Scientific Research Publishing

International Journal of Otolaryngology and Head & Neck Surgery, 2024, 13, 442-460
https://www.scirp.org/journal/ijohns
ISSN Online: 2168-5460
ISSN Print: 2168-5452

Appropriate Hearing Aids Significantly Increase the Quality of Life in Presbycusis: An Observational Study

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How to cite this paper: Delwar, A.H.M. (2024) Appropriate Hearing Aids Significantly Increase the Quality of Life in Presbycusis: An Observational Study. *International Journal of Otolaryngology and Head & Neck Surgery*, **13**, 442-460.
https://doi.org/10.4236/ijohns.2024.136038

Received: October 17, 2024
Accepted: November 15, 2024
Published: November 18, 2024

Abstract

Background: Hearing is a unique sense that allows communication. Hearing loss leads to mental depression, social deprivation, cognitive decline, and gradually decreasing daily performance, making the person handicapped. Presbycusis is a disease of older people, suffering 360 million worldwide. Methods: The present study is a cross-sectional study in the Comilla Medical College (https://www.cumc.edu.bd) and Cumilla Medical Centre (http://www.comillamedicalcentre.com/) of the Department of the Otolaryngology and Head-Neck Surgery Cumilla, Bangladesh, from 01 February 2024 to 31 July 2024. Results: The study was conducted in a developing country searching for adequate rehabilitation with hearing aids at maximum hearing loss. Hearing rehabilitation faces challenges like low awareness, stigma, and insufficient healthcare infrastructure. The paired sample T-test was done between pure tone audiometry (PTA) tests before and after using a hearing aid in the right and left ear. It showed that hearing aids significantly increased hearing that $p \leq 0.001$. The t-test of WHO quality of life before and after using hearing aids revealed $p \leq 0.001$, and the HHIE-S score exhibited $p \leq 0.001$. Conclusion: It needs adequate support to improve hearing health by increasing the number of audiologists and trained healthcare workers and supplying low-cost hearing aids and services.

Keywords

Presbycusis, Hearing Aid, Pure Tone Audiometry, WHOQOL, HHIE-S

1. Introduction

Hearing impairment is among the most critical health issues in developed and

developing countries. Bangladesh is a developing country with limited healthcare facilities. However, hearing disparity is less significant than other health problems. It affects communication, social interaction, and quality of life. Older adults with hearing afflictions regularly face isolation, depression, and cognitive decline. Bangladesh faces many burdens like other developing countries, such as decreased awareness, stigma, and insufficient healthcare facilities to address hearing loss effectively. The prevalence of hearing disparity is 9.6% in Bangladesh [1]. Age-related hearing loss may be progressive bilateral sensorineural hearing loss, termed presbycusis. Some conditions related to ear diseases, such as noise-induced hearing loss, otosclerosis, chronic otitis media, ototoxicity, Meniere's disease, and generalised diseases such as atherosclerosis, diabetes, hypertension, Paget's disease of bone, and myxoedema, also show the same hearing loss. So, these conditions are excluded from the presbycusis. The rate of deterioration of hearing loss tends to increase in the middle years (60 - 70 years) once the loss has occurred, and further progression is prolonged [2], particularly in the higher frequencies [3]. Hearing loss represents a hereditary or genetic degenerative process [4] or an alternative process causing sensorineural hearing loss. Causes of sensorineural hearing loss to prevalence were age-related (70% - 95%), noise, idiopathic, ear infection, Meniere's disease (5% - 30%), head injury, ototoxicity (>0.004%), non-syndromic genetic (0.7%), syndromic genetic (0.3%) including systemic illness (meningitis, renal failure, diabetes), and others (autoimmune, otosclerosis, acoustic neuroma) [5]. Decreased hearing acuity correlates with increased falls, depression, and dementia in the elderly [6]. The prevalence of hearing impairment was 17% for the 18 - 50 age group, 17% for the 51 - 60, 30% for the 61 - 70 age group, and 53% for the 71 - 80 age group [7]. The problems and the consequences of age-related hearing loss are compounded in older people due to additional degenerative processes in the central nervous system. This can result in a relative loss in neural plasticity, a loss of cognitive abilities, and other sensory modalities, in particular sight. Therefore, the diagnosis of related hearing loss is made on the clinical basis of a recognisable constellation of features. Recent research shows that age-related hearing loss impacts psychological well-being and physical ability [8]. The feelings of imprisonment and anxiety that result from social isolation lead to reduced cognitive functioning, which can, in turn, increase the economic and societal burden of age-related hearing loss [9]. It is, therefore, ever more critical as the life expectancy of our population rises to make the diagnosis and offer early treatment. Toynbee suggested involvement of the middle ear in age-related hearing loss [10]. Several age-related changes occur in both the outer and middle ear. However, these do not significantly contribute to hearing loss [11] [12]. Schuknecht *et al.* hypothetically divided the age-related changes in the cochlea associated with six distinct types based on their histopathological studies [13] [14]; other authors have correlated clinical results with pathological findings, leading to the consensus that this represents valuable distinctions in the pathological substrate of age-related hearing loss [15] [16]. The neural type of histopathology was believed to be the most

common, though a longitudinal study [17] [18] has indicated that metabolic and sensory-metabolic phenotypes increase with age. The sensory type of histopathology showed loss of hair cells and sustentacular cells at the basal end of the organ of Corti [19], the neural type showed degeneration of cochlear nerve neurons and cochlear ganglion cell loss, and the vascular or metabolic type showed atrophy of the cochlear stria vascularis, loss of stria vascularis tissue in the cochlea [20]. Primarily in the apical and middle turns of the cochlea, the mechanical or cochlear conductive type showed a stiffened cochlear basilar membrane and an increase in the number of fibrillar layers of the basilar membrane. The intermediate type showed submicroscopic changes in the cochlear duct, possible modifications in intracellular organelles involved in the cell metabolism, decreased synapse numbers, and changes in endolymph composition. Age-related degenerative change in the central nervous system contributes to age-related hearing loss. Such change in the related hearing loss is subtle and highly variable; a significant consequence is reduced plasticity, partly for the marked acclimatisation period required for older people to obtain maximum benefit from hearing rehabilitation by amplification [21]. Central auditory processing abilities decline with age, and decrements in tests of temporal fine structure and word recognition and discrimination have been reported [22]. Over recent years, a strong association has been demonstrated between age-related hearing loss and cognitive impairment, including dementia and depression, which reduce the quality of life [23]. The patient comes with his attendant because he has difficulty understanding the voice. The first symptom is difficulty hearing conversation due to background or competing sounds. His description involves a lack of clarity rather than a loss of volume. The symptoms have been present for many years and are frequently more of a problem for the rest of the family. The patient may have tinnitus. Patients may complain of a more obvious hearing problem as hearing loss progresses and frequently ask others to repeat themselves. The television is louder than is comfortable for other members of the household. These problems can all lead to significant domestic distress. As hearing loss worsens, a complaint of deafness becomes more apparent, and recruitment may be described as an abnormal growth in the perception of loudness by an individual with hearing loss. Tinnitus is accompanied by hearing loss and is most troublesome to the patient. The prevalence of troublesome tinnitus rises from 5% in the under-thirties to 16% in the over-sixties [24]. If the hearing loss is not so severe, the hearing loss may lead to social isolation, and depression may ensue. This should be specifically asked for, especially in older people who often have lost social contact opportunities. A positive family history of hearing loss in old age may frequently be encountered. The frequency of falls increases with worsening hearing thresholds in old age. This can compound problems with social isolation and reduced overall mobility and should be addressed with the involvement of relevant allied healthcare professionals and specialists as required. When diagnosing, it is essential to be aware of other significant causes of hearing loss. Considerable head injury, meningitis, systemic severe illness, often involving previous

aminoglycoside treatment, and a strong family history of early hearing loss indicating a non-syndromic hereditary/genetic degenerative hearing loss should all be enquired. Typically, an otological examination exhibited normal findings. The first and often only investigation required is pure-tone audiometry. Most commonly, audiometry shows a hearing loss in the higher frequencies. As the condition advances, progressive loss of the middle 1 - 2 KHz and even low 250 - 500 KHz frequencies tends to occur. A diagnosis of age-related hearing loss is reasonably secure in individuals over 60, with normal examination findings of bilateral high-frequency hearing loss. Here, there is often an overlap with the increasingly recognised and described heterogeneous group of genetically determined, progressive, degenerative hearing loss.

Management and Rehabilitation

It is necessary to investigate first whether the patient has hearing loss, what types of hearing loss are present, and what types of management and rehabilitation are needed. The handling and recovery of age-associated hearing loss (AAHL) can be directed to three broad areas: psychological, practical (non-specific), and sensory (specific). Unfortunately, hearing thresholds cannot be returned to their pre-elevation acuity levels. It is beneficial to advise on optimising an individual's acoustic environment. The involvement of allied health professionals and general practitioners can offer psychological counselling and support in case of other comorbidities. Practical measures for individuals with more severe hearing loss include wireless headphones for use with their television, volume-controllable telephones, and louder doorbells, often with an alternative alerting system such as a flashing light and vibrating pager system. Hearing dogs can take on such a role and provide a valuable source of companionship for older people. Lip-reading classes can be precious. A hearing aid or cochlear implant can become increasingly beneficial as hearing loss worsens. Successful hearing aid fitting and adjustment for the patient's desired level of hearing makes the rehabilitation process rewarding both for patients and allied health professionals [25]. Some research has demonstrated that hearing aids are helpful, even in mild or moderate hearing loss cases, and the benefits include improved health-related quality of life and listening abilities [26]. The binaural hearing has been shown to produce an approximate additional 10 dB signal-to-noise ratio advantage [27]. Recent National Institute for Health and Clinical Excellence (NICE) reports suggested a significant benefit to patients when fitted with binaural hearing aids. The evidence suggests that digital aids substantially improve the now obsolete analogue devices, and there is perfect evidence of the importance of follow-up and rehabilitative support after fitting to ensure maximum benefit and hearing aid use. The success of hearing aid use in older adults is higher in those where use is supported by their family members and in those with a positive attitude towards the technology. The role of family support in hearing aid use cannot be overstated, as it significantly enhances the user's experience and acceptance of the technology. It is crucial to provide continuous care and

support to the user, as it ensures the maximum benefit and use of the hearing aid. Modern neurological methods, such as tinnitus retraining therapy, utilise a combination of cognitive, directive counselling, and sound therapy, including hearing aids; success rates are reported to be 60% - 70%. Comorbidities affecting cognition, like dementia, can significantly impact an individual's ability and readiness to adapt to hearing aids. In these situations, cooperation is required from caregivers and family members to support ear and hearing hygiene and assist with the insertion of hearing aids. Early recognition of the need for hearing aids, and thus, early administration of hearing aids, is likely to recognise speech and grasp the benefits of hearing aid technology. This may reduce the development of the psychological comorbidities of hearing loss and decrease the quality of life. Hearing aids partially overcome the deficits associated with hearing loss. However, several deficits remain for sensorineural hearing loss; some sounds are inaudible. Other sounds can be detected because part of their spectra is audible but may not be correctly identified because different (high-frequency) parts remain inaudible. The range of levels between the weakest sound that can be tolerated is less for a person with sensorineural hearing loss than for an average hearing person. To compensate for this, hearing aids amplify weak sounds more than intense sounds. In addition, sensorineural impairment diminishes the ability of a person to detect and analyse energy at one frequency in the presence of energy at other frequencies. The range of levels between the weakest sound that can be heard and the most intense sound that can be tolerated is less for a person with sensorineural hearing loss than for a normal-hearing person. To compensate for this, hearing aids must amplify weak sounds more than intense sounds. In addition, sensorineural impairment diminishes the ability of a person to detect and analyse energy at one frequency in the presence of energy at other frequencies. Similarly, a deaf person cannot hear a signal that rapidly follows or is rapidly followed by a different signal. Deaf people are also less able to separate sounds based on the direction from which they arrive. The decreased resolution (frequency, temporal, and spatial) means that noise, or even other parts of the speech spectrum, will mask speech more than would be the case for a normal-hearing person. The physiological origins of sensorineural hearing loss include loss of inner hair cell and outer hair cell function, reduced electrical potential within the cochlea, and changes to the mechanical properties of the cochlea. The resulting auditory deficits mean a person with a sensorineural hearing impairment needs a signal-to-noise ratio (SNR) more significant than usual to communicate effectively, even when a hearing aid has amplified sounds. To understand how hearing aids work, the physical characteristics of signals must be understood. These characteristics include the rate at which sound fluctuates (frequency), the time taken for a repetitive fluctuation to repeat (period), the distance over which its waveform repeats (wavelength), the way sound bends around obstacles (diffraction), the length of a sound wave (pressure and sound pressure level), the break-up of a complex sound into pure-tone components at different frequencies (spectrum), or into several frequency bands

(octave, one-third octave or critical bands), and the degree to which a body of air vibrates when it is exposed to vibrating sound pressure (velocity and impedance). The highest level of sound amplification by a hearing aid is known as the saturation sound pressure level (SSPL). The SSPL is usually estimated by measuring the output sound pressure level (OSPL) for a 90 dB SPL input (OSPL90). To decrease in size, hearing aids are now available in different sizes, shapes and levels of placement like body, spectacle, behind-the-ear (BTE), in-the-ear (ITE), in-the-canal (ITC), and completely-in-canal (CIC). The most used hearing aids are behind-the-ear hearing aids. Further categorisation is needed to distinguish between styles where the hearing aid receiver (the output transducer) is within the hearing aid case (receiver-in-the-aid, RITA) or within the ear canal (receiver-in-the-ear, RITE).

The study aims to clarify how much presbycusis patients benefit from hearing aids to improve their quality of life from the perspective of developing countries like Bangladesh.

2. Methods

2.1. Study Design and Population

It was a cross-sectional observational study of sixty cases in the two tertiary care Centres Comilla Medical College (http://www.cumc.edu.bd/) and Cumilla Medical Centre (http://www.comillamedicalcentre.com/), concern clinic of Central Medical College (http://www.cemec.edu.bd/) Cumilla, of the Department of the Otolaryngology and Head-Neck Surgery, Cumilla, Bangladesh, from 01 February 2024 to 31 July 2024. The target population was patients from the Otolaryngology and Head-Neck Surgery outpatient departments. During this period, 24637 patients attended with several types of diseases. A total of 7362 (29.88%) ear patients, of which 527 (7.16%) suffered from presbycusis, and 60 (11.39%) could provide appropriate digital hearing aids for themselves. The sixty patients fulfil the following criteria: A. Age above 60 years with bilateral equal or 45 to 120 dB hearing loss in high frequency (2000, 4000, 6000, and 8000 Hz). B. Normal Impedance Audiometric test. C. Pure Tone Audiometry showed an air-bone gap of less than 10 dB in all frequencies. D. no sudden sensorineural fluctuation or a short history of rapidly progressing hearing loss exists. E. If they need a hearing aid, they can provide a hearing aid for themselves, and somebody came with interest in using a hearing aid. F. The participants have no history of hearing aids. G. They agree to participate in the research and could answer the questionnaire themselves or with the attendant's help. All patients with three tests were evaluated. I will complete the self-perception test, including the PTA test, HHIE-S (Hearing Handicap Inventory for the Elderly-Score) questionnaire, and WHOQOL (World Health Organization Quality of Life) questionnaire, before and after one month of using the appropriate hearing aids. Hearing aid fitting and adjustment are essential parts of the study protocol. Hearing aid fittings are a combined approach for prosthetic audiologists, ENT doctors, counsellors, family members, patients, and hearing aid

provider companies. If the patient is fitted with a proper hearing aid, it significantly improves the quality of life. So, the appropriate hearing aid fittings must depend on the thorough evaluation of the patient's hearing loss to achieve the perfect fitting of a proper hearing aid. Hearing aid provision is not a one-time event but a continuous care process. It commences with understanding the customer's needs and the extent of their hearing loss, selecting and fitting the appropriate hearing aid, and providing ongoing rehabilitation, support, and assistance. This commitment to customer care is unwavering, extending to both the short and long term to ensure their satisfaction and an improved quality of life.

2.2. Hearing Aid Fitting and Adjustment

The fitting of hearing aids must include the delivery of the auditory system, the adaptation process, and the necessary assistance. The effectiveness of the hearing system depends on the type of hearing aids chosen, the adaptation, advice, and monitoring. The adaptation process for hearing aids is a continuous journey that necessitates active dialogue with the customer. We encourage their participation and feedback, which is vital for making informed decisions. The availability of adequate facilities and equipment is also crucial for the success of the hearing aid provision service. We mainly focus on customers new to hearing aids, ensuring they feel supported and comfortable. Here, all the patient's demographic data were collected, and they are using WIDEX hearing aids behind the ear (receiver-in-the-ear, RITE). Here, categorical variables are the participant's sex, socioeconomic condition, residential status, and educational qualification, and continuous variables are the age of the participant, PTA test in the right ear before using the hearing aid, PTA test in the right ear after using the hearing aid, PTA test in the left ear before using the hearing aid, PTA test in the left ear after using the hearing aid, WHO quality of life before using the hearing aid, WHO quality of life after using the hearing aid, Hearing handicap inventory elderly scores before using the hearing aid, and Hearing handicap inventory elderly scores before using the hearing aid.

2.3. Inclusion Criteria

All patients aged over sixty years suffer from moderate to severe bilateral progressive sensorineural hearing loss.

2.4. Exclusion Criteria

Noise-induced hearing loss, otosclerosis, chronic otitis media, ototoxicity, Meniere's disease, and generalised diseases such as atherosclerosis, diabetes, hypertension, and Paget's disease of bone were excluded from the study.

2.5. Data Analysis

All data was analysed in the IBM SPSS version 28.0.0.0 (190). In descriptive statistics, categorical variables were analysed in frequency and percentage, and

continuous variables in mean, median, mode, SD, variance, range, skewness, kurtosis, minimum, maximum, and sum. In inferential statistics, some tests of significance were performed based on hypotheses. The chi-square (x^2) test determined the p-value between different categorical variables. The paired sample t-test determined the p-value between continuous variables before and after hearing aid use. My research principal hypothesis was that hearing aids significantly decrease HHIE-S score. The significance level was set at $p \leq 0.05$; Two-tailed.

3. Result

Categorical variables were analysed using frequency and percentage descriptive statistics, using the chi-square test to determine the p-value between categorical variables. The results of the categorical variables statistics, which are concluded in frequency and percentage, are shown in Table 1. Results showed the following: in terms of age, there were 16 females (26.7%) and 44 males (73.3%); the socioeconomic status was poor in 38 of the participants (63.3%), lower middle in 19 subjects (31.7%), and upper middle in 3 subjects (5%); the residential status was rural in 39 of the participants (65%), and urban in 21 subjects (35%); the educational qualification was undergraduate in 30 of the participants (50%), graduate in 19 subjects (31.7%), and postgraduate in 11 subjects (18.3%) (Table 1). The Chi-Square test showed a p-value = 0.052 between sex and educational qualification, p-value ≤ 0.001 between socioeconomic status and residential status, p-value = 0.002 between socioeconomic status and academic status, and p-value = 0.008 between residential status and educational qualification (Table 1).

Table 1. Descriptive statistics and p-value of categorical variables.

Serial No.	Variables	Division	Frequency	Percentage
1	Sex	Female	16	26.7
		Male	44	73.3
		Total	60	100
2	Socioeconomic Status	Poor	38	63.3
		Lower Middle	19	31.7
		Upper Middle	03	05
		Total	60	100
3	Residential Status	Rural	39	65
		Urban	21	35
		Total	60	100
4	Educational Qualification	Undergraduate	30	50
		Graduate	19	31.7
		Postgraduate	11	18.3
		Total	60	100
Serial No.	Variables Name		p-value	
1	Sex	Educational Qualification	0.052	
2	Socioeconomic Status	Residential Status	<0.001	
3	Socioeconomic Status	Educational Qualification	0.002	
4	Residential Status	Educational Qualification	0.008	

Table 2. Descriptive statistics of continuous variables.

Analysing Part	Age	PTA in Right Ear before HA	PTA in Right Ear After HA	PTA in Left Ear before HA	PTA in Left Ear After HA	WHO QOL Before HA	WHO QOL After HA	HHIE-s Before HA	HHIE-s After HA
Mean	72.92	72.23	28.75	75.17	28.75	38.82	118.58	35.83	6.23
SD	8.143	19.484	4.181	19.133	5.011	6.326	16.211	2.865	2.860
Range	29	75	15	75	15	26	55	12	10
Minimum	60	45	20	45	20	27	90	28	2
Maximum	89	120	35	120	35	53	145	40	12

Continuous variables were analysed using descriptive mean, standard deviation, range, minimum, and maximum studies. Age is essential because presbycusis usually occurs as a degenerative process. The patient's age is from sixty to ninety years. After data collection, it was entered into SPSS for analysis. The result of the age mean was 72.97 years ± 8.143. The PTA test is essential data for quantitative tests to know the loss of the patient's hearing near about perfectly. Right and left ear PTA tests were done before assessing the hearing threshold for fitting appropriate hearing aids. The tests result put in the SPSS analytical apps, and the results in the right ear before and after fitting the hearing aid mean was 72.23 dB ± 19.848 and 28.75 dB ± 4.181 and in the left ear, 75.17 dB ± 19.133, and 28.75 dB ± 5.011. WHOQOL-BREF consists of twenty-six questions designed to assess the quality of life depending on four aspects of individual concepts: physical health, psychological health, social relationships, and environment. After collecting all the data, the collected data was put down in the SPSS before and after fitting the hearing aid. The result showed that the mean before and after the hearing aid was 38.82 ± 6.326 and 118.58 ± 16.211. Hearing handicap inventory elderly screening score before using a hearing aid mean = 35.83, SD = 2.865, and the Hearing handicap inventory elderly screening score after using a hearing aid mean = 6.23 SD = 2.860 (Table 2). The paired sample T-test between pure tone audiometry (PTA) tests before and after using a hearing aid in the right and left ear (Table 3, Table 4). It showed that hearing aids significantly increased hearing that $p \leq 0.001$. The t-test of WHO quality of life before and after using hearing aids revealed $p \leq 0.001$ (Table 5), and the HHIE-S score exhibited $p \leq 0.001$ (Table 6). One older woman with presbycusis was wearing a hearing aid, usually hidden under her clothes, due to the stigma of the social barrier of wearing a hearing aid (Figure 1).

Table 3. Paired Sample t-test: PTA test before and after using a hearing aid in the right ear.

Test Name				95% confidence	level			Significance	
PTA test in the right ear before and after using HA	Mean	SD	Std error mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
	43.483	17.508	2.260	38.961	48.006	19.238	59	<0.001	<0.001

Table 4. Paired Sample t-test: PTA test before and after using a hearing aid in the left ear.

Test name				95% confidence	level			Significance	
PTA test in the left ear before and after using HA	Mean	SD	Std Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
	46.417	15.760	2.035	42.345	50.488	22.813	59	<0.001	<0.001

Table 5. Paired sample t-test WHO quality of life before and after hearing aid use.

Test name				95% confidence	level			Significance	
WHO QOL before and after HA use	Mean	SD	Std Error Mean	Lower	Upper	t	df	One-Sided p	Two-Sided p
	−79.767	16.828	2.172	−84.114	−75.420	−36.718	59	<0.001	<0.001

Table 6. Paired Sample t-test**:** Hearing handicap inventory elderly Screening Score (HHIE-S) before and after hearing aid use.

Test name				95% Confidence	level			Significance	
HHIE-S score before and after HA use	Mean	SD	Std Error Mean	Upper	Lower	t	df	One-Sided p	Two-Sided p
	29.600	3.470	0.448	28.704	30.496	66.076	59	<0.001	<0.001

The study aimed to evaluate the effectiveness of hearing aids in improving the quality of life and reducing the hearing handicap of elderly patients (https://www.who.int/tools/whoqol) presents the results of a Paired Sample T-test on the WHO quality of life before and after hearing aid use.

The result of the study is a cause for optimism, as it showed that the use of hearing aids significantly increased the quality of life ($p \leq 0.001$). This finding underscores the potential of hearing aids to improve the well-being of elderly individuals. The hearing Handicap inventory of the elderly screening score (HHIE-S) before and after hearing aid use was also conducted. The p-value is <0.001, supporting the hypothesis that there is a significantly reduced HHIE-S score after hearing aid use.

Post-Intervention Criticism

It is important to note that a few participants had significant hearing loss, with 10 (16.67%) in the right ear and 14 (23.33%) in the left ear. Their hearing gain was slightly lower than regular participants, but they are managing for now. The majority, 50 (83.33%) in the right ear and 46 (76.67%) in the left ear, are satisfied with their hearing aids supporting them and are gaining hearing loss. Some participants experienced ambient noise discomfort and difficulties using mobile phones, which were adjusted during follow-up. These patients are ideal for cochlear implants. However, due to the stigma of developing countries and inadequate support of economic and rehabilitation services, they did not afford the appropriate treatment options. They expressed gratitude that the hearing device increased communication with their daughter and son abroad.

Figure 1. A behind-the-ear hearing user of a 70-year-old female patient.

4. Discussion

Blockage of hearing ability is an intolerable environment for humans. Hearing and communication are essential for maintaining social bonds and mental well-being. People always love to hear and talk with everyone as a social bond. If he loses his hearing ability, he feels alone and enters the silent world, which causes mental depression and loss of self-reliability. However, technology, particularly the advancement of hearing aids, always makes us overcome this disability. As presbycusis has no option for medical or surgical treatment, hearing aids are the only support to make up for this insecurity. The use of hearing aids sometimes makes the patient mentally uncomfortable. So, the decreasing size of hearing aids is a constant trend, but everyone cannot afford it due to the high price. The wireless era of hearing aids promises to advance at least significantly comfort and ease for the receiver and user of the hearing aid. The comfortable amplification formula links some characteristics of a person to the target amplification. The amplification formula is based on the hearing threshold of the patient's audiometric test. It provides the linear procedure of hearing aids, including prescription of gain and output (POGO), National Acoustics Laboratories (NAL), and desired sensation level (DSL).

4.1. Hearing Tests

In the present study, the participants with hearing disabilities presbycusis were

diagnosed after all available examinations such as Speech (voice) test, Tuning Fork test, and investigations such as Pure Tone Audiometry (PTA), Impedance Audiometry, Stapedial Reflex Test, and speech audiometry and some test if needed which are not available in my centre Auditory Brain Stem Response (ABR), Otoacoustic Emission (OAE), Auditory Steady State Response (ASSR) were made in the NIENT (National Institute of Ear, Nose and Throat), Dhaka. Here, males (73.3%) suffer more than females (26.7%), as supported by a study by Kabir *et al.* [1], which exhibited that males were 61.27%. Females were at 38.73%, and the Ertugrul *et al.* [28] study investigated males at 60.5%. Females 39.5%, Mondelli *et al.* [29] research showed 17 men (56.6%) and 13 women (43.4%), Li L *et al.* [30] had 27 (66%) male and 14 (34%) female, other researchers Gomes *et al.* [31] revealed female predominant 14 (70%) were female, and 6 (30%) males, Sacco *et al.* [32] also showed 17 women (54.8%), and 14 men (45.2%) which are opposite our reports. The participant's sex is the most critical demographic data to clarify the target group. In developing countries, women are a neglected group as their problems are not heard or appropriately initiated to solve. The presbycusis patients are aged above sixty, and they cannot share any economic support with their families. Females in developing countries are engaged in household work, and their difficulties are not adequately expressed like those of males. Like in other developing countries, males suffer more than females.

4.2. Age of the Participant

The patient's age is essential to my research data, and presbycusis usually occurs in the elderly group above sixty years. In this study, the age of the participants Mean = 72.97 years, median = 71.00, SD = 8.143, and ranged from 60 - 89 near to Li L *et al.* [30] mean = 72.32, and SD = 6.81, Ertugrul *et al.* [28] mean = 73.44, SD = 7.03, range from 65 - 89, Mondelli *et al.* [29] mean = 76.8, range = 60 - 90, Sacco *et al.* [32] also showed mean = 78.3, SD = 9.5, Bhat *et al.* [33] mean = 65.88, range from 51 - 79, Lutfi *et al.* [34] mean = 73.01, SD = 8.43. We know that with the increase in age, different body organs have a more degenerative process due to the degenerative process of hair cells in the organ Corti; there is more sensorineural hearing loss. So, age itself is one of the diseases of human beings. The adaptation process of degeneration is challenging for older people. Moderate to profound hearing loss cuts their communication with their near and dear ones. Also, lose their social communication with society. Hearing aids may overcome this extending age and minimise the confrontation of social development [35]. So, fewer older adults are more likely to be satisfied with hearing devices than others [36].

4.3. Socioeconomic Status

Regarding socioeconomic status, 63.3% were poor, 31.7% were lower middle class, and 5% were upper middle class. This is another essential demographic data point. The price of digital hearing aids in Bangladesh is about 400 USD. So, among 527 (7.16%) patients diagnosed with presbycusis, only 60 (11.39%) patients provided

digital binaural hearing aids for themselves. The high cost of hearing aids causes mono-aural hearing aid users in the Indian subcontinent [33]. In developed and well-established industrial countries with available hearing aid equipment, audiologists and deaf people have easy access to solve hearing difficulties [30]. Considering the low-cost availability of OTC hearing aids introduced in France, low affordability is the first reason for 78% of hearing aid receivers [37].

4.4. Residential Status

Residential status is another crucial factor for older adults in developing countries. Data showed that 65% were rural, and 35% were urban. Urban elderly adults can easily reach the hospital without others' help, but rural people stay far from the clinic. Audiological services are unique, so there may be only one in one city. Rural people are also poor and can manage one hearing aid with others' help, as most older people with hearing devices cannot frequently visit the clinic for their problems.

4.5. Education Level

Education is one of the sophisticated data sets that will help the researchers complete the questionnaire quickly. In my investigation, 50% were undergraduates, 31.7% were graduates, and 18.3% were postgraduates, which is near to Sacco *et al.* [32] work showed 38.71% had completed school, 9.68% were in college, 41.93% had completed their university studies, and 9.68% were without information. Gomes *et al.* [31] exhibited that in the study group, 40% completed high school, and 60% completed elementary school; in the control group, 30% completed high school, and 70% completed elementary school. Education is a basic need for a country, and following the hearing aid adjustment instructions is essential to understanding the fitting, cleaning, and use. It also diversifies the stigmata of hearing aid users. As spectacles, hearing aids are not easily accessible to both young and older people. Social acceptance of hearing devices is still low. Hearing aid users feel discomfort and do not expose the device to people. The hearing aid's wireless stage is developing to be more petite and fit with the patient's ear ornaments. So, it is now like the ornament of the women. However, the cost is remarkably high, which is not affordable for 99% of deaf patients in developing countries like Bangladesh.

4.6. Satisfaction with Hearing Aid

Hearing aids are an excellent blessing for deaf people. However, to achieve optimum patient satisfaction, the assessment of hearing aids' benefits involves both objective and subjective measurement. Objective measurement includes audiometry and speech perception tests. Audiological tests include pure tone audiometry and speech recognition in quiet and noisy environments with and without hearing aids. Speech perception tests conclude that the patient can understand speech before and after using the device. Subjective measures include Self-Report

Questionnaires and Daily Listening situations. The famous self-report questionnaire is the Client Oriented Scale of Improvement (COSI), a clinical tool developed by National Acoustic Laboratories (NAL) for outcome measures of hearing improvement. In the present study, the Cosi scored the degree of changes in hearing ability [38]. The study found, except for profound hearing loss, the patient is satisfied with 83.33% in the left ear and 76.67% in the right ear, fulfilling the COSI outcome measure of hearing improvement supported by Bhat *et al.* [33], showed 74%, Kochkin *et al.* [39] exhibited 80% deaf older patient was satisfied with their hearing aid. Profound hearing loss patients are subject to cochlear implants. Some articles suggested that severe and profound hearing loss patients, after continuous use of hearing aids, cause increasing hearing loss. Bertoli *et al.* [40] reported that some patients showed that hearing loss increased due to the overuse of hearing devices.

4.7. The Binaural Hearing Aid

The binaural hearing aid user is more comfortable than the mono-aural one. Fitting hearing aids in both ears is inconvenient for people in developing countries. In my survey, only 11.39% of lucky, eligible elderly deaf provide binaural hearing devices. The super profit of binaural hearing aids is significantly optimised SNR (Sound-Noise-Ratio) ratio, localising the background sound in all planes, loudness summation, and tinnitus masking provides the near normal hearing of removing mental depression and making an enjoyable environment of auditory background [41]. Some research articles investigated the advice of binaural hearing aid users, who sometimes use only one device and take feedback that they are getting the same benefits from monoaural hearing aids [25].

4.8. The WHOQOL-BREF

Quality of life depends on many factors. The WHOQOL-BREF includes twenty-six questions about a person's physical and psychological health, level of independence, social relationships, and personal beliefs. Deaf people have lost their communication with the world. Eighty per cent of deaf older people live in developing countries [42]. They are fighting for basic needs such as food, water, clothing, sleep, shelter, and health. Their physiological needs are breathing, food, water, shelter, clothing, and sleep; safety and security need health, employment, property, family, and social stability; love and belonging include friendship, family, intimacy, sense of connection, self-esteem belongs, confidence, achievement, respect of others, the need to be a unique individual, and self-actualisation affiliation of creativity, problem-solving, and acceptance of facts. Complete audiological services are available in the two government centres and near about five centres at the nongovernment level in the capital city of Dhaka, Bangladesh. Some towns of Bangladesh have partly supported centres at the peripheral level. In developed areas, the USA and the UK have four audiologists per 100,000 people, and Taiwan region has one audiologist per 100,000 [30]. In the present study, the presbycusis

patients were surveyed, and the WHOQOL score was obtained before and after using a hearing aid. The paired sample t-test showed high significance statistically that p-value ≤ 0.001. Different studies also supported my conclusion that the use of devices improved the quality of life by increasing the speech and hearing ability that Sacco *et al.* [32] showed speech and hearing ability both in silent and noise environments p < .05 - .01, after one month use of hearing device QOL improved in the following parameters: decrease of perceived hearing difficulties during conversation in quiet place p = 0.018, in the noisy environment p = 0.0076, decrease of negative attitude while watching TV with family members p = 0.011. Mondelli *et al.* [29] research showed that the result of the WHOQOL questionnaire answered before and after hearing with a hearing aid was that all the patients ranked their quality of life as good or exceptionally good after fitting it. Chisolm *et al.* [12] exhibited different methods of investigation on deaf older people, and the reports concluded that hearing devices improved their health-related quality of life.

4.9. HHIE-S Scoring

The Hearing Handicap Inventory for the Elderly (HHIE-S) Score is the most helpful scoring system for screening deaf people. In my paper, the score of HHIE-S before the use of the hearing device was mean = 35.83, SD = 2.885, ranging from 28 - 40, and after the use of the hearing device, mean = 6.23, SD = 2.860, range from 2 - 12 was highly significant that p ≤ 0.001. The interpretation of the score is 0 - 8, which means a 13% probability of hearing impairment and no need for referral due to handicap is not proofing. A 10 - 24 score is mild-moderate handicap and should be referred to an audiologist for further investigation. A 26 - 40 score is a severe handicap and should be an immediate referral to an audiologist for further investigation and assistance. Hearing disability affects people's manner of living, profession, position, education, residence, behaviour, and mental attitude. Ten questions were developed based on elderly deaf people's social and emotional status. Lotfi *et al.* [34] showed that the HHIE questionnaire scores before and after wearing a hearing aid significantly increased the quality of life and p = 0.000, but between male and female social and emotional total scores were insignificant and p ≥ 0.05. Li L *et al.* [34] revealed the HHIE questionnaire score had a sensitivity of 0.67 (95% CI 0.35% - 0.89%) and specificity of 0.31 (95% CI 0.316 - 0.51). This screening test suggests that it may be ineffective due to the early stage of hearing disability. Otherwise, it may be due to economic, social, and cultural differences between developed and developing countries' expectations. Gomes *et al.* [31] used the Brazilian SADL (Satisfaction of Amplification of Daily Life) questionnaire like HHIE-S, revealing that 94% of hearing aid users were satisfied with their lives; 48.9% were delighted that they investigated that they used an in-the-ear hearing aid. Ertugrul *et al.* [28] reported that after using hearing aids, the emotional and social HHIE scores of males and females significantly decreased by p = 0.001. They explained that due to hearing disability for presbycusis, older deaf people lost their communication with others and reduced their quality of life. Bhat

et al. [33] study described that 68% of cases understand the HHIE questionnaire, which may be due to the presbycusis being related to the awareness, knowledge, and judgment of the study people. Sprinzl *et al.* [43] contrast the sensitivity of the HHIE-S score with the pure tone audiometry. Their sensitivity was 72% - 76%, and specificity was 71% - 77%. Compared to other studies, the specificity of my studies was 76.6% - 83.33% because of a high degree of hearing loss. Some patients with profound hearing loss were candidates for the cochlear implant due to their economic condition and lack of support. There were only four government-level cochlear implant facilities in Bangladesh and two non-government centres with inflated costs.

4.10. Limitation of Study

The study's limitations include a low participation rate, social stigma, the inflated cost of appropriate hearing aids, the low quality of aftercare service, and the distance from the centres. However, a few patients are supported by poor funds and social welfare services.

5. Conclusion

Audiological services are not developed worldwide. Some developed industrialised countries have OTC hearing aid services. However, they are not proven to be sensitive to elderly presbycusis patients. Developing countries have fewer facilities for the audiological workforce, investigation, and interventional procedures. Overcoming these barriers, hearing devices provide critical assistance for elderly individuals with hearing impairment. This study reflects that this device is a game-changing treatment for presbycusis patients. Hearing aid reduces the disability of older people and increases their quality of life through active participation in personal and social activities with near and dear ones.

Conflicts of Interest

The author declares no conflict of interest regarding this paper's publication.

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