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**RESEARCH ARTICLE**

# The prevalence of hearing impairment in high-risk infants in Kuwait

**Aseel Al-Meqbel[1*], Hamad Al-Baghli[2]**

[1]-Department of Hearing and Speech Sciences, Faculty of Allied Health Sciences, Health Sciences Center, Kuwait University
[2]-Department of Clinical Neurophysiology, IBN SINA Hospital, Kuwait

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## Abstract

**Background and aims:** This is a pilot study investigated the prevalence of hearing impairment and the impact of the known risk factors for hearing loss on infants at risk born in Kuwait.

**Methods:** Two hundred infants with risk of hearing impairment who met the Joint Committee on Infants Hearing (1990) criteria were screened. All newborns were included in this study if they had hospital stay for more than 48 hours and at least with one of the known risk factors of hearing loss. At time of discharge from the hospital, they were referred for hearing screening at Ibn Sina Hospital, Clinical Neurophysiological Department. The hearing screening protocol included high frequency tympanometry, transient evoked otoacoustic emission (TEOAE) and auditory brainstem responses (ABR).

**Results:** Of 200 infants, 11.5% had sensorineural hearing loss (SNHL). There was no significant relationship between hearing loss and gender, but there was a significant statistical relationship ($p \leq 0.05$) between hearing loss and prematurity. Of 23 infants with SNHL, positive history of hearing loss occurred in five families, SNHL detected in four of the 19 cases with hyperbilirubinemia (17.4%), 2 of the 15 cases with severe perinatal asphyxia ($p \leq 0.05$), one of the 2 cases with a meconium aspiration syndrome ($p \leq 0.05$), and a single case with gentamycin ototoxicity.

**Conclusion:** The prevalence of hearing impairment in high-risk infants was 11.5%. About 43.48% severe prematurity (gestational age $\leq$ 30 weeks) was a main risk factor of hearing loss. This finding should guide healthcare providers when adapting their protocols.

**Keywords:** Transient evoked otoacoustic emission, auditory brainstem responses, risk factors, hyperbilirubinemia, severe prematurity, sensorineural hearing loss

[*]**Corresponding author:** Department of Hearing and Speech Sciences, Faculty of Allied Health Sciences, Health Sciences Center, Kuwait University, Sulaibikat, 90805, Kuwait. Tel: +965249833412, E-mail: aseel.m@hsc.edu.kw

### Introduction

It has been demonstrated that early identification and appropriate intervention of hearing impairment in children within the first six months of life would prevent or reduce many lifelong deficits in speech and language acquisition, poor academic performance, and emotional/social difficulties. In the last two decades, developed countries such as the United States and Italy have specified the early identification of hearing impairment and appropriate auditory habilitation as a primary healthcare standard prior to six months of



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age [1-5].

As recently demonstrated by Martines et al. [6,7] the aim of early identification of hearing loss is to achieve better verbal and social communication through hearing aids or cochlear implants that means delayed identification may have a negative impact on a child's verbal, educational, and psychological abilities [1].

The prevalence of hearing impairment in newborns is 2-4 cases in every 1000 live births. Even mild hearing impairment remained unrecognized until the second year, may produce great impact on later conversational ability and language acquisition [8].

Some infants born with hearing impairment have risk factors associated with hearing loss, such as positive family history of hearing loss, in-utero infections, craniofacial anomalies, preterm neonates, birth weight <1500g, hyperbilirubinemia requiring exchange transfusion, ototoxic medication, bacterial meningitis, apgar scores of 0–4 at 1 minute or 0-6 at 5 minutes, or mechanical ventilation lasting five days or longer [8], whereas other hearing-impaired infants demonstrate no risk factors [8,9]. Therefore it has been suggested that all infants should be screened for hearing impairment after birth or during the first three months of life, thus early hearing intervention can be implemented, if necessary [8,10].

All country's pediatric hearing health services should be based on the knowledge of the prevalence of both congenital permanent childhood hearing impairment and later acquired hearing impairment and hearing screening should be introduced as a public health matter [5]

In some countries, the universal hearing screening program is not feasible [11], and in Kuwait only those newborns who are at risk are currently screened. Because the prevalence of hearing impairment in Kuwait is unknown, partly due to the lack of representative epidemiological studies on hearing impairment and awareness, our study has a twofold purpose: (i) to investigate the prevalence of hearing impairment in a targeted population with risk factors for hearing loss; and (ii) to identify the percentage of single risk factor among a sensorineural hearing-impaired population. The estimation of risk factor provides the chance to identify the cause of hearing loss and its occurrence within families.

**Methods**

Two hundred infants who were at risk of hearing impairment were screened at Ibn Sina Hospital, Clinical Neurophysiology Department from 2011 to 2012. All infants admitted to the neonate intensive care unit (NICU) and were subjected to a clinical examination by their pediatrician. All newborns were included in the study if they had hospital stay more than 48 hours with at least one of the known risk factors. At the time of discharge from hospital, they were referred for hearing screening at Ibn Sina Hospital, Clinical Neurophysiological Department. Ethical approval from Ibn Sina Hospital, Clinical Neurophysiology Department was obtained.

Full detailed history was taken from parents. Otoscopic examination was performed to rule out infection of debris in the ear, then two screening procedures were carried out: auditory brain stem evoked responses (ABR) and transient evoked otoacoustic emission (TEOAE) proceeding by high frequency tympanometry.

Infants were considered at risk of hearing impairment if they met at least one of the 10 criteria established by the Joint Committee on Infant Hearing (1990): premature birth (gestational age ≤ 34 weeks); low birth weight (<1500 g); hyperbilirubinemia; children from hearing-impaired families; craniofacial anomalies; ototoxic medication; syndromes known to be associated with hearing loss; in-utero infection; severe perinatal asphyxia; and neurological complications (hypotonia, bacterial meningitis).The risk factors were detected by a pediatrician's detailed examination or at interview of the mother in the intensive care unit [12].

In present study, every high-risk infant was tested by both TEOAE and ABR, and underwent tympanometry, using a high-frequency probe tone of 1000 Hz, to rule out

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other problems such as internal ear effusion. Infants were also checked that they had no ear wax in their external ear canal before screening. ABR was recorded using 16 channels EMS Surpass (Biomedical, Austria); Click stimulus has been used, starting from 90 dB HL down to 20 dB HL intensity level. Wave V was tracked along the trace, which is the most stable wave. All infants were tested under naturally sleeping. For ABR three electrodes, C3, C4, Cz, were placed on infant's scalp and diagnosis of hearing loss was based on the absence or severely distorted ABR waves.

The TEOAE (Interacoustics Eclipse, Denmark) was conducted, using click stimulus. The probe tip was introduced to both ears and the results were recorded either as preserved response with a good emission level, or absent response with a poor emission level.

High frequency tympanometry was conducted using Interacoustics AA 222. Infants with type A were included and infants with type B tympanogram excluded.

After the ABR test, each infant's characteristics (such as age, sex, risk factors, and ABR, TEOAE, and tympanometer results) were collected and analyzed using SPSS software.

Nonparametric statistical tests, including Chi-square analyses, were conducted to detect significant relationships between hearing loss and risk factors, with probabilities less than 0.05 considered statistically significant.

## Results

Between 2011 and 2012, two hundred high-risk cases were referred to Ibn Sina Hospital, Clinical Neurophysiology Department for hearing testing, and 23 (11.5%) had SNHL. Table 1, shows the characteristics of infants with SNHL.

Hearing loss occurred in 11 out of 105 boys (10.5%) and 12 out of 95 girls (12.6%). Hearing loss had no significant statistical relationship with gender (p=0.62). Out of 23 infants with hearing loss 10 (15%) of them had gestational age ≤ 30 weeks, indicating a significant statistical relationship between hearing loss and prematurity (p≤0.05). Of 23 with SNHL, positive family history of hearing loss occurred in 5 cases (21.7%, p≤0.05). SNHL was also detected in 4 of the 19 cases with hyperbilirubinemia (17.4%, p≤0.05), 2 of the 15 cases with severe perinatal asphyxia (13.3%, p≤0.05), 1 of the 2 cases with a meconium aspiration syndrome (p≤0.05), and in a single case of gentamycin ototoxicity. The frequency of risk factors in infants with SNHL is presented in Table 2.

## Discussion

The incidence of hearing loss in this study by using ABR and OAE was 11.5%. Of the 10 known risk factors, five significant factors were found to have higher prevalence among the Kuwaiti infants: premature birth (gestational age ≤ 34 weeks, family history of childhood onset of SNHL, hyperbilirubinemia, severe perinatal asphyxia, associated syndrome, and ototoxic drugs.

Congenital SNHL have been found in a small proportion of extreme preterm babies, but prematurity is a commonly reported risk factor for acquired hearing impairment. In extreme preterm populations, the occurrence of high frequency hearing impairment among survivors ranges from 0 to 4%, about 10 times the prevalence in unselected populations. The causes of SNHL in very preterm newborns may differ from those in more mature infants as, the period between 20 and 33 weeks' gestation is one of rapid fetal audiological development [13].

Recent studies of hearing-impaired infants have highlighted the benefits of early screening. Downs and Yoshinaga-Itano showed that the identification of hearing impairment before six months of age is crucial for the normal development of speech, and recommended the Universal Newborn Hearing Screening (UNHS). However, while early identification and management of hearing impairment in infants is of critical value, the economic aspects of such screening should be considered. In some instances, the most cost-effective solution might be to screen only those with risk factors for hearing impairment [14].

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**Table 1. Clinical characteristics of infants with SNHL**

| No | Gender | Gestational age (weeks) | Ear affected | Tympanometry | TEOAEs | ABR |
|---|---|---|---|---|---|---|
| 1 | F | 41 | Bilateral | A | Absent | SA |
| 2 | M | 39 | Bilateral | A | Absent | SA |
| 3 | M | 26 | Bilateral | A | Absent | NR |
| 4 | F | 30 | Bilateral | A | Absent | NR |
| 5 | M | 34 | Bilateral | A | Absent | NR |
| 6 | M | 39 | Bilateral | A | Absent | NR |
| 7 | M | 26 | Bilateral | A | Absent | NR |
| 8 | M | 29 | Bilateral | A | Absent | NR |
| 9 | F | 27 | Bilateral | A | Absent | NR |
| 10 | F | 39 | Bilateral | A | Absent | SA |
| 11 | F | 26 | Bilateral | A | Absent | NR |
| 12 | M | 26 | Bilateral | A | Absent | NR |
| 13 | F | 39 | Bilateral | A | Absent | SA |
| 14 | M | 34 | Bilateral | A | Absent | NR |
| 15 | F | 39 | Bilateral | A | Absent | NR |
| 16 | F | 39 | Bilateral | A | Absent | NR |
| 17 | F | 41 | Bilateral | A | Absent | NR |
| 18 | M | 39 | Bilateral | A | Absent | SA |
| 19 | M | 30 | Bilateral | A | Absent | NR |
| 20 | F | 27 | Bilateral | A | Absent | NR |
| 21 | M | 39 | Bilateral | A | Absent | NR |
| 22 | F | 39 | Bilateral | A | Absent | SA |
| 23 | F | 27 | Bilateral | A | Absent | NR |

A: Normal middle ear function
NR: No response
SA: Severely abnormal

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Lutman et al. studied 218 at-risk infants, and found that the prevalence of hearing impairment in newborns who were in the NICU for more than 48 hours was about 2–4%. Therefore, infants hospitalized in the NICU should be screened for hearing before they are discharged; indeed, these newborns are also at greater risk of disabilities associated with prematurity, low birth weight, use of ototoxic drugs, and mechanical ventilation [15].

Stein reported that hearing loss incidence for NICU infants is 20-50 times greater than in well babies [16]. Roizen studied high-risk newborns; 13% of those with hearing impairment had low birth weight, and 17% of newborns who were discharged from NICU had hearing loss


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**Table 2. Risk factors in infants with SNHL**

| | Number of infants (per cent) | |
|---|---|---|
| **Risk factors** | **Pathologic (23)** | **Normal (177)** |
| **Premature birth (gestational age ≤ 34 weeks)** | 10 (43.5) | 67 (37.9) |
| **Positive family history of hearing loss** | 5 (21.7) | 75 (42.4) |
| **Hyperbilirubinemia** | 4 (17.4) | 19 (10.7) |
| **Severe perinatal asphyxia** | 2 (8.8) | 15 (8.5) |
| **Ototoxic medication** | 1 (4.4) | 0 |
| **Syndromes associated with hearing loss** | 1 (4.2) | 1 (0.5) |

difficulties [17].

Hess et al. studied 942 infants who were at risk of hearing impairment. Using ABR, they found 17(1.9%) cases of hearing impairment, 14 (1.4%) of whom had bilateral hearing loss of more than 30 dB. Furthermore, 4 of the 17 infants with hearing impairment had malformations [18].

Severe hyperbilirubinemia can cause hearing loss.When indirect bilirubin passes the blood-brain barrier, it can be deposited in the basal ganglia and in the vestibulo-cochlear nucleus, with resulting sensorineural hearing loss. Neault reported that 33% of newborns with blood bilirubin levels of 15-25 mg/dl had poor or absent ABR [19].

Sheykholeslami and Kaga investigated localization of the pathological etiology of hearing impairment in infants with a history of hyperbilirubinemia. Their study included three infants with abnormal ABR. They found that severe hyperbilirubinemia was associated with at least some defects in the cochlea, and especially in the outer hair cells, and even moderate forms of hyperbilirubinemia (<20 mg/dl) could cause SNHL [20]. Amin et al. performed ABR for immature newborns (28-32 weeks) during their first week of life, and tested total and indirect bilirubin at 48 and 72 hours after birth. Increasing indirect bilirubin was more sensitive in predicting abnormalities in ABR and encephalopathy of hyperbilirubinemia than total bilirubin. Their results showed a direct significant relationship between hearing impairment and indirect hyperbilirubinemia [21]. In our study, we detected 4 (17%) of the 19 cases with hyperbilirubinemia ($p<0.05$) who had hearing loss. Our results and findings from previous studies suggest that all neonates should be screened for early detection of hearing loss if possible. If this goal is not achievable, all infants with risk factors must be screened.

Other studies, using a cohort of more than 500 newborns, of whom 142 were admitted in NICU, have reported the percentage of a single risk factor, and the increased risk of hearing impairment if several risk factors are present [5-7].

Despite that the highest prevalence of hearing loss was in targeted newborn babies with known risk factors, Gilbey et al. reported that of the 5212 infants completed the universal hearing screening testing 270 infants were referred for full audiological diagnosis. Their results showed that 27 neonates were found to have a conductive hearing disorder, 4 neonates were found to have a mixed hearing disorder and 2 neonates were found to have a SNHL hearing disorder [22].

The difference in the reported prevalence among the studies could be due to the number of participants and the variations in methodology. It is important that before implementing a screening program in Kuwait, a number of

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issues should be addressed, including increasing the availability and the accessibility to valuable follow up and intervention services by qualified and trained audiologists, valid and efficient cochlear implant program and acoustical amplification. In addition, it should be met the need for trained and skillful audiologists to administer and interpret the OAEs and the ABR results. The limitation of our study was the small sample size.

## Conclusion

This pilot study provided empirical data and suggested a framework that will guide the choice of suitable and affordable newborn hearing screening programs in Kuwait. The prevalence of hearing loss in high-risk infants in our participants was 11.5%. Severe prematurity was a main risk factor of hearing loss in our targeted population, and this finding should be incorporated into protocols for healthcare providers in Kuwait. However, further research is suggested.

## REFERENCES


1. Yoshinaga-Itano C. Efficacy of early identification and intervention. Seminars in Hearing. 1995;16:115-20.
2. Yoshinaga-Itano C, Sedey A, Coulter DK, Mehel AL. Language of early- and later- identified children with hearing loss. Pediatrics. 1998;102(5):1161-71.
3. Martines F, Porrello M, Ferrara M, Martines M, Martines E. Newborn hearing screening project using transient evoked otoacoustic emissions: western sicily experience. Int J Pediatr Otorhinolaryngol. 2007;71(1):107-12.
4. Martines F, Bentivegna D, Ciprì S, Costantino C, Marchese D, Martines E. On the threshold of effective well infant nursery hearing screening in Western Sicily. Int J Pediatr Otorhinolaryngol. 2012;76(3):423-7.
5. Salvago P, Martines E, Martines F. Prevalence and risk factors for sensorineural hearing loss: western sicily overview. Eur Arch Otorhinolaryngol. 2013;270(12):3049-56.
6. Martines F, Martines E, Mucia M, Sciacca V, Salvago P. Prelingual sensorineural hearing loss and infants at risk: western sicily report. Int J Pediatr Otorhinolaryngol 2013; 77(4):513-8.
7. Martines F, Martines E, Ballacchino A, Salvago P. Speech perception outcomes after cochlear implantation in prelingually deaf infants: the western sicily experience. Int J Pediatr Otorhinolaryngol. 2013;77(5):707-13.
8. Kenna M. The Ear. In: Behrman RE, Kliegman RM, Jenson HB, editors. Nelson textbook of paediatrics. 16th ed. Philadelphia: Saunders; 2000. P. 1940-9.
9. Shehata-Dieler WE, Dieler R, Keim R, Finkenzeller P, Dietl J, Helms J. Universal hearing screening of newborn infants with the BERA-phone. Laryngorhinootologie. 2000;79(2):69-76.
10. The medical home. Medical home initiatives for children with special needs project advisory committee. American Academy of Pediatrics. Pediatrics. 2002;110(1 Pt 1):184-6.
11. Martines F, Salvago P, Bentivegna D, Bartolone A, Dispenza F, Martines E. Audiologic profile of infants at risk: experience of a Western Sicily tertiary care centre. Int J Pediatr Otorhinolaryngol. 2012; 76 (9):1285-91.
12. Joint Committee on Infant Hearing 1990 position statement. ASHA Suppl. 1991; (5):3-6.
13. Marlow ES, Hunt LP, Marlow N. Sensorineural hearing loss and prematurity. Arch Dis Child Fetal Neonatal Ed. 2000; 82(2): F141-4.
14. Downs MP, Yoshingata-Itano C. The efficacy of early intervention for children with hearing impairment. Pediatr Clin North Am. 1999; 46(1):79-87.
15. Lutman ME, Davis AC, Fortnum HM, Wood S. Field sensitivity of targeted neonatal hearing screening by transient evoked otoacoustic emissions. Ear Hear. 1997; 18(4): 256-76.
16. Stein LK. Factors influencing the efficacy of universal newborn hearing screening. Pediatr Clin North Am. 1999; 46(1):95-105.
17. Roizen NJ. Etiology of hearing loss in children. Nongenetic causes. Pediatr Clin North Am. 1999;46(1):49-64.
18. Hess M, Finckh-Krumer U, Bartsch M, Kewitz G, Versmold H, Gross M. Hearing screening in at-risk neonate cohort. Int J Pediatr Otorhinolaryngol. 1998;46(1-2):81-9.
19. Neault MW. Pediatric audiology. In: Wetmore RF, Muntz HR, McGill TJ, editors. Pediatric otolaryngology, principlee and practice pathways. 1st ed. New York: Thieme; 2000. p. 191-200.
20. Sheykholeslami K, Kaga K. Otoacoustic emissions and auditory responses after neonatal hyperbilirubinemia. Int J Pediatr Otorhinolaryngol. 2000; 52(1):65-73.
21. Amin SB, Ahlfors C, Orlando MS, Dalzell LE, Merle KS, Guillet R. Bilirubin and serial auditory brainstem responses in premature infants. Pediatrics. 2001; 107(4): 664-70.
22. Gilbey P, Kraus C, Ghanayim R, Sharabi-Nov A, Bretler S. Universal newborn hearing screening in Zefat, Israel: the first two years. Int J Pediatr Otorhinolaryngol. 2013;77(1):97-100.


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