

# Strengthening Rehabilitation for Children with Moderate Sensorineural Hearing Impairment

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**Abstract** This article examines modern approaches to strengthening auditory-verbal rehabilitation in children with moderate sensorineural hearing impairment. A clinical study conducted at the Tashkent Medical Academy demonstrated the high effectiveness of an individualized program that included digital hearing aids, regular speech therapy sessions, auditory training, and psychosocial support. Children who received comprehensive rehabilitation showed significantly better outcomes in auditory perception, speech development, and social adaptation compared to the control group.

**Keywords** Sensorineural hearing impairment, Auditory-verbal rehabilitation, Children, Hearing aids, Speech therapy, Auditory training, Social adaptation

## 1. Introduction

Sensorineural hearing impairment (SNHI) represents a persistent deficit of auditory function caused by damage to the inner ear structures, the auditory nerve, or central auditory pathways. In children, this pathology has particular significance, as hearing plays a decisive role in the development of speech, cognitive processes, and successful social adaptation [1]. According to the World Health Organization, more than 34 million children worldwide live with hearing loss, and over 60% of these cases could be prevented or effectively managed through timely interventions [2].

A growing concern is the rising number of cases of SNHI identified in early childhood, often linked to adverse environmental conditions, perinatal complications, intrauterine infections, hereditary factors, and insufficient prenatal diagnostics in certain regions [3]. Among all types of hearing loss, moderate sensorineural impairment (41–55 dB) is especially insidious, as it may remain unnoticed for a long time, particularly in children who have not yet developed active speech. The absence of timely detection and correction leads to secondary delays in speech and intellectual development, reduced learning ability, and, later in life, social and professional limitations [4].

In this context, strengthening rehabilitation strategies has become one of the most urgent tasks in pediatric otorhinolaryngology, speech therapy, and special education. While approved clinical protocols exist, their effectiveness often remains limited due to late diagnosis and a lack of systematic approaches that consider age-related, neurological,

and psycho-emotional characteristics of children [5] [6].

Contemporary research highlights that the most successful outcomes can be achieved through multidisciplinary collaboration between otorhinolaryngologists, audiologists, speech therapists, neurologists, and child psychologists. Such integrated rehabilitation not only restores sound perception but also ensures the acquisition of speech, socialization, and quality of life [7]. Strengthening and expanding these approaches today represents an essential direction in both clinical practice and scientific research.

## 2. Materials and Methods

The study was conducted at the Department of Otorhinolaryngology of the Tashkent Medical Academy between 2022 and 2024. A total of 80 children aged 3–7 years with a confirmed diagnosis of moderate sensorineural hearing impairment (Grade II, 41–55 dB) were enrolled. The participants were divided into two equal groups of 40 children each: the main group (Group I) and the control group (Group II). Allocation was performed taking into account age, sex, severity of impairment, and the presence of comorbid somatic conditions.

The main group received a strengthened rehabilitation program, which included:

- individualized fitting and adjustment of modern digital hearing aids;
- regular speech therapy sessions with a speech-language pathologist (at least three times per week);
- auditory training based on specialized acoustic stimulation protocols;

psycho-emotional support, involving both a child psychologist and parental counseling;

continuous medical supervision (pediatrician, neurologist, otorhinolaryngologist).

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

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

Audiological diagnostics: pure-tone threshold audiometry and measurement of auditory thresholds before and after intervention;

Speech assessment: evaluation of phonemic hearing, active and passive vocabulary, and connected speech;

Cognitive and social adaptation: assessment of memory, attention, and group adaptation using the Social Behavior Scale (SocD);

Parental perception: structured questionnaire assessing satisfaction with rehabilitation outcomes;

Dynamic monitoring: three checkpoints—baseline (T0), after 6 months (T1), and after 12 months (T2).

All data were recorded in individual observation charts. Results were analyzed using descriptive statistics, and intergroup comparisons were carried out with Student's t-test. Statistical significance was set at  $p < 0.05$ .

Thus, the study design allowed for evaluation not only of objective measures of hearing and speech, but also of social integration dynamics and parental feedback, providing a comprehensive picture of rehabilitation effectiveness.

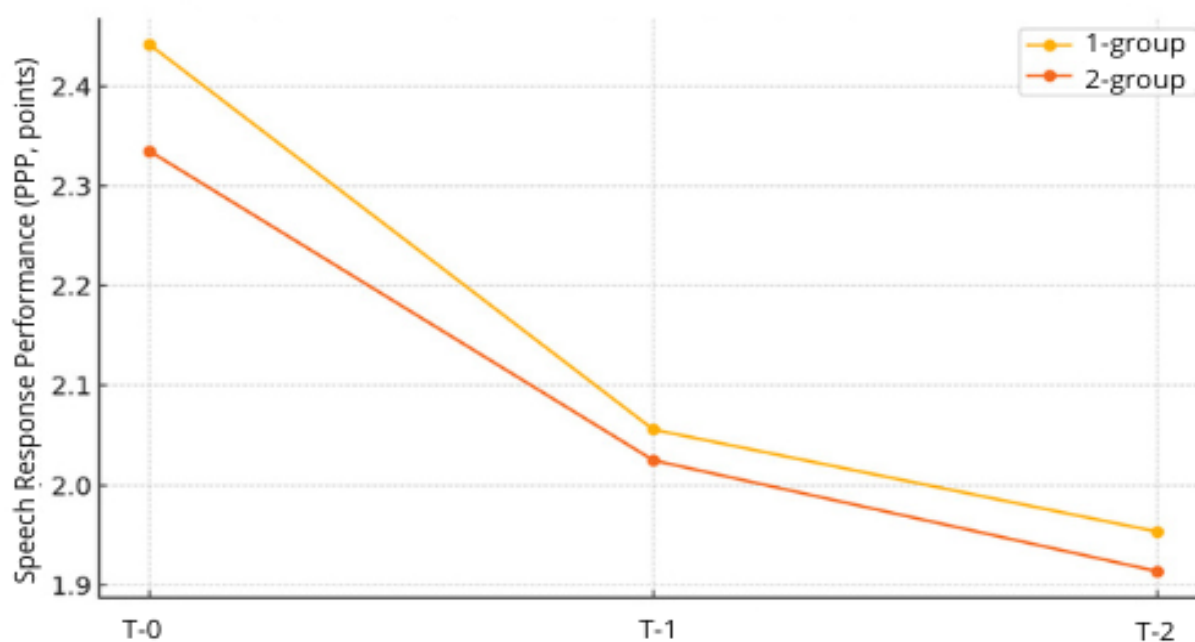
### 3. Results

Children in the main group demonstrated significant progress. The mean auditory threshold improved from 50.2 dB to 37.1 dB ( $p < 0.01$ ), the active vocabulary increased 1.5-fold, and notable improvements were observed in pronunciation and grammatical structure of speech. In the control group, changes were less pronounced and statistically insignificant. Social adaptation improved in 87% of children in the main group compared to 58% in the control group. Parental satisfaction with rehabilitation outcomes was also higher in the main group (91% vs. 63%).

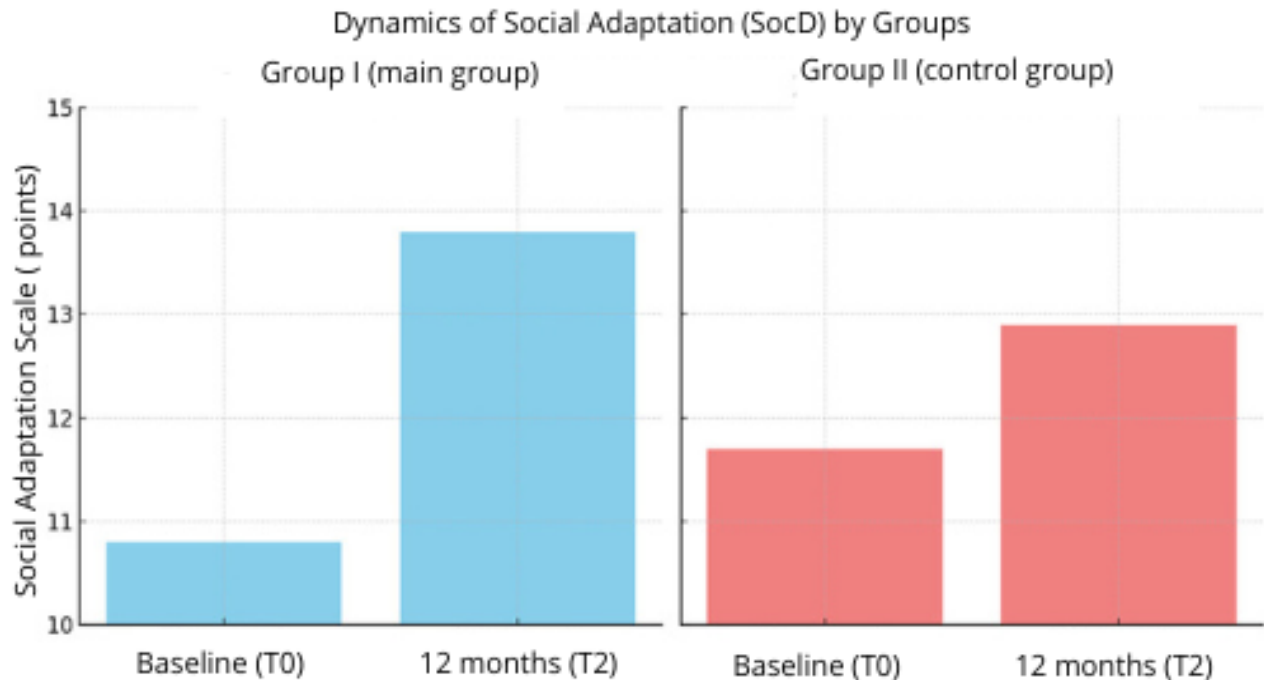
After 12 months of observation, children with moderate SNHI (Grade II) in the two comparative groups showed distinct differences. The main group, which received the strengthened and individualized rehabilitation program, demonstrated marked positive dynamics across all key parameters—auditory perception, speech development, and social adaptation—while the control group showed only limited improvements.

The Basic Hearing Scale (BHS), which reflects perception of speech and background sounds, confirmed these findings. In the main group (Group I), the mean score increased from 15.9 at baseline (T0) to 17.5 after 6 months (T1) and 19.0 after 12 months (T2), corresponding to a gain of +3.1 points. In contrast, the control group (Group II) demonstrated only a modest improvement, from 14.9 at baseline to 15.7 at 6 months and 16.8 at 12 months, yielding an overall gain of just +1.9 points. The difference between the groups at the final stage was statistically significant ( $p < 0.05$ ).

## Speech Response Dynamics (SRD)



**Figure 1.** Dynamics of auditory perception (BHS) across three observation stages: baseline, after 6 months (T1), and after 12 months (T2)



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

The curve for the main group shows a steady and consistent increase, from 15.9 at baseline to 19.0 at the final stage. This reflects systematic improvement of auditory functions in children undergoing the strengthened, comprehensive rehabilitation program. In contrast, the control group line remains flatter, with only modest gains from 14.9 to 16.8. The difference in slope between the two curves clearly illustrates the effect of modern hearing aids, intensive speech therapy, and structured auditory training applied in the main group. Moreover, the gap between the groups becomes visible as early as after 6 months, underlining the importance of early intervention and consistency in rehabilitation. The diagram thus visually confirms the results of statistical analysis and highlights the advantages of an individualized and multimodal rehabilitation model.

## 2. Speech Response Rating (SRR)

The average values of speech development in the main group were as follows:

- baseline: 2.6,
- after 6 months: 2.2,
- after 12 months: 2.1.

The reduction of  $-0.5$  points indicates fewer difficulties in speech perception and production (lower scores reflect better outcomes), highlighting clear progress in phonemic awareness, vocabulary expansion, and grammatical structuring.

In the control group, SRR decreased only from 2.4 to 2.2 ( $-0.2$  points), a change that was not statistically significant. This confirms the necessity of systematic speech therapy and auditory correction rather than episodic interventions.

## 3. Social Adaptation (SocD)

The Social Adaptation Scale assessed group behavior,

interaction with peers and adults, emotional responsiveness, and the ability to express needs. Children in the main group demonstrated marked improvement:

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

In the main group, a marked improvement of +3.0 points was observed, reflecting the high effectiveness of the strengthened rehabilitation program, which included psychological support and systematic parental involvement. In contrast, the control group showed only a modest increase from 11.7 to 12.9 (+1.2 points), indicating the limited potential of the standard rehabilitation model in addressing psychosocial adaptation.

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 evident by the end of the 12-month intervention period, underscoring the importance of strengthening rehabilitation strategies through a multidisciplinary and individualized approach.

The improvement in auditory perception in the main group significantly outpaced that of the control group. The mean gain was +3.1 points in Group I versus +1.9 points in Group II. Moreover, progress in the main group was already evident after 6 months, while in the control group improvements were slower and less consistent. This indicates that supplementing standard rehabilitation with auditory training and regular hearing aid adjustments considerably strengthens the effect of basic therapy.

The Speech Response Rating (SRR) in the main group decreased by 0.5 points, reflecting improvements in phonemic

perception, vocabulary expansion, and the development of elementary connected speech. In the control group, the reduction was only 0.2 points, highlighting weak dynamics in the absence of systematic speech therapy. These findings emphasize the necessity of regular rather than episodic speech interventions for children with moderate SNHI. In the social domain, the main group also showed a clear advantage. The Social Adaptation Scale (SocD) improved by +3.0 points, compared with +1.2 points in the control group. This reflects greater confidence, improved peer and teacher interactions, reduced anxiety, and emotional stabilization. The involvement of a psychologist and consistent parental engagement—implemented only in the strengthened program—played a crucial role in these outcomes. Across all three domains—hearing, speech, and social adaptation—the differences between groups at the 12-month endpoint were statistically significant ( $p < 0.05$ , Student's  $t$ -test). Statistical reliability was demonstrated both in absolute values and in improvement rates.

Thus, comparative analysis demonstrates the clear superiority of a multidisciplinary, strengthened approach to auditory and speech rehabilitation in children with moderate sensorineural hearing impairment. Only a comprehensive intervention—technical (hearing aids), speech therapy, auditory training, and psycho-emotional support—ensures rapid and meaningful progress within a relatively short period.

Across all parameters—**hearing, speech, and social adaptation**—the main group demonstrated a more pronounced positive dynamic. Statistical analysis (Student's  $t$ -test) revealed significant differences between the groups in all three domains ( $p < 0.05$ ). These findings confirm the effectiveness of the strengthened comprehensive rehabilitation program, which was based on an individualized approach, multimodal techniques, and interdisciplinary collaboration among specialists.

## 4. Discussion

The results of this study confirm the high effectiveness of a strengthened comprehensive auditory-verbal rehabilitation program for children with moderate sensorineural hearing impairment. 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 reports from other studies emphasizing the advantages of a multidisciplinary approach [1,4,5].

The most notable difference was observed in auditory perception: over the 12-month period, the Basic Hearing Scale (BHS) increased by an average of +3.1 points in the main group, compared to only +1.9 points in the control group. This highlights the importance of individualized hearing aid fitting and regular auditory training aimed at enhancing auditory perception and phonemic awareness [2,6].

Speech development also showed statistically significant improvement in the main group. The 0.5-point reduction in SRR over one year reflects more stable speech skills, expansion of vocabulary, and the ability to produce connected speech. In contrast, the changes in the control group were minimal, likely due to the limited intensity of speech therapy sessions.

Particular attention should be paid to social adaptation (SocD), which improved by +3.0 points in the main group, as confirmed by graphical analysis. These gains can be attributed to the involvement of a child psychologist in the rehabilitation process, as well as systematic training of parents in communication strategies with hearing-impaired children. Social inclusion, emotional intelligence, and communication skills proved to be highly responsive to psycho-emotional support, a trend also supported by other research in this field [3,7].

Overall, the findings not only confirm the relevance of implementing a strengthened, multimodal rehabilitation model, but also emphasize the need for its adaptation to the individual characteristics of each child. Such an approach enables not only compensation for auditory deficits but also the prevention of secondary complications related to emotional development, learning potential, and social integration.

## 5. Conclusions

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

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

**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               |

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

| Groups  | SRR Baseline (T0) | SRR 12 months (T2) | $\Delta$ SRR (T2–T0) | SocD Baseline (T0) | SocD 12 months (T2) | $\Delta$ 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                  |

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 methods into pediatric otorhinolaryngology and speech therapy practice substantially improves the quality of life of children with hearing loss, supports successful social integration, and contributes to the formation of a well-rounded personality.

The findings underscore the importance of early initiation of rehabilitation (preferably before the age of 4), interdisciplinary collaboration among specialists, and active parental involvement in restoring auditory-verbal functions.

The strengthened rehabilitation program presented in this study may be recommended for broad implementation in audiology and speech therapy centers, as well as for adaptation within public healthcare institutions engaged in the rehabilitation of children with hearing impairments.

## Conflict of Interest

The authors declare that the subject, content, and direction of the research presented in this article do not conflict with any competing or personal interests.

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## Data and Material Transparency

All clinical, audiological, and statistical data collected and analyzed within the framework of this study are fully presented in the article. No supplementary materials are required.

## Authors' Contribution

All authors actively contributed to the development of the research concept, formulation of methodology, analysis of results, and preparation of conclusions. Each section of the article was jointly discussed, revised, and approved by all co-authors.

## Ethical Standards and Informed Consent

This study did not involve experiments on animals. All

participants were fully informed about the procedures, and written informed consent was obtained. The research was conducted in strict accordance with established ethical standards and clinical research norms.

## Consent for Publication

The article does not contain photographs or personal data that could identify study participants; therefore, separate consent for publication was not required.

## Publisher's Note

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