

Observational Clinical Studies

From Neonatal Hearing Screening to Rehabilitation: A Descriptive Mixed-Methods Study on Continuity of Care Pathways in Romania

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Abstract: Congenital hearing loss is one of the most common sensory disorders diagnosed in newborns and may adversely affect language development and communication when diagnosis and intervention are delayed. Although neonatal hearing screening has progressively expanded in Romania, the integration of screening, post-screening follow-up, and rehabilitation services remains a challenge. This study aimed to evaluate the continuity of care pathways associated with neonatal hearing screening in Bacău County, Romania. A descriptive mixed-methods observational study was conducted using data collected between 2021 and 2024 within the National Program for Women's and Children's Health. The quantitative component included a longitudinal analysis of administrative indicators related to neonatal hearing screening coverage. The questionnaire-based component included 54 healthcare professionals involved in program implementation and evaluated aspects related to post-screening follow-up, interservice communication, monitoring activities, and coordination of care. The neonatal hearing screening program remained operational throughout the study period, with coverage rates ranging from 45.03% to 74.61%. Questionnaire findings identified difficulties related to post-discharge follow-up, communication between healthcare services, implementation of standardized procedures, and monitoring activities. Although neonatal hearing screening activities were maintained during the analyzed period, limitations persist regarding continuity of follow-up and coordination between audiological evaluation and rehabilitation services.

Keywords: neonatal hearing screening; congenital hearing loss; follow-up; early intervention; auditory rehabilitation; continuity of care; mixed-methods study; newborn health; rehabilitation medicine; Romania

1. Introduction

Congenital hearing loss is one of the most common sensory disorders identified in newborns and may affect language development and communication when diagnosis and intervention are delayed. The introduction of neonatal hearing screening programs is considered an important public health intervention for preventing delayed diagnosis and delayed access to intervention [1]. The first months of life represent a critical period for auditory and language development, and lack of auditory stimulation during this stage may negatively affect language and communication outcomes [2]. International recommendations for Early Hearing Detection and Intervention (EHDI) programs support screening within the first month of life, confirmation of diagnosis by 3 months of age, and initiation of intervention before 6 months of age in order to reduce the impact

on language and communication development [3]. The development of universal population-based screening programs has significantly reduced the age at diagnosis of congenital hearing loss [4].

Early diagnosis and intervention are associated with better receptive and expressive language development, educational performance, and social participation. Early intervention, including the use of hearing aids or cochlear implants and family support, may reduce the impact of hearing impairment on child development [5,6].

However, the effectiveness of a screening program depends not only on the number of newborns screened, but also on continuity of follow-up after identification of a positive result. One of the main problems reported internationally is the lack of integration between the screening stage, diagnostic confirmation, and audiological evaluation and intervention services. In many cases, children identified as being at risk of hearing impairment do not undergo complete audiological evaluation or are diagnosed late, reducing the benefits of early detection [3,7].

Another important issue is “loss to follow-up,” frequently encountered after discharge from maternity services. This may result from administrative difficulties, lack of efficient monitoring systems, limited access to specialized services, or insufficient communication between levels of care. These difficulties are more commonly reported in settings where monitoring systems and access to specialized services are limited [8]. Data from neonatal screening programs have shown that a significant proportion of children with a positive screening result do not complete the recommended audiological evaluation [9].

In Romania, the literature regarding the evaluation of neonatal hearing screening programs remains limited, particularly at the regional and operational levels. Most available data originate from aggregated national reports and provide limited information regarding continuity of follow-up and integration of services after the screening stage. At the same time, few studies have analyzed how these interventions are implemented locally and the difficulties encountered in routine practice. In addition, studies using mixed-methods approaches to evaluate the integration between screening and post-screening follow-up are scarce. Internationally, the expansion of neonatal hearing screening programs has become a public health priority in the context of the growing number of people affected by disabling hearing loss [10].

In this context, the present study aimed to analyze continuity of follow-up after the screening stage and to identify difficulties reported by professionals that may influence access to specialized services for children at risk of hearing impairment.

2. Materials and Methods

2.1. Study Design

An observational, longitudinal study with a descriptive mixed-methods approach was conducted using quantitative administrative data and qualitative data obtained through a structured questionnaire administered to professionals involved in program implementation. The mixed-methods approach was used to evaluate the integration between neonatal hearing screening, post-screening follow-up, and early intervention at local level.

2.2. Study Setting

The study was conducted in Bacău County, Romania, and analyzed the implementation of neonatal hearing screening within the National Program for Women’s and Children’s Health between 2021 and 2024. Screening activities performed in healthcare units with maternity services were evaluated, together with aspects related to post-screening monitoring and coordination of services involved in follow-up care.

2.3. Quantitative Component

The quantitative component included a longitudinal descriptive analysis of administrative indicators reported annually at county level. The analyzed variables included

the number of eligible newborns, the number of screened newborns, and neonatal hearing screening coverage rates.

The analysis focused on annual variations in implementation indicators and on the operational continuity of screening activities throughout the study period.

2.4. Questionnaire-Based Component

The questionnaire-based component evaluated the perceptions of professionals involved in the implementation of the National Program for Women's and Children's Health regarding organization, monitoring, and evaluation of interventions included in the program, with emphasis on neonatal hearing screening.

A structured questionnaire containing closed-ended and open-ended items was administered to healthcare professionals, personnel involved in data reporting and monitoring, and local program coordinators. Fifty-four professionals from institutions involved in program implementation in Bacău County participated in the survey, including healthcare units with obstetrics and neonatology services, the Public Health Directorate, and family medicine practices. Respondents included physicians, nurses, and personnel involved in program coordination, reporting, and monitoring activities.

The questionnaire included items related to procedure implementation, post-screening follow-up, communication between services, and coordination of evaluation and monitoring activities. The questionnaire was developed specifically for this study based on the operational objectives of the national screening program and included both closed-ended and open-ended items. Closed-ended items evaluated perceptions regarding implementation, monitoring activities, and continuity of care pathways, while open-ended items allowed respondents to describe operational difficulties and perceived barriers in routine practice. The instrument was administered to healthcare professionals directly involved in program implementation, including physicians, nurses, local coordinators, and personnel responsible for reporting and monitoring activities. Before administration, the questionnaire was reviewed by professionals involved in the implementation of the National Program for Women's and Children's Health in order to assess the clarity, relevance, and comprehensibility of the items. Feedback obtained during this review process was used to refine the wording of several questions. Because the instrument was designed for descriptive and exploratory purposes, no formal psychometric validation was performed. Open-ended responses were analyzed thematically by grouping the main operational difficulties reported by participants. Statistical analysis had a descriptive and exploratory character, and no inferential statistical analysis was performed.

2.5. Data Analysis

Quantitative data were analyzed descriptively by evaluating the annual evolution of neonatal hearing screening indicators, including the number of eligible newborns, the number of screened newborns, and screening coverage rates.

Qualitative data obtained through the questionnaire were synthesized thematically in order to identify the main difficulties reported by professionals regarding case monitoring, communication between services, implementation of procedures, and use of information systems.

No inferential statistical analysis was performed.

2.6. Ethical Considerations

The study used aggregated administrative data and questionnaire-based information without direct patient identification. Data confidentiality and respondent anonymity were maintained throughout the study process. Participation in the questionnaire survey was voluntary, and the collected data were used exclusively for scientific purposes.

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Research Ethics Committee of the "Grigore T. Popa"

University of Medicine and Pharmacy, Iași, Romania (Registration No. 255/17 January 2023).

3. Results

3.1. Quantitative Component

Between 2021 and 2024, the neonatal hearing screening program implemented in Bacău County showed interannual variations in coverage indicators and screening activity volume. Screening activities were maintained throughout the analyzed period, although coverage levels varied across the evaluated years.

Table 1. Main indicators of neonatal hearing screening in Bacău County (2021–2024).

Year	Eligible newborns	Screened newborns	Coverage rate (%)
2021	5,259	2,368	45.03
2022	4,856	2,614	53.83
2023	4,466	2,216	49.62
2024	4,148	3,095	74.61

Source: administrative reports of healthcare units from Bacău County, National Program for Women's and Children's Health, 2021–2024.

As shown in Table 1, neonatal hearing screening coverage remained below complete population coverage throughout the analyzed period, despite the increase observed in 2024. Variability in screening coverage was observed between the analyzed years

Only descriptive statistical analysis was performed. No inferential statistical analysis was conducted.

Figure 1 illustrates the annual variation in neonatal hearing screening coverage between 2021 and 2024.

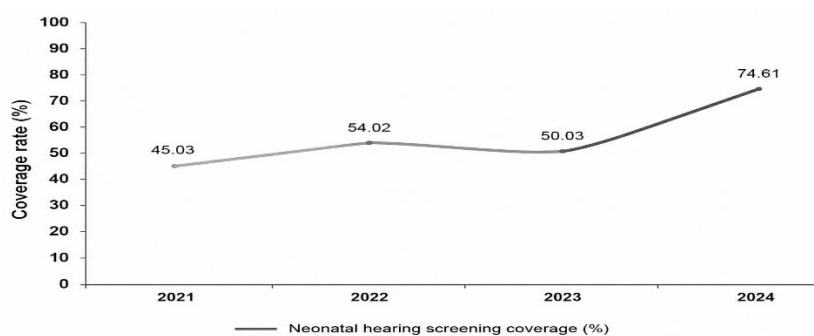


Figure 1. Annual variation in neonatal hearing screening coverage in Bacău County (2021–2024).

Between 2021 and 2023, fluctuations in screening coverage were observed, without a constant upward trend. The highest coverage value was recorded in 2024.

3.2. Continuity of Care Pathway and Implications for Early Intervention

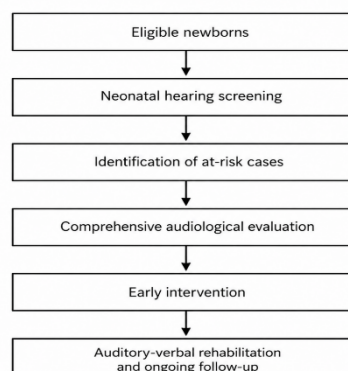


Figure 2. Schematic representation of the neonatal hearing screening and follow-up care pathway.

Figure 2 illustrates the main stages of the neonatal hearing screening care pathway and the subsequent monitoring process.

The available administrative data did not allow direct assessment of continuity of follow-up after identification of newborns at risk of hearing impairment. However, questionnaire findings highlighted difficulties related to post-discharge monitoring, communication between services, and coordination of subsequent audiological evaluation and early intervention stages.

3.3. Questionnaire-Based Component

Analysis of questionnaire responses revealed a generally favorable perception regarding the relevance of the National Program for Women's and Children's Health and the role of neonatal hearing screening in routine clinical practice.

However, respondents reported several operational limitations related to post-discharge follow-up, communication between services, implementation of procedures, and use of reporting and monitoring systems.

Table 2. Main difficulties identified in neonatal hearing screening implementation and continuity of care pathways.

Evaluated domain	Difficulties reported by respondents
Case monitoring	Difficulties in post-discharge follow-up
Communication between services	Incomplete transfer of information between levels of care
Procedure implementation	Non-uniform application of protocols and standards
Information systems	Limited use of reporting and monitoring tools
Program evaluation	Limited use of outcome and performance indicators
Continuity of care pathway	Limited integration between screening, diagnosis, and rehabilitation

As shown in Table 2, the most frequently reported difficulties were related to post-discharge monitoring, communication between services, and limited use of information systems for reporting and monitoring.

Descriptive responses obtained through the questionnaire were analyzed thematically by grouping the main operational difficulties reported by respondents.

3.4. Integration of Quantitative and Qualitative Findings

Administrative indicators suggested continuity of neonatal hearing screening activities throughout the analyzed period, while questionnaire responses revealed limitations related to follow-up monitoring, interservice communication, and coordination of subsequent care pathways.

4. Discussion

The findings of this study highlight the existence of an active neonatal hearing screening program at the county level, while also revealing several limitations related to continuity of follow-up after the screening stage. Although screening activities were maintained throughout the analyzed period, variations in coverage rates and the difficulties reported by professionals suggest the presence of coordination and monitoring challenges during the post-screening stages of care.

At the international level, the effectiveness of neonatal hearing screening programs depends on the existence of efficient systems for follow-up, audiological evaluation, and early intervention [1,3]. The literature shows that the benefits of early detection are reduced when children identified as being at risk for hearing loss do not complete audiological evaluation or fail to access specialized services [7]. “Loss to follow-up” remains one of the major challenges reported in neonatal screening programs [3,9].

The findings obtained in the present study suggest the existence of similar difficulties in the evaluated setting. Although the available administrative data did not allow direct assessment of follow-up continuity, the responses provided by professionals highlighted difficulties related to post-discharge follow-up, communication between services, and coordination of subsequent audiological evaluation stages.

The benefits of neonatal hearing screening depend on continuity of evaluation and follow-up after the identification of at-risk cases. International recommendations emphasize the importance of timely diagnosis confirmation and early access to intervention in order to reduce the impact of hearing impairment on language and communication development [3]. Previous studies have shown that early intervention is associated with better language outcomes in children with hearing loss [5,6].

From the perspective of physical and rehabilitation medicine, early identification of hearing impairment is beneficial only when accompanied by rapid access to audiological evaluation and specialized rehabilitation services. Continuity of follow-up after screening may influence children’s access to auditory-verbal rehabilitation interventions and interdisciplinary rehabilitation services [2,3].

The study findings also highlighted limitations related to the use of information systems for reporting and monitoring. Limited use of digital tools and the absence of standardized tracking mechanisms may affect continuity of follow-up and the identification of children lost to follow-up. The literature emphasizes the importance of integrated monitoring systems for tracking children between the screening stage and subsequent audiological evaluation [3,10].

This study also has several limitations. The quantitative analysis was based on aggregated administrative data, without the possibility of individual follow-up of children after screening. In addition, the absence of standardized indicators regarding follow-up limited the direct assessment of continuity of care pathways. The questionnaire-based component reflects the perceptions of professionals involved in the program and may have been influenced by the characteristics of the local context.

Overall, the findings support the need to strengthen follow-up after neonatal hearing screening and to improve coordination between the services involved in the evaluation and care of children at risk for hearing loss.

Clinical Implications for Physical and Rehabilitation Medicine

Early identification of hearing impairment through neonatal hearing screening is beneficial only when continuous follow-up and access to audiological evaluation and rehabilitation services are available. The findings of this study highlight the importance of coordination between screening, post-screening follow-up, and specialized services involved in the care of children at risk for hearing loss.

From the perspective of pediatric physical and rehabilitation medicine, continuity of care after the screening stage may facilitate early access to auditory-verbal rehabilitation interventions and interdisciplinary rehabilitation services. Improving monitoring systems and communication between the involved services may reduce delays in evaluation and intervention for children with hearing impairment.

Strengths and Limitations of the Study

One of the strengths of this study is the use of a mixed-methods approach, which allowed the integration of administrative data regarding neonatal hearing screening implementation with the perceptions of professionals involved in the program. The study provides regional data regarding the implementation of neonatal hearing screening in real-world practice and highlights issues related to follow-up, service coordination, and continuity of care after screening.

The study also has limitations. The quantitative analysis relied on aggregated administrative data, without the possibility of individual follow-up of children after screening. In addition, standardized data regarding continuity of follow-up or subsequent access to audiological evaluation and rehabilitation services were not available. Another limitation is that the study was conducted in a single county, which may limit the generalizability of the findings.

5. Conclusions

This study provides a descriptive evaluation of neonatal hearing screening implementation and continuity of care pathways within a local public health setting between 2021 and 2024. The findings indicate that neonatal hearing screening activities were maintained throughout the study period, although variations in screening coverage were observed across years.

Analysis of administrative indicators and healthcare professionals' perspectives identified several operational challenges related to post-screening follow-up, communication between healthcare services, monitoring activities, and coordination of subsequent stages of care. These findings were derived from program-level administrative data and professional reports and do not represent direct measurements of patient-level follow-up outcomes.

Although the available data did not allow assessment of individual patient trajectories after screening, the reported difficulties suggest potential barriers affecting continuity of care between screening, audiological evaluation, and rehabilitation services. Strengthening monitoring mechanisms, improving information exchange between providers, and supporting more integrated care pathways may contribute to improving continuity of follow-up for children identified as being at risk of hearing impairment. The study also highlights the value of combining administrative program indicators with healthcare professionals' perspectives to obtain a broader understanding of implementation processes and operational challenges. Future research based on patient-level follow-up data and standardized continuity-of-care indicators would provide a more comprehensive assessment of neonatal hearing screening pathways and their integration with rehabilitation services.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the questionnaire-based component of the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request. The data are not publicly available due to institutional and confidentiality restrictions.

Conflicts of Interest: The authors declare no conflict of interest

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