

**TREND ANALYSIS OF HEARING AIDS DISPENSED UNDER HDDU
SCHEME OF AIISH**

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Degree of Master of Science (Audiology)
University of Mysore



**ALL INDIA INSTITUTE OF SPEECH AND HEARING
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SEPTEMBER 2021**

CERTIFICATE

This is to certify that this dissertation entitled '**Trend Analysis of Hearing Aids Dispensed under HDDU Scheme of AIISH**' is a bonafide work submitted in part fulfillment for degree of Master of Science (Audiology) of the student Registration number: 19AUD013. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru
September, 2021

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This is to certify that this dissertation entitled '**Trend Analysis of Hearing Aids Dispensed under HDDU Scheme of AIISH**' has been prepared under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled '**Trend Analysis of Hearing Aids Dispensed under HDDU Scheme of AIISH**' is the result of my own study under the guidance of Dr. Sandeep M., Associate Professor, All India Institute of Speech and Hearing, Mysuru, and has not been submitted to any other University for the award of any other Diploma or Degree.

Mysuru
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Chapter-1

INTRODUCTION

Hearing loss is the fourth leading cause of disability globally. Prevalence estimates show that 466 million persons in the world (> 6.1% of the world's population) have disabling hearing loss, of whom, 432 million (93%) are adults and 34 million (7%) are children. The prevalence is particularly high in low and middle income countries (WHO, 2018). Hearing loss in adults can be caused by ageing, exposure to excessive noise, or use of ototoxic drugs. It is typically sensorineural in nature and cannot be reversed with medication or surgery.

Hearing loss is shown to adversely affect the individual's communication abilities, quality of life, cognitive functioning, work efficiency, social and emotional well-being. Additionally, in children, pre-lingual hearing loss can affect the child's ability to develop speech, scholastic performance and emotional development, if not effectively treated.

Fortunately, majority of persons with hearing loss benefit from hearing devices such as hearing aids and cochlear implants (Laplante-lévesque et al., 2020). Yet, the uptake of hearing aids is limited throughout the world (Haile et al., 2021; Manchaiah et al., 2015; Orji et al., 2020). A systematic review by Bright et al. (2018) showed that the number of people who require hearing aid and actually have received it is generally low in all countries with wide variation in the coverage. The WHO (2018) estimates show that only 5 to 15% of people in need receive assistive devices in low and middle income countries. With reference to hearing aids, less than 3% of actual demand is being met. According to WHO (2016), the percentage of adults who could benefit from using hearing aid and are actually using it remains low across the world, ranging from just a few percent in some countries to 20–30% in others. This can be in partly attributed

to the high cost of hearing aids.

Affordability is found to be one of the major barriers to access hearing aids, especially in low and middle income countries. Inability to afford services and no provision of insurance claims are major issues (Bright et al., 2018) in the hearing aid uptake. Lack of knowledge as to what, how or where to access the hearing aids/assistive devices would also refrain some people from procuring hearing aids. Understanding market trends in terms of hearing aid pricing, quality, style, and the availability of advanced features can guide stakeholders decide how to access, what will best fit, what is most preferred and other viable options (Blazer et al., 2016).

Facilitating affordability and accessibility to hearing aids, without compromising on the quality is likely to enhance hearing aid uptake by the needy. Subsidy schemes and insurance coverage might serve this purpose. Private/public insurance and out-of-pocket payments or the combination of these are the main means of financial access to hearing aids for a high proportion of patients worldwide. Public insurance for hearing aid purchases and services varies widely across countries in terms of the population covered, device options and generosity of benefits. In the United Kingdom, all patients have access to public coverage of the costs of hearing aids whereas Australia and United States restrict social insurance cover hearing aids only to older adults having low income. Some European countries provide extensive financial coverage, reimbursing nearly 100% of costs incurred by the patient. In countries such as Australia, Brazil, Germany, United Kingdom, and United States, the coverage extends up to premium devices. Whereas countries such as China and Japan provide little to no central public insurance coverage to any type of hearing aids (Wilson et al., 2017). Apart from this, several **health initiative programs** are being offered by respective **governments** across the globe. There are also some private organizations

such as Hear the World Foundation that support hearing aid projects worldwide by funding agencies and schemes involved in hearing health care.

In India, many non-governmental organizations such as Audiology India (AI), All India Federation of Deaf, National Association of the Deaf, Delhi Foundation of Deaf Women, have been rendering services to individuals with hearing loss. India has launched the National Program for Prevention and Control of Deafness (NPPCD) to promote effective hearing care service. Indian government has adopted schemes like ADIP and Deendayal Disabled Rehabilitation to aid persons with disability, including those with hearing loss. The scheme aims at helping persons with disability by bringing suitable, durable, scientifically-manufactured, modern, standard aids and appliances within their reach. It implements the same through several recognized agencies such as local bodies (Zilla parishad & municipalities), registered charitable trusts, and national/apex institutes (including ALIMCO) functioning under administrative control of the ministry of Social Justice and Empowerment (Ministry of Social Justice & Empowerment, 2005).

All India Institute of Speech and Hearing (AIISH), under the Ministry of Health and family welfare, government of India is one such agencies known to render clinical services, train speech and hearing professionals, conduct research, and educate the public on issues related to communication disorders. For persons with hearing difficulties, the institute offers detailed audiological assessment and management services. With the objective to promote affordability of hearing devices, AIISH has been successfully running a unit called Hearing Device Dispensing Unit (HDDU) since 2006–07. Through this, a wide array of hearing aids and assistive listening devices are dispensed at a subsidized costs for the patient. The discount on a device varies based on the type, technology, model and make of the hearing aid. A total of 12 hearing aid

manufacturers/authorized dealers have signed Memorandum of Understanding with the institute and they offer a range of discounts for their products dispensed under the scheme, called the dealer's price. The institute collects charges 5% of the dealer's price as administrative charges. The total of dealer's price and administrative charges makes the price for the device under the scheme. Overall, the patients get a discount up to 55% on Maximum Retail Price of the devices.

Additionally, AIISH financially supports patients who are below poverty line (BPL) through the client welfare fund (CWF). Ministry of Health and Family Welfare, GoI, allocates Rupee 25 lakhs every year towards CWF of AIISH. Through this scheme, 40% of the assistive devices are funded while the rest would be borne by the patient. Through CWF the support is provided even to hearing aids and the eligible patients will have to bear only 60% of the cost of the hearing aid under HDDU. Apart from this, the patients are encouraged to avail financial support from Employees' State Insurance (ESI), Member of Legislative Assembly funds, Chief Minister fund and other funds, and procure hearing aid through HDDU scheme.

1.1 Justification for the Study

The Indian census presented by Indian National Sample Survey Organization in the year 2011, showed that, approximately 2.21% of the Indian population fall under the category of disability where about 5.03 lakh (18.9%) of the population is with hearing impairment, (Sanju et al., 2017). In India, majority of the people are below the poverty line, residing in urban slums and rural areas. The Indian health care sector has received the lowest percentage of the country's national budget and as a result, health care expenditures are largely out of pocket. This is restraining the access to hearing aids too. Literature survey shows that, an issue of improving affordable and quality accessibility to hearing aids in India is being addressed by several government and

nongovernment organisations. In line with these is, the ‘Hearing Device Dispensing Unit (HDDU) scheme’, the scheme initiated by AIISH to promote easy and affordable access to hearing devices. It dispenses hearing aids ranging from basic to premium, in all available styles, with advanced features like Bluetooth connectivity, offering option of different hearing aid manufacturers and brands, all on a large scale. The scheme has been active and beneficial to the stakeholders for more than a decade. In such a scheme, apart from satisfying hearing aid procurers in terms of quality and timely supply, supporting demands becomes equally important. Understanding trend in market helps to have enough stock of the fast moving products regarding style and price of hearing aids and also to avoid market variations. Analysing whether self-funding dominates the help funding or vice versa in the scheme, facilitates the framework of budget as well as assists in understanding the need for insurance policies and schemes. Trend analysis can help to improve relationship with the leading brand manufacturers and in return to avail discounts and instant updates offered by them. Trend analysis would hint to further probe into reasons for higher demands. Therefore, present study aims to analyse trends in hearing aids being dispensed under the HDDU scheme.

1.2 Objectives of the Study

1. To identify the trend in the beneficiaries of HDDU scheme of AIISH.
2. To identify the trend in hearing aids dispensed under HDDU scheme of AIISH
3. To identify the trend in funding source availed by the beneficiaries for procuring hearing aids under HDDU scheme.

Chapter-2

REVIEW OF LITERATURE

Food and Drug Administration (FDA) considers hearing aids as medical devices and defines as “any wearable instruments designed for the purpose of aiding persons with or compensating for, impaired hearing”. Hearing aids can be customised in terms of type, size, technology, etc. to meet individual needs. Advancement in technology has made it possible for hearing aids to include digital noise reduction circuitry, directional microphones, telecoil, wireless signal reception from televisions, mobile phones and so on. The fact of whether the hearing aid is of basic or premium level decides the extent to which these innovations can be included within that hearing aid (Medicine et al., 2016). The FDA and the number of state regulations ensure the quality control pertaining to hearing aids’ technical standards, manufacturing practice requirements, mandatory labelling, user instructional brochures, and dispensing. With all these efforts, hearing aids have become quite popular, but at the same time, the prevalence of hearing aid uptake is way less than that of hearing loss worldwide (Blazer et al., 2016).

2.1 Prevalence and Incidence of Hearing Loss

A systematic review on prevalence of global hearing loss by Haile et al. (2021) used data from hearing impaired population representative surveys from 1990 to 2019. Study defined and categorized severity of hearing loss considering the average of pure tone thresholds at 0.5, 1, 2 and 4kHz. Average thresholds above 20dB was considered as hearing loss, assigned to mild category and those above 94dB to profound/complete category. Data included 113 survey sources in 54 countries. These countries belonged to South-East Asia region, Western Pacific region, European region, American regions, regions of Africa, and Eastern Mediterranean region. Study estimated global hearing

loss in 2019 to be 1.57 billion accounting for 1 in 5 people. The Western Pacific region had the largest prevalence of moderate to profound hearing loss. Findings predict that, by 2050, hearing loss would affect 2.45 billion people globally.

According to WHO (2012), the prevalence of disabling hearing loss in South Asia is 27%, and hearing loss accounts for highest of the causes for disability in India, as per the National Sample Survey of 2002. The number of persons with hearing disability per 100,000 persons was 291, and the prevalence was higher in rural regions compared to urban regions (Garg et al., 2009). The same survey also found that, about 32% of the persons had profound, and 39% had severe hearing disability. The survey results revealed that about 7% of people were born with a hearing disability. About 56% and 62% reported the onset of hearing disability at ≥ 60 years of age in the rural and urban areas, respectively. The incidence of hearing disability in 2002 was reported to be 7/100,000 population (Varshney, 2016). WHO (2012) estimated that, hearing loss affects 12.3 million children in south Asia alone. The prevalence of hearing loss in school going children (5 – 15 years of age) in India is found to be 11.7% (Modi, 2014).

2.2 Determinants of Help Seeking Behaviour and Hearing Aid Uptake

Despite benefits from hearing care professionals and hearing assisting instruments/devices, there is a tendency in large group of people with hearing loss worldwide, not to seek for the necessary help (Hartley et al., 2010; Knudsen et al., 2010).

A review study by Meyer and Hickson (2012) aimed at identifying factors influencing help seeking behaviour and/or hearing aid uptake in older adults with hearing loss. Findings suggested that adults mostly seek help and take-up hearing aids if they (1) have moderate to severe hearing loss, (2) self-acceptance of the loss that is precluding social participation, (3) are older, (4) understand about their poor hearing

ability, (5) are considerate about the benefits of amplification than its demerits and (6) perceive that they get support from family members and peer groups in the process of hearing rehabilitation. A major barrier to seek help appears to be General practitioners' management of age-related hearing impairment.

Barnett et al. (2017) conducted a systematic review to study the factors influencing hearing rehabilitation in adults (>18 years of age) with hearing impairment. Final results have outlined the key promoters of help seeking as - degree of hearing loss, self-efficacy, family support, and self-recognition of hearing loss. Primary hurdles were found to be financial limitations, stigma of hearing devices, inconvenience, competing chronic health problems, and unrealistic expectations. Compliance was mostly affected by self-efficacy, education level, and engagement in the rehabilitation process.

A qualitative study by Merugumala et al. (2017) recruited parents of children with hearing loss, who had low income from a South Indian city. Results identified some of the barriers to hearing health care access. They were, failure to timely identify deafness, refusal by elder people at home, superstitious beliefs related to deafness, reassurance from a child's overall good health, lack of financial support and transportation problems, especially in rural areas, to visit the rehabilitation centre.

A cross sectional study by Moodie et al. (2011) included 193 children with hearing loss in the age range of 5 to 15 years. These children visited ENT department of civil hospital at Surat. Study aimed at identifying treatment seeking behaviors of parents of such children. Study found that, securing disability certificate, followed by treatment with minimum expenses were the most common reasons for seeking help in case of hearing loss. In cases of acquired hearing loss, the most common reason was treatment with minimum cost.

A study carried out in a clinic of West of England recruited 27 adults with hearing loss, aged 60 years and above. The study aimed to explore how the Audiologists present various treatment options to patients seeking help for hearing loss. Results highlighted on clinician dominance in decision making and patients being deprived of knowledge about several options available in hearing care, including hearing aids (Pryce et al., 2016). Behaviours of individuals with hearing loss like, help seeking, hearing aid adoption, consistent usage and satisfaction are attributed to the characteristics of hearing caring professionals. Knowledge, empathy, professionalism, effective counselling regarding hearing aid care and maintenance, and realistic expectations are among the most important characteristics of professionals. (Kochkin et al., 2010; McCormack & Fortnum, 2013).

Difficulty of maintenance of hearing aids and other assistive technology in low and middle income countries reduces interest in accessing too. (Baltussen et al., 2009; Bond et al., 2009). A systematic review by Orji et al. (2020) summarized the barriers to hearing aid access as those corresponding to high cost, lack of resources and services, poor awareness on hearing aid benefits and stigma associated with hearing aids.

A study by Manchaiah et al. (2015) described the societal factors causing poor uptake and nonuse of hearing aids in Portugal, Iran, India and the UK. Administering questionnaires on group of people with hearing loss fetched the data. Cosmetic concerns, over concerns about appearance, designs of hearing aids, hearing aid cost, comfort, fit, negative attitude and stigma of wearing hearing aids even before the first try, restrained many people from using hearing aids.

2.3 Factors Influencing Trends in Hearing Aid Dispensing

Dispensing hearing aid involves several domains to ensure satisfactory fitting, such as evidence based practice, effective counselling, proper selection and

programming of hearing aids, considering individual needs, electroacoustic analysis, taking ear impressions, guiding about reimbursement plans, repair and many more (Adams & Cox, 2008; Boateng et al., 2018; Bond et al., 2009). Audiologists need to consider the cost of hearing aid and severity of the problem while recommending a particular hearing aid. In this process, Audiologist/dispenser acts as a mediator between the manufacturers and consumers, fulfilling the demands of consumers. Knowledge of the dispenser about the hearing aid market trends helps in timely and quality supply (De Silva et al., 2013).

Lansbergen and Dreschler (2020) profiled hearing aid features using Hierarchical Latent Class Analysis. A total of 3083 hearing aids (BTE & ITE) of different manufacturers and brands were considered. The details were drawn from the database used by Dutch hearing care professionals for selection of hearing aids. As a result, 10 features of hearing aids were found to be fundamental, which included, compression, sound processing, noise reduction, expansion, wind noise reduction, impulse noise reduction, active feedback management, directionality, noise reduction environments and ear-to-ear communication.

Johnson and Ricketts (2010) found certain predictor factors contributing for variability in the dispensing rates of 4 common hearing aid features; digital feedback suppression, digital noise reduction, telecoil and directional processing. They described the dispensing rates as the frequency with which a particular hearing aid or a feature/s in hearing aid was dispensed. They found factors which could be categorised under 4 domains; i) Audiologist characteristics (clinical experience, knowledge about the research findings, etc.), ii) recommendations based on Evidence Based Practise, iii) characteristics of dispensed hearing aids (style, technology level, brand & price range), and iv) characteristics of patient population in a clinic (type & degree of hearing loss,

age range, self-payment or third party payment, etc). These factors under 4 domains were subjected to regression analysis to establish the associative relationship. Results showed direct relationship between technology level and price of the hearing aid with the dispensing rates of product features. There was also a direct link between an Audiologist's decision on a hearing aid feature that could help a patient and the frequency with which that feature was disseminated. According to the findings, the characteristics of dispensed hearing aids and the characteristics of the audiologist contributed more to the variability in hearing aid feature dispensing rates.

Abdellaoui and Huy (2013) conducted a prospective nationwide survey on age related hearing loss in France. ENT specialists helped in the recruitment of subjects by filling out a standard questionnaire. A total of 184 adults aged above 55 years who were prescribed hearing aids for the first time participated in the study. Study found that the hearing aid trial before the purchase and suggestions of Audiologists played a major role in selecting and accepting hearing aids.

Survey research by Johnson et al. (2009) gathered data from 367 hearing aid dispensing audiologists. The study aimed to figure out reasons for Audiologists' preference for some of the brands of hearing aids. The reasons found were related to (i) Reliability and quality of the brand, (ii) Image of the brand in the market, (iii) Cost, (iv) Sales and speed of delivery, (v) Brand's merits and demerits, (vi) Recommendations from colleagues and previous mentors, and (vii) Contracts and incentives associated with the brand.

Global market research report published on April 2021 discussed the latest trends in hearing aid market based on research data derived during 2017 to 2020. Increasing prevalence of hearing loss is expected to boost hearing aid uptake. Hearing aids connecting wirelessly with smartphones have positive impact on dispensing.

Dispensing of hearing aids of some brands declined significantly in 2020 compared to previous year. Features like rechargeable batteries, artificial intelligence, high sound processing, miniaturization of devices, etc. are found to be major driving factors of dispensing. BTE hearing aids resembling Bluetooth earphone devices, emergence of CIC and Invisible-in-the-canal hearing aids such as Oticon opn model with good sound quality are expected to boost confidence of procurers. Favourable health related reimbursement policies would also contribute to the uptake of hearing caring devices.

2.4 Government and Non-Governmental Schemes to Promote Hearing Aid Uptake and Usage

Framing appropriate policies and regulations without compromising quality and safety determines the success of programmes undertaken to improve access to hearing aids (Nieman & Lin, 2017). Improving affordability is a very important issue to promote access to hearing aids, especially in developing countries. Introducing reimbursement policies and subsidising hearing aid purchases would serve the purpose (Caposecco et al., 2016; McPherson, 2011). Lack of public awareness regarding hearing aid benefits and subsidy schemes, scarcity of audiologists, dependency on multinational hearing aid manufacturers, limited number of reimbursing schemes are some of the challenges faced by policy makers in low and middle income countries (Olusanya et al., 2006).

Ministry of social justice and empowerment, govt. of India succeeded to some extent in helping the needy. The ministry introduced a scheme for distributing hearing aids free of cost or at 50% discount to poor families. Consequently, India could manufacture and distribute about 90,000 hearing aids with the support of 200 implementing government and non-governmental organisations (Basavaraj, 2008). Central government health scheme (CGHS) adopted by Indian govt. is providing

comprehensive medical care to central govt. employees and pensioners enrolled under it. People from 74 cities all over India are benefitted under the scheme and it's yet to expand further. Beneficiary can claim reimbursement of expenses for treatment if eligible. This facility not only includes initial procurement, but also replacement of hearing aids after 5 years subject to furnishing a condemnation certificate for the earlier hearing aid. Scheme reimburses expenses of hearing aids ranging from body worn to ITC/CIC in type and technology, upto fixed ceiling rates.

Similarly, the United States introduced Direct-to the consumer" (DTC) service delivery models to improve access to quality devices (hearing devices) and reduce costs (Mamo et al., 2016; Nieman & Lin, 2017). The US govt. has adopted Medicare and Medicaid – federal health insurance programmes for eligible people aged 65 years or older, and certain younger people with disabilities. Medicaid is available to people below a certain income level who meet other criteria (e.g., age, disability status, pregnancy) or be available to all people below a certain income level. But, coverage for hearing aids is not mandated in all the states and for all age groups. American Speech and Hearing Association recommends to extend the benefits of these insurance programmes to all the states (Blazer et al., 2016; Willink et al., 2019).

A study on US population by Arnold et al. (2017) highlighted on the importance of insurance coverage (Medicaid) of hearing aids and associated hearing health care. Study found that, only 28 out of 50 states offered some degree of insurance coverage. Eligibility criteria and coverage policies varied from state to state. Some states covered bilateral hearing aids, supply of batteries for the life time of hearing aids and assistive listening devices, unlike states which covered only unilateral hearing aids and initial supply of batteries. Findings emphasized on need for expanding and standardizing eligibility criteria, and making hearing health care a mandatory benefit under Medicaid.

Despite adoption of effective programmes to promote hearing aid uptake and usage, low and middle income countries like India face many challenges to reach all the beneficiaries. Increasing prevalence of hearing loss, delayed realisation about hearing loss, lack of govt. policy, scarcity of reimbursement and third party payment facilities to procure hearing aids, scarcity of indigenous manufacturers of hearing aids and attractive products are some of the major challenges that are prevalent (Moodie et al., 2011; Seelman & Werner, 2014).

The review of literature provides a clear picture of the prevalence and incidence of hearing loss, as well as what factors contribute to hearing aid uptake and/or non-uptake, factors to consider in order to improve and promote better access to hearing aids, and measures undertaken by different govt. and non govt. organisations to address hearing loss. Literature highlighted on hearing loss being more prevalent in low and middle income countries like India and need for effective ways to assist and reach the needy. Clear understanding of the country's existing hearing loss, the introduction of subsidy schemes and policies to promote affordable access to hearing devices, ensuring that people with hearing loss are benefiting from the schemes introduced, and if not, framing alternative policies, and many other steps would all help to improve hearing health care access and, in turn, access to hearing aids. Understanding the trends in hearing devices/aids dispensed under the scheme/program aimed at distributing the devices on a broad scale would help to improve hearing aid dispensing practices.

Chapter-3

METHODS

The study analysed the trend of hearing aids dispensed under Hearing Device Dispensing Unit (HDDU) scheme of AIISH. The retrospective data was analysed for the number of beneficiaries and their characteristics, characteristics of hearing aids, and the source of funding to procure hearing aids. The trend was derived from the data of two years; 2018 and 2019. The method used is described in detail in the following sections.

3.1 Informed Consent and Ethical Considerations

All the beneficiaries who procured hearing aids under the scheme are operationally termed in the study as the 'Beneficiaries of the scheme'. As a standard practice during the first time registration at the institute, all the registered patients of the institute sign an informed consent, which includes their prior consent to use the clinical information pertaining to them for research purpose. Considering that all the beneficiaries of the HDDU scheme were the registered patients at the institute, the study had the informed consent of the beneficiaries.

In order to access the clinical data required for the study, prior permission was taken from two authorities at the institute: the Chairperson of HDDU, and the Head, department of clinical services. While some of the demographic details of the beneficiaries, details of hearing aids and source of funding was accessed from HDDU, few of the other demographic details and audiological findings of the beneficiaries were accessed from medical records section, department of clinical services, AIISH.

A hand written requisition letter was submitted through the dissertation guide

to the authorities mentioned above to access and utilize the data for trend analysis. The letter had a mention of the specific details required for the study besides an assurance for confidentiality. Both the authorities had approved the access of the data subsequent to which, the investigator personally visited the respective database and noted down the details. All the procedures followed in the study adhered to the bio-behavioural research standards (Venkatesan & Basavaraj, 2009) framed by the institutional ethical review board.

3.2 Input Data

From the database of HDDU, the data available during 1st January 2018 to 31st December 2019 were collected. The data in the HDDU was available as hard copy entered in a register maintained in the unit. The investigator noted down the details one by one in an Microsoft Excel sheet. The data included demographic and audiological findings of the beneficiaries, and the details of the procured hearing aids. The specific variables noted down are listed in Table 3.1.

Table 3.1: *The specific demographic details and audiological findings of the beneficiaries, and the details of the procured hearing aids collected for the study*

Details drawn from the database of HDDU: demographic details and details of the procured hearing aids		
Sl. No.	Variables	Categories (if any)
1.	Patient registration number	-
2.	Age in years	0-14, 15-47, 48-63, ≥64 (WHO classification)
3.	Gender	Male, female
4.	Date of purchase	Month and year
5.	Make of hearing aid	Name of the company

6.	Model of the hearing aid	low, basic, mid, high, premium technology
7.	Style of hearing aid	Behind the ear, receiver in the canal, in the canal, completely in the canal, body level, bone conduction hearing aid
8.	Cost of the hearing aid/s under the scheme (in Rupees)	-
9.	Number of hearing aid/s purchased	'1' or '2'
10.	Source of funding	Self-funding, client welfare fund of AIISH, Prime Minister fund, Member of Legislative Assembly fund, Chief Minister fund and Mysuru City Corporation fund
Details drawn from case files: Monthly income slab and audiological findings		
1.	Monthly income slab	Slab I- <Rs.10,000/month Slab II- Rs.10,000 to 20,000/month Slab III- >Rs.20,000/month
2.	Degree of hearing loss	Minimal, mild, moderate, moderately severe, severe, profound (Goodman's classification)
3.	Type of hearing loss	Conductive, sensorineural, mixed

Note: In case of binaural fitting, the company, model, style and cost were noted down separately for each hearing aid.

All the data entered by the investigator was reviewed by 2 other peer professionals to ensure the accuracy of the data entry. Thirty data entries were cross-checked against the original sources of data by each peer professional.

3.3 Data Analyses

To begin with, the absolute data obtained in some of the variables were grouped into specific categories mentioned in the Table 3.1. Such variables included age of the beneficiary, make of the hearing aid and model of the hearing aid. Based on the age, beneficiaries were grouped into four categories: paediatric, young adults, middle aged

adults and elderly adults.

The names of hearing aid companies (make) were coded alphanumerically (2 alphabets followed by a number) to maintain confidentiality. The first 2 alphabets were derived randomly from the name of the hearing aid company and the numerical value assigned was arbitrary in nature. There were a total of twelve such companies.

The models of the hearing aids were categorized into five different hierarchical levels based on technological features available in each model (categories mentioned in Table 3.1 & described in Table 3.2). The technology features considered were, analog versus digital programmable, number of channels, digital noise reduction algorithms, directionality, compression features, bluetooth connectivity, tinnitus masker, binaural synchronisation for volume control, directionality and programming, and auto decision precision. An Audiologist with an experience of 12 years in hearing aid dispensing categorized the models into the five levels.

Table 3.2: *The categorization of hearing aid models into different levels based on technology feature availability*

Level of hearing aid model	Technological features available
Low technology	Non programmable, body level style, digital/ analog
Basic technology	Digital programmable, minimum of 4 to 6 channels, basic directionality, volume control option, fixed level digital noise reduction algorithms, tinnitus masker
Mid technology	Digital programmable, minimum of 8 channels, autodirectionality, volume control option, multistage digital noise reduction algorithms for speech, tinnitus masker, Bluetooth connectivity, binaural synchronisation
High technology	Digital programmable, minimum of 12 channels, autodirectionality, volume control option, multistage digital noise reduction algorithms for speech and different types of noise, tinnitus

	masker, Bluetooth connectivity, binaural synchronisation for volume control, directionality and programming
Premium technology	Digital programmable, minimum of 17 channels, autodirectionality, volume control option, multistage digital noise reduction algorithms for speech and noise, tinnitus masker, Bluetooth connectivity, binaural synchronisation for volume control, directionality and programming, and auto decision precision

Subsequent to categorization, all the variables were analysed for their total number of occurrences in each category. The age of the beneficiary and cost of hearing aids were additionally analysed for their mean, standard deviation and range.

Chapter-4

RESULTS

This chapter presents the trend in hearing aids dispensed in the Hearing Device Dispensing Unit (HDDU) of AIISH during 1st January 2018 to 31st December 2019. The trend observed in the study are reported under the following sections.

- 1) Beneficiaries of the scheme
- 2) Hearing aids dispensed in the scheme
- 3) Source of funding for purchasing the hearing aids

4.1 Beneficiaries of the Scheme

A total of 2,141 individuals procured hearing aid/s under the scheme during 1st January 2018 to 31st December 2019. Among them, 43.72% procured in the year 2018 and 56.28% in the year 2019 (Figure 4.1).

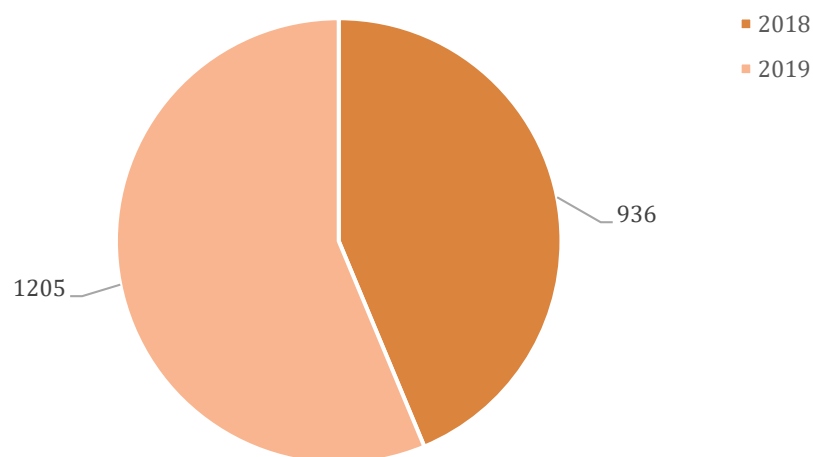


Figure 4.1: *Number of beneficiaries who procured hearing aids under the HDDU scheme in the two years.*

The nature of beneficiaries was analysed in terms of their age, gender, monthly family income and the number of beneficiaries who procured monaural versus binaural hearing aids. Figure 4.2 shows the distribution of beneficiaries across the four **age groups**. Most of the beneficiaries (42.08%) belonged to elderly adult group followed by paediatric group (23.31%), middle aged adult group (20.46%) and least of them being young adult group (14.15%). The beneficiaries of the scheme ranged in age from 3 months to 99 years, with a mean age of 48.3 and a standard deviation of 28.2.

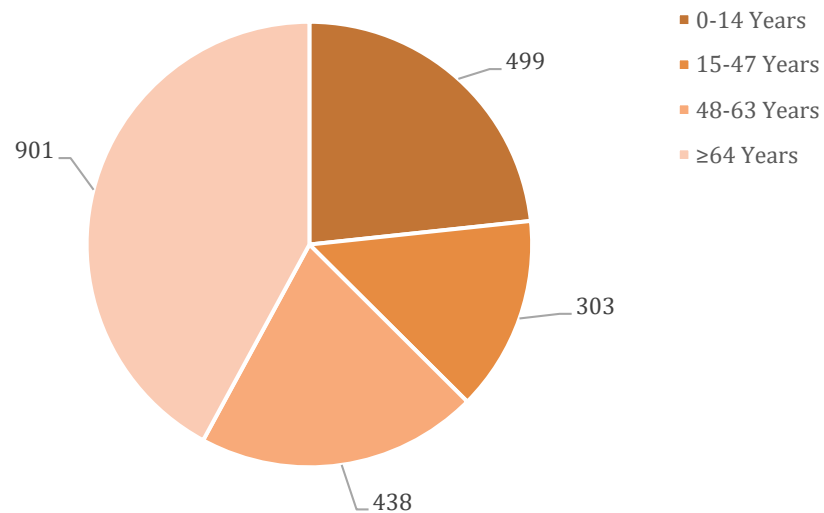


Figure 4.2: *Number of beneficiaries in different age groups who procured hearing aids under the HDDU scheme.*

Figure 4.3 shows the **gender - wise distribution** of the beneficiaries. Among the beneficiaries, 61.61% were males and 38.39% were females.

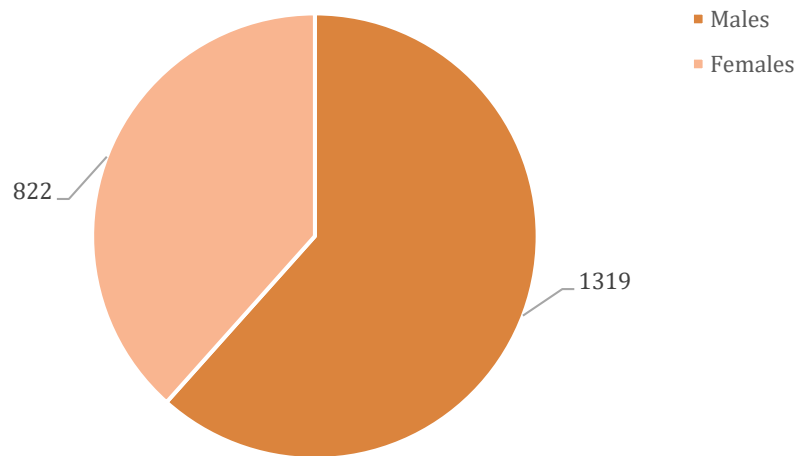


Figure 4.3: *Number of male and female beneficiaries who procured hearing aids under the HDDU scheme.*

Analysis of data in terms of *income slab* of beneficiaries (Figure 4.4) showed that, 75.15% of total beneficiaries belonged to slab I, 14.34% belonged to slab II and only 10.51% belonged to slab III.

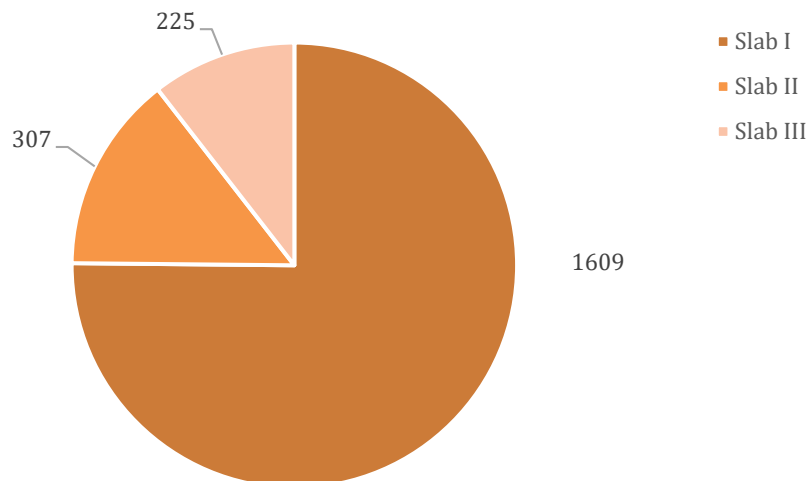


Figure 4.4: *Number of beneficiaries under the HDDU scheme belonging to slab I, slab II and slab III of monthly family income.*

Figure 4.5 shows the total number of beneficiaries with *monaural and binaural fitting of hearing aids*. Results showed that, 61.05% of total beneficiaries procured monaural hearing aids and 38.95% procured binaural hearing aids. Furthermore, data from monaural and binaural fitting were analysed independently by age. The distribution of beneficiaries who purchased monaural and binaural hearing aids across the four age categories is depicted in (Figure 4.6). Most of the beneficiaries (54.62%) belonged to elderly adult group followed by middle aged adult group (27.16%), young adult group (13.31%) and least (4.91%) of them being paediatric group. On the contrary, the distribution of beneficiaries who purchased binaural hearing aids across the four age categories showed that majority of them (52.04%) belonged to paediatric group, followed by elderly adult group (22.42%), young adult group (15.59%) and least (9.95%) of them being middle aged adult group.

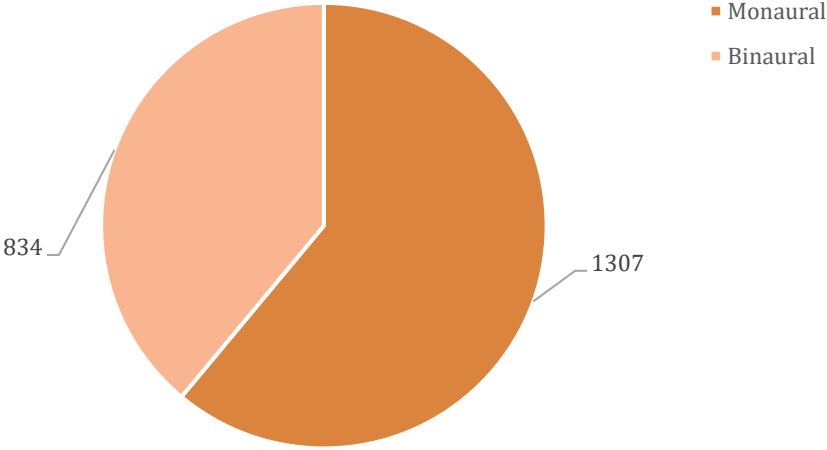


Figure 4.5: *Number of beneficiaries under the HDDU scheme, who procured monaural and binaural hearing aids.*

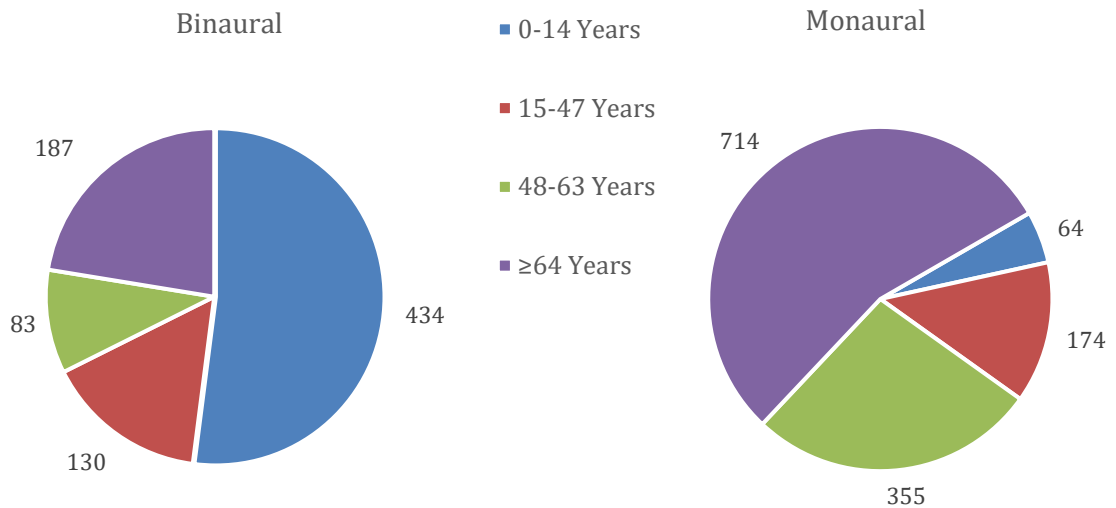


Figure 4.6: *The age-wise distribution of number of beneficiaries who procured monaural and binaural hearing aids under the HDDU scheme.*

4.2 Hearing Aids Dispensed in the Scheme

A total of 2,975 hearing aids were dispensed under the scheme during 1st January 2018 to 31st December 2019. Among them, 42.22% were dispensed in the year 2018 and 57.78% in 2019 (Figure 4.7).

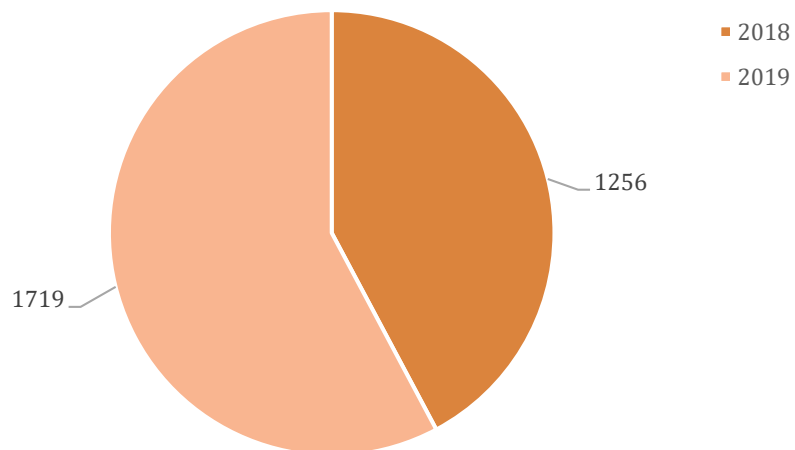


Figure 4.7: *Number of hearing aids dispensed under the HDDU scheme.*

Among the 2,975 dispensed hearing aids, 43.93% belonged to monaural fitting and 56.07% belonged to binaural fitting (Figure 4.8). Number of hearing aids dispensed under the binaural fitting was further analysed in terms of *degree of hearing loss* of beneficiaries. Results (Figure 4.9) showed that, the highest number of hearing aids dispensed (13.51%) belonged to severe degree of hearing loss, followed by other degrees.

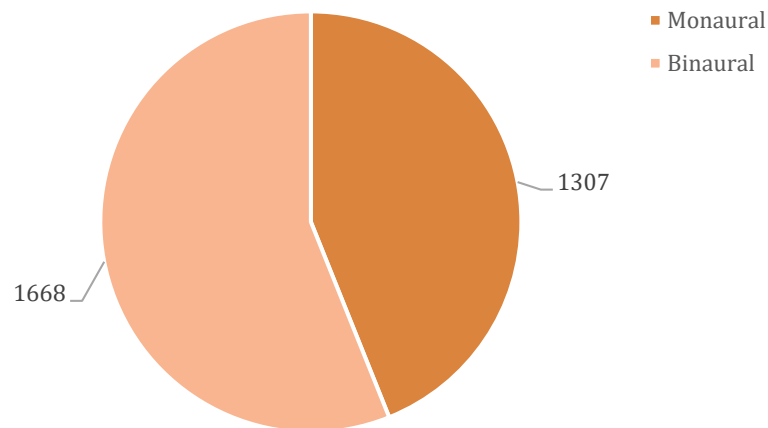


Figure 4.8: Number of hearing aids dispensed under monaural and binaural fitting under the HDDU scheme.

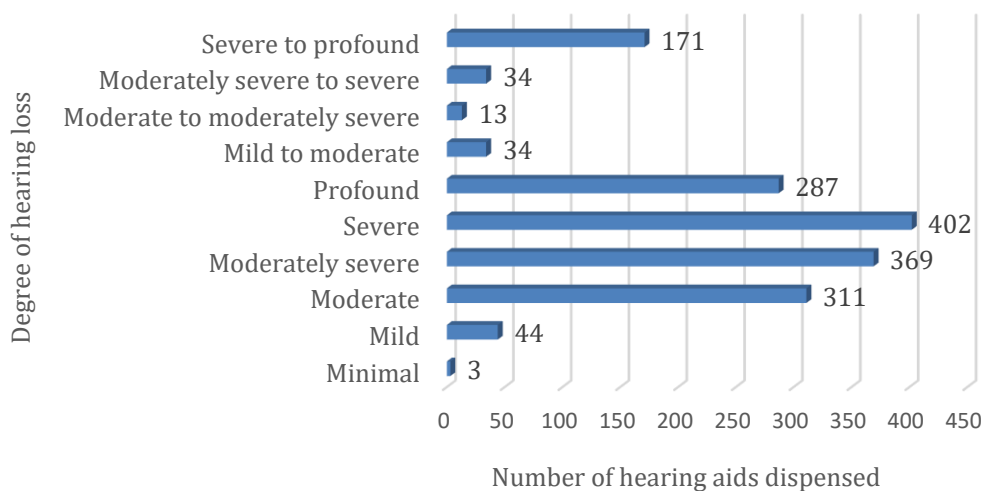


Figure 4.9: Number of hearing aids dispensed under different degrees of hearing loss of beneficiaries who procured binaural hearing aids under the HDDU scheme.

Hearing aid company - wise segregation of HDDU data fetched the number of hearing aids dispensed under each *company (make)*. Hearing aids of 12 different companies dispensed under the HDDU scheme were alphanumerically coded as, AP1, DN2, AP3, OT4, SK5, PK6, IT7, HS8, MT9, BT10, ST11 and WD12. Results (Figure 4.10) revealed that approximately 60% of the total hearing aids dispensed were accounted for by 3 companies (DN2, PK6 & OT4), while 40% by the remaining 9 companies.

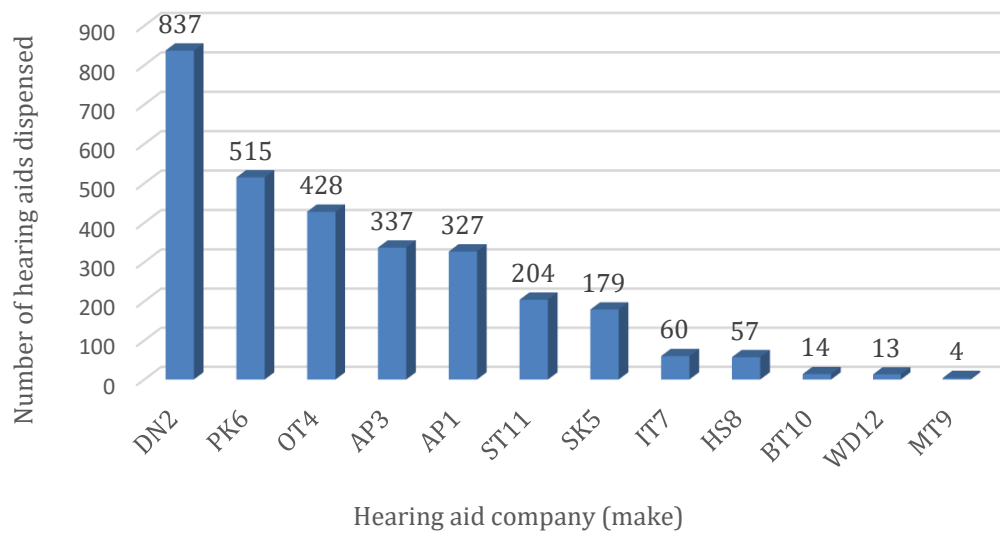


Figure 4.10: *Company - wise representation of number of hearing aids dispensed under the HDDU scheme.*

Hearing aid model – wise segregation of HDDU data showed that, total 130 hearing aid models were dispensed under the scheme in a period of 2 years. These models were categorised into 5 different levels and analysed in terms of *technology*; low technology, basic technology, mid technology, high technology and premium technology. Figure 4.11 shows the number of models dispensed under each category of technology. It revealed that, maximum number of models dispensed under the scheme belonged to basic technology (44.62%) followed by low technology (26.15%), mid technology (22.31%), high technology (4.62%) and 2.3% to premium technology.

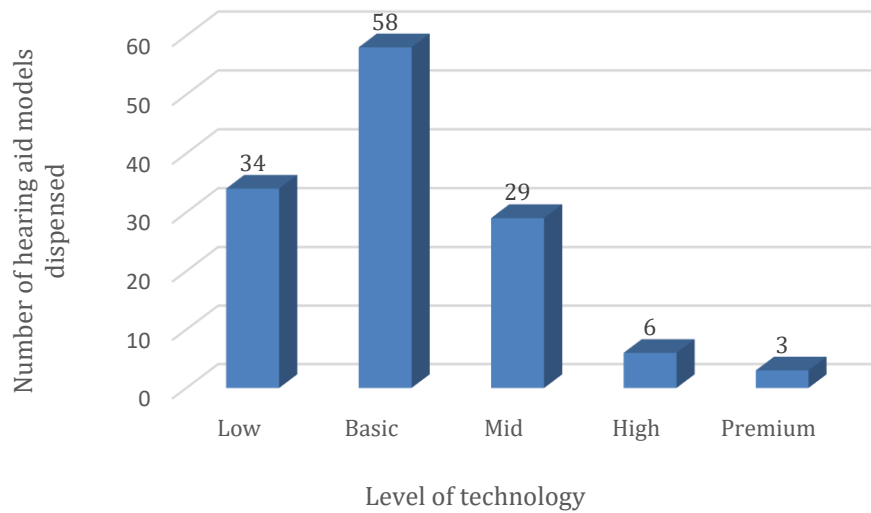


Figure 4.11: *Number of hearing aid models of different levels of technology dispensed under the HDDU scheme.*

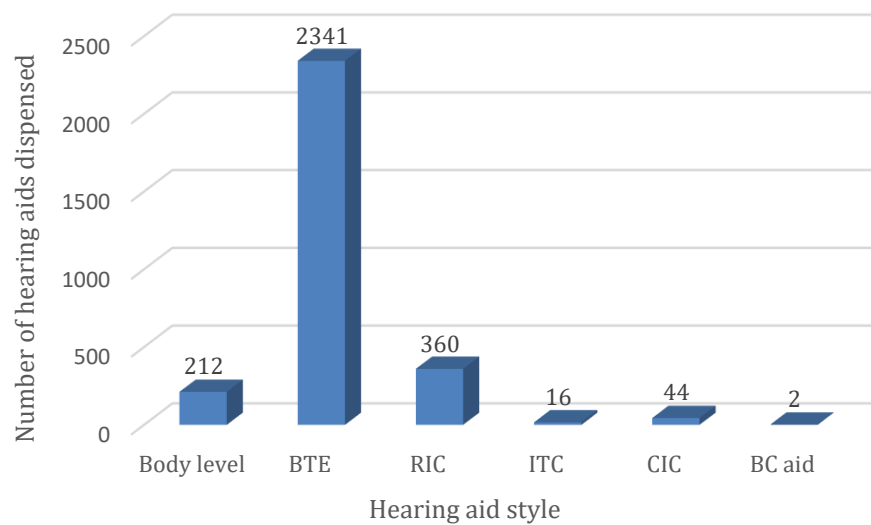


Figure 4.12: *Hearing aid style – wise number of hearing aids dispensed under the HDDU scheme. BTE stands for Behind The Ear, RIC for Receiver In the Canal, ITC for In The Canal, CIC for Completely In the Canal and BC for Bone Conduction hearing aid.*

Analysis of data in terms of **hearing aid styles** revealed that the highest percentage of hearing aids dispensed under the HDDU scheme belonged to behind the

ear style (78.69%), followed by receiver in the canal (12.10%), body level (7.13%), completely in the canal (1.48%), in the canal (0.54%), and bone conduction hearing aid (0.06%) (Figure 4.12).

Cost-wise analysis of the HDDU data; the hearing aids were dispensed at a discounted price under the scheme. The discount depended on the make, model, and technology category of the hearing aid. The cost of the hearing aids dispensed under the scheme ranged from Rs.2850/- to Rs.1,95,000/- in their MRP and from Rs.1030/- to Rs.1,04,895/- in their price under the scheme. The average cost of the hearing aids dispensed in the 2 years was Rs.14,153.25/- (price under the scheme).

4.3 Source of Funding for Purchasing the Hearing Aids

Out of 2,141 beneficiaries who procured hearing aids under the HDDU scheme, maximum number of beneficiaries (94.72%) procured them under self-funding source, followed by self + Client Welfare Fund (CWF). Only one beneficiary each procured hearing aid/s under CWF-only and PM (Prime Minister) funding source. Three beneficiaries utilised Mysuru City Corporation (MCC funds) to procure hearing aids. The results are shown in the Figure 4.13.

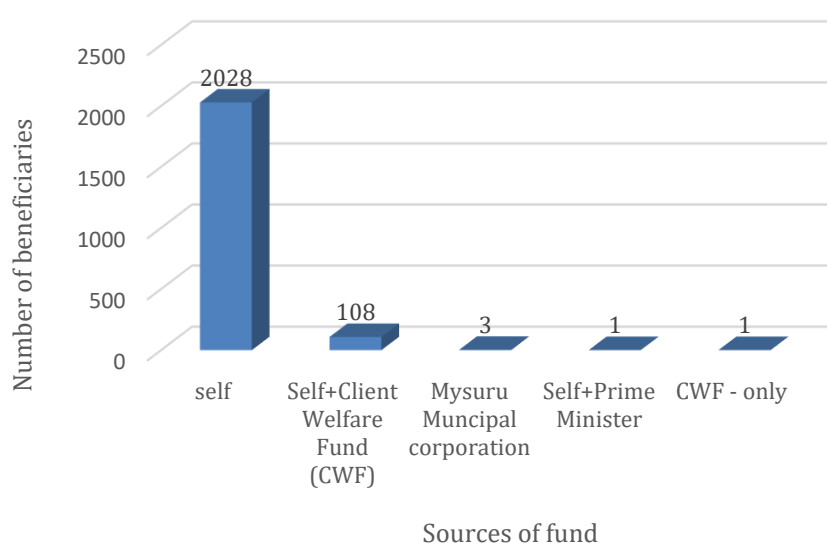


Figure 4.13: Number of beneficiaries who procured hearing aids under the HDDU scheme utilising different sources of funding.

Chapter-5

DISCUSSION

The study analysed the trend of hearing aids dispensed under the Hearing Device Dispensing Unit (HDDU) scheme of AIISH during 1st January 2018 to 31st December 2019. The trend was studied in three sections; beneficiaries of the scheme, hearing aids dispensed in the scheme, and sources of funds to purchase hearing aids. The specific trends are found and implications of it are discussed in the subsequent sections.

5.1 Trend in the Beneficiaries of the Scheme

There was an increase in the number of beneficiaries who procured hearing aids under the HDDU scheme from 2018 to 2019 by 12.56%. Increase in number of beneficiaries indicates the increased awareness among the needy about the hearing aids and the benefits of the HDDU scheme. Age-wise analysis of data showed that the majority of the beneficiaries belonged to the elderly adult group, followed by paediatric group, middle aged adult group and least to the young adult group. This is in agreement with the highest prevalence of hearing loss being in elderly adults, and increasing prevalence and incidence of congenital deafness in India (Varshney, 2016). A systematic review by Meyer and Hickson (2012) showed that acceptance of problem is good in older adults and they are considerate about the benefits of hearing aids rather than the barriers. The uptake of hearing aids or hearing assistive devices in young and middle-aged adults with hearing loss is influenced by job-related factors such as demands to communicate effectively and conflicting expectations at work place, and also by the marital status, to meet the demands of the spouse (Pronk et al., 2017). In order to overcome the impact of hearing problems like, social isolation, isolation from

family members, effortful listening, difficulty in processing speech and other issues, persons with hearing loss, especially the elderly adults would definitely prefer to try out the solutions. A longitudinal study in Netherlands found that work place demands force the employees with hearing loss to opt hearing aids, especially in middle aged adult groups (van Leeuwen et al., 2021).

Number of beneficiaries who procured monaural hearing aids was more than that who procured binaural hearing aids. An age-wise analysis of data revealed that the majority of elderly adults, followed by middle and young-aged adults, purchased monaural hearing aids, whereas for paediatric group binaural hearing aids were procured. Binaural fitting of hearing aids in paediatric group would enhance speech and language acquisition skills owing to the critical age concept and binaural hearing advantages (Avan et al., 2015; Shojaei et al., 2016). At the institute, the audiologists counsel the parents of children with hearing loss regarding the need for binaural amplification in children and insist on binaural hearing aid fitting. This could be the reason for higher binaural hearing aid procurement in paediatric population. In developing countries like India, many individuals with hearing loss would be unable to purchase hearing aids due to financial constraints. Purchasing binaural hearing aids would be considerably more difficult and thus they tend to manage day-to-day communication with a single hearing aid, despite the challenges. Elder adults with hearing loss would face additional problems like dexterity issues, dependency on other family members to procure and handle hearing aids. These findings are supported by an Indian study which aimed at identifying possible reasons for poor uptake of hearing aids by the middle aged and older adults with hearing loss. Financial factors, stigma towards hearing aids, negative attitude towards wearing hearing aid and its benefits, poor acceptance of the problem were some of the major reasons (Archana et al., 2016).

Percentage of male beneficiaries was more than that of the female beneficiaries in procuring hearing aids, which is in agreement with the study by Erler and Garstecki (1998). This could be partly due to higher prevalence of hearing loss in males than females. According to global estimates of hearing loss given by WHO (2012), hearing loss is more prevalent in males than in females. Further, males with hearing loss are known to accept the condition easily and, as a result, hearing aids too: hearing aids are less stigmatising for men than for women. On the contrary, the Indian study by Archana et al. (2016) found that males had more negative attitude towards the acceptance of hearing loss and hearing aids than the females.

Income slab-wise analysis of data showed that majority of the beneficiaries under the HDDU scheme belonged to Below Poverty Line (BPL) category (slab I), followed by slab II and III. This means that the outcomes of HDDU are in tune with its objectives. Discounts provided on the hearing aids by the HDDU scheme is being well utilized by the financially backward population with hearing loss. Financial limitations are found to be one of the major barriers to access hearing aids worldwide, especially in developing countries like India. Hence, govt. policies and discount schemes need to promote the hearing aid uptake and thereby overcome disability (Archana et al., 2016; Barnett et al., 2017; Merugumala et al., 2017; Orji et al., 2020), and HDDU is performing appreciably in this regard.

5.2 Trend in Hearing Aids Dispensed under the Scheme

Nearly 3000 hearing aids were dispensed in the period of 2 years under the HDDU scheme. There was an increase in number from year to year by approximately 15%, indicating progress in the hearing aid adoption rate. Hearing loss degree-wise analysis of data showed that majority of the binaural hearing aids dispensed belonged to severe degree of hearing loss, followed by moderately severe, moderate, and other

degrees which is consistent with the report of WHO (2012), according to which, disabling hearing loss (hearing loss of >40 dB in adults & >30 dB in children in better ear) is the most prevalent type of hearing loss worldwide. Even Meyer and Hickson (2012) observed in a review study that older adults with moderate to severe degree of hearing loss seek help more than those with other degrees of hearing loss.

Trend analysis in terms of company showed that majority of the hearing aids dispensed under the HDDU scheme belonged to DN2. At the institute, after the detailed hearing evaluation, audiologists counsel the subjects about the results of evaluation, need for the hearing aid/s if the hearing loss demands and specifics of the hearing aids dispensed at the institute. If the subject agrees to take up the hearing aid, he/she will be given options to choose and try out the hearing aids. Options include 2-3 different hearing aid models of different company. Audiologist suggests these options considering degree and type of hearing loss, age and needs of the subject, and price range of the hearing aids preferred by the subject. More number of subjects preferring hearing aids of DN2 company can thus be attributed to the efficiency of hearing aid models supplied by DN2 in satisfying the hearing aid procurers on trial, and probably the subjects find the models under DN2 company cost effective.

Model-wise analysis showed that 130 hearing aid models of 12 different companies are being dispensed under the HDDU scheme. This would provide multiple options for the hearing aid procurers to experience the sound quality of multiple models and choose the best one. Analysis of data in terms of technology revealed that majority of the models dispensed under the HDDU scheme belonged to the basic and low technology, and a very few models belonged to the mid, high and premium technology. This can be ascribed to the preferences of the beneficiaries owing to the financial status of the majority of the beneficiaries and probably, the efficacy of the features available

in basic and mid technology hearing aids to satisfy the beneficiaries. In India, prevalence of hearing loss is more in rural areas than in urban areas and India is still one of the low and middle income countries (Singh, 2015). In support with the basic technology is the study by Cox et al. (2016) which found no difference in outcomes between basic and premium feature hearing aids and their impact on daily life of the hearing aid users. Trend analysis in terms of hearing aid style showed that majority of the hearing aids belonged to the Behind The Ear (BTE) style, followed by others. This is in agreement with the capacity of the BTE hearing aids to provide better amplification to severe to profound degrees of hearing loss. BTEs can address the dexterity issues, especially in elder adults. Cost-wise analysis of data clearly showed the extent of discount being provided by the HDDU scheme on a hearing aid. With cost efficiency, the stakeholders are able to afford better technology for lesser cost. Increase in number of beneficiaries from year to year justifies the advantages of the HDDU scheme for the hearing aid procurers.

5.3 Trend in Sources of Funding to Procure Hearing Aids

Trend in terms of source of funding showed that maximum number of beneficiaries procured hearing aids through self-funding and very less number utilised other reimbursing sources. Finding means that, beneficiaries are able to afford the cost of hearing aids under the scheme from their own pocket. Discounts (55% on MRP) for hearing aids are same for all the income groups under the HDDU scheme. If the hearing aid procurer belongs to the BPL category, then he/she will have to bear only 60% of the cost of the hearing aid. These convincing discounts under HDDU scheme and challenges in finding sources of funding to procure hearing aids would be accounted for observing contrasting trend between income slab and source of funding. Despite majority of beneficiaries belonging to slab I, they could afford self-funding to procure

hearing aids under the HDDU scheme. This shows that low income group finds it beneficial to procure hearing aids through the HDDU scheme. Lack of reimbursing schemes and funds for hearing aids, and beneficiaries' lack of awareness about the available funds to procure hearing aids can also be the possible reasons for this contrasting trend.

Chapter-6

SUMMARY AND CONCLUSIONS

Hearing loss being more prevalent in South Asia, especially in low and middle income countries like India, promoting affordable access to hearing assistive devices is found to be challenging. Introducing subsidy schemes and policies, and effective measures to promote hearing device/aid uptake is very necessary. The HDDU scheme of AIISH is one such schemes which dispenses hearing aids on large scale with appreciable discounts on hearing devices. Trend analysis of the hearing aids dispensed under HDDU scheme would provide the comprehensive report on characteristics of dispensed hearing aids and the characteristics of the beneficiaries under the scheme and thereby a guide to plan the steps to be taken to reach the needy.

The current study aimed to analyse the trend in hearing aids dispensed through the HDDU scheme of AIISH in the years 2018 and 2019. The trend in terms of beneficiaries, dispensed hearing aids, and source of funding utilised by the beneficiaries to purchase hearing aids under the HDDU scheme was analysed. All the beneficiaries who procured hearing aids during 1st January 2018 to 31st December 2019 under the HDDU scheme were the participants of the study. Their demographic and audiological data, and details of the procured hearing aids were collected retrospectively by the investigator with due permission from the competent authority. The data gathered were tabulated in an Microsoft Excel sheet and analysed in terms of (i) total number of beneficiaries, (ii) number of beneficiaries by age, gender, monthly family income, and procurement of monaural versus binaural hearing aids, (iii) total number of hearing aids dispensed, (iv) number of hearing aids dispensed by make, style, cost, technology, degree of hearing loss, and (v) number of beneficiaries utilising different source of funding to procure hearing aids.

The following trends could be observed in the study;

- 1) Increase in number of beneficiaries from 2018 to 2019 by 12.56% highlighting on the awareness and advantages of HDDU scheme; Most of the beneficiaries belonged to elderly adult group, followed by other groups, possibly due to the highest prevalence of presbycusis and easy acceptance of hearing loss in the elderly adult group; The number of male beneficiaries was more than that of female suggesting easy acceptance of hearing loss in males; majority of the beneficiaries belonged to slab I indicating that the scheme is being utilized primarily by persons of low economic status and ; majority of the beneficiaries procured monaural hearing aids, mostly elderly adults preferred monaural hearing aids and paediatric group preferred binaural hearing aids owing to the critical age concept in paediatric population.
- 2) There was an increase in number of hearing aids dispensed from 2018 to 2019 by 15% which is in agreement with a yearly increase in number of beneficiaries; Majority of the hearing aids dispensed belonged to DN2 company and were Behind the ear hearing aids; the average cost of the hearing aids dispensed in the 2 years was Rs.14,153.25/- (price under the scheme); overall 130 different hearing aid models are dispensed under the scheme, with majority of them belonging to basic technology which signifies the capacity of basic technology hearing aids to satisfy the beneficiaries; majority of the hearing aids were dispensed for severe degree of hearing loss, followed by moderately severe and other degrees
- 3) The majority of the beneficiaries belonged to slab I, the majority purchased hearing aids through self-funding and very few utilised other sources of funds.

A yearly increase in number of beneficiaries and dispensed hearing aids, and the contrasting trend observed in the study clearly shows that HDDU is meeting its goals by offering discounts on hearing aids. Counselling the hearing aid purchaser about

trends in hearing aid dispensing will assist him or her in selecting the best one. The findings of the study will help the HDDU frame policies and budget effectively in order to meet the demands of hearing aid purchasers on time. The findings also highlight the steps to be taken to ensure that more people, particularly those in the BPL category, use the various sources of funds available to purchase hearing aids.

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