



ASSESSING SENSORINEURAL HEARING LOSS AND HEARING AID EFFICACY: A STUDY OF PRESCHOOL AND SCHOOL-AGED CHILDREN

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Introduction. Hearing is a fundamental sensory pathway required for normal speech acquisition, cognitive growth, and social emotional integration during childhood. Sensorineural hearing loss (SNHL) occurs due to damage or developmental anomalies of the cochlea, auditory nerve, or central auditory pathways. In pediatric populations, the consequences of unaddressed or late-diagnosed SNHL extend far beyond simple auditory deficits. It directly causes profound speech delay, cognitive impairments, behavioral difficulties, and limited academic performance.

Early detection forms the baseline of pediatric audiology. The human brain exhibits maximum neuroplasticity in the first few years of life. Missing this critical therapeutic window impairs the development of the auditory cortex. While severe or profound SNHL is often caught early due to obvious behavioral non-responsiveness, mild-to-moderate forms frequently go undetected until the child enters school. This late identification severely limits the efficacy of subsequent rehabilitation.

Objective diagnostic methods are vital in pediatric practice. Children under school age or those with developmental delays often cannot provide reliable responses during subjective behavioral tests. Objective modalities like Otoacoustic



Emissions (OAE) and Auditory Brainstem Responses (ABR) provide precise, reliable data regarding peripheral and neural auditory function independent of child cooperation.

In developing regions and rural territories, screening and management programs face specific challenges. Infrastructural differences often cause delayed diagnosis. This highlights the urgent need to evaluate current screening protocols and assess rehabilitation outcomes.

The objective of this study is to analyze the clinical and demographic characteristics of pediatric SNHL through comprehensive objective audiological diagnostics and to evaluate the short-term efficacy of digital hearing aids and alternative rehabilitation strategies.

Methods. This prospective clinical study was conducted between 2023 and 2024. The research took place at the Republican Specialized Scientific Practice Medical Center of Pediatrics in Tashkent, Uzbekistan. Informed consent was obtained from the parents or legal guardians of all participating children before diagnostic and therapeutic procedures.

The study enrolled 72 children diagnosed with various degrees of SNHL. The cohort consisted of 39 boys (54.2%) and 33 girls (45.8%). Patient ages ranged from 3 to 14 years. Children with active middle ear pathologies or conductive hearing loss components were excluded from this specific analysis to maintain study focus on pure sensorineural deficits.

A multi-tier audiological evaluation protocol was executed for each patient:

- Subjective Methods: Pure-tone audiometry was performed for older, cooperative children. Play audiometry was utilized for younger preschool children (ages 3–5).
- Acoustic Immittance: Tympanometry using a 226 Hz probe tone was implemented to evaluate middle ear function and verify the absence of conductive pathologies.
- Objective Auditory Testing:



- Otoacoustic Emissions (OAE): Transient-evoked OAE (TEOAE) and Distortion Product OAE (DPOAE) were recorded to assess outer hair cell functionality within the cochlea.

- Auditory Brainstem Response (ABR): ABR testing was performed under natural sleep or mild sedation using click and tone-burst stimuli. This evaluated the integrity of the auditory nerve and brainstem pathways up to wave V.

Following precise diagnostic categorization, patients underwent customized rehabilitation tracks:

- Acoustic Amplification: Patients with mild, moderate, or severe SNHL who retained detectable wave V on ABR were fitted with modern, programmable, digital behind-the-ear (BTE) hearing aids. Amplification profiles were tailored using specialized prescriptive formulas. Custom ear molds were fabricated for every patient to minimize acoustic feedback and maximize comfort.

- Surgical Rehabilitation Strategy: Patients presenting with profound bilateral SNHL, total lack of responses on OAE, and a complete absence of wave V on ABR at maximum stimulus intensity (90–100 dB nHL) were excluded from traditional hearing aid fitting and instead systematically referred for cochlear implantation (CI).

Efficacy was systematically evaluated at a 4–5 month follow-up post-fitting. Assessment criteria included:

- Free-field behavioral audiometry with hearing aids.
- Speech perception tests measuring speech recognition distance for whispered and conversational speech.
- Structured parent-pedagogue feedback questionnaires tracking changes in social communication and sound awareness.

Results. Analysis of the patient cohort revealed significant demographic patterns. The majority of the study population lived in rural regions (57.0%, n=41), while 43.0% (n=31) were from urban areas. School-aged children formed the largest age group, accounting for 59.7% (n=43) of the sample. Preschool children accounted for 40.3% (n=29).



In terms of etiology, congenital SNHL was diagnosed in 53 children (73.6%). Acquired SNHL was identified in 19 patients (26.4%). The primary causes for acquired loss included severe neonatal hyperbilirubinemia, prematurity, exposure to ototoxic medications, and post-infectious complications like meningitis.

The distribution of hearing loss severity was evaluated per individual ear (144 ears total). Hearing loss was classified based on international audiological standards. Grade III (severe) SNHL predominated, accounting for 54.4% (78 ears) of the sample. The remaining ears demonstrated Grade I, Grade II, or Grade IV/Profound losses, as detailed in the comprehensive summary table below.

The study cohort was divided into two distinct therapeutic pathways based on objective ABR parameters:

1. Digital BTE Hearing Aid Fitting: 55 children (76.4%) received acoustic amplification. Binaural fitting was actively prioritized and executed for patients with asymmetric hearing loss to establish balanced sound localization.

2. Cochlear Implantation Referral: 17 children (23.6%) demonstrated profound bilateral deficits and absent wave V on objective ABR testing. They were referred for surgical cochlear implantation.

At the 4–5 month follow-up, children fitted with digital BTE hearing aids demonstrated substantial improvements in auditory capabilities:

- Auditory Perception: Free-field audiometric testing showed shifts in sound detection thresholds toward normal conversational zones (30–40 dB).
- Speech Recognition: Average speech recognition distance for spoken words increased significantly, reaching up to 4 meters in controlled quiet environments.
- Social & Behavioral Adjustment: Parents noted marked improvements in environmental sound awareness, responsiveness to vocal commands, and reduced frustration levels during social interactions.

Discussion. The finding that Grade III SNHL and school-aged children predominated in this study highlights a critical clinical challenge: delayed regional diagnosis. The high proportion of rural patients (57.0%) suggests that localized



newborn and infant hearing screening networks face geographic and logistical constraints. When mild-to-moderate or slowly progressive SNHL is not detected during infancy, children are often only brought to specialized centers when severe speech delays or learning difficulties become apparent at school age. This delayed presentation reduces the long-term speed of speech-language acquisition.

Our clinical results validate the importance of pairing subjective audiometry with objective tests like OAE and ABR. Objective tracking ensures that children with profound damage are not kept on ineffective acoustic amplification tracks. Instead, identifying an absent wave V on ABR allows for immediate referral for cochlear implantation. This rapid triage model prevents wasting valuable developmental time.

The 4–5 month follow-up data confirms that digital BTE hearing aids provide rapid, tangible improvements in acoustic access. Achieving speech recognition up to 4 meters provides children with the acoustic access necessary to participate in mainstream educational environments.

However, technology alone does not guarantee successful rehabilitation. Our observations show that clinical outcomes depend heavily on four interconnected factors:

1. Early Detection: Minimizing the time between onset and amplification.
2. Precise Acoustic Calibration: Regular adjustment of digital compression settings based on growth and feedback.
3. High-Quality Custom Molds: Preventing acoustic leakage and ensuring comfort during extended use.
4. Multidisciplinary Engagement: Structured post-fitting speech-language therapy combined with continuous parental and pedagogical support.

For children with asymmetric hearing loss, binaural fitting remains essential. It prevents auditory deprivation in the poorer ear, enhances speech understanding in noise, and ensures proper social integration.

Conclusion. Objective audiological assessments (OAE and ABR) are critical for the timely management of pediatric SNHL. While digital BTE hearing aids show



excellent 4–5 month efficacy, optimizing pediatric outcomes requires expanding early screening programs into rural regions and maintaining strict, multidisciplinary follow-up protocols.

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