

# Our newborn hearing screening results

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## ABSTRACT

**OBJECTIVE:** The aim of the study was to evaluate the results of neonatal hearing screening in our hospital with the help of literature and to question and reveal the risk factors to gain healthy individuals and to raise awareness for all health workers and the public who are interested in this subject.

**METHODS:** A total of 16,388 newborn infants were evaluated between October 2009 and January 2018. All newborns were screened with transient evoked otoacoustic emissions (TEOAEs) test. Risk factors were investigated. The test repetition and auditory brainstem response (ABR) measurements were performed on newborns who could not pass the TEOAE test and the newborns in the risky group after 15 days.

**RESULTS:** A total of 116 newborns (0.7%) were suspected to have hearing loss. Twenty-seven newborns (0.16%) were found to be in intensive care unit. Twelve newborns (0.07%) had permanent hearing loss. Then, in order: 9 newborns (0.05%) had received phototherapy and 7 newborns (0.04%) were born to consanguineous marriages. In addition, 3 newborns (0.02%) had a low birth weight and 1 newborn (0.006%) had a history of fever.

**CONCLUSION:** Screening tests should be performed in all newborns for early detection of hearing loss. Even though frequency of hearing loss is higher in newborns with risk factors, the treatment should be started within 6 months, the latest, and newborns should be referred for rehabilitation and training.

*Keywords:* Congenital hearing loss; neonatal hearing screening; newborn.

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The diagnosis of hearing loss in premature babies through hearing screening tests contributes to the possibility of early care. This highlights the value of hearing screening. A higher prevalence of hearing loss is faced by premature children with risk factors. The involvement of causes such as the child remaining in the intensive care unit, undergoing phototherapy, consanguinity between mother and father, lifelong family hearing loss, birth weight of about 1500 g, and the mother having a febrile condition making hearing loss were more prevalent [1–3].

The speech and language skills of infants, as well as their physical, social, and cognitive development, can be more effective with early diagnosis and care and recovery of congenital hearing loss. Neonatal hearing screening should also be disseminated and is of considerable significance for early diagnosis, and hearing screening should be done for each newborn [4, 5]. To initiate care without delay, experts in child well-being and illness, family doctors, midwives and nurses, and the importance of hearing screening in newborn children need to be informed [6].

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## MATERIALS AND METHODS

In this study, 16,388 newborns delivered to hospital at Istanbul Beykoz State Hospital from October 2009 to January 2018 were retrospectively assessed and forwarded from other health facilities for hearing screening. In a separate and silent space, four audiometry technicians worked in the clinic, and all babies were tested with the transient evoked otoacoustic emissions (TEOAEs) test. It was preferred for TEOAE calculations that the baby was sleeping. Tests were administered while the child was on the lap of her mother and her two ears were independently examined. The “pass” response found on the monitor suggests that the baby passed the screening examination, while the “refer” response indicates that the baby failed. If there was debris or middle ear effusion in the external auditory pathway, therapy was administered, and then, the test was repeated and the risk factors are discussed in Table 1. Low birth weight presence, history of intensive care of the baby, and mothers with a history of febrile disease have been reported, especially toxoplasma, rubella, cytomegalovirus, herpes virus diseases group, and history of syphilis disease. Test replication and auditory brainstem response (ABR) measurements were conducted after 15 days on babies who were unable to pass the test and babies in the risky group. ABR was carried out by Natus Medical Integrated using the Biologic NavPro system. The screening results for newborns were reported.

The data were analyzed using the Statistical Package for the Social Sciences 15.00 package program. Frequency and percentage distributions were used in the descriptive statistics of the data. In the comparison of qualitative data (Chi-square), the  $\chi^2$  test was used and a significance level of 0.05 was accepted for statistical acceptance. This study has been approved by Beykoz State Hospital Clinical Research Ethics Committee (date: August 27, 2018, no: 7275).

## RESULTS

In this sample, as a result of the hearing screening of 16,388 babies, the number of infants who passed TEOAE screening was 13,319 infants. The percentage is 81.2%. The number of children who have not completed the test for TEOAE and have been referred to for ABR is 116. Therefore, 0.7% was found to be the prevalence of suspected congenital hearing damage detected in our hospital. Just 59 (0.36%) of these 116 babies had a risk factor found. There were no risk factors for the re-

### Highlight key points

- Screening procedures should be conducted for early diagnosis of hearing loss in all newborns.
- The prevalence of hearing loss in newborns with risk factors is greater.
- Treatment should be begun within 6 months at the latest, and counseling and preparation should be referred to children.

maining 57 (0.34%) children. The percentage of patients with fever with a family history of hearing loss, maternal consanguinity, and low birth weight was 1 (0.006%), 12 (0.07%), 7 (0.04%), and 3 (0.002%), respectively, when the risk factors for neonatal hearing loss were investigated. The number of children who received phototherapy among those who missed the ABR test was 9 (0.05%). The number of babies with a history of neonatal intensive care units (NICU) was 27 (0.16%) (Table 1).

There was a statistically important disparity in cases of intensive care, family hearing loss, phototherapy, consanguineous marriage, and low birth weight ( $p < 0.005$ ) when the risk factors for the ABR test were tested in the sample. Maternal fever did not show a statistically important difference ( $p > 0.005$ ) (Table 2).

In this analysis, a statistically important discrepancy between male and female babies was observed ( $p < 0.005$ ). In children with TEOAE, there was a major gap between normal vaginal delivery and cesarean section ( $p < 0.005$ ). Of the newborn infants included in the report, 13,319 (81.2%) were screened for TEOAE; 3069 of the babies who did not pass the test were tested for TEOAE in the newborn risk category. For further examination and treatment, the babies from the ABR test were sent to a tertiary hospital. This research did not include 83 babies who did not come to the controls and migrated out of Istanbul and 83 dying children.

## DISCUSSION

For early detection of hearing loss in premature children, all newborn babies need to be tested. Otherwise, it would influence the development of speech and language of the infant, as well as mental, social, and emotional development and success [3, 4, 7, 8].

The earlier hearing loss diagnosis happens, the healthier. A stable person is returned to the group with early care and recovery. According to the American Pediatric Academy Baby Hearing Committee, congenital hearing

**TABLE 1.** Distribution of newborn risk groups (n=59)

Risk factors	%	p
Intensive care unit follow-up	0.16	<b>0.000*</b>
Hearing loss in the family	0.07	<b>0.000*</b>
Phototherapy	0.05	<b>0.000*</b>
Consanguineous marriage	0.04	<b>0.000*</b>
Low birth weight	0.02	<b>0.000*</b>
Fever disease in mother	0.01	<b>0.007</b>
Total		0.36

\*: p&lt;0.005.

loss should be assessed by hearing screening of newborn babies within the first 3 months after birth and indicated that care and recovery should be undertaken within 6 months [2]. Hearing therapy and recovery training will otherwise be more expensive [5].

In compliance with the orders of the Ministry of Health of the Turkish Republic, TEOAE checks are regularly conducted in neonatal hearing screening. Measurements of ABR are made for those who are unable to pass the TEOAEs test and for babies in the dangerous community, even though they pass the test.

Since it can be easily registered and analyzed, TEOAE is the most often used test for neonatal hearing screening. The widely conducted TEOAE test is the acoustic echo reaction of external hair cells in the inner ear to stimuli that can be measured from the external ear canal. It is a test that is easy to use and realistic. It's not intrusive, it's affordable, so electrodes are not needed. It is reported in a short period of time, but is affected by debris in the outer ear canal and serous middle ear accumulation [2, 3].

ABR is the measurement of the auditory pathway of the brainstem and the auditory nerve's electrical response to the click stimulus. Serous deposits in the middle ear and waste in the external ear canal do not impact the superior side of ABR. For calculation, however, a longer time is required and the baby should be asleep while the test is being done. More technical skills and more time are also needed [1–4, 6, 9]. Oudesluys-Murphy et al. [10] stressed that automated ABR (AABR) is the most important tool in national neonatal hearing screenings.

In stable newborns, the prevalence of hearing loss is between 0.1% and 0.3%. After screening, the levels of au-

**TABLE 2.** Demographic data of newborns (n=16388)

	%	TEOAE pass	TEOAE refer	ABR refer	p
Gender					<b>0.000</b>
Girl	48.5	6465	1483	54	
Boy	51.5	6854	1586	62	
Delivery type					<b>0.000</b>
Normal vaginal	55.9	7511	1597	47	
Cesarean section	44.1	5808	1472	69	
Total		13319	3069	116	

TEOAE: Transient evoked otoacoustic emissions; ABR: Auditory brainstem response.

diological tests did not reach 4% [2]. In our study, the prevalence of possible neonatal hearing loss was found to be 0.7%. Table 3 lists multiple research findings in Turkey. While the findings we have achieved are consistent with studies performed in Turkey, it is considered to be compliant with world literature [8, 11–14].

In the second order, there were 12 babies with hearing loss in the household, then with 9 babies undergoing phototherapy, respectively, 7 consanguineous relationships, poor birth weight with 3 babies, and a baby with a history of fever. While the risk factors are examined in hearing loss infants; 27 babies in the first place when babies live in intensive care; there were a total of 116 risky babies reported. Our number of unsafe newborn babies was 0.36%. These observations are in line with the literature. The history of mechanical ventilation and intensive care units has been reported to be associated with hearing loss, and extended hospitalization with mechanical ventilation has been reported to increase the risk of hearing loss [15]. In this study, the most common risk factor was hearing loss in children with a history of staying in intensive care.

It was noted that there was a substantial gap in the outcomes of neonatal hearing screening between cesarean or vaginal delivery of the infant (p<0.005). In other trials, the same finding was obtained for the distribution system [16, 17].

Jakubikova et al. [18] recorded that more than 90% of cochlear hearing loss was caused by congenital hearing loss, and there was a chance of hearing loss in 1355 children in a sample of 3048 babies, of which 12 (0.39%) had hearing loss; 1663 found that the baby was not at

**TABLE 3.** Newborn hearing loss detection rates of other study groups

Hospital	Observer	n	%
Istanbul Haydarpasa Numune Hospital	Erdogdu [1]	1350	1.6
Izmir Katip Celebi University	Baydar [4]	7918	0.7
Afyon Zubeyde Hanim Children Hospital	Cakal [6]	23,394	0.16
Denizli State Hospital	Ovet [11]	19,464	0.1
Ankara Zekai Tahir Burak Hospital	Celik [12]	142,128	0.27
Istanbul American Hospital	Kayiran [13]	8052	0.13
Istanbul Training and Research Hospital	Turkmen [14]	5605	2.1
Ankara Hacettepe University	Genc [15]	5485	0.2
Kutahya Dumlupinar University	Ozbay [16]	6881	0.47
Almanya Munster University	Hahn [8]	388	0.05
Maternity Hospital Stara Zagora	Rouev [17]	1750	0.11
Rome Catholic University	Paludettin [18]	320	0.00
Gloucestershire Royal NHST UK	Owen [19]	675	0.15
Cheng Kung University Hospital	Lin [20]	5938	0.15

risk and 4 (0.13%) of them had hearing loss. A comparable outcome was observed in our analysis to be 0.36% for the risky group and 0.34% for the non-risk group.

With the AABR measurement, Mason et al. [19] conducted a hearing screening of 10,372 infants in their children's room and 96% of babies were tested for hearing. It was found that the congenital hearing loss rate was 0.1% and risk factors were <2%. In this study, congenital hearing aid was found to be 0.7% and 0.36% for the risky category. The incidence of bilateral hearing loss was found to be 0.13% in 16,000 newborns by Kataoka et al. [5].

Eiserman et al. [7] found that 107 children had 0.24% of hearing disorders in 4519 children under 3 years of age, and 7 of these 107 children (0.015%) had permanent hearing loss. About 52 % of these kids are male. In our study, 48.5% were female; 51.5% male.

Thompson et al. [20] recorded that OAE sensitivity ranged from 80% to 98% and that more than 90% of those referred to were false positive, and permanent neurosensory hearing loss was diagnosed in 6–15% of these infants. They recognized the possibility of being in the NICU for 2 days or longer for neonatal neurosensory hearing loss risk factors and, in addition, Usher syndrome, Waardenburg syndrome, and other hearing loss syndromes. Risk factors were also applied to the abnormalities seen in the ear canal and the auricular and craniofacial anomalies.

In their research on newborn babies, Korres et al. [21], 25288 in their study on newborn infants, 1714 infants stayed in the NICU; family history and congenital defects are the most common risk factor; second, they find low birth weight and, third, premature.

The risk factors of hearing loss were divided by Vos et al. [22] into three groups: (1) High-risk factors: Congenital (cytomegalovirus, toxoplasmosis, and syphilis) diseases, family history, consanguineous marriage, condition of malformation, and syndrome of fetal alcohol. (2) Moderate causes of risk: Toxicity of bilirubin and hyperbilirubinemia. (3) Low-risk factors: Low birth weight, low Apgar score, hospitalization, intensive care unit for neonatal infections, and ototoxic drugs.

Bilateral neurosensory hearing loss was observed in Roth et al. [23], 24,096 neonatal screening, low birth weight in infants with a prevalence of 0.3%. Our ratio is 0.02%. The TEOAE average was found to be 87.2% in the same study. The pass rate for the TEOAE is 81.2%. In addition to risk factors, hypoxia and neurological disorders were included. Ngui et al. [9], DPOAE passed 50.1% in the neonatal screening of 768 babies; AABR found pass rates of 67.9%. About 52% of the study group's babies were male; 48% were female. For 9 years, Wood et al. [24] found 98.9% of 4,645,823 newborns and found the prevalence of hearing loss to be 2.59%. Within the first 6 months after birth, the children were diagnosed and treated.

## Conclusion

A hearing screening must be carried out on all newborns. Hearing deficiency is very important because it has adverse impacts on the speech and language education of children as well as on psychological and social progress. Since newborns with risk factors have a higher incidence of hearing loss, hearing loss should be carefully tested. In addition, before birth, advice should be given to those who have permanent hearing loss in the family and those who have a consanguineous marriage.

Hearing screening services and all newborn babies should be tested within the 1<sup>st</sup> month after birth, reported hearing loss should be confirmed within 3 months, and therapy should be begun no longer than 6 months, and recovery and preparation should be referred to infants.

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