

# Early detection of hearing loss in infants by using otoacoustic emission at national center of hearing and speech

## Abstract

The aim of the study is early screening program to determine the prevalence of hearing loss and the associated risk factors in newborn infants by using Oto-acoustic emission (OAE). This is cross section study done in Medical city hospital in the audiological department from Feb.2023 to July 2023, screening of 532 infant was done, it included all the newborn babies. It takes approximately 30 minutes for the test, after which the audiologist can share the test results. In this study there is a significant association between (consanguinity, ototoxic drugs, NICU admission, kernicterus, and mode of delivery) and hearing loss.

In this study there is no significant association between (congenital anomalies, family history of hearing loss, smoking, maternal age, infant age and gender, otitis media, infants birth weight, RDS, birth asphyxia, prematurity) and hearing loss.

**Keywords:** hearing loss, auditory spectrum disorder, otoacoustic emissions, Oto-Acoustic emission (OAE) device

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## Objectives

To early detect of the number or percentage of infants with hearing loss.

To detect the associated risk factors with the hearing loss.

## Introduction

Hearing loss is a partial or total inability to hear.<sup>1</sup> Hearing loss may be present at birth or acquired at any time afterwards.<sup>2,3</sup> Hearing loss can happen when any part of the ear or auditory (hearing) system is not working in the usual way.

## Types of hearing loss

### According to source

#### Conductive hearing loss

Hearing loss caused by something that stops sounds from getting through the outer or middle ear. This type of hearing loss can often be treated with medicine or surgery.

#### Sensorineural hearing loss

Hearing loss that occurs when there is a problem in the way the inner ear or hearing nerve works.

#### Mixed hearing loss

Hearing loss that includes both a conductive and a sensorineural hearing loss.

#### Auditory neuropathy spectrum disorder

Hearing loss that occurs when sound enters the ear normally, but because of damage to the inner ear or the hearing nerve, sound isn't organized in a way that the brain can understand.

### According to hear loss degree

#### Mild hearing loss

A person with a mild hearing loss may hear some speech sounds but soft sounds are hard to hear.

#### Moderate hearing loss

A person with a moderate hearing loss may hear almost no speech when another person is talking at a normal level.

#### Severe hearing loss

A person with severe hearing loss will hear no speech when a person is talking at a normal level and only some loud sounds.

#### Profound hearing loss

A person with a profound hearing loss will not hear any speech and only very loud sounds.

#### Hearing loss can also be described as

**Unilateral or Bilateral:** Hearing loss is in one ear (unilateral) or both ears (bilateral).

**Pre-lingual or Post-lingual:** Hearing loss happened before a person learned to talk (pre-lingual) or after a person learned to talk (post-lingual).

**Symmetrical or Asymmetrical:** Hearing loss is the same in both ears (symmetrical) or is different in each ear (asymmetrical).

**Progressive or Sudden:** Hearing loss worsens over time (progressive) or happens quickly (sudden).

**Fluctuating or Stable:** Hearing loss gets either better or worse over time (fluctuating) or stays the same over time (stable).

**Congenital or Acquired/Delayed Onset:** Hearing loss is present at birth (congenital) or appears sometime later in life (acquired or delayed onset).

## Otoacoustic emission

Otoacoustic emission is a non-invasive, rapid, and appropriate method for assessing cochlear function. The OAE test is used to find out how well the inner ear, or cochlea, works. It measures otoacoustic emissions, or OAEs. These are sounds given off by the inner ear when responding to a sound. Early detection of hearing loss in the infant is an essential step in preventing family, social, welfare, speech, language

and cognitive problems. The importance of early hearing screening has been recognized for many years and follows two primary goals. Its short-term goal is early detection of hearing loss and its long-term goal is to improve speech, language, and cognitive development.<sup>4</sup>

## Methods and material

This is a cross sectional study was done in Medical city hospital in the audiological department from Feb.2023 to July 2023, screening of 532 infant was done, it included all the newborn babies, infants below one year who their families had wariness for the hearing, all infants that was admitted to neonatal intensive care units (NICUs), both sex was included in the study from day 1 up to 1 year by using Oto-Acoustic Emission (OAE) device for screening of any hearing loss detection. The OAE test which is used is noninvasive small probe to be inserted in the ear. A series of tones or clicking sounds are presented to the infant by the technicians. The test takes place in a small sound booth. It takes approximately 15-30 minutes for the test, after which the audiologist can share the test results. This procedure has been done after taking consent from the parent.

### Inclusion criteria

Newborn infants (up to 1 year), who their families had wariness for the hearing loss and approved to participate in our study.

### Exclusion criteria

Parents' refusal to participate in this study at any time.

Infants older than 1 year of age.

Infants who had congenital abnormality in the external auditory canal or the auricles, ex. Microtia.

Dead infant later.

## Data collection

The researcher was attending the audiological department about 5 days a week, direct face to face interview (Researcher and the infant's parents) was done after explaining the aim of the study and acquiring his/her approval. The OAE test which is used is noninvasive small probe to be inserted in the ear. A series of tones or clicking sounds are presented to the infant by the technicians. The test was taken place in a small sound booth. It takes approximately 15-30 minutes for the test, after which the audiologist read the test results and report it.

## Instruments/tools

### Tools

The infants was assessed by taking a short history from their parents, concentrating on Joint Committee on Infant Hearing (JCIH) criteria which is used for the identification of risky infants to have hearing impairment and all the records had been reported in a questionnaire paper, which was designed in a way that the data can be easily reached.

### Instruments

Oto-Acoustic emission (OAE) Device: Advanced OAE techniques need a sound attenuating booth, but useful OAEs can be done in a quiet office environment.

The audiologist reported the test results by filling a sheet, that include infant's informations (Name, Age, OAE Test result).

## Operational definition

### Infant age classified into:

1-30 days

31-180 days

181-365 days

### Infant gender: Male or Female

**Mode of delivery:** Either the infant was a product of Normal Vaginal Delivery or Caesarian Section.

**Obstructed labor:** Either the infant suffered a labor dystocia (which is a failure to progress due to mechanical problems, a mismatch between fetal size or more accurately the size of the presenting part of the fetus and the mother's pelvis, although some mal-presentation notably a brow presentation or a shoulder presentation).<sup>5</sup>

**NICU Status:** Either the infant was admitted to neonatal intensive care unit for the following causes or not:

**A\Birth asphyxia:** Either the infant suffered from failure to establish breathing at birth or not.

**BARDS:** Either the infant suffered from respiratory distress syndrome or not.

**C\Prematurity:** Either the infant was born alive before 37 weeks of pregnancy or not.

**D\Kernicterus:** Or bilirubin encephalopathy, is bilirubin-induced neurological damage, which is most commonly seen in infants. It occurs when the unconjugated bilirubin (indirect bilirubin) levels cross 25 mg/dL in the blood from any event leading to decreased elimination and increased production of bilirubin.<sup>6</sup>

Either the infant suffered (Yes) or No.

**Otitis media:** Either the infant was with OME (an infection of the middle ear that causes inflammation (redness and swelling) and a build-up of fluid behind the eardrum) or not.

**Congenital anomaly:** Either the infant was born with congenital anomaly (Waardenburg syndrome, Down syndrome, Pendred syndrome, Usher syndrome, etc.) or not.

**Neonatal birth weight:** Either classified into,<sup>7</sup>

**Low birth weight:** birth weight below 2.5 kilograms at birth.

**Normal birth weight:** birth weight  $\geq 2.5$  kg < 4.0 kg.

**Large for age (macrosomia):** birth weight  $\geq 4.0$  kg.

## Ototoxic drug

Sometimes prescribed to babies to treat serious infections or birth complications. The most common ototoxic medications are a family of antibiotics called aminoglycosides, with names such as gentamycin, tobramycin, kanamycin, and streptomycin.

Either the infant was given such drugs (Yes) or No.

Regarding maternal use of such drugs, the majority didn't recall the drug's name prescribed for them so it was removed from the questionnaire and the result.

**Use of alcohol:** Due to social issues this variable was removed from the questionnaire and the analysis.

### Data analysis

Data analysis carried out using the statistical package of SPSS-26 (Statistical Packages for Social Sciences- version 26).

Quantitative data was presented by mean and standard deviation.

Qualitative data was represented by numbers and percentages.

Chi square test was used to assess the statistical difference among the different categories. When not applicable, Fisher Exact test was applied.

The level of P value equal or less than 0.05 was considered to be statistically significant.

### Study duration

From February 2023 to July 2023.

### Pilot testing

A Pilot test was implemented on a sample that includes 10 infants and their parents, to estimate the time needed for the interview, questionnaire filling and the auditory testing. These infants and parents were excluded from the study sample.

### Results

In this study the participants were the infants from day 1 to one year of age , total number was 532 infants were screened for hearing loss by using OAE, from the total number 306 infants male which represents about 60% and female 226 which represent about 40%, majority were of normal birth weight , about 50% were admitted to NICU due to different causes (prematurity ,low birth weight, birth asphyxia ,kernicterus , and RDS), 13% suffered from otitis media ,14% took ototoxic drugs and 12% were with congenital anomalies. At the end of this study the results of 28 infants out of 532 infants were refer (means failure of the test) about 5.3% and 504 infants pass the test about 94.7%. (Table 1 Figures 1 JCIH criteria).

**Table 1** Distribution of the participants' OAE status according to study variables

Study variable		OAE status				$\chi^2$	P value
		Refer		Pass			
		No.	%	No.	%		
Infant age	1-30 Days	14	50	294	58.3	3.12	0.21
	31-180 Days	12	42.9	142	28.2		
	181-365 Days	2	7.1	68	13.5		
Infant gender	Male	21	75	285	56.5	3.7	0.06
	Female	7	25	219	43.5		
Consanguinity	Yes	17	60.7	186	36.9	6.4	0.012*
	No	11	39.3	318	63.1		
Maternal age	Below 30 Years	6	21.4	124	24.6	0.145	0.7
	30 and Above	22	78.6	380	75.4		
Obstructed labor	Yes	5	17.9	157	31.2	2.21	0.137
	No	23	82.1	347	68.8		
Congenital anomaly	Yes	4	14.3	32	6.3	FET	0.112
	No	24	85.7	472	93.7		
NICU admission	Yes	21	75	256	50.8	6.23	0.013*
	No	7	25	248	49.2		
Ototoxic drug use	Yes	21	75	51	10.1	FET	<0.001*
	No	7	25	453	89.9		
Otitis media	Yes	7	25	62	12.3	FET	0.075
	No	21	75	442	87.7		
Mode of delivery	CS	12	42.9	360	71.4	10.3	0.001*
	Normal Vaginal	16	57.1	144	28.6		
Family history of hearing loss	Yes	5	17.9	51	10.1	FET	0.16
	No	23	82.1	453	89.9		
Smoking currently	Yes	13	46.4	319	63.3	3.22	0.073
	No	15	53.6	185	36.7		

FET=Done by Fisher Exact Test \*= statistical significance at p≤0.05

**JCIH criteria for the identification of hearing impairment risks.**

Name: \_\_\_\_\_ Age: \_\_\_\_\_ Gender: \_\_\_\_\_ Date: \_\_\_\_\_

**Type of labor**

- C/S  Normal vaginal
- Obstructed labor  Yes  No
- Birth asphyxia  Yes  No

**Newborn audiological risk factors (0-28 days) (JCIH, 1990, 1994, 2000)**

**Intrauterine infections**

- Cytomegalovirus  Yes  No
- Toxoplasmosis  Yes  No
- German measles  Yes  No

**History of drug in take (Ototoxic drugs) If yes name of drug**  Yes  No

**History of smoking during pregnancy**  Yes  No

**History of Alcoholic during pregnancy**  Yes  No

**Cranio-Facial abnormalities**

- Labiopalatoschisis  Yes  No
- Auricular malformations  Yes  No
- Atresia auris  Yes  No
- Hydrocephalus  Yes  No
- Various  Yes  No

**Familiarity for infantile sensorineural hypoacusis**

**Disorders usually associated with sensorineural and/or conductive hypoacusis**

- Trisomia 8  Yes  No
- Trisomia 21  Yes  No
- Hypothyroidism  Yes  No

**Severe dysfunction at birth**

- Hypotonia  Yes  No
- Hypertonia  Yes  No
- Foetal Alcohol Syndrome  Yes  No

**Icterus (Hyperbilirubinemia )**  Yes  No

JCIH criteria



Figure 1 Distribution of the participants according to OAE status.



## Conclusion

In this study sample size which was included in the OAE test was 532 infants who were attending audiological department and NICU from day 1 to 1 year of age, 504 of them pass the OAE test and 28 infants refer (not pass the test).

In this study there is a significant association between (consanguinity, ototoxic drugs, NICU admission, kernicterus, and mode of delivery) and hearing loss.

In this study there is no significant association between (congenital anomalies, family history of hearing loss, smoking, maternal age, infant age and gender, otitis media, infants birth weight, RDS, birth asphyxia, prematurity) and hearing loss.

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## Conflicts of interest

The authors declare that they have no conflicts of interest related to the present work.

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