n=37), water resistance (72.55%, n=37), volume control (70.59%, n=36), rechargeable batteries (64.71%, n=33), directionality (58.82%, n=30), and wind suppression (58.82%, n=30). It is necessary to clarify the functionalities of each type of hearing aid to determine whether a particular hearing aid model possesses them in order to satisfy clients and provide a more comprehensive view of the devices. Other participants suggested additional functions, such as "auto memory switching," "phone adjustments," "motion sensors, Bluetooth, mobile apps," and "tinnitus management/masker."

Furthermore, the study highlights several important features identified by audiologists that should be incorporated into mobile applications designed to assist in hearing aid selection.

4.1. Essential Features

One of the application's most important features is its availability in multiple languages, with 78.43% (n=40) rating it as "Very Important." This highlights the importance of recognizing linguistic differences among users.

In addition, 68.63% of participants (n=35) strongly indicated that compatibility with multiple smartphones and operating systems is a critical feature. This can be attributed to the wide variety of devices users own, leading to the need for a flexible and convenient application.

Further, 54.90% (n=28) of participants emphasized the importance of adding information about hearing aid insurance coverage. This may be due to the variation in insurance coverage policies in Saudi Arabia for hearing aid devices. Additionally, 50.98% (n=26) of participants were interested in additional information regarding hearing aid accessories, possibly intended to enhance the client's experience with hearing aids.

Moreover, 49.02% of participants (n=25) believed that providing information regarding hearing aid trials was crucial. This suggests that potential hearing aid users prioritize the opportunity to try a hearing aid before making a purchase decision.

Further, the live chat feature for consultation with an Audiologist was also highly valued by 45.1% (n=23) of participants. This aligns with the studies done by both Paglialonga et al. (2018) and Thorén et al. (2014) that demonstrated the importance of audiologist consultation [11, 12]. This indicates a strong demand for real-time consultation features, possibly due to hearing aid use's unique and personalized nature.

Further, 39.22% of participants (n=20) deemed pricing information a very important feature, demonstrating the importance of making pricing information transparent and accessible to users.

As a final point, 33.33% (n=17) of users rated connecting with other users as "Very Important," and the same percentage rated it as "Somewhat Important." To focus on the features that need to be added to the mobile application, we have decided that categorizing this as an essential feature is the most convenient approach. This also resonates with the findings of both Paglialonga et al. (2018) and Thorén et al. (2014), in which peer-to-peer interactions were highlighted [11, 12].

According to the gathered preferences, the eight features mentioned above—pricing information, hearing aid trials, compatibility with different smartphones and operating systems, connecting with other users, insurance coverage, compatibility with hearing aid accessories, Live chat feature, and multi-language support—are considered essential for inclusion in a hearing aid selection mobile application.

4.2. Nice To Have Features

This includes the feature that a significant number of participants perceived as "important." Nearly half of respondents (45.10%, n= 23) recommended adding the feature of user reviews and ratings. Possibly, this is due to the desire to share personal experiences with hearing aids with others [13]. This observation is broadly supported by Paglialonga's findings in 2018 [12].

This feature is not critical, but it can enhance the user experience.

4.3. Features that the participants suggested

In addition to those listed in the survey, participants were asked if they had any additional suggestions based on their experiences. One participant suggested a "simulator feature with two phases: 1) a hearing loss simulator based on the entered audiogram, and 2) an aided simulator to illustrate speech discrimination improvements in different environments, aiding patients in forming realistic expectations".

Another participant recommended "optimization and accessibility for different disabilities (speech-to-text for vision disabilities, haptic feedback)." Furthermore, three participants proposed adding pictures of available/recommended hearing aids, vendor locations on a map, updated working hours, contact information, and details about where the hearing aids are manufactured and their country of origin. Additionally, hearing aid usage and maintenance instructions were suggested, with an emphasis on adding information on battery changing for older individuals, particularly those with vision issues.

4.4. Participants' Perceptions:

In the concluding phase of the investigation, the study delved into participants' perceptions regarding a machine learning-based hearing aid selection mobile application. According to statistical results, participants are willing to adopt such innovative solutions.

Notably, a substantial portion of the participants were strongly willing to use the application. This is evident by 33.33% (n=7) categorizing their likelihood to use this application as "very likely" and 23.53% (n=12) as "likely." Furthermore, participants expressed a considerable tendency to recommend the mobile application to other audiologists or clients.

According to 39.22% (n=20), the hearing aid selection mobile application is "very likely" to be helpful to Audiologists, and 43.14% (n=22) believe it is "likely," reflecting an optimistic viewpoint on the application's professional utility. Similarly, optimism was evident regarding the application's efficacy in aiding clients during the hearing aid selection process, with 33.33% (n=17) indicating that the mobile application is "very likely" to be helpful to the client and 35.29% (n=18) deeming it "likely."

Based on the findings above, our study suggests that a machine learning-enabled hearing aid

selection mobile application is expected to be widely accepted and endorsed by both audiologists and clients. These findings should provide valuable insights for developers to build applications that facilitate and improve the hearing aid selection process for Audiologists and clients. These viewpoints were adopted by both Wasmann in 2012 and Paglialonga in 2018 [3, 12].

4.5. Limitations

The small sample size of this study is one of its main limitations. Therefore, it is not possible to generalize its findings. However, we must acknowledge that we did not intend to generalize the results; rather, we aimed to prioritize the findings to guide future interventions. In addition, our findings are limited by the lack of existing literature that would allow a comprehensive comparison to be made. The lack of contextual information highlights the need for further research to improve our results' reliability and applicability.

5. Conclusion

The outcomes of this study are to automate the HA selection process, improve selection accuracy, provide wider accessibility, and improve patient satisfaction.

This application has the potential to transform the way audiologists and clients approach HA selection by providing recommendations on the most suitable HA device based on audiometric and patient data. Compared with the current process, this mobile application can help audiologists and clients make better decisions and save time and effort. This application is particularly useful for individuals who live in rural areas and have difficulty traveling to hearing aid vendors or an audiologist's office. The future of hearing aids will be marked by even more innovative solutions as technology continues to evolve.

5.1 Recommendations

This study represents the first phase of developing a hearing aid selection mobile application, focusing on the features that should be included in the application from the perspective of audiologists. Future investigations should examine both unmentioned features and those suggested by participants. A subsequent study should focus on the client's perspective on the key features critical to the application's efficacy. Following the application's development, a pilot study is recommended to be conducted to assess its usability, effectiveness, and adoption rate.

6. Declarations

6.1 Abbreviations

Hearing Loss (HL).

World Health Organization (WHO).

Hearing Aid (HA).

Noise Reduction (NR).

Mobile Health (Mhealth).

Low- and Middle-Income Countries (LMICS).

Machine Learning (ML).

Statistical Package for the Social Sciences (SPSS)

6.2 Conflict of Interest Statement

The authors have no conflict of interests to declare.

6.3 Funding Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

6.4 Ethical Considerations

The ethical approval was taken from King Abdullah International Research Center with approval number IRB/2096/23.

6.5 Acknowledgements

None.

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