Early Detection of Hearing Loss by Using Auditory Brainstem Response tests among Neonates: Incidence and Risk Factors

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Abstract

Background: Hearing loss has become the fourth leading cause of disability globally. Disabling hearing loss impairs interpersonal communication, psychosocial wellbeing, academic and professional career opportunities, economic independence, and quality of life. The study aimed to detect hearing loss incidence and Identify risk factors by using Auditory Brainstem Response tests among neonates. **Design:** A cross-sectional research design was used to achieve the aim of the current study. **Sample:** 463 neonates included in the study were calculated using the Epi Info program. **Setting:** This study was conducted at Minia Eastern Health Center and Minia Western Health Center in Minia City. **Tools**: two tools were used; Tool I included three parts: The first part related to: Mother and neonate Socio-demographic data, the second part related to: The medical history of the mother, and the third part related to risk factors of the mother. Tool II: Auditory Brainstem Response (ABR) test. **Results:** most common maternal risk factors were caesarean section delivery , gestational diabetes, premature rupture of membrane and pre-eclampsia. Regarding neonatal risk factors to hearing loss were neonatal respiratory distress, admission to neonatal intensive care unit, neonatal hyperbilirubinemia and neonatal hypoxia. **Conclusion:** caesarean section and gestational diabetes were most common maternal risk factors also, neonatal respiratory distress, and admission to neonatal intensive care unit were the most common neonatal risk factors, the majority of the studied neonates not had hearing loss and the minority of them had hearing loss in unilateral ears. **Recommendation:** Health education to mothers about the risk factors of hearing impairment.

Keywords: Auditory Brainstem Response tests, Early Detection, Hearing Loss, Incidence and Risk Factors.

Introduction

Hearing loss is considered one of the most prevalent global health concerns. Hearing loss in children worldwide constitutes a particularly serious obstacle to their optimal development and education, including language acquisition. Neonatal hearing loss has a prevalence that is more than twice that of other newborn disorders such as congenital hypothyroidism and phenylketonuria. Congenital, bilateral hearing loss occurs in approximately 1 to 5 per 1000 live births, and when permanent unilateral hearing loss is included, the incidence increases to 8 per 1000 live births **(Gatlin and Dhar, 2021).**

The world health organization estimated the prevalence of worldwide hearing loss to be 466 million people. Of these, 34 million individuals are children. By 2050, it is predictable that more than 900 million people will have disabled hearing loss. An international statistic for children with hearing loss is reported to be two to six per 1000 live birth. In the United States, three per 1000 live birth are born with permanent hearing loss **(Keshishzadeh et al., 2021).**

Sixty percent (60.0%) of hearing loss occurring in children is owing to preventable causes. Children's hearing loss may result from congenital or acquired etiology. The term congenital hearing loss indicates that the hearing loss is present at birth. It can include hereditary hearing loss or hearing loss owing to other factors present either in utero or at the time of birth **(El-sheikh et al., 2020).**

Genetic factors are believed to cause more than 50% of all cases of congenital hearing loss in children. Genetic hearing loss may be autosomal dominant, autosomal recessive, or X-linked. Maternal infection such as German measles, cytomegalovirus, or herpes simplex virus; prematurity birth injuries; toxins; complications associated with the Rhesus (Rh) factor in the blood; maternal diabetes; toxemia during pregnancy; and anoxia all are considered other causes of congenital hearing loss. However, acquired hearing loss that presented later in life may be due to certain infectious diseases, chronic ear infections, particular drugs, and exposure to excessive noise **(Han et al., 2020).**

The initial signs of hearing loss are very subtle, and systematic neonatal hearing screening is the most effective means of early detection. The early identification of congenital hearing loss is necessary to minimize the consequences of hearing impairment on future communication skills. Screening should be completed by one month of age, the diagnosis should be made by three months, and intervention and treatment should commence by six months. This was achieved by technological advances in automated neonatal hearing-screening technology, resulting in the introduction of Universal Neonatal Hearing Screening (UNHS) **(Chengetanai et al., 2020).**

Automated auditory brain stem response (AABR) instruments have been developed for screening neonates in a hospital setting to identify patients with auditory neuropathy, and it is also important to reduce the number of false positives. The ABR, sometimes referred to as the brain auditory evoked response (BAER), was a long-established technique used to indicate the brain stem response to auditory stimuli. ABR wave levels indicated the interaction of the auditory pathways, from the cochlea to the cortex. ABRs effectively provided signatures of brain activity that could be used for various forms of neuro-performance analysis.

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Typically, ABR was used to assess hearing, particularly in infants **(Kobrina et al., 2020).**

Primary prevention of hearing loss among neonates is concerned with the prevention of the occurrence of any condition that may lead to hearing loss and includes such activities as immunization, the avoidance or rational use of ototoxic drugs, improved obstetric care, personal hygiene, and living conditions. For primary prevention to be effective, it would entail accurate knowledge of the causes and the associated risk factors for permanent congenital and early-onset hearing loss in a given setting **(Anastasio et al., 2021).**

The community health nurse can play in a general practice environment, namely organizer, quality controller, problem solver, educator, and connectivity agent. These are all diverse roles that are part of a nurse's general workload and ensure the best possible care for the patient within the healthcare setting. In addition to these traditional roles, the nurse fulfills specialty duties, such as those carried out within the neonatal intensive care unit **(Hardani et al., 2020).**

The community health nurse often assists with emotional support and counseling. In these settings, the nurse has been known to play an important role in decision-making on the technology available to care for the neonate. The nurse also performs an advocacy role and has been shown to have a personalized communication style with mothers, which is particularly apparent in neonatal nurseries. Mothers value this communication style as it helps them develop a connected relationship with their infant. It is also essential to plan individualized care to suit the infant and the family **(Escobar-Ipuz et al., 2019).**

Aim of the study

The current study aims to detect the level of hearing loss by using Auditory Brainstem Response tests (ABR), to identify the incidence and risk factors of hearing loss among neonates.

Research questions:
- What is the incidence of hearing loss among neonates in selected maternal and child health centers at Minia city?
- What are the most common risk factors associated with hearing loss among neonates in selected maternal and child health centers at Minia city?

Significance of the Study

During early childhood or beyond the newborn period, early childhood screening is critical because hearing loss is an invisible condition. Between birth and age five, the incidence of hearing loss doubles. Just because a newborn passed their hearing screening at birth, it is not a guarantee that a late-onset and/or progressive hearing loss won't develop. As a result, early childhood programs, such as early head start, require hearing screening with all new enrollments **(Wilson and Jungner, 2017).**

The World Health Organization **(WHO, 2018)** estimates that at least 34 million children under 15 have disabling hearing loss. Based on the 2012 WHO report, approximately 7.5 million children were under five years. A hearing loss is disabling for adults if it is greater than 40decbell (dB) in the better hearing ear. For children (0 to 14 years), the WHO has defined a hearing loss exceeding 30 dB in the better hearing ear as disabling.

Hearing loss is considered one of the most prevalent global health concerns. In 2017, the WHO estimated the prevalence of worldwide hearing loss to be 466 million people. Of these, 34 million individuals are children. By 2050, it is predictable that more than 900 million people will have disabled hearing loss. According to Parving and international statistics, children with hearing loss are two to six per 1000 live birth **(WHO, 2017).**

Subjects& Methods

Research design

A cross-sectional research design was used to achieve the aim of the current study.

Subjects:

The sample size was calculated using the Epi Info program software program depending on the total number of neonates attending the two PHC centers and the prevalence of neonatal hearing loss. It was 2253 and 3149 for Western and Eastern Center, respectively **(Information Center at Health Directorate, Minia Governorate 2020),** and prevalence of neonatal hearing loss. The total sample was 463 (235 in Eastern Center and 228 in Western Center).

Study settings:

This study was conducted at Minia Eastern Health Center and Minia Western Health Center at Minia city. These centers were randomly selected from the list of the Maternal and child health (MCH) centers at Minia city. These two centers had the largest frequency of neonate attendance; they are considered the two largest centers in Minia; they are the two centers where audio scanning takes place and is not found on other centers.

Tools of data collection:

The data was collected using a well-designed structured questionnaire; the questionnaire included two tools as follows:

Tool I: included three parts:

The first part related to mother and neonate Socio-demographic data: Included nine (9) questions (Name of neonate & age of neonate, sex, residence, number of family members, father education, mother education, occupation of father, and occupation of mother).

The second part related to the medical history of the mother: Included five (5) questions about consanguineous marriage, family history of hearing loss, ear infection, any problems with the structure of the inner ear, and tumors.

The third part is related to the Risk factors of the mother:

a) During pregnancy, Included sixteen (16) questions about toxemia, toxoplasmosis, rubella virus, cytomegalovirus, Hemophilus influenza, mumps, preeclampsia, syphilis, plasmodium falciparum, streptococcus pneumonia, Neisseria meningitides, gestational diabetes, thyroid dysfunction, cytomegalovirus, prom (premature ruptures of membrane), and drugs.

b) During delivery: Included four (4) questions about preterm labor, post-term labor, cesarean section (C.S.), and perinatal infections.

c) Neonatal risk factors: Included sixteen (16) questions (APGAR) score less than 4, preterm neonate, post-

term neonate, birth weight of less than 2500g, more than 4 kg, neonate, neonatal hyperbilirubinemia, cephalohematoma, caputcusedenum, head injury, craniofacial anomalies, respiratory distress, hypoglycemia, hypoxia, intracranial hemorrhage, neonatal sepsis, and admitted in neonatal intensive care unit.

Tool II: Auditory Brainstem Response (ABR) test:
Brainstem response tests (ABR) check the brain's response to sound.

Validity of the tools:
The tools were tested for content validity by five experts in community health nursing, Faculty of Medicine from Minia University, and community health nursing from Assiut University evaluated the developed tools.

Reliability of the tool:
The reliability of tools done to third part about risk factors of the mother using the coefficient test to confirm its consistency was 0.750.

Study procedure:
- An official letter was requested from the Dean of the faculty of Nursing at Minia University to the director of MCH Centers at Minia, asking for permission to collect data.
- They met with the MCH Centers manager to explain the objectives and aim of the study, which helped to gain their cooperation and allow a meeting with women.
- The investigator attended MCH Centers to collect the data for (24 weeks) All data collection duration was taken (Saturday and Tuesday every Week for Six months).
- The time it takes for each to do the procedure and fill out the questionnaire is about 30 to 45 minutes.
- An auditory brainstem response (ABR) test is safe and painless to see how the hearing nerves and brain respond to sounds. It gives health care providers information about possible hearing loss.

Ethical Consideration:
For ethical considerations, approval was obtained from the faculty of the nursing ethical committee, and official permission was taken from the center administrators. Also, each parent of an infant neonate was informed about the purpose and nature of the study. Then was the emphasis that participation in the study is entirely voluntary; anonymity and confidentiality were assured through coding the data also that information gathered from the study was not used for another purpose than the purpose of the study. Oral consent was taken from infant neonate parents who accept to be included in the study.

Statistical analysis of data
The collected data of the study tools were categorized, tabulated, and analyzed, and data entries were done using SPSS software version 20 (Statistical Package for Social Science). Data were presented using descriptive statistics in frequencies and percentages, mean, standard deviation, and chi-square. Tests of significance were performed to test the study hypotheses Statistical significance was considered at a P -value ≤ 0.05 and logistic multivariable regression analysis was used to predict the most related risk factors for hearing loss among the studied sample.

Results:

Table (1) Distribution of the studied neonates regarding their socio-demographic characteristics (n=463).

Demographic characteristics	No	%
Sex		
Male	217	46.9
Female	246	53.1
Residence		
Rural	224	48.4
Urban	239	51.6
Urban		
Child order		
First child	65	14.0
Second to a fifth child	216	46.7
More than a fifth child	182	39.3
Education of father		
Illiterate	24	5.2
Primary education	61	13.2
Secondary education	208	44.9
University education	170	36.7
Education of mother		
Illiterate	53	11.4
Primary education	68	14.7
Secondary education	196	42.3
University education	146	31.5
Occupation of father		
Professional	35	7.6
Employee	238	51.4
Farmer	109	23.5
Worker	78	16.8
Non-worker	3	0.7
Occupation of mother		
Professional	12	2.6
Employee	177	38.2
Housewife	274	59.2

Table (1) shows that 53.1% of participants were female, and 51.6 % of them lived in rural areas. 46.7% of the participants have 2-5 members. Regarding the parents' education, 44.9% & 42.3% of the fathers and mothers respectively had secondary education. Also, the table reveals that regarding the parents' occupation, 51.4% of the fathers were employees, and 59.2% of the mothers were housewives.

Table (2) Frequency distribution of mothers' medical history (n=463):-

Items	NO	%
You and your husband relatives?		
Yes	131	28.3
no	332	71.7
If yes, degree of kinship		
relatives from 1st degree	55	41.9
relatives from 2ed degree	36	27.5
relatives from ٣rd. degree	20	15.3
relatives from 4th degree	20	15.3
Family history of hearing loss?		
Yes	55	11.9
no	408	88.1
If yes, who?		
relatives from 1st degree	33	60.0
relatives from 2ed degree	22	40.0
Are you exposed to ear infection		
Yes	67	14.5
no	396	85.5
There is any Problems with the structure of the inner ear?		
Yes	28	6.0
no	435	94.0
If yes, there a Tumors?		
Yes	1	3.6
no	27	96.4

Table (2) shows that only 28.3% of mothers had a kinship to their husband and 41.9% of them were relatives from 1st degree. 88.1% of all mothers had no family history of hearing loss. Regarding the exposure to ear infection 85.5% of the mothers were not exposed to this infection previously. Also, 94.0% and 96.4% of mothers had not any problems with the structure of the inner ear or tumors respectively.

Table (3) Frequency distribution of the neonatal risk factor

Exposed to	Yes		No	
	No	%	No	%
• APGAR score less than 4	0	0.0	423	91.4
• Preterm neonate	43	9.4	416	89.8
• Post-term neonate	31	6.7	431	93.1
• Weighted less than 2500g	59	6.3	434	93.7
• Weighted more than 4kg	41	8.9	422	91.1
• Neonatal hyper-bilirubinemia	53	11.4	409	88.4
• Admitted in NICU	74	16.0	388	83.8
• Cephalo-hematoma	8	1.7	455	98.3
• Caputcsedenum	0	0.0	460	99.4
• Head injury	4	0.8	459	99.2
• Craniofacial anomalies	0	0.0	463	100.0
• Hypoxia	50	10.8	408	88.1
• Respiratory distress	95	20.5	346	74.7
• Hypoglycemia	33	7.2	427	92.2
• Intracranial hemorrhage	3	0.6	460	99.4
• Neonatal sepsis	19	4.1	442	95.5

Table (3) displays that No one 0.0% of the neonates had APGAR score less than 4, 9.4% were preterm neonates, and 6.7% were post-term neonates. Regarding the weight of the neonates, 6.3% of them weighed less than 2500g, and 8.9% weighted more than 2500g at birth. 11.4% of them experience neonatal hyper-bilirubinemia. 16.0% of them were admitted to NICU, 1.7% were diagnosed with Cephalo-hematoma, only 0.8% of the studied neonates had a head injury, and 10.8% and 20.5% had hypoxia and respiratory distress, respectively. Also, 7.2% of neonates suffer from hypoglycemia at birth. 0.6% of them were diagnosed with intracranial hemorrhage, and 4.1% had neonatal sepsis.
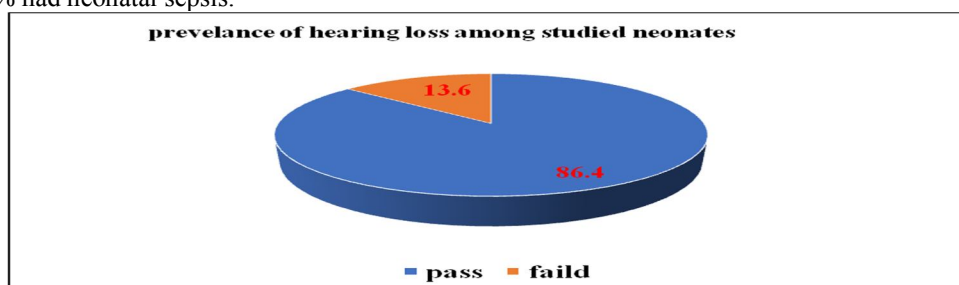

prevelance of hearing loss among studied neonates

- pass: 86.4
- faild: 13.6

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Table (4) Prevalence of hearing loss in the yest one and two among studied neonates in both ears (n=463).

Items	Pass		Failed	
	NO	%	NO	%
• Test one for right ear Pass	393	84.9	70	15.1
• Test one for left ear Pass	378	81.6	85	18.4
• Test Two for right ear Pass	47	67.1	23	32.9
• Test Two for left ear Pass	42	49.4	43	50.6

Table (4) shows that 15.1% &18.4% of all studied neonates failed the first right and left ear test. Out of 70% neonates who failed the first test for the right ear, 32.9% failed in the second test, and out of 85 neonates who failed the first test for the left ear, 50.6% failed in the second test.

Table (5) Percentage distribution of prevalence for hearing loss among studied neonates (n=463):

Hearing loss	NO	%
• No	400	86.4
• Yes	63	13.6
• If yes, Unilateral	60	95.2
• Bilateral	3	4.8

Table (5) shows that 13.6% of studied neonates had a hearing loss, and 95.2% of those who had lost were unilateral loss and only 4.8% bilateral loss.

Table (6) Relation of hearing loss to maternal history risk factors among studied neonates (n=463).

Risk factors	Hearing loss				X^2	P-value
	present		Not present			
	NO	%	NO	%		
Consanguition and family history						
• Yes	41	31.3	90	68.7	11.41	.125·
• no	22	16.6	310	93.4		
If yes, the degree of kinship.						
• relatives from 1st degree	15	27.3	40	72.7	11.21	0.117
• relatives from 2ed degree	13	36.1	23	63.9		
• relatives from 3rd. degree	10	50.0	10	50.0		
• relatives from 4th degree	3	15.0	17	85.0		
Family history of hearing loss						
• Yes	45	81.8	10	18.2	87.22	.001*·
• no	18	4.4	390	95.6		
If yes, who?						
• relatives from 1st degree	28	84.8	5	15.2	1.09	.618·
• relatives from 2ed degree	17	77.3	5	22.7		
You were exposed to an ear infection.	230	34.3	44	65.7	33.29	.751·
• There are any problems with the structure of the inner ear.	14	77.8	14	22.2	40.08	.324·
• There are any problems with the structure of the inner ear?	14	77.8	14	22.2	40.08	.324·

Table (6) shows that 65.1% of the parents of studied neonates with hearing loss were relatives, 36.6% of the relatives from 1st degree, 71.4% had a family history of hearing loss, 36.5% were exposed to ear infection, 22.2% had a problem with the structure of the inner ear, and 7.1% of them had a tumor.

Table (7) Logistic multivariable regression analysis predicts the most related risk factors for hearing loss among the studied sample (n=463).

Risk factors	Odds Ratio (OR)	95 % CI (OR)	P-value
Preterm neonate	2.8	1.04 - 15.7	0.07*
Family history of hearing loss	1.7	0.73 – 6.3	0.04*
Respiratory distress	0.2	0.06 – 0.7	0.02*
Hypoxia(perinatal asphyxia)	0.2	0.06 – 0.7	0.01*
neonatal hyper-bilirubin mea	1.3	0.62 – 4.4	0.04*
Congenital infection	0.6	0.81-1.02	0.01*
Neonatal sepsis	0.3	0.06-0.8	0.05*
Admitted in NICU	3.5	1.2– 23.5	0.01*

Table (7) shows that preterm neonates were 2.8 times higher to have hearing loss than full-term neonates, and studied neonates who had a family history of hearing loss were 1.7 times higher to have hearing loss than those who had not. Regarding neonates diagnosed with respiratory distress isnd hypoxia was 0.2 times higher to have hearing loss than normal respiration. Neonates with hyper-bilirubinemia were1.3 times higher to have hearing loss than those with normal levels. Also, neonates with congenital infection and neonatal sepsis were 0.6 and 0.3 times higher to have hearing loss than those who had not been infected. Neonates admitted for more than four days in NICU were 3.5 times higher to have hearing loss than those not required to admit to NICU, and these findings were significant.

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Discussion

The current study displayed that no one of the neonates had APGAR score eighth of them were preterm neonates and were post-term neonates. In the investigator point of view this result was due to no APGAR score, preterm neonates and post-term neonates from the risk factors of the neonates hearing loss.

This study agreed with the study of **Hrnčić, (2018)** who conducted a study about "Identification of risk factors for hearing loss" who indicated that APGAR score was not noted in low percent of the newborns that had hearing loss. This study disagree with the study of **Maqbool et al., (2015)** who conducted a study about "Screening for hearing impairment in high risk neonates" who found that the majority of newborns APGAR score was noted, the lowest percent had a low score, while the lowest APGAR score was two in the first and five in the fifth minute.

The current study showed that regarding prenatal risk factors of the neonates the lowest percent of them had low percent of them weighed less than 2500g, and less than eighth weighted more than 2500g at birth. Eighth of them experience neonatal Asphyxia and hyper-bilirubinemia. Eighth of them admitted more than 4 days in NICU, diagnosed with Cephalo-hematoma, only low percent of the studied neonates had a head injury, and less than eighth and less than quarter of them had Hypoxia and respiratory distress. Also, the lowest percentage of neonates suffer from hypoglycemia at birth, have diagnosed with intracranial hemorrhage and of them had neonatal sepsis and craniofacial anomalies, this finding associated with a syndrome known to include hearing loss. There were one quarter of the total number of screened newborns with one or more known risk factors for hearing impairment. In the investigator opinion because of this risk factors have a great influence on the hearing of the newborn it causes problems or loss in hearing to the neonates.

This result agreed with the study of **James, et al., (2018)** who conducted a study entitled "A study on prevalence and risk factors of hearing impairment among newborns in Alappuzha " who stated that in his results preterm birth was more than eighth of the study sample, perinatal asphyxia, hyperbilirubinemia requiring phototherapy, congenital infection, family history of hearing impairment, NICU admission more than 5 days, culture positive sepsis all of this neonate had hearing impairment.

This result agreed with the study of **Maharani, et al. (2015)** who conduct a study about "Risk factors for hearing loss in neonates" who stated in his study the risk factor for hearing loss in neonates" include preterm birth, perinatal asphyxia, hyperbilirubinemia requiring phototherapy, congenital infection, family history of hearing impairment, NICU admission more than 5 days, culture positive sepsis and babies who received ototoxic medicine.

The current study showed that regarding mothers who had a newborn with hearing loss the lowest percent of them were diagnosed with toxemias, those mothers were diagnosed with toxoplasmosis and rubella virus, eighth of them suffer from homophiles influenza. Also, the lowest percent of those mothers diagnosed with Neisseria meningitis, eighth of them had streptococcus pneumonia. Low percent of the studied mothers took medication during pregnancy, less than half of them were diagnosed with gestational diabetes, eighth of the mothers have had PROM, eighth of them

diagnosed with Pre-eclampsia, and eighth of the studied mothers suffering from thyroid dysfunction.

In the investigator point of view this due to when the mothers had toxemia, toxoplasmosis during their pregnancy and suffered from syphilis, rubella virus, Haemophilus influenza, or had Lassa virus, mumps virus, Neisseria meningitis, had Streptococcus pneumonia, mothers take medication during the pregnancy or the mothers diagnosed with gestational diabetes, a PROM the mothers had Pre-eclampsia and the lowest had thyroid dysfunction all of these diseases will expose the mother to have baby with congenital anomalies and from this anomalies neonate hearing loss.

This study was in consistent with the study of **Kelsey, et al., (2017)** who conducted study about "High risk factors associated with early childhood hearing loss" who showed no association between hearing loss and congenital herpes, rubella, syphilis, or toxoplasmosis and meningitis.

The current study showed that regarding mothers who had a newborn with hearing loss more than half of them had caesarean section delivery and eighth of them had perinatal infections. In the investigator point of view this due to that the caesarean section delivery and perinatal infections from the causes that would expose the neonates to hearing loss.

This study in parallel with the study of **Hrnčić, (2018)** who indicated that caesarean section delivery and perinatal infections was documented in eighth of newborns with the mothers who their neonates was risk factor for hearing impairment. This result was similar to **Khairy et al., (2018)** who conducted a study about "Hearing loss among high-risk newborns admitted to a tertiary neonatal intensive care unit" who found that one third of the caesarean section delivery and perinatal infections of the mothers had neonates having pathological hearing loss.

The current study showed that regarding natal risk factors neonates with hearing loss no one of the neonates had APGAR score less than 4, two third of them were preterm neonate, less than eighth of them were post-term neonate, third weighted less than 2500g at birth, third weighted more than 2500g at birth, three quarter had neonatal hyper-bilirubinemia, the majority of the sample admitted more than 4 days in NICU, 6.3% cephalo-hematoma, 1.6 % had head injury, three quarter of the studied neonates had hypoxia, half had respiratory distress, less than quarter of them had hypoglycemia, 1.6% Intracranial hemorrhage, and more than quarter of them had neonatal sepsis. In the investigator point of view this due to all of these was a risk factors that causing hearing loss in the neonates .

This result was supported with the **American Speech-Language-Hearing Association, (2017)** who conducted a study about "Hearing facts on newborn hearing loss and screening" who stated that Asphyxia, APGAR score less than 4, preterm neonate or post-term neonate, weight less than 2500g at birth, neonatal hyper-bilirubinemia, admission more than 4 days in NICU, cephalo-hematoma, head injury, hypoxia, respiratory distress, hypoglycemia, Intracranial hemorrhage, and neonatal sepsis was identified as risk factors to hearing loss in neonates. In supported to this result the study of **El-sheikh, et al., (2020)** who conducted a study about "Hearing Affection in High Risk Neonates" who stated that ototoxic medications was the most common risk factor identified in the majority of studied group followed by assisted ventilation more than 5 days three quarter,

prematurity two third low birth weight two third, septicemia half and perinatal asphyxia eighth. In agreement to the study of **Di Stadio et al., (2019)** who conducted a study about "Sensor neural hearing loss in newborns hospitalized in neonatal intensive care unit" who performed a study on newborns hospitalized in NICU and found that the most common risk factor was prematurity followed by stay in NICU more than 5 days.

This study incongruent with some research as **Kraft, Malhorta, Boerst, & Thorne, (2014)** who conducted a study about "Risk indicators for congenital and delayed-onset hearing loss" they did not find an association between specific risk factors and hearing loss. This study inconsistent with **Pearson, Mann, Nedellec, Rees, & Pearce, (2013)** who conducted a study about "Childhood infections, but not early life growth, influence hearing in the Newcastle thousand families" who indicated that there was no relation between risk factors and hearing loss as low birth weight, congenital infections, NICU stay greater than 5 days, ototoxic medication treatment, mechanical ventilation, syndromes, craniofacial anomalies. This study disagreement with **Pourarian, Khademi, Pishva, & Jamali, (2012)** who conducted a study about "Prevalence of hearing loss in newborns admitted to neonatal intensive care unit" who stated that there were no association between specific risk factors and hearing loss as low birth weight, congenital infections, NICU stay greater than 5 days, ototoxic medication treatment, mechanical ventilation, syndromes, craniofacial anomalies.

The current study showed that minority of studied neonates had a hearing loss, and the majority of those who had loss were unilateral loss and lowest percentages bilateral loss. In the investigator point of view this due to every one of those neonates had one or more from the risk factors that causing hearing loss .

This result in the same line with the study of **Wroblewska-Seniuk et al., (2017)** who conducted a study about "Hearing impairment in premature newborns" who found that neonates had a hearing loss, and the majority of those who had loss were unilateral loss and lowest percentages bilateral loss. Also this result hand by hand with the study of **Jackson, et al., (2018)** who conducted a study about "Association between furosemide in premature infants and sensor neural hearing loss and nephron-calcinosis" who found that neonates had a hearing loss, and the majority of those who had loss were unilateral loss and lowest percentages bilateral loss. Also, **Yenamandra et al., (2018)** who conducted a study about "Universal hearing screening of newborn to detect hearing loss and aid in early intervention" performed a study at risk neonates and found that third of the study sample had failed the OAE but passed the A-ABR during the newborn hearing screening were identified with permanent bilateral or unilateral hearing loss. Three quarter of them had mild hearing loss.

The current study showed that less than quarter of all studied neonates failed in the first test for the right and left ear. Out of three quarter of neonates who failed in the first test for the right ear one third were failed in the second test and out of one third of neonates who failed in the first test for the left ear half were failed in the second test. In the investigator point of view this failure in the tests of hearing due to these neonates had hearing difficulties .

This study contradicted line with the study of **Khairy et al., (2018)** who conducted a study about "Hearing Loss among High-risk Newborns Admitted to a Tertiary Neonatal Intensive Care Unit" who found that half of the studied neonates had failed oto-acoustic emission (one third bilaterally failed and eighth unilaterally failed) and one half of the studied neonates had passed otoacoustic emission. In the failed group, one third were bilaterally failed while eighth were unilaterally failed. This result inconsistent with the study of **Nair et al., (2018)** who conducted a study about "Prevalence and risk factors of hearing impairment among neonates admitted in NICU in a tertiary care" who performed a study on neonates, half of them failed the initial OAE screening. Results of first OAE screening were analyzed and it showed both ears pass in half of them neonates, while one quarter of neonates had both ears failure. One eighth of neonates showed only left ear failure and lowest percentage of neonates showed only right ear failure .

The current study demonstrated that two third of the parents' of studied neonates with hearing loss were relatives, third of them relatives from 1st degree, three quarter had family history of hearing loss, third were exposed to ear infection, quarter had a problems with the structure of the inner ear, and the lowest percentage of them had a tumor. In the investigator point of view this due of the marriage of relatives of 1st degree consider from the risk factor of hearing loss this causing many of heredity diseases.

In the light of this study **Hrnčić, (2018)** who indicated that the majority of the newborns with risk factors for hearing impairment there were with known heredity also there were less than half of relatives with impaired hearing from the father's side and two third of relatives with impaired hearing from the mother's side. The same author indicated that risk factors for hearing impairment identified in the study included family history of permanent childhood hearing impairment (PCHI). Similar results were the study of **Regina, et al. (2017)** who conducted a study about "Audiological screening of high risk infants and prevalence of risk factors" who stated that in studies from India that the conclusion of a large retrospective study was that children with a family history of hearing loss should be followed up during the childhood. In the same line with this result the study of **Gouri, et al. (2015)** who conducted a study about "Hearing impairment and its risk factors by newborn screening in north-western India" who indicated that the majority of the study was children with a family history of hearing loss should be followed up during the childhood.

The current study revealed that preterm neonates were 2.8 times higher to have hearing loss than full-term neonates, and studied neonates who had a family history of hearing loss were 1.7 times higher to have hearing loss than those who had not. Regarding neonates who were diagnosed with respiratory distress and hypoxia were 0.2 times higher to have hearing loss than with normal respiration. Neonates with hyper-bilirubinmea were1.3 times higher to have hearing loss than those with normal levels. Also, neonates with congenital infection and neonatal sepsis were 0.6 and 0.3 times higher to have hearing loss than those who had not been infected. Neonates who were admitted more than 4 days in NICU were 4.5 times higher to have hearing loss than those not required to admit to NICU, and these findings were significant. In the investigator point of view this due to there were a strong relation between the risk factors and hearing lose .

This results in the same line with the study of **Wroblewska-Seniuk et al., (2017)** who conducted a study about "Hearing impairment in premature newborns" who found that the most frequent risk factor in preterm neonates <

33 weeks (preterm) was exposure to ototoxic medications, followed by low birth weight < 2500 g, treatment in the intensive care unit, neonates with hyper-bilirubinmea, neonates with congenital infection, neonatal sepsis and, neonates who were diagnosed with respiratory distress and hypoxia. The use of ototoxic medications was also the most frequent risk factor in infants > 33 week gestational age. In contrast to our study was **Di Stadio et al., (2019)** who conducted a study about "Sensor neural hearing loss in newborns hospitalized in neonatal intensive care unit" who reported that newborns hospitalized in NICU and found that the most common risk factor was prematurity followed by stay in NICU more than 5 days, neonates with hyper-bilirubinmea, neonates with congenital infection, neonatal sepsis and, neonates who were diagnosed with respiratory distress and hypoxia and, neonates who had a family history of hearing loss.

Conclusion

The current study concluded from the current study that most common maternal and neonatal risk factors were caesarean section, gestational diabetes, and premature rupture of membrane pre-eclampsia, neonatal respiratory distress, admission to neonatal intensive care unit, neonatal hyperbilirubinemia and neonatal hypoxia. The majority of the studied neonates not had hearing loss and the minority of them had hearing loss in unilateral ears.

Recommendations

Based on the current study's findings, the following recommendations were suggested:

- Health education to mothers about the risk factor of hearing impairment.
- Screen risk factors neonates for hearing impairment who admitted to neonatal intensive care unit.
- Both otoacoustic emission and auditory brainstem response are good tools for screening neonatal hearing states.
- ABR test is more realistic than otoacoustic emission in the diagnosis of hearing impairment in neonates

Acknowledgments

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