Sofia Margarida Marques de Paiva

# Age Related Hearing Loss: Social and Emotional Impact Clinical Study

Tese do Programa de Doutoramento em Ciências da Saúde, ramo de Medicina
Orientada por Professor Doutor Francisco José Franqueira Castro Sousa e Professor Doutor Jean-Pierre Bébéar
e apresentada à Faculdade de Medicina da Universidade de Coimbra

Março de 2017

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UNIVERSIDADE DE COIMBRA

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**2017**

## On the front cover

## Imagem da capa

This photo represents a centenary oak tree from my grandparents' farm. It is a large tree that has been in the property of our family for generations transmitting strength and dignity. This image stands for one of the objectives of this work, that in a near future our patients can grow old in harmony next to their loved ones and in society, able to hear the words of the younger people; only this way will they be able to transmit all the knowledge they have acquired throughout life to future generations.

Na fotografia da capa desta dissertação encontra-se uma das carvalhas da propriedade que era dos avós, Maria Julieta e Afonso. Trata-se de uma árvore centenária, de grande porte que atravessou gerações com dignidade. Esta imagem pretende representar um dos objetivos do trabalho, que no futuro os nossos doentes venham a envelhecer em harmonia com a família e em sociedade, capazes de ouvirem as palavras dos mais novos pois só desta forma será possível transmitir às gerações futuras todos os conhecimentos que adquiriram no seu percurso.

Tese apresentada à Universidade de Coimbra para candidatura ao grau de Doutor em Ciências da Saúde, ramo de Medicina, especialidade de Otorrinolaringologia, realizada sob a orientação científica do Professor Doutor Francisco José Franqueira Castro Sousa e do Professor Doutor Jean-Pierre Bébéar.

## Acknowledgements

## Agradecimentos

A conclusão de um projeto de doutoramento é o resultado de um longo e exigente trabalho individual e solitário pautado por desafios, incertezas e alegrias. Porém, nunca seria possível a sua concretização sem o suporte de uma enorme rede de apoios individuais, institucionais e afetivos aos quais me cabe uma palavra de reconhecimento.

Assim, gostaria de dirigir um agradecimento especial aos meus orientadores.

Ao Professor Doutor Francisco Castro e Sousa que me acompanhou, primeiro no meu percurso de estudante na Faculdade de Medicina da Universidade de Coimbra e, mais tarde, como orientador da minha tese de Mestrado, tenho de agradecer o permanente estímulo e as muitas palavras sábias de mestria e motivação. Obrigada pela amizade e confiança que sempre me demonstrou.

Au Professeur Docteur Jean-Pierre Bébéar de la Clinique Universitaire d'O.R.L - Bordeaux II, ma profonde reconnaissance et l'expression de ma plus affectueuse gratitude pour sa disponibilité, son soutien, son intérêt et pour l'énorme appuie à tous mes projets de recherche. Merci pour l'amitié, l'accueil chaleureux, la confiance, l'encouragement et les permanents conseils.

Ao Dr. Pedro Tomé, meu orientador de formação em Otorrinolaringologia e atual Diretor do Serviço de Otorrinolaringologia do Centro Hospitalar e Universitário de Coimbra uma palavra de reconhecimento e gratidão pelo incentivo e amizade que sempre me dedicou.

To Professor Craig Newman, from the Cleveland Clinic, Head & Neck Institute, United States of America for all the invaluable advices and suggestions on the study protocol validation.

À Professora Doutora Isabel Carreira os meus sinceros agradecimentos pela colaboração, pelo rigor científico e pelo constante estímulo determinantes para a minha progressão.

À Dra. Helena Donato pela imprescindível ajuda na pesquisa bibliográfica, pela sua enorme disponibilidade e simpatia expresso o meu reconhecimento.

A todos os colegas do Serviço e em particular à Dr.ª Ana Margarida Amorim que com grande dedicação e espirito de sacrifício me substituiu durante a ausência do Serviço, cabe-me uma palavra especial de agradecimento e amizade.

Ao Professor Doutor João Carlos Ribeiro agradeço pelo estímulo científico e companheirismo.

Ao Dr. José Romão pelo constante incentivo.

Ao Dr. João Filipe Simões, simultaneamente, um colega e amigo incansável presente mesmo nos momentos difíceis deste percurso, digo simplesmente obrigada!

Aos audiologistas do Serviço de Otorrinolaringologia do Centro Hospitalar e Universitário de Coimbra, em especial à Dr.ª Elisabete Grade, agradeço o auxílio e dedicação prestados.

A todos os profissionais do Serviço exprimo o meu reconhecimento pelo apoio demonstrado.

Aos meus Pais pelo exemplo que sempre me deram como seres humanos e como profissionais; por estarem sempre presentes. Seja-me permitida uma referência especial ao meu Pai que me transmitiu a paixão, o rigor, o respeito pelo doente e a nobreza desta especialidade.

Ao Miguel pelo afeto, pelo carinho e pela força demonstrada em momentos, às vezes, difíceis!

Ao Bruno que me fez voltar a acreditar, a quem fico devedora de muita serenidade e paciência em alguns momentos adversos.

À minha querida Júlia, fonte de energia e inspiração.

Aos meus Avós e muito em especial ao Avô Afonso que entendeu os meus sacrifícios e acreditou no meu trabalho.

Ao Diogo que é a minha vida. O teu sorriso doce foi a força que me permitiu concluir este trabalho.

The studies presented in this thesis were carried out at the Department of Otorhinolaryngology, Centro Hospitalar e Universitário de Coimbra, Portugal.

All the data and research material and methods is available on the manuscript.

The Author declare that there is no conflict of interest.

## Table of Contents

## Resumo

A presbiacusia ou surdez neurossensorial relacionada com a idade é uma patologia multifatorial caraterizada por perda progressiva da audição. No início da sintomatologia as frequências agudas são as mais afetadas, embora a apresentação da presbiacusia possa ser variável. Estas frequências da audição são responsáveis pelo reconhecimento da palavra no discurso oral, é por esse motivo que estes doentes, mais do que surdez, referem dificuldade em perceber as palavras.

A presbiacusia afeta aproximadamente dois terços da população mundial com idade superior aos 70 anos e a sua prevalência aumenta ao mesmo ritmo do envelhecimento. Não sendo uma surdez exclusiva da terceira idade, cerca de 80% dos casos ocorrem em idosos.

Dado o início insidioso da patologia e a progressão lenta da perda auditiva, o diagnóstico da presbiacusia pode ser protelado levando a um isolamento social do doente, que não compreende o que lhe dizem, com um enorme impacto na qualidade de vida.

A principal preocupação que tínhamos com estes doentes prendia-se com a perda auditiva evidenciada pelo audiograma, mas não podemos negligenciar de todo o impacto social e emocional que os doentes podem manifestar. Um diagnóstico multidisciplinar está assim na ordem do dia.

O nosso estudo teve início com a criação de uma base de dados em 2010, em que foram incluídos os doentes com presbiacusia observados em consulta externa do Serviço de Otorrinolaringologia do Centro Hospitalar e Universitário de Coimbra; foram identificados um total 2643 casos dos quais 50,7% eram do sexo masculino e 49,3% do sexo feminino. A distribuição dos doentes em termos de estrato etário foi semelhante para os dois sexos e a media de idades foi de 69,6 anos. Estes doentes eram seguidos regularmente em consulta externa e nesse sentido pareceu-nos importante selecionar um questionário que nos permitisse avaliar o impacto na qualidade de vida relacionado com a presbiacusia. A partir de uma revisão sistematizada da literatura, selecionamos o *Hearing Handicap Inventory for Elderly* (HHIE), uma "ferramenta" importante, com adaptações para múltiplas línguas e em que todas as versões foram validadas mantendo as características psicométricas da versão original.

Iniciamos assim o nosso trabalho com a tradução do HHIE para a língua Portuguesa. Foram testadas as correlações individuais em cada item e o *score* final do questionário. Correlacionamos as variáveis demográficas e clinicas com o *score* final. Avaliamos a consistência interna, variabilidade teste-reteste e validade discriminante. A reprodutividade e consistência interna geral dos itens foi observada por um valor alto do alfa de Cronbach (0,79). No final verificou-se que o *score* elevado do HHIE estava relacionado com limiares auditivos mais elevados. Foi assim possível proceder à sua adaptação e validação para a população estudada, confirmando as propriedades psicométricas do HHIE. Gostaríamos ainda assim de destacar a importância deste instrumento de trabalho para avaliar o handicap psicossocial dos doentes idosos com presbiacusia.

Não há tratamento para a presbiacusia, no entanto existem múltiplas opções que permitem compensar a perda auditiva e melhorar o estado geral dos doentes. Em termos gerais considera-se que os doentes com um limiar auditivo a partir dos 40 decibéis no audiograma tonal têm indicação para uma opção de reabilitação auditiva, com recurso a próteses ou implantes auditivos (de ouvido médio, de condução óssea e cocleares).

Na vasta amostra do nosso estudo (2643) apenas um pequeno número, 3.14%, usavam próteses auditivas; destes 67.45% eram do sexo feminino. Perante um baixo número de doentes que recorreram a esta hipótese de reabilitação auditiva optamos por selecionar um questionário que nos permitisse avaliar o grau de satisfação dos doentes que usam próteses auditivas; selecionamos assim o *International Outcome Inventory for Hearing Aids* (IOI-HA) que tem sido utilizado e foi validado em varias línguas. Validar e implementar o IOI-HA na população portuguesa foi um dos objetivos da nossa tese. No nosso estudo prospetivo foram testados oitenta doentes com mais de 18 anos, utilizadores de próteses auditivas, oitenta e quatro por cento usavam próteses unilateralmente enquanto dezasseis por cento usavam bilateralmente. Todos os doentes responderam ao IOI – HA apos a sua tradução para Português (de Portugal). Analisamos os scores dos questionários entre os dois géneros, feminino e masculino. Utilizou-se o Coeficiente de Correlação de *Pearson* (adotando-se como significante o p-valor de 5%) foi avaliada a correlação entre cada item e o limiar medio audiométrico. A análise destes dados é fundamental para determinar a capacidade de descriminação e validade de cada uma das questões. A media do *score* total nesta população foi 27.33 ± 4.93 (9 – 35) e a dos valores obtidos para cada item do questionário variou entre 3.19 e 4.54. Estes dados e um *score* total acima de 50% demonstram que os doentes se encontram bem adaptados às próteses auditivas. Da análise da distribuição das repostas concluímos que são poucos os doentes que evidenciam algum grau de insatisfação. O alfa de Cronbach foi 0.838. Desta forma foi possível validar as propriedades psicométricas da versão traduzida do IOI-HA, que nos parece de suma importância para avaliar o grau de satisfação relativo à utilização de próteses auditivas na população portuguesa. A validação deste questionário permite ainda avaliar do grau de satisfação relativo a outras medidas de reabilitação auditivas como os implantes de condução óssea, de ouvido medio e cocleares.

Em conclusão, esperamos que este estudo nos permita ter uma perspetiva mais vasta sobre a esta patologia, em particular em relação à qualidade de vida dos doentes.

## Palavras chave

Presbiacusia; surdez neurossensorial; qualidade de vida; impacto social; impacto emocional, questionários; reprodutibilidade de resultados.

## Abstract

Presbycusis, or age-related hearing loss, is a multifactorial disorder characterized by symmetrical progressive hearing loss. In the beginning it usually affects the high frequencies of sound, although its presentation and clinical course can be variable. These high frequencies are responsible for word recognition (carried by the consonants during the speech). So the clinical hallmark of this disorder is the difficulty in comprehending words rather than not hearing. Patients often refer complaints of tinnitus and vertigo associated with the hearing loss.

Presbycusis affects about two thirds of the population older than 70 years old and its prevalence increases as the population grows older. It is not exclusive of old age but up to 80 percent of functionally-significant hearing loss occurs in older adults.

The insidious onset of the disorder and the slow course of hearing decline may postpone the diagnoses and, if left unrecognized, can lead to progressive social withdrawal, isolation and significant familial stress, with a huge impact in the quality of life of the patient.

Until now, the main concern of this hearing loss was the audiogram threshold, but we cannot neglect the social and emotional impact that this disorder has on our patients. A multidisciplinary diagnosis approach of the problem is in the order of the day.

In our study a patient registry database was created dating from 2010 onwards. A total of 2643 individuals were diagnosed with presbycusis, 50,7% male and 49,3% female patients from the Ear Nose and Throat (ENT) appointment in the ENT Department of Coimbra University Hospitals. The age distribution among the patients was similar for the male and female patients, and the mean age was 69,6 years. All these patients were followed on a regular bases and had a careful follow-up with pure tonal audiogram and vocal audiogram, but there was no concern or evaluation regarding the quality of life. In this line of thinking we decided to select a tool to evaluate this impact. After a systematic review of the literature we selected the Hearing Handicap Inventory for Elderly (HHIE). This screening instrument is widely used and has been going through adaptations and validations for other languages worldwide. All of these versions have kept the validity and reliability of the original version and have been useful to assess the psychosocial handicap of hearing impairment in the elderly.

We began our work by translating the HHIE to Portuguese from Portugal. In our study two hundred and sixty (260) patients from our database volunteered to answer the 25-item HHIE during an Ear Nose and Throat (ENT) appointment. Correlations between each individual item and the total score of the HHIE were tested, and demographic and clinical variables were also correlated with the total score. The instrument's reproducibility was assessed using the internal consistency model (Cronbach alpha). The reliability of the instrument was proven by the 0,79 Cronbach Alpha Index. We were also able to see that the total HHIE score was significantly related to the hearing threshold level.

We were able to access the psychometric properties of the HHIE, translated into Portuguese, and to validate this instrument on the studied population. We would also like to emphasize the importance of this instrument to assess the psychosocial handicap of hearing impairment in the elderly.

There is no direct treatment of presbycusis, but there are multiple options available to compensate for hearing loss and its impact on wellbeing. We consider that when the high-frequency thresholds are greater than 40 dB on the audiogram a rehabilitation option is in order. We have several options like a hearing aid or, in more severe cases, ear implants (middle ear, bone conduction implants and bone cochlear implants).

Despite the high prevalence of individuals with presbycusis in our study (2643), only a small number of these (3.14%) were hearing aid users (HAu), of which 67.45% were female.

It is important to understand these numbers and so we selected once more a questionnaire, the International Outcome Inventory for Hearing Aids (IOI-HA), an important instrument, widely used, that has been going through adaptations and validations for other languages. Therefore, the aim of our article was to validate and implement the IOI-HA on the Portuguese population.

In our prospective study, eighty (80) hearing aid users aged 18 or older (from the initial data base), hearing aid users (unilateral or bilateral) were tested; eighty-four percent (84%) of the participants were unilateral hearing aid users, whereas 16% were bilateral users (the questionnaire was answered after its translation from English to Portuguese from Portugal. The mean of the total score of the International Outcome Inventory for Hearing Aids in this population was 27.33 ± 4.93 (9 – 35). The mean values obtained in each item of the questionnaire ranged from 3.19 to 4.54. The Cronbach Alpha was 0.838 and the Cronbach Alpha values when the item was removed were also significant. Thus, we were able to assess the psychometric properties of the translated version of the IOI-HA, which may be useful to assess perceived hearing aid benefit for patients who speak Portuguese (from Portugal). This questionnaire is also a valuable tool when evaluating patients with other rehabilitation options like bone conduction implants, middle ear implants and cochlear implants.

In conclusion, we hope that these studies will help us in the future to answer questions regarding the wellbeing of our patients, to minimize comorbidities associated with presbyscusis and finally to understand the reason for such a poor adhesion to the hearing rehabilitation options.

We believe that this can be the starting point for a fresh vision of this disorder.

## Keywords

Presbycusis; sensorineural hearing loss; elderly people; quality of life; social impact; emotional impact; questionnaires; reproducibility of results.

## Thesis outline

This PhD thesis focuses on presbycusis, and on the social and emotional impact this pathology has on the patients. It is divided in four parts whose content is summarized below.

On **Chapter I** we present a general introduction on the subject, followed by a description of the etiology and epidemiology of the pathology. A correct and early diagnosis of these patients is very important as the implications of presbycusis are profound. This kind of hearing loss can lead to social isolation with all its consequences, including cognitive loss as well as social isolation, withdrawal from life activities and depression. Traditionally, the method for clinical evaluation of people with hearing loss is a formal audiogram but this practice should always include a questionnaire that will provide us with the answers of the social and emotional impact of this pathology. The use of questionnaires enables us to measure self-perceived handicaps and they are also a valuable tool to quantify the satisfaction of hearing aid users and the impact the use of these devices have on hearing aid users' lives.

In **Chapter II** we summarize the key research aims that will be addressed in this thesis.

**Chapters III** to **V** of this thesis contain the original research papers submitted and published in international peer-reviewed journals.

**Chapter III** describes a systematic review of the literature conducted using the 5S levels of organization of healthcare research evidence (systems, summaries, synopses, syntheses, studies), based on the model described by Haynes that identified the Hearing Handicap Inventory for Elderly (HHIE) as a valuable, simple, complete and reliable tool when studying patients with presbycusis.

In **Chapter IV** we present the psychometric properties of the HHIE, translated into Portuguese, and the validation of this instrument of study on the Portuguese population.

In **Chapter V** we present an article that aims to implement the International Outcome Inventory for Hearing Aids (IOI-HA), in Portuguese from Portugal, on the Portuguese population, after its translation and validation.

**Chapter VI** summarizes the main results of this thesis and includes an integrated conclusion.

**Chapter VII** gives us a future perspective of the multidisciplinary approach to this disorder, optimizing the diagnosis, follow up and hearing rehabilitation options. We hope that this line of work will be a reference for a future intervention with these patients.

## Publications

Articles in international peer-reviewed journals:

I. Sofia Paiva, João Simões, João Neves, António Paiva, Craig Newman, Francisco Castro e Sousa, Jean-Pierre Bébéar. Instruments for evaluation of restriction on auditory participation in the elderly: a systematic review. *Submitted*.

II. Sofia Paiva, João Simões, António Paiva, Craig Newman, Francisco Castro e Sousa, Jean-Pierre Bébéar. Validity and Reliability of the Hearing Handicap Inventory for Elderly - Version Adapted for Use on the Portuguese. Journal of the American Academy of Audiology*, Q2.* 2016 Sep;27(8):677-82. doi: 10.3766/jaaa.15146.

*III.* Sofia Paiva, João Simões, António Paiva, Francisco Castro e Sousa, Jean-Pierre Bébéar. Translation of the International Outcome Inventory for Hearing Aids into Portuguese from Portugal. A*ccepted for publication in BMJ Open, Q1.*

## Abbreviations

| | |
|---|---|
| **ACE** | Active Communication Education |
| **DNA** | Deoxyribonucleic acid |
| **ENT** | Ear Nose and Throat |
| **dB** | Decibel |
| **HAu** | Hearing Aid users |
| **HHIE** | Hearing Handicap Inventory for Elderly |
| **Htz** | Hertz |
| **IOI- HA** | International Outcome Inventory for Hearing Aids |
| **QA - AA** | Questionário Internacional - Aparelhos Auditivos |
| **PCR-RFLP** | Polymerase chain reaction restriction fragment length polymorphism |
| **PTA** | Pure Tone Average |
| **SPSS** | Statistical Package for the Social Sciences |
| **WGA** | Wide genome analysis |

# Chapter I

## Introduction

# Introduction

## Presbycusis

Presbycusis is the most common hearing loss in the elderly. The prevalence of this disorder grows in parallel with ageing of world's population; this can lead to communication problems, compromising the quality of life.

It is mandatory to develop a multidisciplinary evaluation for these patients. The use of questionnaires as a diagnostic tool will bring a novel approach to the patients concerns, taking into account the emotional and social impact this sensory deficit has on their lives.

We believe that this multidisciplinary approach on the subject will improve the hearing rehabilitation of the patients and minimize co-mobility associated, like depression, cognitive loss and even dementia.

With an early recognition of presbycusis we can initiate measures to increase function and minimize potentially devastating complications associated with this disorder.

## Definition

Presbycusis, also known as elderly hearing loss, is a complex and multifactorial disorder, characterized by symmetrical progressive loss of hearing over many years. It is a common cause of hearing loss in adults worldwide [1]. It usually affects the high frequencies of hearing, although its presentation and clinical course can be variable. Presbycusis is increasingly prevalent as the population ages and has a tremendous impact on the quality of life of millions of older individuals [2]. It has been considered one of the most devastating and incapacitating deficiencies of old age, as this kind of hearing loss causes difficulties in understanding speech, affects communication, and compromises family and social life. [3]

## The ear

Ageing is an irreversible process that affects all organs and systems; the ear is not an exception. The normal ear is divided into three anatomic areas: the external ear, middle ear, and inner ear. Disorders of any of these areas can contribute to hearing loss. The external ear directs the sound to the middle ear and it includes the pinna and the external auditory canal. In the middle ear, we can find the tympanic membrane, tympanic cavity, ossicles, the eustachian tube and mastoid cells; finally the inner ear includes the organ of hearing (cochlea) and balance (vestibular system), both of which translate motion of fluid around hair cells (from either sound or head acceleration) into neural signals. The neural signals produced by the stimulation of the hairy cells enter the spiral ganglion and are subsequently carried to the brain by the vestibulocochlear (eighth) cranial nerve. As all the structures of the ear can be affected we can find different kind of hearing loss: conductive (inability to mechanically transmit sound vibrations from the environment to the inner ear), sensorineural (inability to effectively transduce sound information into usable neural signals) and mixed (a combination of the previous two).

In the inner ear we find the organ of Corti, with hair cells, support cells, Reissneir and Tectoria membrane and the Stria Vascularis (a system of small blood vessels, produces the fluid - endolymph for the scala media, one of three fluid-filled compartments of the cochlea). This anatomic structure extends from the base to the apex of the cochlea and its cells establish tonotropic connections with the central nervous system in order to recognize different sound frequencies. The high frequencies (4000 and 8000 Htz) are located at the base of the cochlea. Multiple disorders of vital cochlear anatomic structures have been found in studies of temporal bones from patients with typical presbycusis audiograms [1]. These include degeneration of the stria vascularis, spiral ganglion cells, and hair cells. Consistent with findings seen in other causes of sensory hearing loss, the outer hair cells were the predominant structures affected [1]. Presbycusis is a true sensorineural loss, in which both cochlear hair cells and, to a lesser extent, the spiral ganglion cells in the vestibulocochlear nerve can be affected [2,4,5].

## Etiology

Presbycusis is a multifactorial disorder caused by the interaction of multiple factors which can influence the onset and severity of hearing loss [6]. These factors include noise exposure, ototoxins (eg aminoglycosides, chemotherapeutic agents and heavy metals), low socioeconomic status, infections, smoking, hypertension, diabetes, vascular disease, immunologic disorders, and hormonal factors [7-13]. Some individuals have also a genetic predisposition to age-related hearing loss [14,15]. There is some controversy regarding factors like nutritional status, alcohol consumption and bone density [16]. It is believed that the etiology of this disorder is cell damage as a result of the combination of different factors [17]. A retrospective case review performed in temporal bones, from patients that exhibited downward sloping audiometric patterns of hearing loss, confirmed the degeneration of the stria vascularis, spiral ganglion cells, inner hair cells, and outer hair. The authors were able to correlate these findings with those reported in the literature to clarify conflicting concepts regarding the association between hearing loss and morphologic abnormalities [18].

Temporal bone histology provides some insight to the underlying pathophysiology of presbycusis. Schuknech first classified presbycusis in four categories: Sensory, Neural, Metabolic and Mechanical [19]. Afterwards, Johnson & Hawkins included two more categories: Vascular and Central [20]. Presbycusis classification is subdivided, based on the associated audiometric pattern of loss, with abnormalities of inner ear vasculature, hair cells, and membranes all contributing to audiometric findings [4-6].

Nowadays we consider the following classification to be the most complete [4]:

Sensory - characterized by loss of hair cells as well as supporting cells in the Organ of Corti, in the basal end cochlea. It manifests as an abrupt high tone hearing loss that usually begins in the middle age, but progresses slowly. As it remains limited to the most basal end of the cochlea it doesn't involve speech frequencies so the discrimination is preserved.

Neural - characterized by loss of ganglion cells (a total higher than 90% cells). The neural loss probably parallels the neuron loss in the central nervous system. The onset and severity of the process varies considerably. Clinically it shows variable patterns of hearing loss and discrimination, related to the neuron loss. Usually it manifests later in life.

Metabolic - characterized by atrophy of stria vascularis on the apex and middle portion of the cochlea which affects endolymph production. An equal or nearly equal threshold loss for all frequencies constitutes the hearing curve in this type. The patients have a good discrimination of word with a low-frequency hearing deficit.

Mechanical – is thought to be caused by a disturbance in the motion mechanism of the cochlear partition such as stiffening of the basilar membrane or atrophy of the spiral ligament as there is no pathological correlation in the organ of Corti, auditory neuron or strial tissue. Clinically it manifests as a slowly progressive hearing loss and is characterized by a descending audiometric curve.

At least 25% of all clinical cases show no pathological alterations of the cell at the cochlea when examined by a light microscope. Among many putative explanations for this kind of hearing loss are: impaired cell function rather than cell loss, auditory pathology more central than peripheral (of the inner ear) and putative cochlear hearing loss, namely alteration in the motion mechanism of the basilar membrane.

Finally, mixed presbycusis includes cases that meet the criteria of having significant alterations in more than one cochlear structure, that can be the combination of: basal sensorial lesions of 10mm or more in length, neural losses of 50% or greater compared to congenital normal, strial tissues losses of 30% or greater, and gradual descending pure-tone threshold denoting cochlear pathology. It is characterized by the presence of multiple pathological findings in different cochlear structures, with different clinical presentation.

## Epidemiology

The prevalence of hearing loss increases as the population grows older, with up to 80 percent of functionally-significant hearing loss occurring in older adults [21]. Although presbycusis is not exclusive to elderly people, it affects about two thirds of the population older than 70 years old [22].

According to the numbers of the World Health Organization, presbycusis affects 360 million people worldwide, which represents 5.3% of world's population. It has been reported by the

*Center of Disease Control* as the second most common pathology in the elderly population, with arthritis being the first [23].

## Clinical presentation

Presbycusis is a symmetric high-frequency hearing loss which is progressive over many years 2]. It can be accompanied by tinnitus, vertigo, and disequilibrium leading to falls.

This kind of hearing loss can have a great impact in the quality of life in the elderly causing low self-esteem, isolation, depression and cognitive loss [24,25,26]. Presbycusis may also be related to dementia as this kind of hearing loss has been linked to an accelerated cognitive decline, incident cognitive impairment and Alzheimers disease. [27]

Typically, this kind of hearing loss begins in the sixth decade of life and it has a slow course. At the beginning it affects mainly high frequencies, above 2 KHz. Over the time, these high frequencies will continue to drop and the mid and low frequencies (0.5 to 2 KHz) also become progressively involved.

The low and mid frequencies of human speech carry the majority of energy of the sound wave. They include most of the vowel information of words. The high frequencies carry the consonant sounds. These tend to be high pitched and soft and carry the majority of speech information. This makes them particularly difficult for patients with presbycusis to hear.

A common complaint these patients have is hypersensitivity to loud sounds; this is the result of "recruitment," a disordered processing of sound in the inner ear [24]. This kind ofhearing loss can have a great impact in the quality of life in the elderly causing low self-esteem, isolation, depression and cognitive loss [25,26,27]. Presbycusis may also be related to dementia as this kind of hearing loss has been linked to an accelerated cognitive decline, incident cognitive impairment and Alzheimers disease. [28]

## Clinical relevance

Presbycusis is the most common sensory deficit in the elderly, and is becoming a severe social and health problem; it can lead to communication problems compromising the quality of life. Since the elderly population is increasing worldwide, presbycusis is showing a similar trend. It is of the most importance to establish an organized and structured evaluation of our patients.

The hallmark of presbycusis is the progressive, symmetric loss of high-frequency hearing over many years [2]. The high frequency hearing loss traduces in an inability to hear vowels but not the consonants. As a result of this pattern of hearing loss the patients frequently refer that they are able to hear but have difficulty understanding the words.

This problem aggravates when the patients are in a room with background noise. These missing frequencies are fundamental to allow the inner ear to focus on sounds and select them from the background noise. These patients usually refer an improvement in the comprehension of words when in a quiet room in a one-on-one conversation. Patients also complain to have more difficulty understanding women voices because they are generally higher; this may have a significant deleterious effect on the spouses of affected individuals [29]. It can also compromise patient-doctor relationship [30].

As the onset of this disorder is progressive, most of the times patients do not seek medical help. In part because they accept that this is the normal process of ageing and have no knowledge that this condition can be treated; there is also a negative stigma associated with hearing aid use and so these patients are often brought to medical attention at the insistence of family members. These patients often refer a hypersensitivity to loud sounds (sound at a level tolerated by persons with normal hearing). There is a narrowing of the individual´s dynamic range of hearing due to elevation of the threshold needed to hear quiet sounds, and the reduction of tolerable loud sounds. Often the patients complain of discomfort when people are talking to them, because they elevate the low vowel frequencies that are amplified by shouting, but carry little of the missing speech information, making this task harder for the listener. This “recruitment” can also complicate fitting hearing aids with an improper hearing rehabilitation.

An incorrect diagnose or if left unrecognized, hearing loss in older adults presbycusis can lead to progressive social withdrawal, depression, isolation, and significant familial stress [25].

Often patients also describe tinnitus which can be an important problem as hearing loss progresses [31,32]. The intensity and frequency of presentation is variable and usually described as affecting both ears, or presents diffusely in the head.

Some patients also complain of dizziness; an associated loss of vestibular end-organ function, termed "presbyastasis," can contribute to vertigo, disequilibrium, and falls [33]. The comorbidities of the elderly patient such as decreased visual acuity or arthritis can limit the ability of an older individual to compensate for peripheral vestibular dysfunction. It is mandatory an early diagnose to minimize the risk of falls and their potentially devastating complications.

A Cross-sectional data on adults 60 to 84 years old in a randomly sampled community of the United States concluded that the greater hearing loss was associated with increased odds of being socially isolated. [34]. Also it has been proved that functional status, as measured by a common activity of daily living scale, is diminished in older hearing impaired adults suggesting that severely diminished hearing could make the difference between independence and the need for formal support services or placement [35]. Both of these factors influence the psychological status of the patients, causing low self-esteem, isolation, and depression [24,25].

Presbycusis may also be associated with dementia. Social isolation, loneliness, poor verbal communication, and cognitive reserve depletion might causally link presbycusis with cognitive impairment and could be a reversible risk factor for dementia and Alzheimer disease [36].

We could say that there is a new definition for this neurossensorial hearing loss, Socio-presbycusis, as the result of the gradual isolation of the patients with a worsening of their Quality of Life. Socio-presbycusis is a hot topic with an increasing incidence and high social costs [37].

## Screening methods

Although there is no consensus regarding population screening for hearing loss, this practice should be a routine in the evaluation of elderly people. The American Speech-Language-Hearing Association has advised that individuals over 50 years of age should have complete audiometric testing every three years [38].

The diagnosis should start with a complete medical history followed by a careful ENT physical examination. It is of the most importance that the patients can understand all the information that is being asked so clinicians should talk slowly, facing the patients (allowing them to use lip-reading clues), clearly and without shouting or over-articulating.

Traditionally, the method for clinical evaluation of people with hearing loss is a formal audiogram to determine pure tone thresholds (the patient is presented with a variety of tones of frequencies varying between 250 Hz and 8 KHz). But human speech is mainly comprised of sounds falling between 500 Hz and 4 kHz, with average conversational levels falling at about 50 dB of loudness. Consonants, which carry the majority of meaning of words, fall in the higher and softer range and vowels tend to be lower and louder, that is why it is mandatory to follow the previous exam with a vocal audiogram that will measure the ability to understand words and measures the ability to process sound. In this exam a standardized list of words is presented at a comfortable listening level and the patient will repeat the words. This will measure the subject's ability to process sound, with normal hearing individuals being able to identify 90 percent or more of words presented. We can see a decrease of the "word recognition score" in cases of neural or central dysfunction.

But these traditional methods of evaluation won't be able to give us a notion of the social isolation of the deaf patient or the impact this disorder has on his quality of life. In our opinion the evaluation of patients with presbycusis should always include other tools like a complete questionnaire with questions regarding social and emotional impact of this pathology that will provide us with a broader and complete vision of these patients [39].

The use of questionnaires enables us to measure self-perceived handicaps, and such instruments are being increasingly incorporated into the evaluation of patients as an objective measure of the outcome of intervention [40]. Based on a systematic review of the literature we identified the Hearing Handicap Inventory for Elderly (HHIE) as being valuable, simple and complete when studying presbycusis patients. This screening instrument is widely used worldwide and its reliability and validity have been well established. [41,42]. It has

undergone adaptations and validations for other languages and all of these versions have kept the validity and reliability of the original version. [43,44,45]. The 25-item Hearing Handicap Inventory for the Elderly Questionnaire (HHIE), Appendix 1, was introduced in 1982, to assess the self-perceived psychosocial handicap of hearing impairment in the elderly as a supplement to pure tone audiometry in the evaluation of hearing aid effectiveness [46].

**Appendix 1. Hearing Handicap Inventory for the Elderly**

| Instructions: The purpose of this scale is to identify the problems your hearing loss may be causing you. Answer *yes*, *sometimes*, or *no* for each question. Do not skip a question even if you avoid a situation because of your hearing problem. If you use a hearing aid, please answer the way you would hear without the aid. | | | | |
|---|---|---|---|---|
| **Item nº.** | **Question**<br><br>S. social; E. emotional | **Yes (4)** | **Sometimes (2)** | **No (0)** |
| S1 | Does a hearing problem cause you to use the phone less often than you would like? | | | |
| E2 | Does a hearing problem cause you to feel embarrassed when meeting new people? | | | |
| S3 | Does a hearing problem cause you to avoid groups of people? | | | |
| E4 | Does a hearing problem make you irritable? | | | |
| E5 | Does a hearing problem cause you to feel frustrated when talking to members of your family? | | | |
| S6 | Does a hearing problem cause you difficulty when attending a party? | | | |
| E7 | Does a hearing problem cause you to feel “stupid” or “dumb”? | | | |
| D8 | Do you have difficulty hearing when someone speaks in a whisper? | | | |
| E9 | Do you feel handicapped by a hearing problem? | | | |
| S10 | Does a hearing problem cause you difficulty when visiting a friend, relative, or neighbors? | | | |
| S11 | Does a hearing problem cause you to attend religious services less often than you would like? | | | |
| E12 | Does a hearing problem cause you to be nervous? | | | |

| | | | | |
|---|---|---|---|---|
| S13 | Does a hearing problem cause you to visit friends, relatives, or neighbors less often than you would like? | | | |
| E14 | Does a hearing problem cause you to have arguments with family members? | | | |
| S15 | Does a hearing problem cause you difficulty when listening to the television or radio? | | | |
| S16 | Does a hearing problem cause you to go shopping less often than you would like? | | | |
| E17 | Does any problem or difficulty with your hearing upset you? | | | |
| E14 | Does a hearing problem cause you to have arguments with family members? | | | |
| S15 | Does a hearing problem cause you difficulty when listening to the television or radio? | | | |
| S16 | Does a hearing problem cause you to go shopping less often than you would like? | | | |
| E17 | Does any problem or difficulty with your hearing upset you? | | | |
| E18 | Does a hearing problem cause you to want to be by yourself? | | | |
| S19 | Does a hearing problem cause you to talk to family members less often than you would like? | | | |
| E20 | Do you feel that any difficulty with your hearing limits or hampers your personal or social life? | | | |
| S21 | Does a hearing problem cause you difficulty when in a restaurant with relatives or friends? | | | |
| E22 | Does a hearing problem cause you to feel depressed? | | | |
| S23 | Does a hearing problem cause you to listen to television or radio less often than you would like? | | | |
| S24 | Does a hearing problem cause you to feel uncomfortable when talking to friends? | | | |
| E25 | Does a hearing problem cause you to feel left out when you are with a group of people? | | | |

We believe that the validation on the Portuguese population of the Hearing Handicap Inventory for the Elderly Questionnaire (HHIE), translated to Portuguese from Portugal, is mandatory to assess the psychosocial handicap of hearing impairment in the elderly.

## Auditory rehabilitation

There is no real treatment for presbycusis, however the correct and prompt diagnosis can attempt to identify and avoid additional factors that can contribute to hearing loss. A correct and prompt diagnosis can be reassuring for many patients [47]. An early intervention is particularly important in older patients with dementia because age-related hearing impairment is potentially a reversible risk factor for dementia and Alzheimer disease [36].

**Hearing aids** — these devices are in general a good option for most cases of presbycusis [48]. These can be quite effective restoring the ability to communicate, reducing the emotional and social impact associated with this disorder [49] and can improve the quality of life of the patients [50]. Technological advancements in hearing aids, such as improved speech processing or strategic direction-specific microphones, may have improved performance significantly [51]. These devices have also suffered a tremendous evolution regarding the cosmetic presentation being almost unnoticeable on the ear.

**Middle ear implants and bone conduction implants** - these devices are indicated for patients with a moderate and severe neurossensorial hearing loss that cannot tolerate hearing aids (when there is too much discomfort in the ear canal or in cases of recruitment and when the device creates static noise).

In the middle ear implants, there is a stimulation of the ossicular chain through a vibratory mechanism, similar to the physiology of the middle ear. In the bone conduction implants the implant is osteointegrated at the mastoid of the temporal bone and the stimulus is transmitted by an osseous conduction.

**Cochlear implants** - When the previous solutions are no longer effective, situations when the hearing threshold is more severe, cochlear implantation is the solution; these devices were first indicated for a severe neurossensorial loss in the pediatric population, but nowadays we

have an excellent result on the elderly patients, a procedure that can be performed safely even in the octogenarians [52]. A significant functional improvement can be achieved in the elderly, similar to that seen in younger patients. [51,53-58]. In this kind of implant an electrode is placed inside the cochlea to electrically stimulate remaining cochlear neurons directly.

As said before, there are multiple options that can compensate for hearing loss and improve daily function as well as wellbeing [59]. A hearing rehabilitation option should always be considered when the high-frequency thresholds are greater than 40 dB on the audiogram. Even so there is a certain stigma associated to this disorder as it is directly related to old age. Many patients will wait several years before seeking assistance and most of the times they are brought to an appointment by a family member. There is obviously also a stigma associated with hearing aids, a stigma that has to be undramatized; the enormous cosmetic evolution that these devices have had recently (some of them are of such a small dimension that won't be noticeable in the patients' ear) and technological evolution should be emphasized by the ENT doctor when advising this rehabilitation option. There is also some concern because sometimes the patient has had a previous negative experience with hearing aids, or has heard other patients' negative reactions to hearing aids.

To diminish these concerns it is important to select the correct rehabilitation measure for each case. The audiometric threshold from the pure tone and vocal audiogram can help us on that process; patients with a low threshold or a poor "word recognition score" predict unfavorable response to amplification. Another problem that will complicate fitting hearing aids, is recruitment, a paradoxical hypersensitivity to loud sounds, which results in a narrowing of the individual's dynamic range, caused by the simultaneous elevation of the threshold needed to hear quiet sounds, and the reduction of tolerable loud sounds. Finally, in some cases the hearing aid will not allow the patient to understand speech any better, but rather only allow the patient to hear noise at a louder level [60]. There are also cases when hearing amplification is not tolerated, like in cases where the meatus is too small, or with patients that produce too much cerumen that can plug the device, or even when the device has increased static or noise.

Despite all these concerns hearing aids offer a potential help to most patients with presbycusis. However, only a small percentage of patients with presbycusis actually receive

effective treatment with amplification [52]. Studies in Western countries suggest that only 10 to 20 percent of adults with significant hearing loss actually have a hearing aid [2 ,52,61].

In this line of thinking we believe that there is a need for well-trained hearing professionals to provide counseling, fitting, assistive listening devices, and/or rehabilitation services to maximize the chance of benefit.

Tools like the International Outcome Inventory for Hearing Aids (IOI-HA), Appendix 2, were developed with the purpose of evaluating the efficacy of hearing aid rehabilitation. It is a seven-item hearing-specific questionnaire [62] used to subjectively evaluate the results of the hearing aids under the following parameters: 1 - time for which hearing aids have been used; 2 - benefit; 3 - residual limitation in daily life activities; 4 - satisfaction; 5 - residual restrictions to participation; 6 - impact on other people; 7 - quality of life. The answers to each question range from poor performance (1) to best performance (5) [63]. It can be used as an advisor identifying areas that need to be improved (to validate a fitting) [64,65,66]. Recent research supports the advantages of its use in the rehabilitation process of hearing aid users (HAUs) [67]. It was initially developed to quantify the satisfaction of HAUs and the impact that these devices have on their lives [65].

**Appendix 2 - International Outcome Inventory for Hearing Aids (IOI-HA)**

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)?

| none | less than 1 hour a day | 1 to 4 hours a day | 4 to 8 hours a day | more than 8 hours a day |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in those situations?

| helped not at all | helped slightly | helped moderately | helped quite a lot | helped very much |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

3. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

| very much difficulty | quite a lot of difficulty | moderate difficulty | Slight difficulty | no difficulty |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

4. Considering everything, do you think your present hearing aid(s) is worth the trouble?

| not at all worth it | Slightly worth it | Moderately worth it | quite a lot worth it | very much worth it |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?

| affected very much | affected quite a lot | affected moderately | affected slightly | affected not at all |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

| bothered very much | bothered quite a lot | bothered moderately | bothered slightly | bothered not at all |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

| worse | no change | slightly better | quite a lot better | Very much better |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

8. How much hearing difficulty do you have when you are **not** wearing a hearing aid?

| severe | moderately-severe | moderate | mild | none |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

We believe that these kind of questionnaires helps us to understand the real improvement patients have with such devices regarding their quality of life. Rather than hearing threshold we want to evaluate variables like the comfort when wearing a hearing aid, the clarity of tone and sound, comfort with loud sounds and satisfaction in the listening situations of

conversation (with one person, in small groups, in large groups, and outdoors). A higher mean IOI-HA scores was most strongly associated with the previous variables and these findings highlight the importance of focusing rehabilitation on improving satisfaction with aided listening across a range of environments and with key attributes of hearing aid performance [68]. The IOI- HA has also been used in a communication education program for older people with hearing impairment [69]. This questionnaire is used worldwide and it can also be used evaluating patients with other devices like Middle Ear Implants, Bone-Anchored Ear implants, and even with Cochlear Implants [70,72,72].

In conclusion we believe that it is fundamental to use self-report questionnaires like the IOI-HA as an outcome measure, when evaluating hearing rehabilitation.

# Chapter II

## Aims of the study

## Aims

Presbycusis is a complex and multifactorial disorder, which affects communication and social adjustment, leading to significant emotional consequences. Presbycusis prevalence increases as the population grows older and has an enormous impact on the quality of life of older individuals.

Up until now there has not been much concern with the emotional and social impact of this disorder, although it has been proved that it can have a huge impact on patients' quality of life, causing low self-esteem, isolation, and depression; it may also be associated with dementia.

Our objectives of the study are the following:

I. To create a patient registry database, dating from 2010 onwards, with the patients' diagnosed with presbycusis by the Ear Nose and Throat (ENT) appointment at the ENT Department of Coimbra University Hospitals.
II. To determine, based on the previous database, the percentage of hearing aid users and its distribution by sex and age.
III. To select tools from systematic reviews of the literature that will help us have a complete vision of this disorder and the impact it has on the well-being of our patients.
IV. To assess the psychometric properties of the Hearing Handicap Inventory for Elderly (HHIE), translated into Portuguese, and to validate this instrument of study on the Portuguese population.
V. To validate and implement the International Outcome Inventory for Hearing Aids (IOI-HA) on the Portuguese population.

# Chapter III

## Instruments for evaluation of restriction on auditory participation in the elderly: a systematic review

# Instruments for evaluation of restriction on auditory participation in the elderly: a systematic review

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## Abstract

**Objective:** To conduct a systematic review of studies regarding the use of tools for the evaluation of restriction on auditory participation in the elderly. These tools should be valid, effective and simple to use when evaluating patients with presbycusis.

**Methods:** A systematic review of the literature was performed using the 5S levels of organization of healthcare research evidence, based on Haynes model. The keywords used were “elderly hearing loss”, “hearing impair”, “restriction on auditory participation”, “presbycusis”, and “questionnaires”. Studies published in English, Portuguese and German from the last 10 years were selected. The evaluation of the impact of hearing loss in psychosocial environment in the elderly was the main inclusion criteria.

**Results:** One hundred and fifty studies were found. The titles and abstracts of twelve articles were selected for full analysis, of which nine articles were finally selected. Three instruments were found for the evaluation of restriction on auditory participation: Hearing Handicap Inventory for the Elderly (HHIE), Hearing Handicap Inventory for Adults and Hearing Handicap Inventory for the Elderly – Screening.

**Conclusion:** The HHIE was the most used questionnaire for the assessment of the psychosocial handicaps of hearing impairment in the elderly. These kinds of instruments are being increasingly incorporated into the evaluation of patients as an objective measure of the outcome of intervention.

**Keywords:** Elderly people, presbycusis, questionnaires, restriction on auditory participation.

## Introduction

Presbycusis affects 360 million people worldwide, which is 5.3% of world's population,[1]. Although not exclusive to elderly people, this hearing loss affects two thirds of patients over 70 years of age,[1]. Subjects with presbycusis hearing loss can present distinct impacts on communication, social and emotional aspects, as well as quality of life,[1].

According to the WHO (1948) "Health is a states of complete physical, presbycusis mental and social wellbeing and not merely the absence of disease or infirmity" and in 1980 this organization established an international classification of health and wellbeing that would be applicable to all forms of rehabilitation services regardless of the discipline,[2].

The International Classification of Impairment, Disabilities and Handicap proposed a generic model of health and rehabilitation applicable to all forms of rehabilitation services in different areas. Impairment is defined as an abnormality in organs systems and structures of the body; a disability is defined as a restriction or inability resulting from the impairment, which will affected the performance of an activity in the manner or with the range considered normal for a human being. Finally, a handicap is a disadvantage caused

by an impairment or a disability that limits a person from fulfilling the role that would otherwise be considered normal,[2].

Therefore, hearing impairment is associated with an individual's self-perception regarding hearing limitations, which affect lifestyle and social and familiar interactions,[3].

The WHO criteria for disabling hearing is a permanent elevation of the hearing threshold of 40dB on the better ear,[1].

The clinical evaluation of hearing loss includes a complete physical examination and complementary test, namely a pure tone audiogram; on the other hand, the impact of hearing loss in the daily life should be evaluate with specific questionnaires. The use of a standardized core set of outcome measures allows for comparison across health care centers, improving communication among clinical providers and scientists as well as promotion of and methodological standardization of international epidemiological studies,[4, 5]. The use of questionnaires helps to complement the information obtained in hearing evaluations, and identifies the specific needs of each individual. In addition, they can also be used for measurement of intervention outcomes,[6].

The purpose of this review is to determine which tools are being used to evaluate activity limitation worldwide; those tools must be valid, effective and simple to use when evaluating patients with presbycusis.

## Materials and Methods

This systematic review was performed using the 5S model of evidence based on information services, described by Haynes as a pyramid with five levels of evidence,[7]. Additionally, we followed the PRISMA 2009 Flow Diagram and the PRISMA check list,[8].

**Inclusion criteria:** This review included studies published over the last 10 years in English that used questionnaires for the assessment of the psychosocial handicaps in hearing impairment in the elderly over.

**Search strategy:** The search followed the 5S model of evidence based on information services described by Haynes,[7]. The search starts at the top of the pyramid with systems and goes down the pyramid to summaries, synopses, syntheses, and studies.

The level of evidence systems was not used as it was not fully developed. So, the first level used were summaries and at this level, the search was carried out in *UpToDate* using the search terms "presbycusis" and "questionnaires" or "elderly hearing loss" and "questionnaires". The search was conducted using the same words in the *Evidence Based Medicine* database at the synopses level of evidence. The authors used *Cochrane Library* at the next level of evidence, syntheses. At the studies level, we searched PubMed, EMBASE and the Cochrane Database for relevant studies performed on human participants and published in English. Search terms (using MeSH headings in PubMed) included: "Presbycusis AND questionnaires" and "elderly hearing loss AND questionnaires". The 5s search strategy was completed at the studies level with the words "restriction on auditory participation AND questionnaires". Additionally, the search was completed by consulting the National Open Access Scientific Repository with the previous Key words; this is an open access library where all the scientific thesis with a large range of subjects are available,[9].

Additionally, there are two relevant tools for auditory participation assessment, the Listening Self-Efficacy Questionnaire (LSEQ) and the Speech, Spatial, and Qualities of Hearing Scale (SSQ) which were selected for revision,[10, 11]. The authors have included these questionnaires considering their important contribution in auditory rehabilitation and its use in recent studies,[2]. A total of 150 articles were retrieved after duplicate studies were excluded.

**Process of study and data collection**. The titles and abstracts of fourteen articles were initially screened for inclusion; the full texts of eleven articles were selected and assessed for inclusion.

**Data collection and analysis.** Data extracted from the articles selected, that met the inclusion criteria, were analyzed regarding the use of questionnaires to measure self-perceived psychosocial handicaps of hearing impairment in the elderly. Extracted data were independently triple checked for accuracy. We consider the hypothesis of publication bias in the assessed topic because the systematic review of the literature did not find any negative or neutral studies.

The PRISMA check list was used to assess the fulfilment of evidence-based items for reporting systematic reviews,[8].

## Results

A significant number of studies evaluated the hearing handicap in the elderly. Figure 1 is a schematic illustration of the 5S model of evidence-based information services,[7].

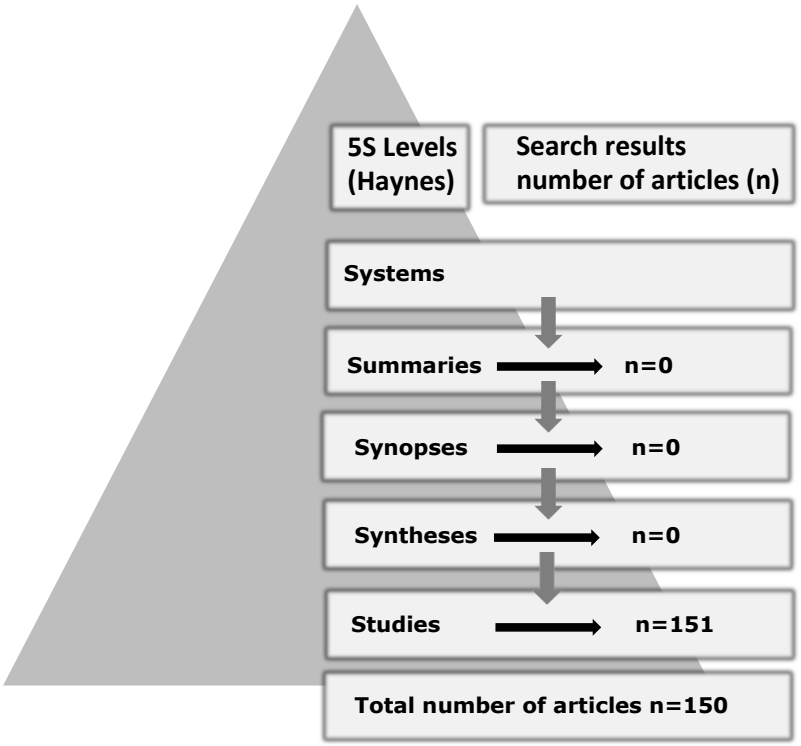



Figure 1. Schematic illustration of the 5S model of evidence-based information services (Haynes, 2006).
This search retrieved 150 articles after exclusion of duplicates.

One hundred and one studies were retrieved in the search and from these one was eliminated because it was duplicated. Fourteen articles were selected based on the inclusion criteria. From these, three were excluded for not using specific tools to evaluate self-

perceived psychosocial handicaps of hearing impairment. At the final, eleven studies that used the hearing handicap protocols in the elderly and adult population are summarized in Table 1,[10-20].

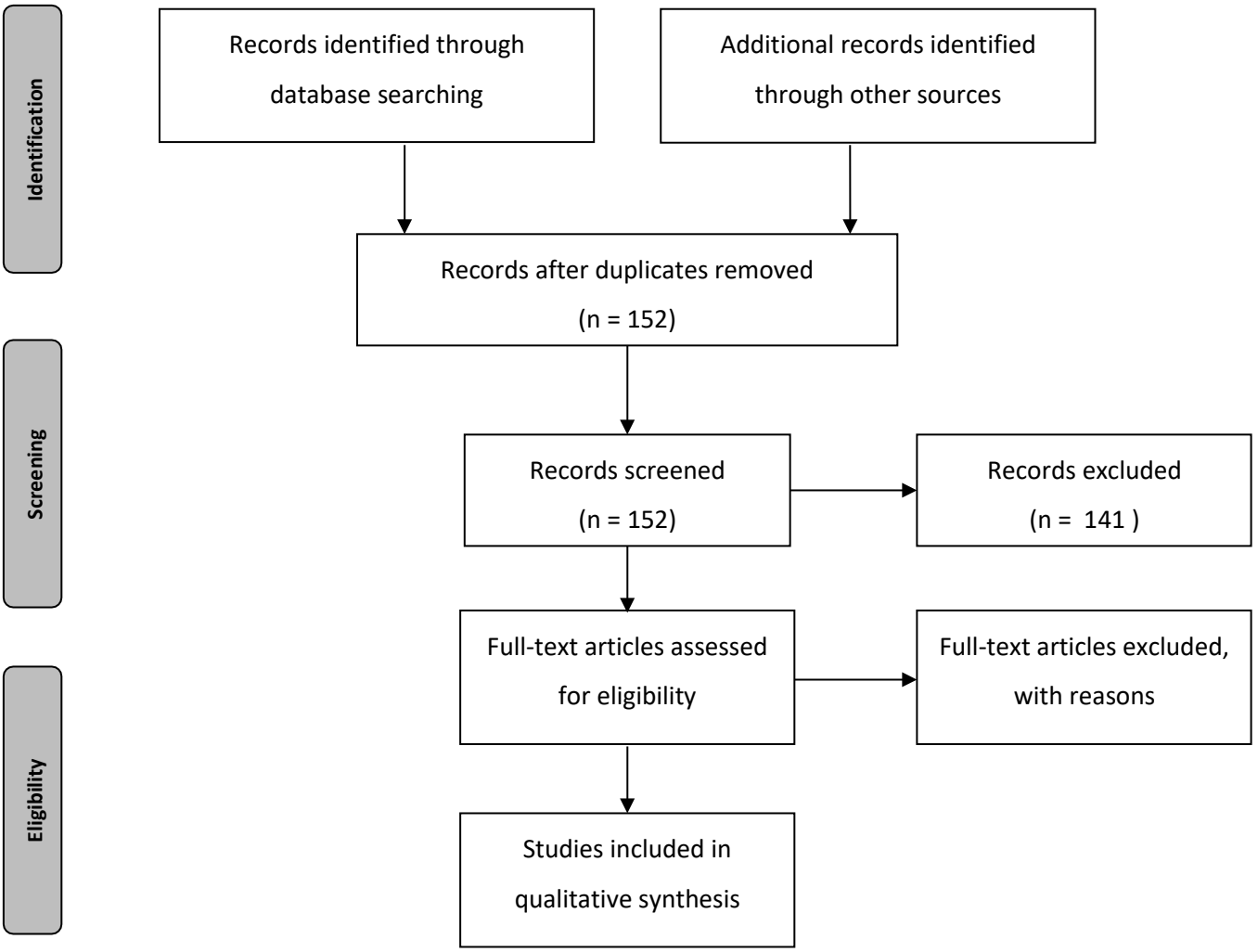
**Table 1.** Description of the results of the studies selected

| Author (year) | Country | Study design | Sample | Instrument | Main findings |
|---|---|---|---|---|---|
| Chang et al (2009) | Taiwan | Cross-Sectional | 1220 | HHIE-S | There was a moderate association between hearing impairment and self-perceived handicap. |
| Shrestha et al (2014) | Nepal | Cross-Sectional | 70 | HHIE | The severity of handicap was significantly associated with the degree of hearing loss. |
| Monzani et al (2008) | Italy | Case-Control | 73 - hearing-impaired subjects 96 - controls | HHIA | A higher level of perceived hearing handicap was associated with deterioration of health-related quality of life. |
| Hidalgo et al (2008) | Spain | Cross-Sectional | 1387 | HHIE-S | There was a high prevalence of hearing loss associated with other functional limitations. |
| Chiossi et al (2014) | Brazil | Cross-Sectional | 72 | HHIE-S | Quality of life was negatively affected by the increase in self-rating of hearing and voice difficulties in daily life. |
| Tomioka et al (2013) | Japan | Cross-Sectional | 197 | HHIE-S | Strong association between self-perceived hearing handicap and quality of life measures. |
| Barbosa et al (2014) | Brazil | Cross-Sectional | 125 | HHIE | The HHIE can be a great ally in helping to understand and rehabilitate the difficulties with amplification. |

| | | | | | |
|---|---|---|---|---|---|
| Tomioka et al (2015) | Japan | Cross-Sectional | 3982 | HHIE | Physical performance is associated with self-perceived hearing handicap. |
| Ciorba et al (2012) | Italy | Systematic Review | - | HHIE, HHIA, IOI-HA | All of the questionnaires are self-assessment tool designed to measure the effects of hearing impairment on the emotional and social adjustment. |
| Moulin et al (2015) | France | Cross-cultural adaption | 230 - hearing-impaired subjects 150 - normal-hearing subjects | SSQ | Good reproducibility of results. A comparison of factor analysis outcomes confirmed good conceptual equivalence and robustness for use in international settings. The three main subscales (speech, spatial, and qualities) confirmed their usefulness in assessing different aspects of hearing disability. |
| Smith et al (2011) | USA | Cross-Sectional | 169 hearing impaired patients | LSEQ | To develop and validate the Listening Self-Efficacy Questionnaire (LSEQ). Listening self-efficacy resumes the confidence and the beliefs that hearing impaired patients have in their capability to successfully listen in specific situations. |

The search flow diagram is represent in figure 2, according the PRISMA strategy.

**Figure 2 -** Search flow diagram according the PRISMA strategy.



In this review, five instruments for the evaluation of participation restriction were found: Hearing Handicap Inventory for Adults (HHIA), Hearing Handicap Inventory for the Elderly (HHIE), the Hearing Handicap Inventory for the Elderly – Screening (HHIE-S), Self-Efficacy Questionnaire (LSEQ) and the Speech, Spatial, and Qualities of Hearing Scale (SSQ).

The most used tools were the HHIE in the elderly population (over 60 years old). The HHIE was developed by Ventry et al to assess perceived functional limitations associated with Hearing impairment,[21]. It is composed of a 13-item emotional subscale and a 12-item socio-situational subscale,[22]. The patients can answer for each question with “yes” “sometimes” or “no” and the sum of the questionnaire can vary from 0 to 100. A higher score suggests a significant self-perception of auditory deficiency. A score from 0 to 16 indicates an absence of perception of the handicap, from 18 to 30, a light handicap, from 32 to 42, moderate handicap and above 42 indicates significant handicap.

The HHIE-S is a shortened version of the HHIE; it includes five emotional response items and five social items,[23-24].The total score varies from 0 to 40; 0 to 8 points indicates the absence of perception in handicap, 10 to 23 points, light to moderate perception and from 24 to 40 points, significant perception of handicap.

The Listening self-efficacy questionnaire (LSEQ) aims to evaluate the beliefs, or confidence, that hearing impaired patients have in their capability to successfully listen in specific situations,[10]. It has three subscales relating different situations: dialogue in quiet, focusing attention on a single source and complex auditory scenes. The content of LSED was accomplished by reviewing preexisting questionnaires used to identify common sources of listening difficulties (the Abbreviated Profile of Hearing Aid Benefit, the Hearing Handicap Inventory for the Elderly, the Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids (MARSHA) and the Speech, Spatial, and Qualities of hearing questionnaire. It is different from traditional tools because it evaluates the hearing abilities of patients in different situations and can also influence speech perception and spoken language comprehension in daily life activities.

The SSQ is a 50 items questionnaire divided in three subscales: (1) the hearing for speech subscale (speech) included 14 questions regarding the subject’s ability to understand speech in the presence of different types of noises; (2) the spatial hearing subscale (spatial) included 17 questions concerning sound and source localization; and (3) the qualities subscale dealt with naturalness and clarity of sounds and included 19 items,[11]. In the study presented the

authors chose to eliminate on of the items of the last subscale because it dealt specifically with hearing aids and it was not relevant for the studied population.

Regarding the design of the studies, the majority were cross-sectional studies,[10, 12-14, 16, 18-20]. These studies are important but they did not evaluate the changes in hearing handicaps over time and also did not evaluate patients before and after any intervention, like auditory rehabilitation.

The study of Ciorba and colleagues elucidates the social and emotional consequences resulting from presbycusis and its optimal management,[15]. It gives an insight notion of the importance of methods to evaluate the deterioration of patient's quality of life (QoL) through several instruments (hearing-related QoL instruments and generic QoL instruments) as well as the optimal management of this condition.

One of the studies selected presented results of the validation of evaluation instruments for the assessment of the restriction on auditory participation in the elderly,[20]; this study presents high reliability and validity of the instrument studied (the HHIE-S), with a Cronbach's alpha coefficient of 0.91, a Spearman–Brown coefficient of 0.90, and intra-class correlation coefficient of 0.85. The HHIE-S showed a high specificity for detection of hearing loss over 40 dB and the authors concluded that this questionnaire was a very specific and sensitive tool assessing the impact of hearing impairment on patients QoL.

In the study of Chiossi JS et al it was verified the self-rated impact of voice and hearing changes of active elderly individuals in their daily lives, and the influence of this self-rating on quality QoL,[14]. It was a cross-sectional study conducted with 72 elderly individuals which used the following questionnaires: HHIE-S, Voice Handicap Index--VHI and WHO Quality of Life among older people (QoL-Old). The self-rating of hearing impact on daily life was correlated with the voice handicap index and the results suggest that that there was an impact of voice and hearing handicap on quality of life justifying the need for improving actions of self-care and empowerment for the elderly.

The Fujiwara-kyo study investigated whether physical performance and musculoskeletal pain were associated with self-perceived hearing handicap among high-functioning older adults,[19]. The authors used the HHIE-S to asses hearing handicap, hearing impairment was evaluated using a single question and measured the handgrip strength, and measured walking speed (WS) and standing balance for assessments of physical performance. The study

concluded that the walking speed in older adults is associated with self-perceived hearing handicap and suggested that exercise programs to improve walking ability could be effective in preventing hearing handicap among high-functioning older adults.

In the study conducted by Barbosa *et al*, the HHIE self-assessment questionnaire was used to identify self-perceived limitations, before and after hearing aids (HA) fittings, in a population of adults suffering from hearing loss,[12]. The use of HA significantly improved the hearing handicap although some older adults still maintain social and emotional limitations especially in basic daily life activity's like when using a telephone or hearing when someone speak in a whisper. The authors concluded that this particular instrument can be extremely useful in helping professionals understand the difficulties that remain after hearing aid fitting.

## Discussion

As the world population is growing older, the number of people who suffer from hearing impairment will increase in the future,[27]. Presbycusis or elderly hearing loss can be one of the most disabling condition causing compromising communication, which can lead to serious social consequences that greatly affect an individual's QoL,[28-30]. Hearing loss has been associated with accelerated cognitive decline and incident cognitive impairment in older adults,[31]. Impairment in communication caused by presbycusis can lead to social isolation and loneliness; studies have demonstrated an association between loneliness with cognitive decline and dementia in older adults,[32]. The use of specific tools is fundamental when evaluating the impact of presbycusis in order to prevent all these consequences.

This review of literature studied the use of questionnaires used to evaluate auditory activity limitation in the elderly. The studies retrieved have a notorious heterogeneity which turns unfeasible the quantitative analysis of combining studies. Thus, more similarity between studies is required to analyze the benefit of the questionnaires use.

In the studies selected, the questionnaires were used to evaluate the emotional and social impact of presbycusis; they were also used to evaluate the impact of voice and hearing changes of elderly individuals on their QoL and finally were used to investigate whether physical performance and musculoskeletal pain were associated with self-perceived hearing handicap.

The use of questionnaires enables us to measure self-perceived handicaps, and these instruments are being increasingly incorporated into the evaluation of patients as an objective measure of the outcome of intervention,[33]. Several instruments can be used to access deterioration of the quality of life due to hearing,[34-35]. These instruments can be divided into hearing-related QoL and generic QoL instruments. The HHIE is a reliable self-assessment tool designed to measure the effects of hearing impairment on the emotional and social adjustment of elderly people,[36]. It is a reliable instrument, widely used, and its reliability and validity have been well established on the original population,[37-38].

The HHIE-S is a short form of the original version, easy to administer and effective, that has also been translated to many different languages; because of its reliability, validity, and brevity, the HHIE-S has been one of the instruments most widely used in English-speaking countries,[39].

Both of these tools have been found to help in the rehabilitation process with hearing aids, increasing the awareness of the patients hearing loss and subsequently benefiting hearing aid rehabilitation,[40]. The study by Barbosa et al, concluded that the HHIE can be an important ally in helping professionals understand the difficulties that remain after hearing aid fitting,[12]. This result was similar to previous studies using these tools when evaluating HA users,[26].

The LSEQ was developed by Sherri L. Smith et al and aims to quantify listening self-efficacy in a variety of situations where the goal of the listener is to understand speech,[10]. Considering the existence of several questionnaires that assess self-reported difficulty in various listening situations and benefit from hearing aids, the novelty of this study was to purpose a tool to evaluate the beliefs that individuals have in their capabilities for listening in a given situation given their current skills and not just how individuals rate their ability to perform by asking questions such as “how much?” or “how often?”. The performed factor analysis showed that the LSEQ has three subscales, with beliefs about listening capabilities relating to the following situations: (1) dialogue in quiet, (2) focusing attention on a single source, and (3) complex auditory scenes. The authors of LSEQ also conclude that LSEQ is a valid and reliable measure of listening self-efficacy with good potential for use in clinical and research settings. Clinicians can use LSEQ as a tool for identifying listening situations in which patients need further assistance because of low self-efficacy.

In the study conducted by Annie Moulin and colleagues, the aim was to validate a French version of the SSQ, a subjective evaluation of patients hearing disability, and to assess SSQ reproducibility across different language versions,[11]. They performed a pilot study with 26 Hearing-impaired subjects to check that the first four types of equivalences in the Universalist model (conceptual, item, semantic, and operational equivalences) were met. The main study included 230 participants. The internal validity showed high values for the Cronbach's alpha (all above 0.91), but the F-SSQ scores were statistically significantly lower than the SSQ scores in other languages. However, regardless of the language version considered, the pattern of the items was remarkably similar, with good correlations between the different language versions SSQs. Thus, the authors conclude that SSQ is a potential international standard for hearing disability and hearing-aid benefit evaluation.

These instruments are crucial for the evaluation of self-perceived activity limitations and participation restrictions, which are fundamental in the rehabilitation process,[41]. In the era of evidence-based medicine, reliable and valid instruments to evaluate audiologic rehabilitation (e.g., hearing aids; cochlear implants; bone-anchored instruments) are of increasing importance,[42].

## Conclusion

The questionnaire most used for the assessment of the restriction on auditory participation was the HHIE and its variations (i.e., HHIE-S and HHIA). These latter questionnaires can be used as powerful tools to evaluate consequences of hearing loss on an individual's everyday life. In addition, these measures can be useful in quantifying auditory rehabilitation treatment outcome.

## Conflict of interests

The Author(s) declare(s) that there is no conflict of interest.

All the data and research material and methods is available on the manuscript.

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# Chapter IV

## Validity and Reliability of the Hearing Handicap Inventory for Elderly - version adapted for use on the Portuguese

# Validity and Reliability of the Hearing Handicap Inventory for Elderly - Version Adapted for Use on the Portuguese Population

J Am Acad Audiol 27:677–682 (2016)

DOI: 10.3766/jaaa.15146

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## Abstract

**Background:** The use of the Hearing Handicap Inventory for the Elderly Questionnaire (HHIE) enables us to measure self-perceived psychosocial handicaps of hearing impairment in the elderly as a supplement to pure tone audiometry. This screening instrument is widely used and it has been going through adaptations and validations for many languages; all of these versions have kept the validity and reliability of the original version.

**Purpose:** To validate on the Portuguese population the Hearing Handicap Inventory for the Elderly Questionnaire (HHIE) translated to Portuguese from Portugal.

**Research Design:** Descriptive correlational qualitative study. Translation from English into Portuguese, linguistic adaptation and counter translation.

**Study Sample:** Two hundred and sixty (260) patients from the ENT Department of Coimbra University Hospitals were divided to constitute a case group (83 individuals) and a control one (177 individuals).

**Intervention:** All of the 260 patients completed the 25 items in the questionnaire and the answers were reviewed for completeness.

**Data Collection and Analysis:** The patients volunteered to answer the 25-item HHIE during an Ear Nose and Throat (ENT) appointment. Correlations between each individual item and the total score of the HHIE were tested, and demographic and clinical variables were correlated with the total score, as well. The instrument's reproducibility was assessed using the internal consistency model (Cronbach alpha).

**Results:** The questions were successfully understood. There was a significant difference in the HHIE-10 and HHIE-25 total score between the two groups (P<.001). Positive correlations can be seen between the global question and HHIE-10 and HHIE-25. In the regression study, a relationship was observed between the PTA and the HHIE-10 (P<.001). Reliability of the instrument was proven by the 0,79 Cronbach Alpha Index.

**Conclusion:** The HHIE translation into Portuguese from Portugal maintained the validity of the original version and it is useful to assess the psychosocial handicap of hearing impairment in the elderly.

**Keywords:** Elderly people, presbycusis, questionnaires, reproducibility of results.

**Abbreviations:** HHIE – Hearing handicap inventory for elderly; PTA- Pure Tone Average.

## Introduction

Presbycusis has been reported by the *Center of Disease Control* as the second most common pathology in the elderly population, with arthritis being the first (Lee, 2013). According to the numbers of the World Health Organization, presbycusis affects 360 million people worldwide, which is 5.3% of world's population. Although this pathology is not exclusive to elderly people, it affects about two thirds of the population older than 70 years old (Lin et al, 2013).

The implications of presbycusis are profound as it can lead to social isolation with all its consequences, including cognitive loss as well as social isolation, withdrawal from life activities and depression (Russo, 1999). As the population grows older, screening for hearing loss should be routine in the evaluation of elderly people. Traditionally, the method for clinical evaluation of people with hearing loss is a formal audiogram but this practice should always include a questionnaire that will provide us with the answers of the social and emotional impact of this pathology (Magalhães and Iório, 2011). The use of questionnaires enables us to measure self-perceived handicaps, and these kinds of instruments are being increasingly incorporated into the evaluation of patients as an objective measure of the outcome of intervention (Newman and Weinstein, 1988).

Ventry and Weinstein introduced the 25-item Hearing Handicap Inventory for the Elderly Questionnaire (HHIE) to assess the self-perceived psychosocial handicap of hearing impairment in the elderly as a supplement to pure tone audiometry in the evaluation of hearing aid effectiveness, in 1982, Appendix 1, and was followed by a shorter 10-item version of the HHIE, the Hearing Handicap Inventory for the Elderly–Screening (HHIE-S) in 1986 (Weinstein, 1989). This screening instrument is widely used and its reliability and validity have been well established on the original population of the study. (Dubno and Dirks, 1983; Weinstein, 1986). The HHIE has been going through adaptations and validations for other languages like Spanish, Chinese or Finnish. All of these versions have kept the validity and reliability of the original version. (Lichtenstein and Hazuda, 1998; Jupiter and Palagonia, 2001; Salonen et al, 2011).

The purpose of the present study was to assess the psychometric properties of the HHIE, translated into Portuguese from Portugal, and to validate this instrument of study on the Portuguese population.

## Methods

This prospective study was held at the ENT Department of Coimbra University Hospitals and was approved by the Ethics in Research Committee of this Institution.

We began our work by translating the HHIE from English to Portuguese from Portugal according to the international guidelines for translation provided by the International Collegium of Rehabilitative Audiology of the USA. The steps of this process were as followed: First, the translation from English to Portuguese was performed by performed by an individual who was well versed in Audiology and hearing aids and who had Portuguese as his/her first language. The translator carefully followed the design principles of the original version. Second, this translation was then "back-translated" from Portuguese into English. The back-translation was performed by a third individual; this person was unaware of the original wording and very fluent in both languages. Third, the back-translation was then checked against the original wording to ensure that each translated item captured the nuances of the original English wording. Fourth, if there had been differences in nuance between the original version and the back-translated version, the translation would have been modified to improve the correspondence between the two versions but this final procedure was not necessary. Finally, the complete translation included not only the items or questions but also the instructions, responses, and the overall format of the questionnaire. All of these were carefully reproduced from the English original to produce an accurate translation.

We studied 260 patients from the ENT Department of Coimbra University Hospitals. The patients were divided into two groups. One with pure tone average (PTA; 500, 1000, 2000 Hz) ≥ 40 dB HL (Case group, 83 individuals) and another with PTA < 40 dB HL (control group, 177 individuals). The case group consisted of 42 females and 41 males and the mean age was 73.35 ± 7.84. There were 111 females and 66 males in the control group and the mean age was 70.50 ± 7.53.

All of the patients volunteered to answer the 25-item HHIE (Attachment 1 and Attachment *2)* during an Ear Nose and Throat (ENT) appointment followed by an audiogram; the subjects in the study did not have any help from the assistant and the answers were reviewed for completeness. All of the 260 patients completed the 25 items in the questionnaire and the answers were scored as follows: 0 points for a *no* response, 2 points for a *sometimes*

response, and 4 points for a *yes* response. The score was the sum of all the responses and can vary from 0 to 100 points. The values of the social subscale score (12 items) can vary between 0 and 48 and the emotional subscale score (13 items) can vary between 0 and 52. Higher values indicate a greater perception of the auditory handicap. Moreover, the patients were asked to answer to the following question (global question): "'Do you feel you have a hearing loss?".

The handicapping hearing level criteria used were recommended by Ventry and Weinstein, namely an audiometric screening threshold level of 40 dB HL or greater at 1 and 2 kHz in one ear or at 1 or 2 kHz in both ears (Tun and Wingfield, 1999).

Data collected were analyzed using SPSS software (*Statistical Package for the Social Sciences*), version 21.

The chi square test was used to analyze proportions in hearing problems and hearing loss criteria between genders. Comparison between groups was performed with Student`s t-test for continuous variables and correlation analysis was conducted by Pearson correlation for continuous variables and Spearman rank correlation for the categorical variables. The authors also have used a linear regression model to underline the possible positive relationship between PTA and score in HHIE-25 and HHIE-10. Internal consistency reliability was assessed with Cronbach`s alpha model defined as the level of homogeneity between the different items of the questionnaire. Values higher than 0.70 were considered to be adequate. Statistical significance was set at P =.05.

## Results

Table 1 shows the demographic characteristic of the group including, hearing status and HHIE-S scores of the 260 subjects.

The authors found a significant difference in the HHIE-10 total score between the case and control groups (21.61 ± 10.6 vs 14.43 ± 11.02, P<.001, respectively). The same was found in the HHIE-25 total score (46.89 ± 27.3 vs 32.62 ± 26.05, P<.001, respectively). A significant statistical difference was observed between the groups considering the individual items HHIE-S (2.08 ± 1.12 vs 1.35 ± 1.05, P<.001) and HHIE-E (1.64 ± 1.15 vs 1.26 ± 1.07, P=0,009).

Given these results, we can affirm that there is a statistically significant difference between case and control group in the HHIE-10, HHIE-25, HHIE-S and HHIE-E scores.

Furthermore, significant positive correlations were observed between global question and HHIE-10 and HHIE-25 (R=0.266, P<.001 and R=0.319, P<.001, respectively). The linear regression model emphasizes the positive association between PTA and HHIE-25 (t=6.92; P<.001), and between PTA and HHIE-10 (t=7.69; P<.001).

The Internal consistency (Cronbach`s alpha) for all the items was 0.79.

Table 2 displays the mean score for each item on the HHIE-S in descending order, and the Spearman rank correlation coefficient of each item to the global question and to the hearing loss criterion.

## Discussion

Study reliability is a degree in which the measured variables result reflects the true result. We measured the reliability with the internal consistency. The minimum acceptable value for the Chronbach's alpha coefficient for internal consistency is equal to 0.70 (Newman et al, 1991). In our study this value for all the items was 0.79. There are significant associations between the total score and the different emotional and social sub-scales. This indicates that in the Portuguese HHIE version there is an association between the results measured in each subscales and the total score of the questionnaire. We were also able to see that the total HHIE score was significantly related to the hearing threshold level.

Regarding the discriminant validity, we can clearly see that the scores from individuals with hearing loss were significantly different from those of the group of normal hearing patients. In addition to this, the results of the HHIE for those who said yes to global question nº10 were significantly higher than for those patients that said they did not have a hearing problem.

This was seen in all the total scores and also in the subscales. There was a limitation in the study, however, as we were not able to match the socio-demographic data from case group and control group participants, which could have influenced the results.

## Conclusion

The purpose of this study was to establish the validity of the Hearing Handicap Inventory for the Elderly Portuguese version questionnaire and the results obtained show that this instrument of study maintains the validity and reliability of its original version.


## Acknowledgements

We wish to express our gratitude all of the audiologists of the Department of Otorhinolaryngology Head & Neck Surgery of Coimbra University Hospital, in Portugal, for their work and support of the study.


**Table 1 .**Demographic characteristic of the 260 subjects including hearing status and HHIE-S scores.

| **Demographic. Hearing and HHIE characteristics of subjects** | | | |
|---|---|---|---|
| | **Global (n=260)** | **Male (n=107)** | **Female (n=153)** |
| **Age, years** | 71.4 ± 7.7 (53-89) | 71.1 ± 7.1 (59-87) | 71.6 ± 8.1 (53-89) |
| **PTA (worse ear)** | 29.8 ± 11.9 (8 – 80) | 30.9 ±11.7 (8-60) | 29.0 ± 12 (10-80) |
| **HHIE (25 items)** | 37.1 ± 27.2 (0-98) | 33.4 ± 24.4 (0-94) | 39.8 ± 28.7 (0-98) |
| **HHIE (10 items)** | 16.7 ± 11.3(0-40) | 15.8 ± 10.8 (0-38) | 17.3 ± 11.7 (0-40) |
| **Hearing problem. %[1]** | 30.4 | 8.8 | 21.5 |
| **Hearing loss criteria. %[2]** | 32 | 15.8 | 16.2 |

[1] Evidence of significant difference between genders. *P*<.001

[2] Without a significant difference between genders. *P*>.05

**Table 2.** Mean score for each item on the HHIE-S in descending order, and the Spearman rank correlation coefficient of each item to the global question and to the hearing loss criterion.

| **Mean scores on HHIE ranked in decreasing order and correlations of score to audiometric hearing loss and self-reports of hearing problems** | | | | |
|---|---|---|---|---|
| **Rank** | **Item** | **Media** | **Correlation Hearing Loss** | **Correlation Global Question** |
| 1 | S8 | 2.98 | 0.293 (*P*<.001) | 0.109 (*P*>.05) |
| 2 | S15 | 2.25 | 0.301 (*P*<.001) | 0.183 (*P*<.05) |
| 3 | S21 | 1.86 | 0.208 (*P*<.05) | 0.176 (*P*<.05) |
| 4 | E5 | 1.68 | 0.074 (*P*>.05) | 0.218 (*P*<.001) |
| 5 | E2 | 1.63 | 0.159 (*P*<.05) | 0.147 (*P*<.05) |
| 6 | E9 | 1.51 | 0.190 (*P*<.05) | 0.190 (*P*<.05) |
| 7 | S10 | 1.45 | 0.234 (*P*<.001) | 0.196 (*P*<.05) |
| 8 | E20 | 1.22 | 0.191 (*P*<.05) | 0.186 (*P*<.05) |
| 9 | E14 | 1.15 | 0.172 (*P*<.05) | 0.229 (*P*<.001) |
| 10 | S11 | 0.99 | 0.271 (*P*<.001) | 0.255 (*P*<.001) |

## Appendix 1- Hearing Handicap Inventory for the Elderly

Instructions: The purpose of this scale is to identify the problems your hearing loss may be causing you. Answer *yes*, *sometimes*, or *no* for each question. Do not skip a question even if you avoid a situation because of your hearing problem. If you use a hearing aid, please answer the way you would hear without the aid.

| **Item nº.** | **Question**<br><br>S. social; E. emotional | **Yes (4)** | **Sometimes (2)** | **No (0)** |
|---|---|---|---|---|
| S1 | Does a hearing problem cause you to use the phone less often than you would like? | | | |
| E2 | Does a hearing problem cause you to feel embarrassed when meeting new people? | | | |
| S3 | Does a hearing problem cause you to avoid groups of people? | | | |
| E4 | Does a hearing problem make you irritable? | | | |
| E5 | Does a hearing problem cause you to feel frustrated when talking to members of your family? | | | |
| S6 | Does a hearing problem cause you difficulty when attending a party? | | | |
| E7 | Does a hearing problem cause you to feel “stupid” or “dumb”? | | | |
| D8 | Do you have difficulty hearing when someone speaks in a whisper? | | | |
| E9 | Do you feel handicapped by a hearing problem? | | | |
| S10 | Does a hearing problem cause you difficulty when visiting a friend, relative, or neighbors? | | | |
| S11 | Does a hearing problem cause you to attend religious services less often than you would like? | | | |
| E12 | Does a hearing problem cause you to be nervous? | | | |
| S13 | Does a hearing problem cause you to visit friends, relatives, or neighbors less often than you would like? | | | |

| | | | | |
|---|---|---|---|---|
| E14 | Does a hearing problem cause you to have arguments with family members? | | | |
| S15 | Does a hearing problem cause you difficulty when listening to the television or radio? | | | |
| S16 | Does a hearing problem cause you to go shopping less often than you would like? | | | |
| E17 | Does any problem or difficulty with your hearing upset you? | | | |
| E14 | Does a hearing problem cause you to have arguments with family members? | | | |
| S15 | Does a hearing problem cause you difficulty when listening to the television or radio? | | | |
| S16 | Does a hearing problem cause you to go shopping less often than you would like? | | | |
| E17 | Does any problem or difficulty with your hearing upset you? | | | |
| E18 | Does a hearing problem cause you to want to be by yourself? | | | |
| S19 | Does a hearing problem cause you to talk to family members less often than you would like? | | | |
| E20 | Do you feel that any difficulty with your hearing limits or hampers your personal or social life? | | | |
| S21 | Does a hearing problem cause you difficulty when in a restaurant with relatives or friends? | | | |
| E22 | Does a hearing problem cause you to feel depressed? | | | |
| S23 | Does a hearing problem cause you to listen to television or radio less often than you would like? | | | |
| S24 | Does a hearing problem cause you to feel uncomfortable when talking to friends? | | | |
| E25 | Does a hearing problem cause you to feel left out when you are with a group of people? | | | |

## Appendix 2- Hearing Handicap Inventory for the Elderly

| Instruções: O objetivo desta escala é identificar o impacto da perda auditiva na sua vida. Responda *Sim*. *Não* ou Às *vezes*. em cada questão. Não salte nenhuma questão mesmo no caso de evitar a situação por causa do seu problema auditivo. No caso de usar aparelho auditivo responda como iria ouvir sem o estar a usar. | | | | |
|---|---|---|---|---|
| **Item nº.** | **Questão**<br><br>S. social; E. emocional | **Sim (4)** | **Às vezes (2)** | **Não (0)** |
| S1 | A sua perda auditiva faz com que use menos vezes o telefone do que aquilo que gostaria? | | | |
| E2 | A sua perda auditiva faz com que se sinta constrangido quando conhece novas pessoas? | | | |
| S3 | A sua perda auditiva faz com que evite grupos de pessoas? | | | |
| E4 | A sua perda auditiva faz com que fique irritado? | | | |
| E5 | A sua perda auditiva faz com que se sinta frustrado quando fala com membros da sua família? | | | |
| S6 | A sua perda auditiva provoca-lhe algum incómodo/dificuldade quando frequenta uma festa? | | | |
| E7 | A sua perda auditiva faz com que se sinta “estúpido” ou “burro”? | | | |
| D8 | Tem dificuldade em ouvir quando alguém fala a sussurrar? | | | |
| E9 | Sente-se de alguma forma incapacitado pela sua perda auditiva? | | | |
| S10 | A sua perda auditiva torna-se um problema quando visita um amigo, familiar ou vizinho? | | | |
| S11 | A sua perda auditiva faz com que vá menos à sua igreja assistir a eventos religiosos do que aquilo que gostaria? | | | |
| E12 | A sua perda auditiva faz com que seja mais nervoso? | | | |
| S13 | A sua perda auditiva faz com que visite amigos, familiares ou vizinhos com menor frequência do que aquilo que gostaria? | | | |

| | | | | |
|---|---|---|---|---|
| E14 | A sua perda auditiva faz com que tenha discussões com membros da sua família? | | | |
| S15 | Tem dificuldade em ouvir o radio ou a televisão por causa da sua perda auditiva? | | | |
| S16 | A sua perda auditiva faz com que vá com menos frequência às compras do que aquilo que gostaria? | | | |
| E17 | Fica aborrecido ou chateado pela perda auditiva ou outro problema com a sua audição? | | | |
| E18 | A sua perda auditiva faz com que se isole dos outros? | | | |
| S19 | A sua perda auditiva faz com que fale menos com os membros da sua família do que aquilo que gostaria? | | | |
| E20 | Sente que a sua vida pessoal ou social esta prejudicada pela sua perda auditiva? | | | |
| S21 | A sua perda auditiva é um problema quando fala com amigos ou familiares num restaurante? | | | |
| E22 | Sente-se deprimido por causa da sua perda auditiva? | | | |
| S23 | A sua perda auditiva faz com que oiça menos vezes o radio ou a televisão do que aquilo que aquilo que gostaria? | | | |
| S24 | A sua perda auditiva faz com que se sinta desconfortável quando fala com amigos? | | | |
| E25 | A sua perda auditiva faz com que se sinta excluído quando está num grupo de pessoas? | | | |

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# Chapter V

## Translation of the International Outcome Inventory for Hearing Aids into Portuguese from Portugal

# Translation of the International Outcome Inventory for Hearing Aids into Portuguese from Portugal

*Accepted for publication in BMJ Open*

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## Abstract

**Objective:** To translate the International Outcome Inventory for Hearing Aids (IOI-HA) Questionnaire from English to Portuguese (from Portugal) and to validate this instrument of study on the Portuguese population.

**Design:** In this prospective study, a translation from English into Portuguese of the IOI-HA was performed, and linguistic adaptation and counter translation were also accomplished. The data was analyzed for internal consistency testing for correlations between each individual

item and the total score of the IOI-HA, assessing the Cronbach alpha and performing test-retest analysis.

**Setting and Participants:** Eighty hearing aid users aged 18 or older were recruited from an Ear, Nose and Throat appointment in Coimbra's hospital, Portugal. Eighty-four percent (84%) of the participants were unilateral hearing aid users, whereas 16% were bilateral users.

**Interventions:** The patients volunteered to answer the questionnaire during an ENT appointment. All of the patients had been using the hearing aids for more than 3 years.

After the first application of the questionnaire, a new appointment was planned for retesting, within at least seven days to no more than sixty days. Twenty-seven participants answered the questionnaire again according to the same procedure.

**Results:** The mean IOI-HA total score in the study population was 27.33 ± 4.93 (9 – 35). The mean values obtained for each item of the questionnaire ranged from 3.19 to 4.54. The Cronbach Alpha was 0.838 and the Cronbach Alpha values when the item was removed were also significantly strong. The test-retest analysis revealed no differences between the paired groups.

**Conclusion:** In the present study a valid and reliable translation and adaptation of the IOI-HA into Portuguese from Portugal is proposed. This tool will be available for clinical assessment of hearing aid users.

**Keywords:** Hearing aids, questionnaires, reproducibility of results, elderly hearing loss.

## Introduction

The International Outcome Inventory for Hearing Aids (IOI-HA) is a questionnaire developed to quantify the satisfaction of hearing aid users (HAUs) and the impact these devices have on their lives [1]. The IOI-HA was developed to be used as an international standardized self-report measure [2]. Recent research supports the advantages of its use in the rehabilitation process of HAUs [3].

The IOI-HA contains seven questions used to subjectively evaluate the results of the hearing aids under the following parameters: 1 - time for which hearing aids have been used; 2 - benefit; 3 - residual limitation in daily life activities; 4 - satisfaction; 5 - residual restrictions to participation; 6- impact on other people; 7 - quality of life. The answers to each question range from poor performance (1) to best performance (5) [3]. Previous studies have shown that the IOI-HA can be used administratively to record the outcomes of a service facility, as a research instrument and an advisor for potential deficits that need to be improved [1]. The IOI-HA was translated and validated in 27 languages.

The validation of the IOA-HA in Portuguese from Brazil (Brazilian) was published in 2010 [3] and is known as the QI-AA (Questionário Internacional - Aparelhos Auditivos). Brazilian Portuguese is a variant of the original Portuguese language, spoken in South America, which has significant differences from the European Portuguese spoken in Portugal and in other Portuguese-speaking countries. These differences are for example, how words sound (phonology), the use of gerund in verbs, and, most important, in vocabulary (ex: hearing aids is “aparelhos auditivos” in Portuguese and “aparelhos de amplificação sonora” in Brazilian). These differences can have a tremendous influence when using questionnaires like the IOI-HA, influencing the validation trial of this tool. Therefore, the purpose of the present study was to assess the internal consistency of the IOI-HA translated into Portuguese from Portugal, and to validate this instrument of study on the Portuguese population. It is fundamental to analyze the psychometric properties of this tool so that its results can be accurately and reliably interpreted.

## Materials and Methods

This prospective study was held at the ENT (Ear Nose and Throat) Department of Coimbra University Hospitals and was approved by the Ethics in Research Committee of this Institution. We began our work by translating the IOI-HA (Appendix 1) from English to Portuguese (from Portugal), according to the guidelines for translation provided by the International Collegium of Rehabilitative Audiology [4]. The complete translation included not only the items or questions but also the instructions, answers, and the overall format of the questionnaire. All of these were carefully reproduced from the English original version in order to produce an accurate translation. The steps of this process were as follows: First, an individual who was well versed in Audiology and hearing aids and who had Portuguese as his /her first language performed the translation from English to Portuguese. The translator carefully followed the design principles of the original version. Second, this translation was then "back-translated" from Portuguese into English. The back-translation was performed by a third individual; this person was unaware of the original wording and was very fluent in both languages. Third, the back-translation was then checked against the original wording to ensure that each translated item captured the nuances of the original English wording.

Eighty HAUs aged 18 or older from the ENT Department of Coimbra University Hospitals, without cognitive disorders, answered the questionnaire (Appendix 2) during an ENT appointment. The mean age of the patients was 68.1 years ± 11.2 (36-96), 57.5% were female patients and 42.5% male patients.

We ruled out any cognitive disorder based on basic questions (ex: day and month of the year, location, date of birth) during the interview. The patients included in this study answered the questionnaire in person and did not have any help from the assistant; we reviewed the answers for completeness. Instructions were included in the text preceding each question, and the subjects could select only one answer for each question. All of the patients had been using the hearing aids for more than 3 years. In Portugal, the hearing aids are prescribed by an ENT doctor and can be acquired by the patients themselves or they can be provided by the National Health Care Service.

After the appointment, the patients were submitted to a pure tone and pure bone audiogram followed by a speech audiogram with and without the hearing aid.

During the follow-up period, the HAUs did an aided audiogram (open field, with the speakerphones on 90º and 270º azimuth).

The unilateral HAUs had the other ear opened. The aided audiogram was important to quantify the audiometric gain of the patients when using the hearing aids.

After the first application of the questionnaire, a new appointment was planned for retesting, within at least seven days to no more than sixty days. Twenty-seven participants answered the questionnaire again according to the same procedure, and they did not have access to the answers they had given the first time.

Data collected from the IOI-HA was converted into numeric values and analyzed using SPSS software (*Statistical Package for the Social Sciences*), version 21. An independent t-test was used to detect differences in IOI-HA scores between genders and the results obtained from testing-retesting were analyzed and compared using the paired T-test. The correlation between each individual item of the IOI-HA and between PTA (Pure Tone Average) and IOI-HA scores was tested with the Pearson Correlation Ratio with a level of significance set at 5%. This analysis provides very important information about the discrimination capacity of each question. Moreover, the Cronbach alpha coefficient, defined as the level of homogeneity between the different items of the questionnaire was also assessed. Values higher than 0.70 were considered adequate.

## Results

Eighty-four percent (84%) of the participants were unilateral HAUs, whereas 16% were bilateral users.

The mean pure tone average before amplification was 56 ± 20 dB HL (29-116). The mean of the total score of the IOI-HA in the studied population was 27.33 ± 4.93 (9 – 35).

The mean values for each item of the questionnaire and the correlation with the total score are presented in Table I. This table also includes the values of Cronbach alpha if each item is removed and for the questionnaire as a whole. The Cronbach Alpha value was 0.838, suggesting that the items have high internal consistency.

**Table I. Mean values, standard deviations (SD) obtained in each item of the questionnaire, corrected item-total correlation and Cronbach alpha if each item is removed and for the questionnaire as a whole.**

| Question | Mean | SD | Corrected item-total correlation | Cronbach Alpha if item is removed |
|---|---|---|---|---|
| **Q1** | 4.54 | 0.84 | 0.441 | 0.836 |
| **Q2** | 3.88 | 1.02 | 0.774 | 0.785 |
| **Q3** | 3.19 | 1.04 | 0.668 | 0.803 |
| **Q4** | 4.08 | 1.04 | 0.729 | 0.793 |
| **Q5** | 3.91 | 1.02 | 0.555 | 0.821 |
| **Q6** | 3.98 | 1.13 | 0.292 | 0.865 |
| **Q7** | 3.75 | 0.97 | 0.728 | 0.794 |
| **Total** | 27.33 | 7.06 | - | 0.838 |

Table II presents the correlation between each item, which was statistically significant in the majority of the cases. Finally, Table III contains the test-retest reliability of the IOI-HA and the correlation between answers in both test applications. The correlation between the test and retest application is strong, with no statistical differences between each question ($p>0.05$).

**Table II. Correlation between IOI-HA questions (significant if *p<0.05)**

| Question | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 |
|---|---|---|---|---|---|---|---|
| **Q1** | 1.000 | - | - | - | - | - | - |
| **p** | - | - | - | - | - | - | - |
| **Q2** | 0.535 | 1.000 | - | - | - | - | - |
| **p** | 0.000* | - | - | - | - | - | - |
| **Q3** | 0.359 | 0.614 | 1.000 | - | - | - | - |
| **p** | 0.001* | 0.000 | - | - | - | - | - |
| **Q4** | 0.488 | 0.770 | 0.569 | 1.000 | - | - | - |
| **p** | 0.000* | 0.000* | 0.000* | - | - | - | - |
| **Q5** | 0.188 | 0.389 | 0.490 | 0.399 | 1.000 | - | - |
| **p** | 0.095 | 0.000* | 0.000* | 0.000* | - | - | - |
| **Q6** | 0.001 | 0.193 | 0.249 | 0.194 | 0.489 | 1.000 | - |
| **p** | 0.993 | 0.086 | 0.026* | 0.084 | 0.000* | - | - |
| **Q7** | 0.429 | 0.781 | 0.581 | 0.693 | 0.423 | 0.189 | 1.000 |
| **p** | 0.000* | 0.000* | 0.000* | 0.000* | 0.000* | 0.094 | - |

**Table III. Test-Retest results (significant if *p<0.05)**

| Question | Difference between mean values | Paired T-test<br><br>p value | Correlation between items in both tests (Pearson's Correlation Ratio and p value) |
|---|---|---|---|
| **Q1** | -0.068 | 0.161 | 0.924 (<0.001) |
| **Q2** | -0.034 | 0.573 | 0.956 (<0.001) |
| **Q3** | 0.103 | 0.184 | 0.936 (<0.001) |
| **Q4** | -0.172 | 0.232 | 0.723 (<0.001) |
| **Q5** | -0.103 | 0.184 | 0.888 (<0.001) |
| **Q6** | -0.172 | 0.096 | 0.868 (<0.001) |
| **Q7** | -0.069 | 0.326 | 0.940 (<0.001) |

## Discussion

Study reliability is the degree at which the measured result reflects the true result; this study evaluated the internal consistency of the Portuguese version of the IOI-HA, translated into Portuguese from Portugal.

The IOI-HA has been translated into various languages allowing its standardized use across countries and linguistic communities. The use of this questionnaire as a self-assessment tool is extremely important as user satisfaction is closely related to the success of rehabilitation. The results of this study demonstrate that the use of the questionnaire was adequate, simple and easy to apply and that it can be used as a measure of self-perception. It can also be used to evaluate measures as speech perception and sound quality.

The mean value for each item varied between 3.19 and 4.54. These values highlight a good level of satisfaction with the hearing aids, as it shows favorable attitudes (above 50% of the total score) towards hearing aids. The literature supports this finding [1, 5, 6, 7].

The distribution of answers shows that few subjects selected the answers associated with the poorest outcomes. The data obtained in this study are similar to other studies [1, 3, 6, 7] and

we believe that the IOI-HA is feasible for detection of individuals who are not satisfied with their experience with amplification.

These data suggest that we could use the questionnaire in three ways: administratively to document the outcomes of a service facility (obtaining the total score), as a research instrument (as a two-score index was identified) and as a mini-profile with norms for identifying areas that need to be improved for the patient (if the inventory is used clinically to validate a fitting) [1, 6, 7].

Study reliability is a degree in which the measured variables result reflects the true result. We measured the reliability with the internal consistency of the questionnaire as a whole through the Cronbach Alpha that was 0.838. A higher Cronbach Alpha ratio corresponds to a high internal consistency [8]. This result is similar to the value observed in the English version [1] and lower than that of the German version [7] and it indicates that the translated version is consistent. The test-retest analysis showed no statistically significant difference between groups, reflecting an acceptable reliability.

## Conclusion

The purpose of this study was to establish a translation of the Portuguese Version of the IOI-HA. From the results, we could see that the questionnaire presents an acceptable reliability. We believe, as also seen in other studies [1, 6, 7], that the IOI-HA can be used in the rehabilitation process of HAUs. The results show that this instrument of study maintains the utility of its original version.

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## Acknowledgements

We wish to express our gratitude to all the audiologists of the Department of Otorhinolaryngology Head & Neck Surgery of Coimbra University Hospital, in Portugal, for their work in and support to this study.

## Declaration of interest

The authors report no declarations of interest.

## Authors Contribution

S. M. M. Paiva- Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, and drafting the article.

J. F. C. P. M. Simões - analysis and interpretation of data, and revising the article.

A. M. D. Paiva, F. J. F. C. Sousa, J-P Bébéar - revising it critically for important intellectual content, and final approval of the version to be published.

Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

## Supporting Information

Appendix 1- International Outcome Inventory for Hearing Aids (IOI-HA)

Appendix 2- Questionário Internacional – Aparelhos Auditivos (QI-AA)

## Appendix 1- International Outcome Inventory for Hearing Aids (IOI-HA)

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)?

| none | less than 1 hour a day | 1 to 4 hours a day | 4 to 8 hours a day | more than 8 hours a day |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in those situations?

| helped not at all | helped slightly | helped moderately | helped quite a lot | helped very much |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

3. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

| very much difficulty | quite a lot of difficulty | moderate difficulty | Slight difficulty | no difficulty |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

4. Considering everything, do you think your present hearing aid(s) is worth the trouble?

| not at all worth it | Slightly worth it | Moderately worth it | quite a lot worth it | very much worth it |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?

| affected very much | affected quite a lot | affected moderately | affected slightly | affected not at all |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

| bothered very much | bothered quite a lot | bothered moderately | bothered slightly | bothered not at all |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

| worse | no change | slightly better | quite a lot better | very much better |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

8. How much hearing difficulty do you have when you are **not** wearing a hearing aid?

| severe | moderately-severe | moderate | mild | none |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

Norms for the IOI-HA

Cox, Alexander, & Beyer, 2002

| Item | **Individual clients** | | **Groups of clients** | |
|---|---|---|---|---|
| | | | | |
| | Mild-moderate lower/upper | Mod-severe+ lower/upper | Mild-moderate mean/SD | Mod-severe+ mean/SD |
| 1. use | 3/5 | 4/5 | 3.73/1.17 | 4.5/.96 |
| 2. benefit | 3/4 | 3/4 | 3.39/.98 | 3.52/1.08 |
| 3. RAL | 3/4 | 2/4 | 3.4/.95 | 3.19/1.05 |
| 4. satisfac. | 2/4 | 3/5 | 3.2/1.21 | 3.84/1.17 |
| 5.RPR | 3/4 | 3/4 | 3.57/1.13 | 3.38/1.11 |
| 6.imp-oth | 3/5 | 2/4 | 3.79/1.13 | 3.38/1.1 |
| 7. QofLife | 3/4 | 3/4 | 3.19/.93 | 3.68/1.02 |

The category of norms used should depend on the patient's answer to the 8$^{th}$ item of the questionnaire. If they choose "none". "mild" or "moderate", use the "mild/moderate" norms. For the other 2 options, use the "mod/severe" norms.

The norms for individual clients are the middle 50% of the data. Hearing aids were: Single-channel, single-memory, ITE; All bilateral fittings; All compression (any type); standard fitting protocol; Purchased between Aug/00 & Jan/01.

## Appendix 2 - Questionário Internacional – Aparelhos Auditivos (QI-AA)

1. Nas últimas duas semanas, pense no tempo em que usou o(s) aparelho(s) auditivo(s). Durante quantas horas usou o(s) aparelho (s) de audição num dia normal?

| nunca | menos do que 1 hora por dia | entre 1 e 4 horas por dia | entre 4 e 8 horas por dia | mais do que 8 horas por dia |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

2. Pense em que situação gostaria de ouvir melhor, antes de obter o(s) seu(s) aparelho(s) auditivo(s). Como é que o(s) aparelho(s) o ajudaram nessa mesma situação, nas duas ultimas semanas?

| não ajudou/ajudaram | pouco | ligeiramente | bastante | ajudou/ajudaram muito |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

3. Pense novamente na mesma situação em que gostaria de ouvir melhor, antes de obter o(s) seu(s) aparelho(s) auditivo(s). Quando usa o(s) seu(s) aparelho(s) auditivo(s), nessa situação, que grau de dificuldade AINDA sente?

| muita dificuldade | bastante dificuldade | alguma dificuldade | ligeira dificuldade | sem dificuldade |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

4. Tendo em conta todas as vantagens e desvantagens, acha que vale a pena usar o(s) aparelho(s) auditivo(s)?

| não vale a pena | vale pouco a pena | vale ligeiramente a pena | vale bastante a pena | vale muito a pena |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

5. Nas duas ultimas semanas usando o(s) aparelhos(s) auditivo(s), quanto é que a sua dificuldade em ouvir afetou as suas atividades diárias?

| afetou muito | afetou bastante | afetou moderadamente | afetou ligeiramente | não afetou |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

6. Nas últimas duas semanas, com o(s) seu(s) atual aparelho(s) auditivo(s), quanto pensa que a sua dificuldade em ouvir possa ter incomodado outras pessoas?

| incomodou muito | incomodou bastante | incomodou moderadamente | incomodou ligeiramente | não incomodou |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

7. Considerando tudo, como é que lhe parece que o(s) seu(s) aparelho(s) auditivo(s) teve(tiveram) influencia na sua alegria de viver?

| pioraram | sem alteração | ligeiramente melhor | bastante melhor | muito melhor |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

8. Como classifica a sua dificuldade em ouvir quando não esta a usar o(s) seu(s) aparelho(s) auditivo(s)?

| grave | severa a moderada | moderada | ligeira | nenhuma |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

Portuguese Version (from Portugal)

Inventory for Hearing Aids (IOI-HA)
Cox/Stephens/Kramer
Norms for the IOI-HA
Cox, Alexander, & Beyer, 2002

| Item | Doentes individuais | | Grupos de doentes | |
|---|---|---|---|---|
| | | | | |
| | Ligeira-Moderada Mínimo/Máximo | Moderada-Severa+ Mínimo/Máximo | Ligeira-moderada Média/ Desvio Padrão | Moderada-severa+ Media/ Desvio Padrão |
| 1. Utilização | 1/5 | 3/5 | 4.55/0.84 | 4.33/1.16 |
| 2. Beneficio | 1/5 | 3/4 | 3.88/1.04 | 3.67/0.58 |
| 3.(LAR) Limitações atividade residual | 1/5 | 2/4 | 3.21/1.04 | 2.67/1.16 |
| 4. Satisfação | 1/5 | 3/4 | 4.09/1.05 | 3.67/0.58 |
| 5.Restrição de Participação Residual | 1/5 | 3/5 | 3.91/1.03 | 4/1 |
| 6. Impacto sobre outros | 1/5 | 3/5 | 3.97/1.15 | 4/1 |
| 7. Q. Vida | 2/5 | 3/4 | 3.75/0.99 | 3.67/0.58 |

A categoria de normas dependem da resposta ao item nº.8.
No caso de escolherem “nenhuma” “ligeira” ou “moderada”, use as normas “ligeira/moderada”.
Para as outras duas opções use as normas “moderada/severa”.

As normas para doentes individuais são a media em 50% do total dos dados.
Para próteses auditivas: Canal Único; Memoria Única, ITE (Intra-canal), todo o tipo de próteses com compressão (qualquer tipo), com protocolo *standard* de adaptação

*Nota: Para obter os resultados, as respostas da esquerda para a direita são classificadas de 1 a 5. Os valores no final são adicionados. Valores mais elevados indicam um resultado mais favorável.*

# Chapter VI

## Conclusions

## Conclusions

We began our work by creating a data base dating from 2010 onwards, with all the patients diagnosed with presbycusis in the Ear Nose and Throat (ENT) appointment at the ENT Department of Coimbra University Hospitals. A total of 2643 individuals were diagnosed with presbycusis, 1340 (50,7%) male and 1303 (49,3%) female. The age distribution among the patients was similar, for the male and female patients, and the mean age was 69,6 years.

From the 2643 patients only a small percentage of these 3,14% (83 patients) were hearing aid users (HAUs), 67,45% of which were female and 32,5% were male. The mean average of age distribution among the HAUs was 74,27 years.

We know for a fact that presbycusis has a tremendous impact on the quality of life of the patients, but there was no previous study reflecting the social or emotional impact of this disorder in samples studied.

From a systematic review of the literature using the 5S levels of organization of healthcare research evidence (systems, summaries, synopses, syntheses, studies), based on the model described by Haynes, we were able to select the Hearing Handicap Inventory for Elderly (HHIE) as a screening instrument to assess the psychosocial handicap of hearing impairment in the elderly.

We proceeded our work by adapting and evaluating the psychometric properties of this tool, including its validity and reliability, translated into Portuguese, from Portugal.

After performing a prospective recruitment, 260 patients responded to the HHIE, after its translation from English to Portuguese from Portugal (according to the international guidelines for translation provided by the International Collegium of Rehabilitative Audiology, USA).

We were able to evaluate the psychometric properties of the HHIE, translated into Portuguese, and to validate this instrument of study on the Portuguese population.

The results show a significant statistical difference on the total score between the case and control groups (46.89 ± 27.3 vs 32.62 ± 26.05, P<.001, respectively). A significant statistical difference was observed between the groups considering the individual items HHIE-Social

(2.08 ± 1.12 vs 1.35 ± 1.05, P<.001) and HHIE-Emotional (1.64 ± 1.15 vs 1.26 ± 1.07, P=0,009).

There were significant associations between the total score and the different emotional and social sub-scales, which indicates that in the Portuguese HHIE version there is an association between the results measured in each subscales and the total score of the questionnaire. We were also able to see that the total HHIE score was significantly related to the hearing threshold level. Furthermore, significant positive correlations were observed between global questions with a high internal consistency value and reliability of the instrument was proven by the Cronbach Alpha Index (0,79).

Thus we were able to conclude that the HHIE maintained the validity of the original version and it is useful to assess the psychosocial handicap of hearing impairment in the elderly Portuguese population.

After this step of our study, we continued the work validating another tool to study our patients, in this case the HAUs. The numbers of the data base showed a poor adhesion to earing rehabilitation measures; to understand these numbers it is fundamental to quantify the satisfaction of hearing aid users (HAUs) and the impact that these devices have on their lives; the International Outcome Inventory for Hearing Aids (IOI-HA) was designed for this purpose. It is also a valuable tool in the rehabilitation process of HAUs.

The purpose of this last work was to assess the internal consistency of the IOI-HA and to validate this instrument of study on the Portuguese population.

Eighty HAUs aged 18 volunteered to answer the IOI-HA during an ENT appointment after its translation from English to Portuguese from Portugal (according to the international guidelines for translation provided by the International Collegium of Rehabilitative Audiology, USA); a new appointment was planned for retesting the questionnaire (this time answered by twenty-seven participants according to the same procedure and without access to the answers given at the first time).

The correlation between each individual item of the IOI-HA and between PTA (Pure Tone Average) and IOI-HA scores was tested with the Pearson Correlation Ratio with a level of significance set at 5%. The mean value for each item varied between 3.19 and 4.54, a valuable information about the discrimination capacity and validity of each question.

These values highlight a good level of satisfaction with the hearing aids. Response distribution shows that relatively few subjects selected the responses indicative of the poorest outcomes.

The Cronbach Alpha value was 0.838, suggesting that the items have high internal consistency. The test-retesting analysis showed no statistically significant difference between groups, reflecting an acceptable reliability.

These results confirm that the questionnaire presents acceptable levels of internal consistency. We were able to assess the psychometric properties of the translated version of the IOI-HA and we believe that our work highlights a significant validity and usefulness of the translated questionnaire.

We believe that our work highlights the importance of these tools when evaluating patients with presbycusis and is of great value regarding the rehabilitation process of HAUs. Moreover, we would also like to emphasize the importance of these instrument to assess the psychosocial handicap of hearing impairment in the elderly. Both questionnaires are relevant as a powerful tool in clinical decision making and relevant for medical education.

However, despite the answers provided by this research, the results presented raise even more questions. Despite the high prevalence of presbycusis in our study and its enormous impact, only a small percentage of the patients (3,14%) were hearing aid users (HAUs). We know for a fact that hearing aids can improve hearing function for most cases of presbycusis [48]. It has been proven that the use of hearing aids can minimize the emotional impact that is commonly associated with presbycusis [49], leading to improvement in the quality of life [50]. Presbycusis usually develops over many years, and the progression of hearing loss rarely becomes so severe that hearing aids are not effective in restoring the ability to communicate. Although it has not yet been proven that hearing aids can promote cognitive function or mental health, they may promote better physical health [73].

An early intervention to improve hearing is fundamental as hearing loss further exacerbates cognitive decline in these patients. On the other hand, positive cognitive abilities are related to verbal information processing and have been correlated with a good outcome in the rehabilitation process [74]. So it is fundamental that these hearing

rehabilitation measures should be prescribed while the patients still have a good cognitive function, and to keep in mind that postponing this process may compromise their wellbeing.

Our numbers presented reflect a poor adhesion to the rehabilitation measures in particular hearing aids, with only 3,14% being HAUs; of these the majority were female (67,45%) and the mean age was 74,27 years. These numbers are inferior to those of the literature where 10 to 20 percent of adults with significant hearing loss actually have a hearing aid [2,52,61] with 25 to 40 percent abandoning hearing aid use. Also we believe that a good outcome of a rehabilitation program will also depend on the age of the patients and their cognitive abilities; lowering the mean age of this group should be a goal for future intervention. Overall, these data emphasize the need for an adequate program of rehabilitation service and counselling to maximize the chance of benefit.

There was a limitation in our study, however, as we were not able to evaluate the socio-demographic data of the patients. This information should not have been neglected, as studies have shown that individuals with hearing impairment, who choose to use hearing aids and other technologies, are likely to be healthier and of higher socioeconomic status than individuals with hearing impairment, who don't use hearing aids [75].

In conclusion, the results presented and discussed in this thesis demonstrate that presbycusis should not be seen purely as a neurossensorial hearing loss but as a complex disorder that must be thoroughly studied to minimize comorbidities and improve the quality of life of the patients.

# Chapter VII

## Future interventions

## Future interventions

When we began our work, one of the goals was to validate tools that would be able to help us understand the emotional and social impact that this disorder had on patient life. We consider that presbycusis is not only a neurossensorial hearing loss but a complex disorder that requires a multidisciplinary approach. The validation of the HHIE and the IOI – HA was of utmost importance so that we could help our patients in distress. A strong association between hearing loss and domains critical to aging like dementia [25], cognitive functioning [76], and falls [77,78] highlights the need for further intervention, in terms of diagnosis but also regarding hearing rehabilitation measures.

Presbyastasis, an associated loss of vestibular end-organ function, is quite common and can contribute to vertigo, disequilibrium, and falls [33]. In our opinion an early diagnose is mandatory in order to minimize the risk of falls and their potentially devastating complications. The observation of these patients in an integrated appointment with an Otoneurologist opinion is fundamental. With the prompt recognition of presbyacusis and presbyastasis patients can initiate measures to increase function while reducing the risk of falls and their potentially devastating complications.

Regarding the hearing rehabilitation measures there is still so much left unsaid; studies have showed that the main reasons reported by the patients for not acquiring hearing aids or abandoning these devices are negative attitudes towards aids and stigmatization [79,80,81]. Other reasons for not using hearing aids are handling problems and receiving less-than-desire benefit from hearing aids [79,82,83,84,85,86]. As clinicians, our primary goal is to increase elderly people's awareness of hearing losses and of the benefits of hearing rehabilitation. We believe that with a good fitting protocol, which should include a period of training and counseling, these numbers might decrease. Also, simple measures like promoting meetings with same age patients with hearing losses, who convey positive experiences with rehabilitation measures, may increase hearing-aid uptake and use [87]. Further intervention studies are needed to determine the role of hearing rehabilitative modalities in helping mitigate comorbidities; if a small beneficial effect of hearing aid use could be demonstrated, it would have significant implications for public health, given that hearing aids are currently not utilized by nearly 23 million older adults with hearing loss [88]. There is a variety of these devices in the market that

can reduce the impact of presbycusis on daily life [89]. These can be linked with a hearing aid (such as telecoils for telephone use that transmit sound information directly to an individual's hearing aid) or can be independent of hearing aids (such as tactile or visual alerts that can compensate for lack of auditory input). The use of assistive listening devices is not very common in our country, but depending on the specific listening environment in which they are applied, in most patients satisfaction is good [90]. These devices can be used in several settings, including at home or at work [91], and can be of particular benefit in theaters and lecture halls with otherwise adverse acoustics [92,93]. We believe that with proper counseling these devices could be easily integrated in the rehabilitation process of our patients. Auditory rehabilitation must not be forgotten and should be routinely performed in combination with an hearing device; it is defined as sensory management, instruction, perceptual training, and counseling for hearing impairment [94]. The interest on this practice has increased recently due to the advances on these techniques, such as speech tracking and analytic auditory training reappear in computerized forms. These new delivery methods allow for a consistent, cost-effective, and convenient training program [95].

Because many patients still complain of communication difficulties after being fitted with hearing aids or when they choose not to wear hearing aids, the use of communication programmed interventions is fundamental. Programs like the Active Communication Education (ACE) focuses on the development of problem-solving strategies to improve communication in everyday life situations [96]. This is an interactive group program for older people and their significant others; it starts with a communication analysis, in which participants (including the significant others) are asked to describe the communication and hearing difficulties in everyday life. After this first evaluation the group facilitator assists participants to prioritize communication needs, and then patients are encouraged to develop their own individual problem-solving skills. The problem solving includes analyzing the source of the difficulty in a real life situation, identifying solutions and practicing these until success is achieved. Studies support the use of the IOI-HA to evaluate the outcomes of programs such as the ACE [97]. These data reinforce the use of the IOI-HA in clinical practice with rehabilitation measures and when alternative interventions are being applied. These programs represent an important adjunct to, or supplement for, the traditional approach with hearing aid fitting.

There is still so much to investigate regarding for instance the pathophysiological processes underlying age-related hearing loss; many studies have been conducted to illustrate the risk factors related to presbycusis such as heritability, environment factors, medical conditions, free radical (reactive oxygen species, ROS) and damage of mitochondrial DNA [98]. Because this specific kind of hearing loss affects older people it is almost impossible to separate the contribution of genetic factors to age-related hearing loss from other factors. It has been established that a genetic component also predisposes individuals to age-related hearing loss, the contribution of familial factors to age-related hearing loss cannot be quantified [99]. Studies conducted on a large population of twins older than 75 years of age showed that genetic factors play an important role in self-reported reduced hearing, with higher values for monozygotic twin pairs than for dizygotic twin pairs [100]. Findings from these studies are important to identify those patients genetically susceptible to age related hearing loss and to establish genetic counseling. In what concerns the genetic role on presbycusis our work is yet to be concluded; we are engaged in two different projects: the first one was conducted in collaboration with the Institute Pasteur, in Paris. In this study the main goal is to identify by wide genome analysis (WGA) new loci in different genes that would contribute to presbycusis. The final objective of the project is to conduct a genetic analysis of the entire genome in patients with a family history of presbycusis or in sporadic cases, to determine if known genes responsible for hearing loss in younger ages are present and also to discover other genes responsible for presbycusis.

The second project is intended to identify deoxyribonucleic acid (DNA) mitochondrial mutation that has been implicated with non-syndromic neurossensorial hearing loss. The first mitochondrial mutation was identified in 1993 and since then a number of acquired mtDNA mutations have been proposed as a cause of presbycusis. However, the pathophysiology between the mutations and the clinical phenotype remains poorly understood [101]. This work is currently being developed in our Faculty. The laboratorial work will begin with DNA Sangers sequencing to track known mutations and we hope that with this method we will be able to find new ones. The positive cases will be confirmed by the amplification of the region of selected gene, with a polymerase chain reaction restriction fragment length polymorphism (PCR-RFLP). All of these findings will be crucial in the future; we will be able to identify patients with risk factors for

presbycusis and prevent additional damage with for instance treatments with aminoglycosides.

We believe that future treatments for hearing loss will include genetic, cellular, or pharmacotherapy to induce the regeneration of hair cells in damaged regions of the cochlea [102]. A first step towards these expectations was the identification of endogenous stem cells within the inner ear, especially regarding stem cell therapy [103-105]. Stem cell based treatments with embryonic stem cells, or induced pluripotent stem cells may show a high potential in "turning back the clock" which would be the turning point on presbycusis therapy [102]. The ability to unlock the regenerative potential of such cells could help to address the fundamental deficits in presbycusis.

In conclusion, further understanding of the underlying causes of age-related hearing loss is needed, so that more targeted interventions can be developed. Most of our patients showed the willingness to return in order to continue the study; they fell that it is of utmost importance to enlighten the causes of this disorder so that their next generation can prevent it.

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