Correlation between hearing loss and risk indicators in a neonatal hearing screening reference service

Correlação entre perda auditiva e indicadores de risco em um serviço de referência em triagem auditiva neonatal

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ABSTRACT

Purpose: To investigate the correlation between risk indicators and hearing impairment in infants of a Newborn hearing screening program **Methods:** A retrospective study with 3151 newborn records with and without risk indicator for hearing loss, followed-up by a Newborn hearing screening program at a Public Hospital in the city of Belo Horizonte (MG). **Results:** In the group without risk indicators, the incidence of hearing loss was 1.04%: 0.04% were sensorineural and 0.99% were conductive. In the group with risk indicators, the incidence of hearing loss was 8.38% (5.27% conductive and 3.1% sensorineural). In the high risk group one child (0.33%), who passed the screening, was diagnosed during the follow up with bilateral sensorineural mild hearing. The most common risk indicators were neonatal intensive care of >5 days (43.47%) followed by use of ototoxic drugs, (29.81%) and mechanical ventilation (28.88%). It was observed that children with suspected syndromes have 18 times more chance of acquiring sensorineural hearing loss. **Conclusion:** The risk indicator which correlated to hearing loss was suspicion of syndromes. Health promotion actions are necessary to reduce the presence of risk indicators found in the served population.

Keywords: Neonatal Screening; Hearing; Hearing Loss; Risk Index; Audiology

RESUMO

Objetivo: Verificar a ocorrência de perda auditiva e a sua correlação com os indicadores de risco, em bebês de um Serviço de Referência de Triagem Auditiva Neonatal. **Métodos:** Estudo retrospectivo com casuística composta por 3151 prontuários de bebês, dos quais 803 apresentaram indicadores de risco para a deficiência auditiva. O estudo foi realizado em um Serviço de Referência em Triagem Auditiva Neonatal de um Hospital Universitário na cidade de Belo Horizonte (MG). A coleta dos dados abrangeu o período de janeiro de 2009 a dezembro de 2010. **Resultados:** No grupo sem indicadores de risco, a ocorrência de perda auditiva foi de 1,04%, sendo 0,04% do tipo neurossensorial e 0,99% do tipo condutiva. No grupo com indicadores de risco, a ocorrência de perda auditiva foi de 8,38%: 3,10% do tipo neurossensorial e 5,27% do tipo condutiva. Na etapa de acompanhamento, uma criança (0,33%) obteve diagnóstico de perda auditiva neurossensorial de grau moderado bilateral. Os indicadores de risco mais frequentes na população estudada foram a permanência em UTI neonatal por mais de cinco dias, com 43,47%, seguido de uso de ototóxicos, 29,81% e ventilação mecânica, 28,88%. Foi observado que crianças com suspeita de síndromes têm 18 vezes mais chance de apresentar perda auditiva neurossensorial. **Conclusão:** A ocorrência de perda auditiva foi maior no grupo de crianças com indicadores de risco. O indicador de risco que apresenta correlação com a presença de perda auditiva neurossensorial é a suspeita de síndromes. Verifica-se a necessidade de desenvolvimento de ações de promoção da saúde para diminuição dos indicadores de risco encontrados na população atendida.

Descritores: Triagem Neonatal; Audição; Perda Auditiva; Indicador de Risco; Audiologia

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INTRODUCTION

The purpose of the neonatal hearing screening (NHS) is to identify hearing loss and enable early intervention in order to provide adequate global development of the child with this alteration. A survey with the results of the NHS programs in Rhode Island, United States, from 1993 to 1996, found a hearing loss rate of 2:1000. From these results, actions to anticipate the age of identification and intervention in hearing loss in infants[1] were proposed.

The *Joint Committee on Infant Hearing* (JCIH) in 1994[2], recommended the Universal Neonatal Hearing Screening (UNHS), i.e., in all neonates and not just in those with risk indicators for hearing loss (RIHL). In 2000, this same committee recommended intervention until the sixth month of life[3].

In Brazil, the Brazilian Committee on Hearing Loss in Childhood (CBPAI), in 1999, recommended the UNHS through Evoked Otoacoustic Emissions (EOAEs), hearing behavioral assessment and Auditory Brainstem Responses (ABR)[4]. Subsequently, the Multiprofessional Committee on Hearing Health (COMUSA) published a document containing recommendations of quality indicators for the implementation and evaluation of actions for the full attention to hearing health during childhood[5].

Hearing loss does not involve risk to life, but compromises the psychointelectual and psychosocial development of the child. It is a very frequent congenital alteration, being more prevalent than other diseases that are routinely included in the mandatory neonatal screening, such as phenylketonuria and congenital hypothyroidism[6,7].

The early identification of hearing impairments allows for intervention still in the "*critical period*", ideal for language and hearing stimulation. The maturation of the central auditory system occurs during the first years of life. The language and hearing development occurs during this period of greater neural plasticity, with establishment of new neural connections. Therefore, the hearing experience is essential at this time[8]. Thus, the early identification and intervention in hearing loss enable children with hearing impairment to achieve communicative performance very close to that of hearing children[9].

Researchers stressed that the prevalence of hearing loss in apparently normal neonates is of 1:1000 and increases to 1:50 in children with RIHL[10], whereby these indicators may present variable occurrence[11-13].

COMUSA, in its recommendations, mentions that the implementation of a neonatal hearing health program should include all actions for prevention, diagnosis and rehabilitation of hearing loss, including prevention of hearing loss through specific measures to be applied after epidemiological prevalence studies and determinants of hearing loss in neonates[5].

A recently published study suggests that each neonatal intensive care unit shall determine its own risk indicators and develop actions to prevent hearing loss[14].

The importance of the survey of risk indicators for infantile hearing loss is also related to the fact that many of these indicators can lead, at a later date, to hearing loss and/or progression of existing hearing loss at birth[6].

Thus, the purpose of this study was to verify the occurrence of hearing loss and its correlation with the risk indicators in infants monitored by a Neonatal Hearing Screening Reference Service (NHSRS) of a University Hospital from January 2009 to December 2010.

METHODS

This is a retrospective descriptive study. The study of cases consisted of 3185 records of infants with and without RIHL, in a NHSRS of the Hospital das Clínicas of the Federal University of Minas Gerais (UFMG), a reference in high-risk pregnancies in the State of Minas Gerais, accredited by the State Department of Health (SES-MG). Thirty four records were excluded due to lack of data as: complete medical history, results of transient otoacoustic emissions (TOAEs) of the ABR or Hearing Behavioral Assessment totaling therefore 3151 records.

The children were sent from January 2009 to December 2010 by the hospital itself (when assisted in the neonatal intensive care unit, NICU, after discharge), or by the Basic Health Units (UBS) of the city of Belo Horizonte (MG), according to the guidelines of the Resolution SES-MG No. 1321, which Establishes the State Program of Neonatal Hearing Screening (PETAN)[15].

The children referred by the UBS appeared after 15 days of life. The average age of the population assisted in the hearing screening test, including the infants from the ICU was 64 days.

The RIHLs considered in this study were based on those proposed by the *Joint Committee on Infant Hearing* (JCIH)[2,16]. The children whose mothers were seropositive for HIV (*Human Immunodeficiency Virus*)[17] were also included in the group with RIHL.

The screening was performed through TOAEs or ABR and the Cochleopalpebral Reflex (CPR)[18], with the agogo instrument (single bell) at the intensity of 100 dBNPS. The care protocol followed the guidelines of the PETAN of the SES-MG[15]. When there was a "failure" in the hearing screening test, a new test was performed in approximately 15 days. In cases where there was "failure" in the hearing screening retest, the child was referred to the Hearing Health Care Unit (SASA) of the same hospital for diagnostic evaluation. For children who have "passed" in the screening, guidelines on the child hearing and linguistic development were given to their parents and, for those with RIHL, the audiological follow-up was also indicated, six months after the hearing screening.

The TOAEs were surveyed in 2524 children with the equipment ILO292 USB Echoport, of the Otodynamics® brand. The adopted emission registration protocol used nonlinear stimuli clicks at an intensity of 80 dBNPS and the testing window

was of 12 milliseconds, with 512 stimuli. The TOAEs were considered present when the reproducibility was greater than or equal to 70% and the S/N (signal/noise) ratio, greater than or equal to 6 dB.

During the studied period, the screening with the ABR was made in 627 children using the equipment Navigator Pro of the Biologic® brand, with the software EP Potentials, screening mode, with click stimulus, presentation rate of 21.1 clicks per second, with two recording channels, rarefaction polarity and stimulation of 35 dBHL, with supra-aural phones. The criterion adopted for the result "pass" in the screening was the presence of V wave in the researched intensity.

The medical records of the children were divided into two groups: without RIHL and with RIHL. Then, they were distributed into two flowcharts that considered the number of "pass", "fail"; "pass" retest; "fail" retest; follow-up (for the group with RIHL) and auditory diagnosis. The risk indicators were investigated and correlated to the audiological results.

The collected information was entered into a database developed in Excel. For the association analyzes, the *software* Statistical Package for Social Sciences (SPSS) 15.0 for Windows - SPSS Incorporation, Chicago, Illinois, United States, 2008 was adopted.

To characterize the sample, flowcharts and frequency distribution tables were elaborated.

To check the association between the categorical variables, the Pearson Chi-square test or Fisher's test was applied when samples with small frequencies were used. The risk difference between the categories was quantified by the *Odds Ratio* and Confidence Interval. A significance level of 5% was considered.

This study was approved by the Ethics Committee in Research of the UFMG - COEP, on January 17, 2012, with the opinion number 577/11.

RESULTS

Of the 3151 children included in this study, 25.4% presented at least one risk indicator for hearing loss. The profile of the two groups sorted by the NHSRS during the studied period according on the gestational age, prematurity, weight and gender, is outlined in Table 1.

In the patient care flow analysis in the NHSRS, of 2348 children without RIHL (Figure 1), it was observed that 2056 (87.1%) "passed" and were discharged. Of the 292 (12.4%) children who "failed" the screening test and were referred for screening-retest, only 154 (52.7%) attended.

Of the 61 (20.8%) children without RIHL referred to diagnosis, only 28 (45.9%) completed this step.

In the group without RIHL, that completed all steps of the UNHS, it was observed the occurrence of 1.04% of hearing loss, whereby 0.04% (n=1) sensorineural hearing loss and 0.99% (n=22) conductive hearing loss.

The patient care flow analysis in the NHSRS of the 803 children with RIHL (Figure 2) showed that 583 (72.6%) "passed" and followed in the program with follow-up and 360 (61.74%) did not attend the follow-up.

Of the 220 (27.3%) children with RIHL that "failed" in the screening test, 80 (36%) "passed" in the screening retest and

Table 1. Profile of the children with and without risk indicators, referred to a Neonatal Hearing Screening Reference Service of a University Hospital of Belo Horizonte from January 2009 to December 2010

Characteristics	Group without RIHL (n=2348)	Group with RIHL (n=803)
Gestational age (weeks)		
Minimum	30	24
Maximum	44	42
Medium	38.89	36.57
Standard deviation	1.54	3.6
Weight		
Minimum	1620.00	309.00
Maximum	4800.00	5500.00
Medium	3147.30	2679.79
Standard deviation	457.80	848.41
Gender		
Female	1153 (49.1%)	387 (48.2%)
Male	1195 (50.9%)	416 (51.8%)
Premature		
No	2214 (94.3%)	501 (62.4%)
Yes	134 (5.7%)	281 (35%)

Note: RIHL = Risk Indicators for Hearing Loss

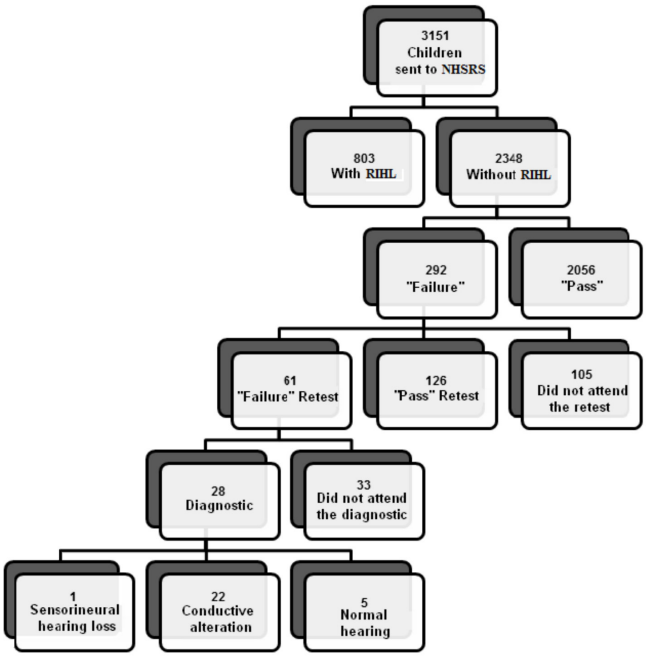

Figure 1. Follow-up of infants without risk indicators for hearing loss (RIHL) referred to a Neonatal Hearing Screening Reference Service (NHSRS) of a University Hospital of Belo Horizonte from January 2009 to December 2010

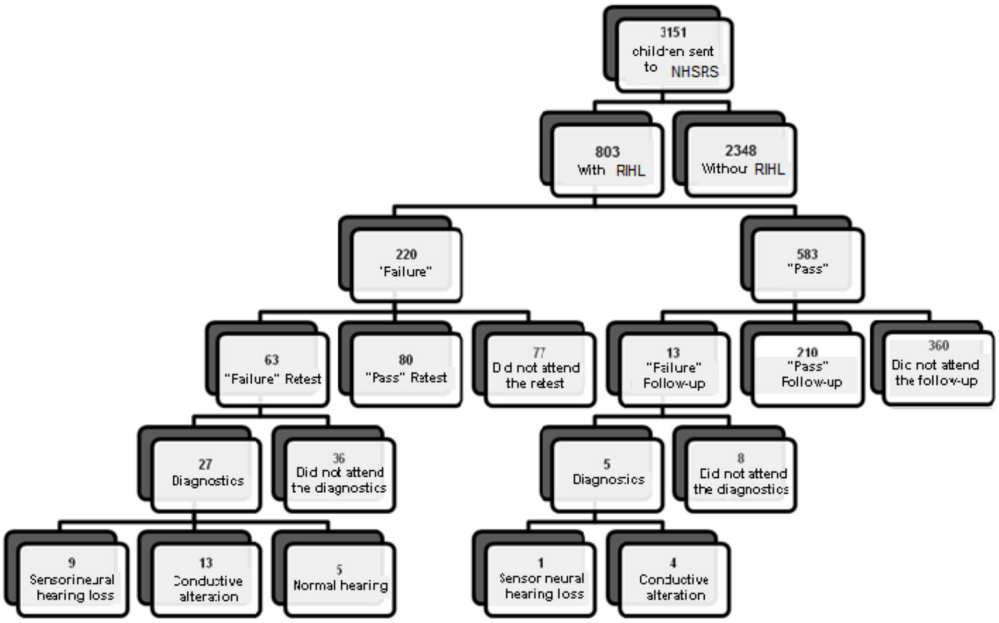

Figure 2. Follow-up of infants with risk indicators for hearing loss (RIHL) referred to a Neonatal Hearing Screening Reference Service (NHSRS) of a University Hospital of Belo Horizonte from January 2009 to December 2010

followed with follow-up until discharge, after six months, and 77 (35%) did not attend the screening retest.

Sixty three children with RIHL were referred for diagnosis and only 27 (42.8%) completed this step.

The occurrence of hearing loss in the group with RIHL was of 8.38%, whereby 3.10% (n=9) presented sensorineural hearing loss and 5.27% (n=13) presented conductive hearing loss.

In the follow-up step, hearing loss was detected in five children with occurrence of 1.69%, whereby 0.33% (n=1) presented sensorineural hearing loss and 1.35% (n=4) presented conductive loss.

The most frequent RIHL was the stay in ICU for more than five days, representing 43.47% (n=140), followed by use of ototoxics, 29.81% (n=96) and mechanical ventilation, 28.88% (n=93). However, only the suspicion of syndrome was statistically significant for the presence of hearing loss (p<0.001). The analysis revealed that a newborn with suspicion of syndrome has 18 times more chance to have hearing loss compared with those without suspicion of syndromes (Table 2).

Of the ten children with RIHL and diagnosis of sensorineural hearing loss, five presented suspicion of syndrome at birth: three with Down syndrome, confirmed later, one with suspicion of trisomy 13 and one with suspicion of Fraser Syndrome, still in confirmation process.

Table 2. Analysis of risk indicators for hearing loss in 322 children referred to a Neonatal Hearing Screening Reference Service of a University Hospital of Belo Horizonte from January 2009 to December 2010, which performed all the steps of the screening program

Risk Indicators	Without hearing loss	With hearing loss	p-value	OR (IC 95%)
Mother HIV+				
No	303	10	1.000	ND
Yes	9	0		
Family history of permanent hearing loss in the childhood				
No	227	7	1.000	1.145 (0.289-4.528)
Yes	85	3		
ICU > 5 days				
No	179	3	0.109	3.140 (0.797-12.371)
Yes	133	7		
Hyperbilirubinemia – indicative levels of exchange transfusion				
No	282	10	0.607	ND
Yes	30	0		

Table 2. Analysis of risk indicators for hearing loss in 322 children referred to a Neonatal Hearing Screening Reference Service of a University Hospital of Belo Horizonte from January 2009 to December 2010, which performed all the steps of the screening program (cont.)

Risk Indicators	Without hearing loss	With hearing loss	p-value	OR (IC 95%)
Mechanical ventilation				
No	223	6	0.482	1.670 (0.460-6.061)
Yes	89	4		
Weight at birth less than 1500 g				
No	267	9	1.000	0,659 (0.082-5.330)
Yes	45	1		
Infection - Toxoplasmosis				
No	298	10	1.000	ND
Yes	14	0		
Infection - Rubella				
No	310	10	1.000	ND
Yes	2	0		
Infection - Syphilis				
No	310	10	1.000	ND
Yes	2	0		
Infection - Cytomegalovirus				
No	307	10	1.000	ND
Yes	5	0		
Infection - Herpes				
No	312	10	ND	ND
Yes	0	0		
Craniofacial anomaly				
No	294	8	0.122	4.083 (0.807-20.653)
Yes	18	2		
Suspicion of syndromes				
No	296	5	<0.001*	18.5 (4.855-70.496)
Yes	16	5		
Neurodegenerative disorders				
No	308	10	1.000	ND
Yes	4	0		
Postnatal infection, confirmed, bacterial or viral, of meningitis				
No	311	10	1.000	ND
Yes	1	0		
Chemotherapy				
No	312	10	ND	ND
Yes	0	0		
Cranial trauma				
No	312	10	ND	ND
Yes	0	0		
Suspicion of speech, language delay or developmental delay				
No	269	9	1.000	0.695 (0.086-5.625)
Yes	43	1		
Use of ototoxic medication				
No	221	5	0.156	2.429 (0.687-8.591)
Yes	91	5		

* Significant values (p<0,005) – Fisher's exact test

Note: OR = odds ratio (chance ratio), CI = confidence interval; ND = not determined

DISCUSSION

The rate of 25.4% of infants that presented RIHL, among the 3151 that composed the studied cases, was higher than that described in the national - 12.6%[19] and international - 5 to 10%[20] literature, which can be justified by the fact that this study was conducted in an University Hospital, tertiary referral in high-risk obstetrics, which assists pregnant women in the city of Belo Horizonte and metropolitan region and of other regions of the State of Minas Gerais.

The occurrence of hearing alterations, taking into consideration the 2532 infants that completed all screening steps (hearing screening test, hearing screening retest, follow-up and diagnosis), was of 1.97%, a value very close to the findings of national studies conducted with similar population[11,21]. Other national studies have found much lower rates: 0.3%[19], 0.5%[12] and 0.32%[22]. In the international literature, a prevalence of 0.1% to 0.3%[1,20] was reported. More recent studies have reported prevalence ranging from 0.12%[23] to 1.8%[13]. The difference between the studied populations and the methodologies used may have contributed to this variation.

Previous studies, both in Brazil as in other countries, report that the occurrence of hearing loss in the population with RIHL is higher[13,24]. In the present study, the presence of hearing loss in the group with RIHL was eight times higher than in the group without RIHL (1.04% in the group without RIHL and 8.38% in the group with RIHL). It must be highlighted that the hearing losses found were primarily conductive, whereby 0.99% for the population without RIHL and 5.27% for the population with RIHL, rates lower than those reported in the literature[24].

It is also important to highlight that 13.40% of the 261 children who "failed" and attended the screening-retest step showed temporary conductive alteration (n=39). These alterations were identified through immitanciometry and otorhinolaryngologic evaluation and, after that, the diagnosis of normal hearing was confirmed by the SASA staff of the hospital where the study was conducted. It is known that the conductive alterations, even if temporary, interfere in the development of the speech and language[25]. In this regard, preventive measures should be taken to improve both language acquisition as quality of life[26].

The occurrence of sensorineural hearing loss was of 0.43% considering the total population. Considering just the group without RIHL this value was 0.04% and 3.10% for those with RIHL. In a study conducted at the São Paulo Hospital, records of 1696 newborns (NB) submitted to NHS were analyzed. Among these, 648 were preterm newborn, assisted in the NICU. The protocol used was similar to the present study and the authors found a prevalence of 3.1% of sensorineural hearing loss in the group of preterm newborn and in the full-term group, of 0.82%[24]. Another study, conducted in a public hospital in Belo Horizonte, with 346 newborns with very low weight, also found a prevalence of 3.0% of hearing loss in this population[10]. Nevertheless, a study conducted with 311 high-risk newborns followed at a School Maternity and two public hospitals in São Paulo, reported incidence of 11.6% of sensorineural hearing loss pointing to reports in the international literature of values close to those obtained by the authors[27].

Of the 295 children at-risk who attended the follow-up, and followed with the diagnosis, 1.69% (n=5) had some type of hearing alteration, being 1.35% of conductive hearing loss (n= 4) and 0.33% sensorineural loss (n=1). It should be noted that the child with sensorineural hearing loss was diagnosed through ABR with moderate grade, bilateral. The Joint Committee on Infant Hearing (JCIH) in 2000, stressed the importance of the quality of the program, of the early intervention and of the auditory and language follow-up of children with risk indicators up to three years old, in order to identify and intervene in progressive hearing loss and of late-onset[3]. In 2006, a study conducted in Austria, with 105 children over four years, who were submitted to UNHS and were diagnosed with late-onset hearing loss, found that 25% had RIHL at birth[28].

The child in this study, with sensorineural hearing loss diagnosed in the follow-up, presented several RIHLs, being: ICU stay for more than five days, need of mechanical ventilation, use of ototoxic medication and exchange transfusion. The association of RIHL is common, especially for those who remain in the NICU for more than five days[5]. It is known that the multiplicity of RIHL favors the increase of hearing deficits[10] and that, among the RIHLs presented by the child, the use of mechanical ventilation is related to progressive sensorineural loss, or late-onset[10]. In addition, prolonged use of ototoxic drugs, common in children in the ICU, may cause late-onset hearing loss[29].

In relation to risk indicators, considering the 322 children of the group with RIHL who completed all steps of the UNHS, the stay in the NICU for more than five days was the most frequent risk, with 43.41%, followed by the use of ototoxic medication (29.81%), use of mechanical ventilation (28.88%) and family history of permanent childhood hearing impairment (27.32%). In a study conducted in a public hospital in the city of Belo Horizonte, in 2007, with 798 children, the key risk indicators found were the use of ototoxic medication by newborns (34.2%), stay in an incubator (17%), mechanical ventilation (14%) and weight less than 1500 g[11]. In another study conducted in Brazil, with 382 records, the stay in the NICU was the most frequent risk indicator, however, with period longer than 48 hrs[29].

Despite the RIHL "syndromes suspected at birth" was not the most frequent (50%) among the ten children with RIHL and diagnosis of sensorineural hearing loss, compared to the stay in NICU longer than five days (70%), the use of ototoxic drug (50%) and mechanical ventilation (40%), it was the only one that presented correlation with hearing loss. The risk of a child with suspicion of syndrome at birth to present sensorineural hearing loss is 18 times greater than those without this RIHL. A study conducted with 1696 newborns found a correlation

of the diagnosis of hearing loss with the risk indicators. In the same study, it was observed that among the most common risks found in term neonates, the syndrome risk had a significant relationship with the presence of sensorineural hearing loss, i.e., the chance of a full-term newborn with syndrome to present a sensorineural hearing loss was 13 times greater than a full-term newborn without this risk indicator[24].

The high rate of absenteeism (23.14%) in the steps of hearing screening retest, diagnosis and follow-up of this study may have underestimated the actual occurrence of hearing alterations in the studied population.

Considering the results, there is a need to develop actions to promote health and prevention of hearing loss in the assisted population.

CONCLUSION

The occurrence of hearing loss was higher in the group of children with risk indicators. The risk indicator that presents a correlation with the presence of sensorineural hearing loss is the suspicion of syndromes.

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