

Improving Rehabilitation for Children with Moderate Sensorineural Hearing Loss

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Abstract Moderate sensorineural hearing loss in children represents a significant challenge for both clinical practice and educational development. Timely diagnosis and effective rehabilitation programs are crucial to prevent delays in speech, cognitive, and social skills. This article examines current approaches to pediatric auditory rehabilitation, highlighting the role of modern hearing technologies, individualized therapy, and interdisciplinary collaboration. Special attention is given to optimizing rehabilitation strategies that integrate medical, psychological, and pedagogical support. By improving early intervention and tailoring treatment plans to the specific needs of each child, rehabilitation outcomes can be significantly enhanced, contributing to better communication skills and overall quality of life.

Keywords Sensorineural hearing loss, Pediatric rehabilitation, Auditory therapy, Early intervention, Individualized approach

Sensorineural hearing loss (SNHL) is a persistent impairment of auditory function resulting from damage to the inner ear structures, the auditory nerve, or the central pathways of the auditory system. In children, this condition is of particular concern, since hearing is essential for the development of speech, cognitive processes, and successful social integration [1]. According to the World Health Organization, more than 34 million children worldwide are affected by hearing loss, and over 60% of these cases could be prevented or effectively managed with timely intervention [2].

Recent years have seen a growing number of cases of SNHL identified in early childhood. This alarming trend is linked to multiple factors, including environmental deterioration, the rising incidence of perinatal pathologies, intrauterine infections, hereditary diseases, and the insufficient level of prenatal diagnostics in certain regions [3]. Among the various forms of hearing loss, moderate sensorineural hearing loss (41–55 dB reduction) is particularly insidious, as it often goes unnoticed for an extended period, especially if the child has not yet begun to speak actively. The lack of early detection and intervention contributes to secondary delays in speech and intellectual development, reduced learning capacity, and, later in life, significant social and professional limitations [4].

In this context, one of the primary challenges of modern pediatric otorhinolaryngology, speech therapy, and special education is the improvement of rehabilitation strategies for children with moderate SNHL. The development and implementation of individualized auditory-verbal

rehabilitation programs aimed at early and comprehensive restoration of auditory function and speech are crucial. However, despite the availability of standardized clinical protocols, the effectiveness of many rehabilitation programs remains insufficient. This is largely due to delayed diagnosis and the lack of a systemic approach that considers the child's age, neurological status, and psycho-emotional characteristics [5] [6].

Modern research demonstrates that the best outcomes are achieved through a multidisciplinary approach, involving collaboration among otorhinolaryngologists, audiologists, speech therapists, neurologists, and child psychologists. Such coordinated efforts make it possible not only to restore auditory perception but also to ensure the development of intelligible speech, successful socialization, and an improved quality of life for the child [7].

Therefore, the need to enhance the effectiveness of auditory-verbal rehabilitation for children with moderate sensorineural hearing loss has become an essential priority in both clinical practice and scientific research.

1. Participants and Study Design

The study was conducted at the Department of Otorhinolaryngology of the Tashkent Medical Academy between 2022 and 2024. A total of 80 children aged 3 to 7 years with a confirmed diagnosis of moderate sensorineural hearing loss (Grade II, 41–55 dB) were enrolled. The participants were divided into two groups of 40 children each: the main group (Group I) and the control group (Group II). Allocation was carried out with consideration of age, sex, degree of hearing loss, and the presence of concomitant

somatic disorders.

2. Rehabilitation Program

Children in the main group received a comprehensive auditory-verbal rehabilitation program, which included:

- individualized selection and fitting of digital hearing aids;
- regular sessions with a speech therapist-defectologist (at least three times per week);
- auditory training based on specialized acoustic stimulation;
- psycho-emotional support involving both a child psychologist and parental counseling;
- continuous medical supervision (pediatrician, neurologist, and otorhinolaryngologist).

The control group underwent standard therapy, which consisted only of hearing aid fitting and occasional speech therapy sessions (no more than once per week).

3. Assessment Methods

To evaluate the effectiveness of rehabilitation, the following methods were applied:

Audiological diagnostics: pure-tone threshold audiometry with determination of auditory thresholds before and after intervention.

Speech and language testing: assessment of phonemic awareness, active and passive vocabulary, and connected speech.

Cognitive and social adaptation: evaluation of memory, attention, and social adaptation in a peer group using the "SocD" social behavior scale.

Parental perception: questionnaires measuring satisfaction with rehabilitation outcomes.

Dynamic monitoring: intermediate control points were established at baseline (T0), after 6 months (T1), and after 12 months (T2).

Statistical Analysis

All data were recorded in individual observation charts and analyzed using descriptive statistics. Comparisons between groups were conducted using Student's t-test. A significance level of $p < 0.05$ was considered statistically significant.

4. Results

Children in the main group demonstrated significant progress across all evaluated parameters. The average hearing threshold improved from 50.2 dB to 37.1 dB ($p < 0.01$). Active vocabulary increased by approximately 1.5 times, and improvements were observed in pronunciation as well as grammatical speech structure. In contrast, changes in the control group were less pronounced and statistically insignificant.

Social adaptation in a peer group improved in 87% of children in the main group, compared to 58% in the control group. Parental satisfaction with rehabilitation quality was also higher in the main group (91% vs. 63%).

After 12 months of observation of children with Grade II sensorineural hearing loss in both groups, a pronounced positive dynamic was recorded in auditory perception, speech development, and social adaptation among those who underwent comprehensive individualized rehabilitation.

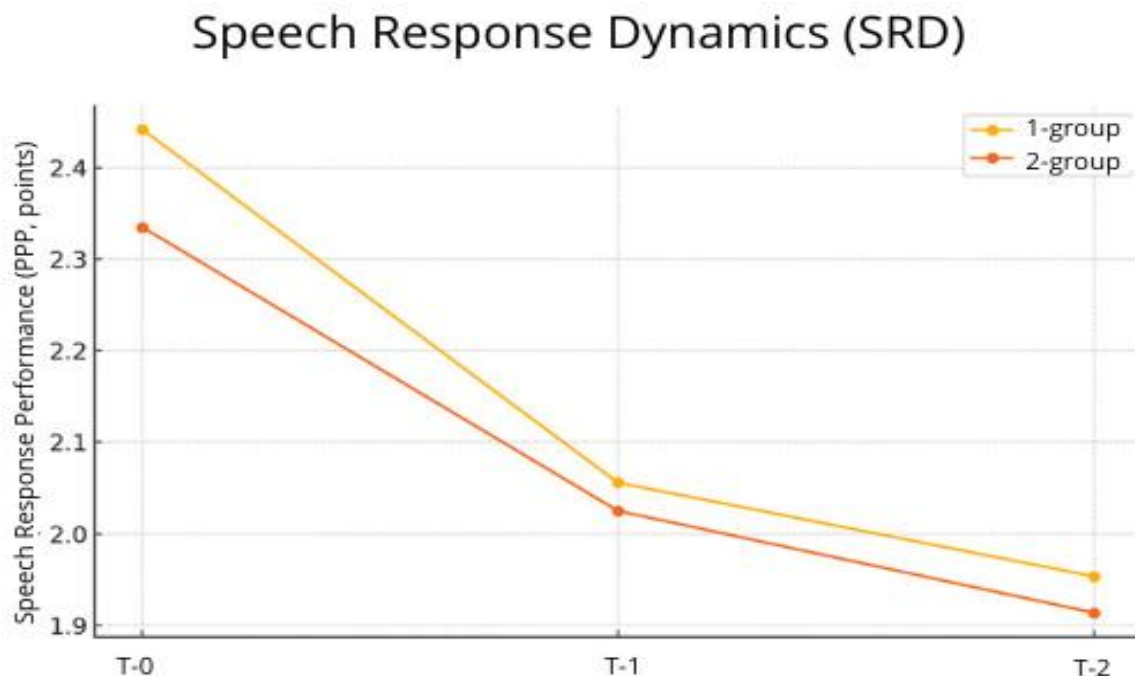


Figure 1. Dynamics of auditory perception (Basic Hearing Scale, BHS) at three stages of observation: baseline (T0), after 6 months (T1), and after 12 months (T2)

A particularly illustrative parameter was the Basic Hearing Scale (BHS), which characterizes the perception of speech and background sounds. In the main group (Group I), the mean baseline value was 15.9 points. After 6 months (T1), this improved to 17.5, and by the end of 12 months (T2), it reached 19.0, corresponding to a total increase of +3.1 points. In the control group (Group II), the baseline value was 14.9, increasing to 15.7 at 6 months and 16.8 at 12 months, showing only a +1.9-point improvement. The difference between the groups at the final stage was statistically significant ($p < 0.05$).

The curve of the main group demonstrates a consistent and steady increase in the Basic Hearing Scale (BHS) score: from 15.9 at baseline to 19.0 at the final stage. This reflects systematic improvement in auditory functions among children who underwent the comprehensive rehabilitation program. In contrast, the control group curve remains much flatter, with only modest positive dynamics: from 14.9 to 16.8.

The difference in slope between the two curves clearly visualizes the effect of modern hearing aids, intensive speech therapy, and auditory training in the main group. Moreover, the divergence becomes evident as early as after 6 months (T1), highlighting the importance of early intervention and a structured rehabilitation approach.

Thus, the diagram not only supports the results of statistical analysis but also illustrates the advantages of an individualized and multidisciplinary model of rehabilitation.

2. Speech Response (SRR)

The mean values on the Speech Development Scale in the main group were as follows:

baseline: 2.6,
after 6 months: 2.2,

after 12 months: 2.1.

A decrease in this parameter indicates reduced difficulties in speech perception and production (the lower the value, the higher the level of speech development). The total improvement was -0.5 points, reflecting marked progress in phonemic awareness, vocabulary expansion, and grammatical structuring of speech.

In the control group, the score decreased only from 2.4 to 2.2 (-0.2 points), which was not statistically significant. This confirms the necessity of systematic speech therapy and auditory correction.

3. Social Adaptation Scale (SocD)

The SocD scale assessed the child’s behavior in a group, interaction with adults and peers, emotional responsiveness, and ability to express personal needs. Children in the main group demonstrated a clear improvement:

baseline: 10.8,
after 12 months: 13.8 (+3.0 points).

The main group (Group I) demonstrated a significant improvement of +3.0 points, reflecting the high effectiveness of the comprehensive program, which included psychological support and active parental involvement. In contrast, the control group (Group II) showed only a modest increase from 11.7 to 12.9 (+1.2 points), indicating the limited potential of the standard rehabilitation model in terms of psychosocial support.

Comparative analysis between the two groups revealed substantial differences in the effectiveness of auditory-verbal rehabilitation across all key parameters: auditory perception (BHS), speech development (SRR), and social adaptation (SocD). The most pronounced differences were observed at the end of the 12-month follow-up period.

Table 1. Dynamics of auditory perception (Basic Hearing Scale, BHS, points)

Groups	BHS at (Baseline, T0).	BHS at 6 months (T1)	BHS at 12 months (T2)	$\Delta (T2 - T0)$
1-group	15.9	17.5	19.0	+3.1
2-group	14.9	15.7	16.8	+1.9

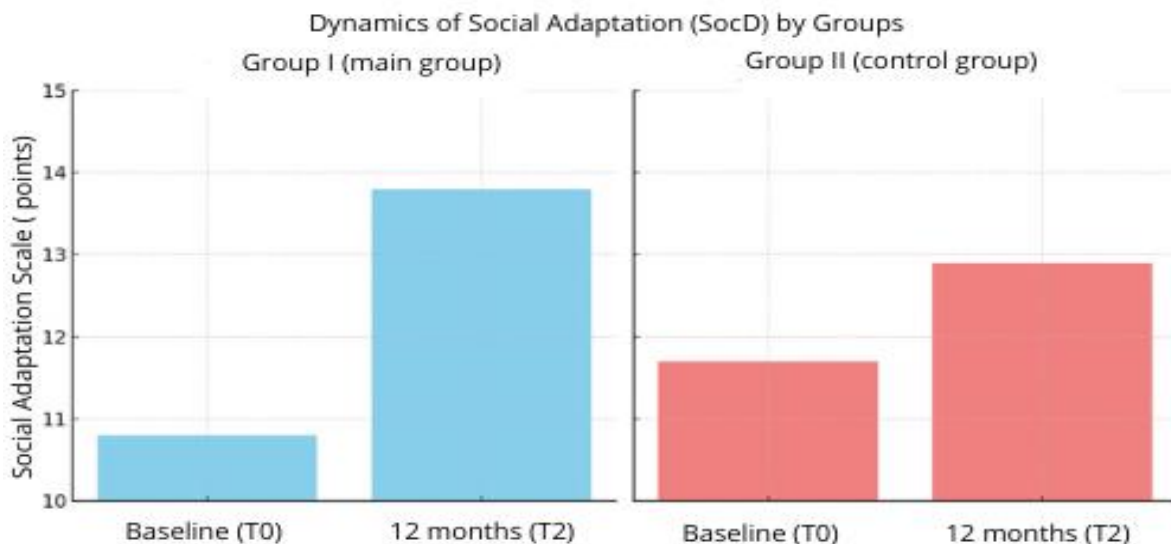


Figure 2. Dynamics of social adaptation (SocD) in children of the main and control groups over 12 months

Comparative Analysis of Rehabilitation Outcomes

The improvement in auditory perception in the main group (Group I) was markedly greater than in the control group. The mean increase on the Basic Hearing Scale (BHS) was +3.1 points in Group I compared to +1.9 points in Group II. Notably, the majority of children in the main group demonstrated significant gains as early as after 6 months, whereas improvements in the control group were slower and less consistent. These findings indicate that supplementing the rehabilitation program with auditory training and regular adjustment of digital hearing aids considerably enhances the effect of basic therapy.

Speech development, as measured by the Speech Response Rating (SRR), also showed stronger progress in the main group. The SRR decreased by 0.5 points, reflecting improvements in phonemic awareness, vocabulary growth, and the formation of elementary connected speech. In the control group, the decrease was only 0.2 points, underscoring the limited effect of rehabilitation without systematic speech therapy. These results highlight the necessity of regular, rather than episodic, speech therapy sessions for children with moderate SNHL.

In the social domain, children in the main group also demonstrated a clear advantage. The Social Adaptation Scale (SocD) improved by +3.0 points compared to only +1.2 points in the control group. This reflects increased confidence, improved communication with peers and educators, and reduced anxiety and emotional instability. The involvement of a child psychologist and consistent parental counseling in the main group played a crucial role in achieving these outcomes.

Across all three domains—hearing, speech, and social behavior—the differences between groups at the final stage (T2, 12 months) were statistically significant ($p < 0.05$, Student's *t*-test), confirming the effectiveness of the comprehensive rehabilitation program. Statistical reliability was demonstrated both in absolute values and in rates of improvement.

Thus, the comparative analysis demonstrates the clear superiority of a multidisciplinary approach to auditory-verbal rehabilitation in children with moderate sensorineural hearing loss. Only through a combined intervention—including technical (hearing aids), speech therapy, auditory training, and psycho-emotional support—can high rehabilitation outcomes be achieved within a relatively short time frame.

Across all parameters—hearing, speech, and social adaptation—the main group demonstrated a more pronounced positive dynamic compared to the control group. Statistical analysis (Student's *t*-test) confirmed significant differences

between the groups in all three domains ($p < 0.05$). These findings indicate the effectiveness of the applied comprehensive rehabilitation program, which was based on an individualized approach, multimodal interventions, and interdisciplinary collaboration.

5. Discussion

The results of this study confirm the high effectiveness of comprehensive auditory-verbal rehabilitation in children with moderate sensorineural hearing loss. Children in the main group demonstrated significant improvements in auditory, speech, and social skills compared to those in the control group who received standard therapy. These findings are consistent with the results of similar studies that emphasize the advantages of a multidisciplinary approach [1] [4] [5].

The most distinct difference was observed in auditory perception dynamics: over 12 months, the Basic Hearing Scale (BHS) in the main group increased by an average of 3.1 points, whereas in the control group the improvement was only 1.9 points. This highlights the importance of individualized hearing aid adjustment and regular auditory training aimed at developing auditory perception and phonemic awareness [2] [6].

Speech development also showed statistically significant improvement in the main group. A reduction of the Speech Response Rating (SRR) by 0.5 points during the year reflects the formation of more stable speech skills, vocabulary expansion, and the ability to construct connected speech. In the control group, changes were minimal, likely due to the insufficient intensity of speech therapy sessions.

Particular attention should be given to the social adaptation parameter (SocD), which improved by +3.0 points in the main group, as clearly demonstrated by the diagrams. Enhancements in this area can be attributed to the involvement of a child psychologist in the rehabilitation program and parental training in interaction strategies with hearing-impaired children. Social inclusion, emotional intelligence, and communication skills proved to be highly responsive to psycho-emotional support, which is consistent with findings from other studies in this field [3][7].

Thus, the results of this study not only confirm the relevance of implementing a comprehensive rehabilitation model, but also emphasize the necessity of adapting it to the individual characteristics of each child. Such an approach makes it possible not only to compensate for hearing deficits but also to prevent secondary complications related to emotional well-being, learning ability, and social integration.

Table 2. Speech development (SRR) and social adaptation (SocD) scores in children of the main and control groups

Groups	SRR at baseline (T0)	SRR at 12 months (T2)	Δ SRR (T2 – T0)	SocD at baseline (T0)	SocD at 12 months (T2)	Δ SocD (T2 – T0)
1-group	2.6	2.1	-0.5	10.8	13.8	+3.0
2-group	2.4	2.2	-0.2	11.7	12.9	+1.2

6. Conclusions

Based on the clinical study conducted, the following conclusions can be drawn:

Comprehensive auditory-verbal rehabilitation with an individualized approach—including modern digital hearing aids, regular speech therapy sessions, auditory training, and psychosocial support—proved to be more effective than the standard scheme of care for children with moderate sensorineural hearing loss.

Children in the main group demonstrated significant improvement in auditory perception (+3.1 points), speech development (SRR reduction by -0.5 points), and social adaptation (+3.0 points), whereas progress in the control group was significantly lower.

The introduction of multimodal rehabilitation methods into pediatric otorhinolaryngology and speech therapy practice substantially improves the quality of life of children with hearing loss, supports their successful social integration, and fosters the development of a well-rounded personality.

The results highlight the necessity of early initiation of rehabilitation (preferably before the age of 4), interdisciplinary collaboration among specialists, and active parental involvement in the restoration of auditory-verbal functions.

The presented program can be recommended for broad implementation in audiology and speech therapy centers, and also as a model for adaptation in public healthcare institutions engaged in the rehabilitation of children with hearing impairments.

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