

# Demographic and Clinical Characteristics of Recipients of Cochlear Implant Prosthesis in Ayatollah Rouhani Hospital, Babol

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**Background:** A cochlear implant is a device that directly activates the eighth nerve fibers using active electrodes. Candidates for cochlear implants differ in demographic factors, including age, gender, the age at which the implant is placed, the method of delivery, and the type of prosthesis utilized. The purpose of this study was to investigate the demographic characteristics of people receiving cochlear implant prosthesis in the implant center of Ayatollah Rouhani Hospital in Babol city.

**Materials and Methods:** This study was a descriptive and retrospective study. Demographic information of 119 individuals with hearing loss who received cochlear implant prosthesis was described. These characteristics included age, gender, age of receiving prosthesis, type of delivery, type of prosthesis, average age of auditory training, history of jaundice before birth, family marriage and several other variables. Descriptive variables were reported with statistical indicators, quantitative variables using central indices of mean, median, and dispersion indices using standard deviation, interquartile range, minimum and maximum values, and qualitative variables were also reported with frequency (percentage).

**Results:** 115 successful operations were reported. 61 females and 54 males underwent surgery. The average age of patients undergoing surgery was 113.37 months. The average age of onset hearing loss (93.21) was 31.83 months with a median (24.00-1.00) of 7, and the average age of starting to use hearing aids before surgery (98.97) was 42.92 months with a median (7.00-30.00) of 18. Also, based on the available data, the average age of starting listening training (125.32) is 56.98 months.

**Conclusion:** This was a descriptive study on the data of patients receiving cochlear implant prosthesis. Demographic elements, including gender, jaundice, seizures, family medical history, and type of prosthesis, play a significant role in determining the candidacy for cochlear implants. It is recommended to conduct studies with statistical analysis and interventional studies in this center.

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## Introduction

**H**earing loss is a common chronic condition that affects millions of individuals worldwide (1, 2). Studies have shown that hearing impairment in childhood is associated with significant challenges in speech and language development, literacy, and academic performance (3-5). Adults with hearing loss are also more prone to depression, social isolation, and cognitive decline (6-9).

According to the World Health Organization (WHO), hearing impairment is classified by severity into mild (26–40 dB), moderate (41–60 dB), severe (61–80 dB), and profound (above 80 dB), and by type into conductive, sensorineural, and mixed hearing loss (10, 11).

Cochlear implantation is a medical intervention that partially restores hearing and is considered a suitable option for individuals with severe-to-profound hearing loss who do not benefit adequately from conventional hearing aids (12-15). The primary benefit of this intervention is the restoration of hearing, which significantly improves verbal communication and overall quality of life (16-24).

Analyzing the demographic and clinical characteristics of cochlear implant recipients can help identify risk factors for hearing loss, promote early diagnosis, and reduce complications associated with delayed intervention (25, 26). Understanding variables such as the cause and duration of hearing loss, age at surgery, pre-implant hearing aid use, and outcomes can offer valuable insights into the factors influencing the success of cochlear implantation (16, 26). Furthermore, identifying subgroups with more favorable outcomes based on demographic profiles can assist in prioritizing candidates for implant services (27).

Several studies have evaluated the demographic features of cochlear implant recipients in other countries ((27-29). Tolisano et al. reported that younger age was a strong independent predictor of candidacy and better outcomes in the United States (27). In a systematic review, Meinhardt et al. found that gender was the most commonly reported demographic variable in cochlear implant studies (29). Additionally, a multi-year observational study by Yu et al. in China involving 288 cochlear implant recipients showed that early implantation and preoperative hearing aid use were associated with better outcomes. Bilateral implantation

and parental awareness were also identified as key factors influencing prognosis (28).

Currently, cochlear implantation is performed in 15 specialized centers across Iran, including Babol. Identifying demographic variables associated with implant success may help improve candidate selection, enable timely intervention, and prevent long-term adverse effects of hearing loss. To date, no study has specifically assessed the demographic profile of cochlear implant recipients in northern Iran. This study aims to provide a descriptive overview of demographic characteristics among patients receiving cochlear implants at Ayatollah Rouhani Hospital in Babol.

## Materials and methods

### Study Design

This research was a retrospective, cross-sectional, and observational study conducted through the review of medical records of cochlear implant recipients at the Cochlear Implant Center of Ayatollah Rouhani Hospital in Babol, from May 2021 to September 2024. The study received ethical approval from the Ethics Committee of Babol University of Medical Sciences (IR.MUBABOL.HRI.REC.1403.162).

### Participants and Procedure

Initially, patients who were candidates for cochlear implantation underwent a comprehensive audiological evaluation to determine their hearing profile. These assessments included Pure Tone Audiometry (PTA), Tympanometry, Speech Reception Threshold (SRT), Speech Discrimination Score (SDS), Auditory Brainstem Response (ABR), and Auditory Steady-State Response (ASSR).

Candidates with hearing loss greater than or equal to 80 dB—classified as severe to profound hearing loss—were considered eligible for cochlear implantation (10, 11). At this stage, an initial file was created for each patient, which included personal information (name, national ID, phone number) and audiometric results.

Subsequently, each patient was referred to the multidisciplinary cochlear implant team, including an otolaryngologist, audiologist, speech therapist, and psychologist. The speech therapist completed questionnaires related to case history (personal, medical, and auditory), Speech Intelligibility Rating (SIR), and Categorization of Auditory Performance (CAP). The psychologist administered the Ages and Stages Questionnaire (ASQ) and a psychological assessment form.

Patients were then guided by the audiologist to use appropriate digital hearing aids for 4 to 6 months, during which they also participated in auditory-verbal

therapy and speech therapy sessions. These steps ensured that the hearing aids were insufficient for satisfactory auditory performance, confirming candidacy for cochlear implantation.

Once all evaluations were complete, patient files were reviewed in a final multidisciplinary committee. Patients with acceptable early speech development, syndromic conditions, significant motor impairments, or satisfactory outcomes from hearing aid use and rehabilitation were excluded from surgery. Eligible candidates were then referred to specialists in cardiology, neurology, and pediatrics, as well as radiology for temporal bone CT and pathology labs for preoperative evaluations.

For pediatric candidates, pneumococcal vaccination was administered at least 10 days before surgery. Additionally, all patients were required to submit a signed legal consent form before the procedure.

During hospitalization, demographic questionnaires were completed, capturing information such as age, gender, place of birth, education level, hand dominance, consanguinity, and medical history (e.g., mode of delivery, prematurity, perinatal hypoxia, jaundice, fever, seizures). Audiological data included the age of hearing loss onset, etiology and severity, duration of hearing aid use, age at surgery, type of implanted device, and the operated ear. High-frequency tympanometry was performed to confirm the absence of middle ear infections. If otitis media was detected, surgery was postponed, and the patient was excluded from the study.

Following discharge, patients were re-evaluated at one week and again after two weeks. Forty days postoperatively, the speech processor and other external components were activated, and the initial programming was conducted. Patients then returned for scheduled mapping sessions and rehabilitation to monitor post-implant progress and the effectiveness of cochlear implantation.

### Statistical Analysis

Extracted data were entered into SPSS version 23. Descriptive variables were reported using central tendency measures (mean, median), measures of dispersion (standard deviation, interquartile range, minimum, and maximum), and frequencies (percentages) for categorical data

### Results

Out of the 115 patients with data recorded, variables such as gestational age at birth, mode of delivery, consanguineous marriage, neonatal jaundice, history of seizures, fever, and hypoxia are presented in Table 1.

A total of 51 (44.3%) patients were females and 64 (55.7%) individuals were males. Among them, 43(37.4%) subjects resided outside Mazandaran, while 72 (62.6%) were residents of Mazandaran, including 18 (15.7%) patients who lived in Babol (**Table 1**). Additional important variables, such as gender, place of residence, and hand dominance, are summarized in (**Table 2**).

**Table 1.** Demographic Information of Patients at the Cochlear Implant Center.

Variable	Subgroup	Frequency (%)
Birth Time	Preterm	22 (19.1)
	Full term	93 (80.9)
Delivery Method	Cesarean	65 (56.5)
	Natural	50 (43.5)
Consanguineous Marriage	Yes	51 (44.3)
	No	64 (55.7)
Neonatal Jaundice	Yes	35 (30.4)
	No	80 (69.6)
Seizure History	Yes	6 (5.2)
	No	109 (94.8)
Fever History	Yes	10 (8.7)
	No	105 (91.3)
Hypoxia History	Yes	19 (16.5)
	No	96 (83.5)

**Table 2.** Descriptive Indexes of Age and Key Variables in the Study.

Variable	Subgroup	Frequency (%)
Gender	Male	51 (44.3)
	Female	64 (55.7)
Residence	Babol	18 (15.7)
	Inside Mazandaran Province (non-Babol)	54 (47.0)

Handedness	Outside Mazandaran Province	43 (37.4)
	Left-handed	18 (15.7)
	Right-handed	97 (84.3)

The mean age at the time of cochlear implantation was  $113.37 \pm 158.64$  months, with a median of 131.00 months (range: 22.00–131.00). The youngest patient was 13 months old, and the oldest was 62 years. The mean age of hearing loss onset was  $31.83 \pm 93.21$  months, with a median of 7 months (range: 1.00–24.00). The mean age at which hearing aids were first used prior to surgery was  $42.92 \pm 98.97$  months, with a median of 18 months (range: 7.00–30.00). According

to available data, the mean age of initiation of auditory training was  $56.98 \pm 125.32$  months (**Table 3**).

An audiological profile analysis revealed that more than half of the patients (67 individuals, 58.3%) had bilateral profound hearing loss. In most cases (105 patients, 91.3%), the right ear was chosen for implantation, while the left ear was operated on in the remaining patients. The underlying cause of hearing loss in the majority of cases (85 patients, 73.9%) was

**Table 3.** Medical History Information of Patients at the Cochlear Implant Center.

Variable	Subgroup	Frequency (%)
Type of Hearing Loss	Mild to Severe / Severe to Profound	1 (0.9)
	Moderate to Profound	4 (3.5)
	Severe to Profound / Moderate to Profound	3 (2.6)
	Mild to Profound	2 (1.7)
	Severe to Profound	20 (17.4)
	Profound / Severe to Profound	11 (9.6)
	Profound / Moderate to Profound	7 (6.1)
	Profound / Profound	67 (58.3)
Operated Ear	Left	10 (8.7)
	Right	105 (91.3)
Cause of Hearing Loss	Genetic	85 (73.9)
	During Birth	7 (6.1)
	After Birth	23 (20.0)
Prosthesis Type	Cochlear	62 (53.9)
	AB	29 (25.2)
	Medel	24 (20.9)

**Table 4.** Hearing-Related Information of Patients at the Cochlear Implant Center.

Variable	Mean $\pm$ SD	Median (IQR)	Min - Max
Age of Hearing Loss Onset (months)	21.93 $\pm$ 31.83	7 (1.00 – 24.00)	0 – 636
Age of Using Hearing Aids Before Surgery (months)	97.98 $\pm$ 42.92	18 (7.00 – 30.00)	0 – 636
Age of Surgery (months)	158.64 $\pm$ 113.37	38 (22.00 – 131.00)	13 – 744
Age of Starting Auditory Training (months)	121.22 $\pm$ 52.83	18 (7.25 – 36.00)	5 – 672

genetic. More than half of the patients (62 individuals, 53.9%) received a Cochlear® implant. Additionally, 29 patients (25.2%) received an Advanced Bionics (AB) implant, and 24 patients (20.9%) were implanted with Med-EL devices (**Table 4**).

## Discussion

The overall findings of the present study highlighted those demographic factors such as gender, neonatal jaundice, history of seizures, consanguinity,

and type of implant were significantly associated with cochlear implantation candidacy. Most of the implanted patients were males, predominantly right-handed, and residents of Babol. Previous studies showed a higher prevalence of hearing impairment among males, which may be explained by X-linked genetic inheritance patterns associated with congenital hearing loss. Since males possess a single X chromosome, mutations on this chromosome can result in a higher likelihood of developing hearing deficits (30).

Furthermore, more than half of the patients had bilateral profound hearing loss. Based on previous research in language processing, the left cerebral hemisphere plays a dominant role in language acquisition and comprehension. Consequently, cochlear implants were more commonly placed in the right ear to enhance auditory-linguistic outcomes (31). Multiple studies have supported the superiority of right-ear implantation in improving speech and language skills (19).

Among the reported risk factors, neonatal jaundice was the most prevalent. The auditory system's vulnerability to elevated bilirubin levels has been demonstrated in several studies (32, 33). Although the incidence of seizures, fever, and hypoxia was lower, the association between seizures and hearing loss has been consistently reported. Children with a history of seizures are 4–5 times more likely to develop hearing impairment. This may be due to shared neuroanatomical pathways and genetic factors affecting both auditory processing and seizure disorders (34).

Consanguineous marriage and cesarean delivery were also common among implant recipients. While some studies found no significant association between mode of delivery and hearing loss (35), consanguineous marriage has been linked to a significantly increased risk (up to 83.1%) of sensorineural hearing loss due to the inheritance of autosomal recessive mutations (36).

Most recipients had profound hearing loss and were deemed unsuitable candidates for hearing aids alone. Cochlear® devices were more frequently used than AB or Med-EL devices, likely due to their established efficacy and familiarity among local surgical teams and institutions.

The mean age at implantation was approximately 113 months, with a broad range from 13 months to 62 years, reflecting the diversity of prelingual and postlingual candidates. The mean age at hearing loss onset was 31.83 months, and the mean age at initiation of hearing aid use was 42.92 months. The mean age at which auditory training began was 56.98 months. These findings underscore the need for early diagnosis and timely intervention to optimize auditory outcomes.

In summary, demographic variables such as gender, jaundice, seizures, family history, and type of prosthesis are key factors in identifying suitable candidates for cochlear implantation. While cesarean delivery showed a higher prevalence in this cohort, its role remains inconclusive. Right-ear implantation, potentially linked to hemispheric dominance, may offer better speech and language outcomes. Nonetheless, the retrospective design of this study and lack of long-term

follow-up for externally treated patients are notable limitations.

## Conclusion

This study provides a descriptive overview of the demographic characteristics of individuals receiving cochlear implants. Our results indicate that male patients, individuals with a history of neonatal jaundice or seizures, and those with consanguineous parentage were more frequently represented among implant recipients. In most cases, the right ear was selected for implantation. Exclusion of patients with syndromic conditions, neurological or systemic impairments, or those who benefited sufficiently from hearing aids may have enhanced the overall surgical success rate. Longitudinal studies evaluating post-implantation outcomes and interventional studies in this population are recommended.

## Declaration

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