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# Rehabilitation with hearing aids for individuals with unilateral hearing loss: a systematic review

## Reabilitação com prótese auditiva em indivíduos com perda auditiva unilateral: revisão sistemática

## Rehabilitación con prótesis auditiva en indivíduos con pérdida auditiva unilateral: revisión sistemática

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***Abstract***

**Objective:** To determine, using a systematic review, the auditory rehabilitation results through hearing aids in individuals with Unilateral Hearing Loss (UHL), in terms of speech recognition skills in competitive noise, location of the sound source, satisfaction and usage time of the hearing aid. **Methods:** The literature review was performed in the databases Cochrane, Lilacs, Medline, Pubmed and Scielo, searching for published studies between 1997 and 2017, with the following descriptors in Portuguese: perda auditiva unilateral e auxiliares de audição; and in English: unilateral hearing loss and hearing aids. The selection criteria of the studies were, sample of individuals presenting UHL, aged at least 18, who had been submitted to results evaluations for speech recognition research recognition in the presence of noise and/or location of the sound source and/or satisfaction and/or usage time of hearing aid, pre and post-adaptation of hearing aid. **Results:** After the bibliographical survey, six articles were analyzed. **Conclusion:** There was a shortage of studies aimed at the investigation of the rehabilitation by hearing aids in individuals presenting UHL. Although most studies show benefit and satisfaction with hearing aid

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**Authors' Contributions:**
LDC participated in the study design, data collection, analysis, interpretation and writing of the article
MDM participated in data collection and analysis
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adaptation, part of this population does not use it. The adaptation of hearing aids in this population should be encouraged, taking into account the evaluation of the communicative demand of each individual, their participation restriction, the main auditory complaints of this individual before and after adaptation and the programming adjustment of the hearing aid.

***Keywords:*** Unilateral hearing loss; Hearing aids; Adults; Elderly.

## *Resumo*

**Objetivo:** Determinar, por meio de uma revisão sistemática, os resultados auditivos da reabilitação por meio de prótese auditiva em indivíduos com Perda Auditiva Unilateral (PAUn), no que se refere às habilidades de reconhecimento de fala na presença de ruído competitivo, localização da fonte sonora, satisfação e tempo de uso da prótese auditiva. **Método:** O levantamento bibliográfico foi realizado nas bases de dados Cochrane, Lilacs, Medline, Pubmed e Scielo, buscando triar estudos publicados entre 1997 e 2017, com os seguintes descritores em português: perda auditiva unilateral e auxiliares de audição; e em inglês: unilateral hearing loss e hearing aid. Os critérios de seleção dos estudos foram, amostra de indivíduos com PAUn, com idade mínima de 18 anos, que tivessem sido submetidos a avaliações de resultados voltados para a investigação do reconhecimento de fala na presença de ruído e/ou localização da fonte sonora e/ou satisfação e/ou tempo de uso da prótese auditiva, pré e pós-adaptação de prótese auditiva. **Resultados:** Após o levantamento bibliográfico, seis artigos foram analisados. **Conclusão:** Observou-se escassez de estudos voltados para a investigação da reabilitação por meio de prótese auditiva em indivíduos com PAUn. Apesar da maioria dos estudos demonstrarem benefício e satisfação com a adaptação de prótese auditiva, parte desta população não faz uso da mesma. A adaptação de prótese auditiva nesta população deve ser incentivada, levando em consideração a avaliação da demanda comunicativa de cada indivíduo, sua restrição de participação, principais queixas auditivas deste indivíduo pré e pós-adaptação e do ajuste de programação da prótese auditiva.

***Palavras-chave:*** Perda auditiva unilateral; Auxiliares de audição; Adultos; Idosos.

## *Resumen*

**Objetivo:** Determinar, a través de una revisión sistemática, los resultados auditivos de la rehabilitación por medio de prótesis auditivas en individuos con Pérdida Auditiva Unilateral (PAUn), en lo que se refiere a las habilidades de reconocimiento de habla en la presencia de ruido competitivo, localización de la fuente sonora, satisfacción y tiempo de uso de la prótesis auditiva. **Metodos**: El estudio de la literatura se realizó en las bases de datos Cochrane, Lilacs, Medline, Pubmed e Scielo buscando clasificar estudios publicados entre 1997 y 2017, con los siguientes descriptores en portugués: perda auditiva unilateral y auxiliares de audição; y en inglés: unilateral hearing loss e hearing aid. Los criterios de selección de los estudios fueron, muestras de individuos con PAUn, con edad mínima de 18 años, que hubieran sido sometidos a evaluaciones de resultados dirigidos a la investigación del reconocimiento de habla en la presencia de ruido y / o localización de la fuente sonora y / o satisfacción y / o tiempo de uso de la prótesis auditiva, pre y post-adaptación de prótesis auditiva. **Resultados**: Después de los estudios bibliográficos, seis artículos fueron analizados. **Conclusión**: Se observó escasez de estudios orientados a la investigación de la rehabilitación por medio de prótesis auditiva en individuos con PAUn. Aunque la mayoría de los estudios demuestran beneficio y satisfacción con la adaptación de la prótesis auditiva, parte de esta población no hace uso de la misma. La adaptación de prótesis auditiva en esta población debe ser incentivada, teniendo en cuenta la evaluación de la demanda comunicativa de cada individuo, su restricción de participación, principales quejas auditivas de este individuo pre y post-adaptación y del ajuste de programación de la prótesis auditiva.

***Palabras clave:*** Pérdida auditiva unilateral; Auxiliares de audición; Adultos; Ancianos.

## Introduction

Unilateral hearing loss (UHL) can be mild to profound in the affected ear. Hearing rehabilitation in cases of profound UHL, in which residual hearing is not amenable to sound amplification, is widely documented in the literature. Being this rehabilitation performed through the Contralateral Routing Signal (CROS) system, hearing aids anchored in the bone or through the cochlear implant.

However, there is a gap to be filled in the literature regarding the outcomes of rehabilitation in cases of UHL, which present residual hearing amenable to amplification by hearing aids, in relation to speech recognition skills in the presence of competitive noise, sound localization, satisfaction and hearing aid use time.

Current trends in hearing rehabilitation in UHL cases reflect a renewed interest in the functional impact of this type of sensory deprivation and also in the advances in technology that have made interventions more effective and more attractive to patients.

According to several studies[1-6], individuals with UHL may present academic difficulty, speech and language alteration, central auditory processing deficit and social and emotional difficulties. The negative impact generated by this type of sensory deprivation on communicative functions is associated with the advantages of binaural hearing compared to monaural hearing, regarding the sound source localization, summation phenomenon, elimination of head shadow effect, improved speech recognition in the presence of competitive noise and less effort to listen[7,8].

Thus, in order to provide the patient with binaural hearing again, in cases of UHL, the use of hearing aids is recommended for those individuals with difficulties in social and/or professional integration and residual hearing amenable to amplification[9]. However, the indication of hearing aids for this population is something complex, multifactorial and unique, thus representing a challenge for professionals involved in the hearing rehabilitation process[10,11].

This population has specific complaints regarding speech recognition, especially in the presence of competitive noise, difficulty in sound source localization and greater effort to listen[1,12]. This makes the process of hearing rehabilitation complex because individuals affected by this type of sensory deprivation can present satisfactory communicative performance in favorable communicative situations, since the contralateral ear has normal hearing.

Thus, the situations in which they report difficulties are singular and inconstant, which hinders both the perception of their daily communicative difficulties, as well as the perception of the benefit generated by the sound amplification and also the professional's ability to measure these difficulties and adapt rehabilitation strategies through hearing aids in this population.

Also, individuals with UHL may discontinue the use of hearing aids, due to the lack of benefit or discomfort generated by sound amplification, or due to interference that may occur in the best ear, in cases of great amplification in the ear adapted with the hearing aid, in more severe losses [12].

However, long periods of sensory deprivation, whether partial or complete, generated by not using the hearing aid in the ear with sensory deprivation, can cause the phenomenon known as hearing deprivation[13]. Failure to use the hearing aid causes a gradual deterioration in hearing performance over time, which can be observed through the reduction of speech recognition, which is associated with the reduction of acoustic information received by this ear[13,14].

Thus, this study aimed to determine, by means of a systematic review, the hearing outcomes of hearing aid rehabilitation in individuals with UHL, regarding speech recognition skills in the presence of competitive noise, sound source localization, satisfaction and hearing aid use time. Seeking, through this review, to offer knowledge for best practices in the process of hearing rehabilitation of this population.

## Methods

### *Search Strategy*

The first stage of the research consisted in the elaboration of the guiding question for the literature review: "What are the hearing outcomes provided by the rehabilitation of individuals with UHL, performed by hearing aid and the use time of sound amplification by these individuals?".

The systematic review of the scientific literature was based on the search for studies in Portuguese and English, published in the last twenty years (between 1997 and 2017). The searched da-

tabases were: Cochrane, Lilacs, Medline, Pubmed and Scielo.

To define the descriptors, the structured vocabulary of the Health Sciences Descriptors (DeCS) in Portuguese was used, as well as the descriptors indexed in the Medical Subject Headings (MeSH) in English. Thus, the descriptors used were: in Portuguese, "adulto" OR "idoso" AND "perda auditiva unilateral" AND "auxiliares de audição" and in English, "adult" [MeSH] OR "elderly" [MeSH] AND "unilateral hearing loss" [MeSH] OR "deafness unilateral" OR "unilateral deafness" AND "aid hearing" OR "aids hearing" [MeSH] OR "hearing aid" OR "ear molds" OR "ear mold" OR "mold ear" OR "molds ear" AND "rehabilitation" [MeSH].

However, at the end of the survey, it was observed that articles of fundamental importance to the theme in question were missing and would not be located using the descriptors in this way. Thus, a second bibliographic survey was performed in the same databases, performing a broader search, using as main terms "perda auditiva unilateral" AND "auxiliares de audição", in Portuguese and "unilateral hearing loss" AND "hearing aid", in English.

### *Selection criteria*

The inclusion criteria of the studies were articles that assessed individuals with UHL, at least 18 years old, who had undergone outcome assessments aimed at investigating speech recognition in the presence of noise and/or sound source localization and/or satisfaction and/or hearing aid use time by the assessed individuals, before and after hearing aid fitting, being the clinical trial, experimental, quasi-experimental, prospective, descriptive, case study, cohort or epidemiological studies.

### *Data analysis*

Initially, the studies were searched in all databases cited using the predetermined keywords. The outcome of this search was blindly analyzed by two reviewers who read the titles and abstracts of each article and should answer the following questions:

- Does the study answer the guiding question of this research?
- Does the study meet the selection criteria for this research?

After completing this step, the selected works were read in full, verifying the aspects related to the research objective, the methodology used (type of study, sample and assessments performed), the outcomes obtained before and after hearing aid fitting and the completion of each study. The data extracted from this selection were recorded in forms.

All discrepancies found in the analysis of the studies were resolved through discussion among the reviewers.

## Results

### *Outcomes in the electronic databases*

As an outcome of the search, were found in the searched databases, 355 studies using the descriptors in Portuguese and 1343 in English, totaling 1698 studies. Soon after, 840 duplicate studies were excluded, which were found in more than one database and also in the Portuguese and English searches. Of the 858 studies remaining, after reading the titles and abstracts, only six met the criteria of this research, which were analyzed in the present review (Chart 1).

**Chart 1.** Reference of articles included in the literature review

| Included Articles |
|---|
| Bishop CE, Hamadain E, Galster JA, Johnson MF, Spankovich C, Windmill I. Outcomes of Hearing Aid Use by Individuals with Unilateral Sensorineural Hearing Loss (USNHL). J Am Acad Audiol. 2017; 28(10):941-9. |
| Golub JS, Lin FR, Lustig LR, Lalwani AK. Prevalence of adult unilateral hearing loss and hearing aid use in the United States. The Laryngoscope. 2017; 29:1-6. |
| José MR, Campos PD, Mondelli MFCG. Unilateral hearing loss: benefits and satisfaction from the use of hearing aids. Braz Otorhinolaryngol. 2011; 77(2):221-8. |
| Lee DH, Noh H. Prediction of the use of conventional hearing aids in Korean adults with unilateral hearing impairment. Int J Audiol. 2015; 54(9):613-9. |
| Mondelli MFCG, Santos MM, José MR. Speech perception in noise in unilateral hearing loss. Braz J Otorhinolaryngol. 2016; 82(4):427-32. |
| Mondelli MFCG, Jacob RTS, Ribeiro JP, Felici MGFM, Sanches RCP. Unilateral hearing loss: the benefit of auditory localization after adaptation of hearing aids individual. Arq Int Otorrinolaringol. 2010; 14(3):309-15. |

## Discussion

According to the systematic review of the literature, it was possible to observe a scarcity of studies that investigated the rehabilitation of individuals with UHL through hearing aids in adults. After rigorous assessment, six studies that addressed the theme in question were analyzed.

The studies selected for this research presented a varied methodology, which investigated different aspects related to the use of hearing aids by individuals with UHL. As can be seen in the chart below (Chart 2).

Regarding the outcome of sound amplification in relation to speech recognition in silence and in the presence of competitive noise, two studies[10,15] used distinct assessments performed in the sound field for this investigation, which also found divergent outcomes regarding speech recognition speech.

In one of the studies analyzed[15], the researchers observed through the Word Recognition Scores (WRS) and Quick Speech in Noise Test (QuickSIN) tests, that the use of hearing aids by the research participants had limitations. There was a slight worsening of speech recognition-related outcomes with the use of hearing aids, when the research participants were assessed in silence by the WRS test. Regarding speech perception in noise, assessed by QuickSIN, with the use of hearing aids, when assessed with speech and frontal noise and when the speech was directed to the side of the best ear and the noise directed to the side of the ear with hearing loss, the individuals presented worse speech recognition performance. In both cases, the noise was amplified and probably caused some interference. However, hearing aids provided considerable benefit when speech was directed to the ear with hearing loss and noise directed to the best ear.

The authors also reported that the reduction in speech recognition with the use of hearing aids, although statistically significant, had no impact on individuals according to self-assessment questionnaires.

These outcomes illustrate the difficulty in the perception of benefit by patients with UHL in certain communicative situations, which oscillate in daily life. These findings also serve as a warning to speech therapists about the need to use specific programming algorithms for noise reduction and speech emphasis, seeking the best possible speech recognition in unfavorable communication situations for this population.

In the second study[10] that investigated the benefit of speech recognition using hearing aids in individuals with UHL, using the Hearing In Noise Test (HINT - Brasil), the researchers observed that both in silence and in noise, individuals improved their speech recognition performance in the different positions assessed (speech in silence, speech with frontal noise, speech with noise presented on the right and speech with noise presented on the left), which demonstrated benefit with the sound amplification in this population in relation to speech recognition.

Regarding the sound localization ability, one of the analyzed studies[16] investigated the benefit of hearing aid fitting in individuals with UHL, us-

**Chart 2.** Analysis of the studies that comprised the systematic review

| Authors | Type of study | Sample | Intervention | Assessment method | Assessed aspects | Assessments performed |
|---|---|---|---|---|---|---|
| Bishop et al.[15] | Quasi-experimental | 22 individuals with different degrees of sensorineural UHL, with residual hearing amenable to sound amplification | Behind-the-ear hearing aid | Before and after (3 months) hearing aid fitting | Speech recognition in silence and noise Subjective benefit of hearing aids | WRS QuickSIN APHAB questionnaire SSQ49 questionnaire |
| Golub et al.[11] | National epidemiological | Individuals with different types and degrees of UHL, with residual hearing amenable to sound amplification | Observation of the use of hearing aids as a form of rehabilitation in individuals with UHL | Interview Analysis of a Database | Use of hearing aid | Interview Analysis of a Database |
| José, Campos e Mondelli[18] | Contemporary cross-sectional cohort | 15 individuals with moderate-to-profound mixed or sensorineural UHL, with residual hearing amenable to sound amplification | Did not specify the type of hearing aid used by individuals | Assessment of hearing aid users effectively for over six months | Objective and subjective benefit Satisfaction Hearing aid use time | In situ measurements IOI-HÁ questionnaire |
| Lee e Noh[19] | Retrospective | 119 individuals with different types and degrees of UHL, with residual hearing amenable to sound amplification | Analog and digital hearing aids of different models (behind-the-ear, intra canal, micro canal) | Interview 6 months after fitting | Use time and predictors of effective use of hearing aids | Medical records review and interview |
| Mondelli, Santos e José[10] | Not described in the study | 30 individuals with moderate and severe sensorineural UHL, effective users of hearing aids | Behind-the-ear hearing aid | Before and after (3 months) hearing aid fitting | Speech recognition in silence and noise | HINT–Brasil |
| Mondelli et al.[16] | Contemporary cross-sectional cohort | 31 individuals with UHL of different types and degrees of hearing loss, effective users of hearing aids | Did not specify the type of hearing aid used by individuals | Before and after (minimum 6 months) hearing aid fitting | Sound source localization | Sound source localization auditory skill questionnaire |

Legend: QuickSIN=Quick Speech in Noise Test; WRS=Word Recognition Scores; APHAB=Abbreviated Profile of Hearing Aid Benefit; SSQ49=Speech, Spatial, and Qualities of Hearing Scale; IOI-HA=International Outcome Inventory for Hearing Aids; HINT–Brasil=Hearing In Noise Test

ing the Sound Source Localization Auditory Skill Questionnaire. The authors observed a statistically significant improvement for all variables considered in the questionnaire with the use of hearing aids, that is, there was a benefit with hearing aid fitting in relation to the sound source localization in this population.

The sound source localization is one of the main complaints reported by individuals with UHL. Since hearing is a binaural process, by comparing the two auditory inputs, the brain can solve acoustic complexities, determine the direction of sound and perfect a relevant signal in the presence of other competitive sounds or noises[17]. Thus, the improvement in this hearing ability through the use of hearing aids also favors speech recognition and reduces the effort to listen.

Regarding the benefit and satisfaction regarding the use of hearing aids in the studied population, in one of the analyzed articles[18], which used in situ measurements and the International Outcome Inventory for Hearing Aids (IOI-HA) questionnaire to assess its participants, the researchers observed that satisfaction in individuals with hearing aids in cases of UHL is not fully correlated with the prescribed gain. Even though the target was not reached in some frequencies, the individuals showed satisfaction regarding the use of hearing aids.

Regarding the subjective benefit assessed through questionnaires, one of the analyzed studies[15] used the Abbreviated Profile of Hearing Aid Benefit questionnaire (APHAB) and the Spatial, and Qualities of Hearing Scale questionnaire (SSQ49), which are two commonly used questionnaires. and documented in research. Although APHAB has received visibility in research published since its inception, the normative data for this questionnaire are not based on individuals with UHL. SSQ49, however, was developed as a measure that is arguably more sensitive to benefit from hearing aid use in cases of UHL. The authors of this study noted for both APHAB and SSQ49 that amplification generally reduces the overall number of hearing problems reported by individu-

als with UHL. In particular, the SSQ49 questionnaire showed significant differences between the situations assessed without and with hearing aids.

Questionnaires aimed at assessing subjective benefit from the use of sound amplification are well-established measures in the academic and clinical setting. Thus, self-assessment questionnaires are used to complement the assessment of objective tests related to the hearing aid fitting process and their use is also recommended in cases of UHL[18].

Although most of the studies analyzed have shown that hearing aid rehabilitation in cases of UHL provided benefit and satisfaction in most of the individuals assessed, the indication and use of hearing aids in this population is a widely discussed aspect among physicians and speech therapists.

In one of the studies analyzed[11], the researchers revealed that of 18 million adult Americans affected by UHL, only 11% of them used hearing aids. This shows that the incidence of UHL is high, but hearing aid rehabilitation in this population is low, even for individuals with hearing complaints, which demonstrates that not using the hearing aid is not only linked to lack of knowledge of hearing loss.

In another study[15], the authors observed that of the 22 individuals assessed three months after fitting, most of them (59%) chose to continue using the hearing aid after their participation in the study, while 41% gave up the use of hearing aids.

Still, according to another study[18], most of the individuals assessed used the hearing aid, even for less time than considered ideal.

Other researchers[19], who assessed 119 adults with UHL, six months after fitting the hearing aid, observed that 58% of the individuals assessed made effective use of the hearing aid, 10.1% were intermittent users and 31.9% of the individuals chose not to use the hearing aid. Also, according to the authors, the predictors of hearing aid use in individuals with UHL included work activities, that is, greater communicative demand and digital signal processing.

These findings demonstrated that despite having complaints related to hearing and benefit provided by sound amplification, regarding speech recognition, sound source localization and satisfaction, individuals with UHL may discontinue the use of hearing aids.

Thus, as exposed in the studies analyzed, it is necessary to encourage the hearing aid fitting in this population, considering the benefits provided by sound amplification, seeking to minimize the difficulties imposed by this type of sensory deprivation.

However, according to the analysis of the studies, it is necessary that the professionals involved in this rehabilitation process are aware of the restriction of participation of these individuals, the expectation with the use of hearing aids, the communicative demand, the before and after fitting assessment of the main complaints reported by these patients, such as speech recognition in adverse situations, sound source localization, in order to verify the real benefit with hearing aid fitting and also hearing aid programming adjustments.

Thus, due to the various aspects that should be taken into consideration during the rehabilitation process of this population and also due to the methodological variability and outcomes found in the studies analyzed, further research is needed to better understand the characteristics and peculiarities of hearing aid fitting in this population to better meet the demands of these patients during the hearing aid selection and verification process.

## Conclusion

The diversity of the assessed aspects and their outcomes in the few studies related to the investigation of the rehabilitation of individuals with UHL, through hearing aids, demonstrates that the hearing rehabilitation in this population is something complex that deserves special attention from the team involved in this process.

Considering the effects of hearing deprivation and most studies have shown benefit and satisfaction with the hearing aid fitting in this population, the use of hearing aids should be encouraged, taking into account several aspects, such as assessment of the communicative demand of each individual, of their participation restriction, the main hearing complaints of this individual before and after fitting and the hearing aid programming adjustment.

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