

Research Paper

Loss to Follow-up After Newborn Hearing Screening and Its Related Factors



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ABSTRACT

Background: Hearing loss is one of the most common birth defects and early detection of this disorder at birth is not possible without hearing screening. The aim of this study was to determine the frequency of loss to follow-up after neonatal hearing screening and its related factors in Khorramabad, Iran.

Methods: This retrospective correlational study was conducted from March 2018 to February 2021. The medical records of 13,710 infants born in this period were assessed. All the infants suspected of hearing loss in the first screening of one or both ears (n=310) were followed up for the second screening. The demographic and medical information of the infants and their parents was collected by a valid researcher-made checklist. The initial and follow-up data were extracted from the infants' electronic records available at Assalian Hospital and the information available at the Dabbagh Clinic, respectively. To analyze the data, frequency distribution was determined and the relationships between the variables were assessed by the Chi-square test using SPSS software v. 16. The significance level was set at $\alpha=0.05$.

Results: Out of 13,710 neonates, 310 cases (2.26%) did not pass the first hearing screening. Of this group, 60 infants (20%) missed the second screening follow-up. Among the studied variables, a number of socio-economic variables and neonatal factors were associated with not following hearing loss screening ($P<0.05$). Among the mothers' personal causes of loss to follow-up, the feeling of no need to follow up with 36.7% and fear of COVID-19 with 26.7% were the most common causes.

Conclusion: About one-fifth of infant hearing screening follow-ups were not performed, which makes education about hearing screening follow-ups necessary for families. Providing a suitable context to facilitate preventing developmental problems in children and save future medical expenses is necessary and this program is needed to be on the agenda of the Ministry of Health and clinics providing mother and child health services.

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Highlights

- Lack of early detection of deafness and hearing loss in infants can jeopardize the development of their language, speech, and communication skills.
- The newborn hearing screening test helps in the early detection of infants who have permanent hearing loss.
- In this study, 20% of the newborns with hearing loss missed the second follow-up screening.
- A number of socio-economic variables and neonatal factors were associated with not following hearing loss screening.

Plain Language Summary

Hearing loss is one of the most common birth defects and early detection of this disorder at birth is not possible without hearing screening. Lack of early detection of deafness and hearing loss in infants can jeopardize the development of their language, speech, and communication skills. In this study, 20% of the newborns with hearing loss missed the second follow-up screening and a number of socio-economic variables and neonatal factors were associated with not following hearing loss screening. Providing further counseling in the villages and offering insurance services and paying attention to other related factors can increase the follow-up of newborn hearing screening. Active follow-up by neonatal nurses is also recommended.

1. Introduction

Hearing loss is one of the most common developmental disorders. According to the latest World Health Organization (WHO) estimates on hearing, by 2050 nearly 2.5 billion people will be living with some degree of hearing loss and at least 700 million of them will require rehabilitation services. Currently, this number is 430 million, which includes people with moderate or higher grades of hearing loss who are most likely to benefit from hearing rehabilitation services. The vast majority of these people live in low- and middle-income countries, where access to ear and hearing care (EHC) is often limited (Organization, 2021). Unaddressed permanent hearing loss, especially when congenital or acquired early in life, significantly impairs a child's development (WHO, 2021). Neumann et al. conducted a survey in 158 countries. The results indicated that less than one-third of the world's newborns and infants were enrolled in universal newborn and infant hearing screening (NIHS) programs covering at least 85% of all babies in a region or country, despite evidence of the effectiveness of this strategy for optimal rehabilitation of deaf and hearing-impaired children (Neumann et al., 2022).

Hearing loss screening programs accelerate the early detection and intervention of hearing loss. In many developed countries, universal public neonatal hearing screening programs are currently well implemented and usually follow a two-stage screening pattern (Qirjazi,

Toçi & Roshi 2019; Greczka et al., 2018; Martínez-Cruz, Ramírez-Vargas, & Themann, 2020). These include otoacoustic emission (OAE) measurements to assess inner ear function, Automated Auditory Brainstem Response (AABR) recordings to evaluate auditory pathway function up to the brainstem, and two-stage OAE-AABR procedures, i.e., AABR recorded only when OAE fails. These methods have high validity (Neumann et al., 2022). These two consecutive electrophysiological assessments prevent speech and language development delays due to early intervention and have long-term beneficial effects on emotional and social development and quality of life (QoL).

The obligation to perform a hearing screening program has had significant results, but still, a significant number of newborns who fail the first stage of hearing screening are never reevaluated.

The results of non-follow-up hearing screening in other countries have shown a prevalence of 12 % to 34% for this problem (Cunningham et al., 2018; Weber et al., 2018; Kanji and Khoza-Shangase, 2018). No study has been conducted in Iran to evaluate this problem. Consequently, this study was conducted to determine the frequency of loss to follow-up of neonatal hearing screening and its related factors in Khorramabad, Iran.

2. Materials and Methods

This retrospective correlational study was conducted from March 2018 to February 2021. The medical records of 13,710 infants born in this period in Khorramabad Province, Iran were assessed. All the infants suspected of hearing loss in the first screening of one or both ears ($n=310$) were followed up for the second screening. The demographic and medical information of the infants and mothers was collected by a researcher-made checklist. The checklist was designed based on previous related studies and available textbooks. The content validity of the checklist was verified using the opinions of expert professors. The initial and follow-up data were extracted by two independent researchers from the infants' electronic records available at Assalian Hospital and the information available at the Dabbagh Clinic, respectively.

The needed information, including demographic data of the infants, parents, and hearing screening of newborns from March 2018 to February 2021 had been recorded by a nurse and an audiologist in the electronic records of the infants. The demographic information about the infants who failed the hearing screening at birth, and also maternal characteristics and social and economic factors were extracted from the medical files by the checklist. To complete the information that was not available in the electronic data files, the phone number of the parents was extracted and the needed information was obtained. A total of ten files were excluded due to parental unresponsiveness, file problems, incorrect parents' phone numbers, and the unwillingness of parents to cooperate. In order to obtain accurate information about those who were referred for the second screening, the data related to the screening follow-up in Dabbagh clinic in Khorramabad were evaluated. If infant information was not available at this clinic, we contacted parents again and asked them about follow-up screening to make sure they have not been screened at another audiology clinic or hearing center. A number of parents had been referred to private centers for follow-up and re-screening. But most of the parents had referred to the Dabbagh clinic in Khorramabad, which is a public center. In the absence of information and lack of follow-up screening by the parents (either in this center or in another center), the infant was considered lost to follow-up. Then, the related characteristics were compared between the infants followed up and lost to follow-up.

To analyze the data, the frequency and percentage of the variables were determined and then the relationship between the variables in the follow-up group and the non-follow-up group was determined by the Chi-square test using SPSS software v. 16. The significance level was set at $\alpha=0.05$.

3. Results

Out of 13,710 neonates born between March 2018 and February 2021, 310 infants (2.26%) did not pass the first hearing screening. Of this group, 60 infants (20%) did not follow up the second screening, and access to the information of ten infants was not possible. Table 1 shows the mothers' reasons for not following the hearing screening of the infants, of which, lack of necessity with 36.7% and fear of COVID-19 with 26.7% had the highest frequency. Tables 2, 3, and 4 show some related factors of loss to follow up. As can be seen in these tables, 11 financial, social, and demographic characteristics are related to lose to follow-up.

4. Discussion

According to the findings, among the neonates who did not pass the first hearing screening, 20% did not follow up the second screening. The follow-up rate in the first stage of screening in the Arabian Peninsula was 90% and in the second stage of screening, it was 88.4% (Koletheekkat et al., 2020). According to the results obtained in the present study, the values obtained in both studies are close to each other. In another study in Africa, the follow-up rate of hearing screening was 66.5%, which is lower than in the current study (Kanji and Khoza-Shangase, 2018). In Brazil, the prevalence of 5 to 66% was reported for not following the hearing screening in public hospitals (Cavalcanti et al., 2014).

The non-follow-up screening rate after the first phase of screening in the Universal Newborn Hearing Screening (UNHS) pilot study was 43% in Malaysia and 66% in Pakistan (Mukari, Tan, & Abdullah, 2006) and in the United States, less than 90% of infants who underwent infant hearing screening met the timely screening standard, and approximately 5% did not receive their final screening until more than two months after birth (Deng et al., 2022).

The infant's birth time was significantly associated with loss to follow-up screening. The highest percentage of loss to follow-up was related to 2019. Perhaps one of the most important reasons is the peak of COVID-19 in Iran and also the socio-economic status of people due to this disease. During the peak period of COVID-19, many patients did not dare to go to the hospital due to the special conditions in these centers or the fear of being infected with the virus (Navab and Bahramnezhad, 2019).

Table 1. Frequency of the maternal causes for not to follow-up the hearing screening of the infants

Reasons for Non-Follow-up	No. (%)
Forgetting	7(11.7)
Not having enough time	3(5.0)
No need	22(36.7)
There are more important problems for following	3(5.0)
Fear of hearing bad news about the infant's hearing	1(1.7)
High cost of hearing tests	8(13.3)
Fear of COVID-19	16(26.7)

Client-Centered Nursing Care

The gestational age of the infant was one of the effective factors influencing the loss of screening follow-up so that infants with a gestational age of 28 to 35 weeks were found with a prevalence of 44.1% for loss of screening follow-up. Kanji et al. also observed that the lower gestational age is one of the reasons for the loss of screening follow-up (Kanji & Khoza-Shangase, 2018)

In other cases, such as bilirubin above 12 mg/dL, head and face abnormalities, history of intrauterine infection, male sex of the infant, family history of hearing loss, and problematic hearing screening results, higher rates of loss of screening follow-up were observed. Fathollahzadeh et al. did not find a significant relationship between the results of the first and second stages

of screening with infant sex, type of delivery, Apgar score, birth weight, and family history of hearing loss ($P>0.05$) (Fathollahzadeh, Arab & Akbarzadeh-Baghiban, 2017). Similar to our results, Cunningham et al. in the United States showed that increasing birth rate and the number of children are directly related to loss of screening follow-up, especially in poor immigrant families and racial minorities (Cunningham et al., 2018). Clearly, having more children, especially when in poverty, increases the likelihood of loss of screening follow-up. The greater sensitivity of families to their first children could be another possible reason.

Table 2. Frequency of economic factors influencing follow-up and non-follow-up of hearing screening of rejected neonates in hearing screening

Economic Factors	No. (%)		P	
	Follow-up	Non-Follow-up		
Family monthly income	Insufficient	146(83.4)	29(16.6)	0.121
	Almost sufficient	78(73.6)	28(26.4)	
	Sufficient	16(84.2)	3(15.8)	
Residency place	City	195(85.5)	33(14.5)	0.001
	Village	45(62.5)	27(37.5)	
Distance from medical centers (km)	1	21(77.8)	6(22.2)	0.379
	2	174(82.5)	37(17.5)	
	3	26(72.2)	10(27.8)	
	More than 4	19(73.1)	7(26.9)	
Number of other children	1	153(84.1)	29(15.9)	0.032
	2	76(76.0)	24(24.0)	
	3	11(61.1)	7(38.9)	
Insurance	Supplementary insurance	38(86.4)	6(13.6)	0.001
	Ordinary insurance	200(84.4)	37(15.6)	
	Without insurance	2(10.5)	1(2.9)	

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Table 3. Frequency of social factors influencing follow-up and non-follow-up of auditory screening of rejected infants in birth screening

Social Factors		No. (%)		P
		Follow-up	Non-Follow-up	
Mother education	Secondary	59(73.8)	21(26.3)	0.396
	Diploma	92(81.4)	21(18.6)	
	Bachelor's degree	6(17.1)	8(21.6)	
	Master's degree	8(88.9)	1(11.1)	
Father education	Secondary	34(69.4)	15(30.6)	0.102
	Diploma	82(78.1)	23(21.9)	
	Bachelor's degree	107(86.3)	17(13.7)	
	Master's degree	14(77.8)	4(22.2)	
	PhD and higher	3(75.0)	1(25.0)	
Mother employment status	House wife	213(80.1)	53(19.9)	0.601
	Employed	22(75.9)	100(24.1)	
	Health staff	5(100)	0(0)	
Father employment status	Unemployed	2(100)	0(0)	0.676
	Worker	139(78.1)	39(21.9)	
	Employed	93(81.6)	21(18.4)	
	Health staff	6(100)	0(0)	

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Table 4. Frequency of infant's factors influencing loss to follow-up the hearing screening of rejected infants in birth screening

Demographic Factors		No. (%)		P
		Follow-up	Non-Follow-up	
Infant Birth date	2018	88(86.2)	14(13.7)	0.001
	2019	5(5.0)	94(94.9)	
	2020	58(80.5)	41(41.41)	
Craniofacial anomalies	Yes	1(25.0)	3(75.0)	0.026
	No	239(80.7)	57(19.3)	
Intrauterine infection	Yes	5(41.7)	7(58.3)	0.003
	No	235(81.6)	53(18.4)	
Gestational Age	28-35 weeks	19(55.9)	15(44.1)	0.001
	36-42 weeks	221(83.1)	45(16.9)	
Bilirubin more than 12	Yes	4(22.3)	14(77.8)	0.001
	No	236(83.7)	46(16.2)	
Family history of hearing loss	Yes	0(0)	11(100)	0.001
	No	240(83.0)	49(17.0)	
Mother Age	Less than 20	35(87.5)	5(12.5)	0.384
	20-29	75(78.9)	20(21.1)	
	30-39	111(80.4)	27(19.6)	
	More than 40	19(70.4)	8(29.6)	
Infant weight	Less than 2800	82(74.5)	28(25.5)	0.075
	2800-3200	119(85.6)	20(14.4)	
	More than 3200	39(76.5)	12(23.5)	
Infant gender	Female	183(87.6)	26(12.4)	0.001
	Male	57(62.6)	34(37.4)	
Postnatal hearing screening	Problem	2(5.9)	32(94.1)	0.001
	No problem	238(89.5)	27(10.5)	

Client- Centered Nursing Care

In this study, the infant sex was significantly related to loss of screening follow-up ($P < 0.001$). While 12.4% of female infants were not screened, 37.4% of male infants lost hearing screening follow-up. Cultural factors can make a difference. There are studies on gender discrimination in non-screening. A study in China found that the follow-up rate was lower in girls than in boys, especially in rural areas. The follow-up rates of the first and second stages of screening in urban areas were 73.69% and 46.97% for girls and 75.34% and 48% for boys, respectively. However, in the rural population, the rate of two-stage follow-up was 66.79% and 34.58% for girls and 67.95% and 41.82% for boys, respectively. This could be related to the interest of Chinese people in their male children. The dominance of men is due to the traditional Chinese view of boys' preference for girls, especially in rural areas (Wenjin et al., 2018). This is also true in Iranian culture so that in some areas, boys are preferred over girls. However, the results of this study, contrary to what was expected, showed that boys were followed less than girls. In order to justify this issue, we can point to the limitations of the study in terms of considering a single center and geographical area, which a definite answer can be reached by conducting further studies.

Among the maternal causes of non-follow-up, "no need to follow-up" with 36.7% and "fear of exposure to COVID-19" with 26.7% had the highest frequency and "fear of hearing bad news about infant's hearing condition" (1.7%) had the lowest frequency. In a study by Hrcic et al., 38.1% of infants for whom a controlled hearing test was recommended, were not tested due to their absence (Hrcic et al., 2021). They pointed to parents' level of knowledge about infant hearing screening, hearing impairment and limited treatment opportunities, poor infant health, and forgetting follow-up visits as the parental reasons for lack of follow-up. Also, in a study in India, it was found that the lack of necessity from the parents' view was the main reason for not referring for hearing screening follow-up (Sharma et al., 2018). Issues, such as the lack of proper appointments and distance from the screening site have been among the reasons for not following the screening (Frary, Thomsen, & Gerke, 2020, Vohr, Moore, & Tucker, 2002). However, in the present study, there was no significant relationship between this variable and not following the hearing screening.

This study was conducted only in one of the provinces of Iran. Therefore, due to this issue and the descriptive correlational nature of the study, the generalizability of the findings decreases. Prospective cohort and qualitative studies are recommended to confirm and deepen the findings.

5. Conclusion

This study determined the frequency of loss to follow-up after neonatal hearing screening and its related factors in Khorramabad, Iran. The findings showed a relatively high frequency of non-follow-up after the neonatal hearing screening. There was also a significant relationship between non-follow-up and some variables related to mother and infant. Accordingly, public awareness of the importance of this screening program should be increased, especially in rural areas. Creating a web-based database and government funding could play an active role in promoting neonatal hearing screening. Increasing educational opportunities in this area can also help improve parental behavior. Overall, due to the relatively high frequency of non-follow-up of neonatal hearing screening in this study and its significant relationship with a number of variables related to infants and mothers, the need to pay attention to the important issue of hearing screening and provide a suitable context to facilitate it to prevent developmental problems in children and save future medical expenses is necessary, and this program is needed to be on the agenda of the Ministry of Health and clinics providing mother and child health services.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Research Ethics Review Board of [Iran University of Medical Sciences](#) (Code: IR.IUMS.REC.1399.1153). The needed permissions were obtained from the medical centers' directors. Additional information was obtained from mothers voluntarily.

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Authors' contributions

The authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interests.

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