

# Frequency of hearing loss related to congenital infections: retrospective cross-sectional study

## Frequência da deficiência auditiva relacionada às infecções congênitas: estudo transversal retrospectivo

### Frecuencia de hipoacusia relacionada con infecciones congénitas: un estudio transversal retrospectivo

Laise Caroba da Silva\* 

Ana Cláudia Florêncio Calife\* 

Dyego Leandro Bezerra de Souza\* 

Sheila Andreoli Balen\* 

#### Abstract

**Introduction:** Congenital infections during pregnancy are risk indicators for hearing loss. **Purpose:** To verify the frequency of hearing loss in children attended at the public service with risk indicators for congenital infections. **Methods:** This is a retrospective cross-sectional study. The population consisted of children aged 0 to 3 years attended in the period from 2011 to 2019. Consultation and analysis were carried out in the Institution's database, extracting information from the children regarding the presence of reported congenital infection (cytomegalovirus, herpes, rubella, syphilis, toxoplasmosis, HIV and Zika virus) and the complete audiological diagnosis. The sample of this study consisted of 558 children and the presence of co-occurrence between infections or other risk indicators for hearing loss was analyzed. Descriptive analysis was performed to establish the frequency of hearing loss in relation to each congenital infection isolated or associated with other risk indicators. **Results:** 14.40% of the children had a report of isolated congenital infection or in combination with another risk indicator. The frequency of hearing

\* Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil.

#### Authors' contributions:

LCS: performed the collection, analysis, tabulation of data and writing and revision of the manuscript.

ACFC: was responsible for writing and revising the manuscript.

DLBS: was responsible for analyzing data and revising the manuscript.

SAB: conceived and guided the study and was responsible for collecting and analyzing data, writing and revising the manuscript.

**E-mail for correspondence:** Laise Caroba da Silva - laise.caroba@yahoo.com.br

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loss was 1.25%, with sensorineural hearing loss in six children (85.71%) and a conductive hearing loss (14.29%), of which six were bilateral (85, 71%) and one unilateral (14.29%). This frequency of hearing loss was related to the history of cytomegalovirus (57.14%), followed by toxoplasmosis (28.57%) and rubella with zika virus (14.29%). **Conclusion:** The frequency of diagnosis of hearing loss was 1.25% in children with reports of congenital infections.

**Keywords:** Child; Hearing loss; Clinical Diagnosis; Congenital Abnormalities; Prevalence.

## Resumo

**Introdução:** As infecções congênicas durante a gravidez são indicadores de risco para a deficiência auditiva. **Objetivo:** Verificar a frequência da deficiência auditiva nas crianças atendidas num serviço público com indicadores de risco de infecções congênicas. **Métodos:** Trata-se de um estudo transversal retrospectivo. A população do estudo foi de crianças de 0 a 3 anos atendidas no período de 2011 a 2019. Foi realizada consulta e análise no banco de dados da Instituição extraindo informações das crianças quanto à presença de infecção congênita relatada (citomegalovírus, herpes, rubéola, sífilis, toxoplasmose, HIV e Zika vírus) e o diagnóstico audiológico completo. A amostra deste estudo foi constituída por 558 crianças e foram analisadas a presença de co-ocorrência entre as infecções ou de outros indicadores de risco para a deficiência auditiva. Realizou-se análise descritiva para estabelecer a frequência da deficiência auditiva em relação a cada infecção congênita isolada ou associada a outros indicadores de risco. **Resultados:** 14,40% das crianças apresentavam o relato de infecção congênita isolada ou em combinação com outro IRDA. A frequência da deficiência auditiva foi de 1,25%, com a presença da perda auditiva sensorineural em seis crianças (85,71%) e uma perda auditiva do tipo condutiva (14,29%), das quais seis foram bilaterais (85,71%) e uma unilateral (14,29%). Esta frequência de deficiência auditiva foi relacionada ao histórico de citomegalovírus (57,14%), seguido de toxoplasmose (28,57%) e rubéola com Zika vírus (14,29%). **Conclusão:** A frequência do diagnóstico de deficiência auditiva foi de 1,25% nas crianças com relato de infecções congênicas.

**Palavras-chave:** Criança; Perda auditiva; Diagnóstico Clínico; Anormalidades Congênicas; Prevalência.

## Resumen

**Introducción:** Las infecciones congénitas durante el embarazo son indicadores de riesgo de hipoacusia. **Propósito:** Verificar la frecuencia de hipoacusia en niños atendidos en el servicio público con indicadores de riesgo de infecciones congénitas. **Métodos:** Se trata de un estudio transversal retrospectivo. La población de estudio estuvo constituída por los niños de 0 a 3 años atendidos en el periodo de 2011 a 2019. Se realizó consulta y análisis en la base de datos de la Institución, extrayéndose información de los niños en cuanto a la presencia de infección congénita reportada (citomegalovirus, herpes, rubéola, sífilis, toxoplasmosis, VIH y virus Zika) y el diagnóstico audiológico completo. La muestra de este estudio estuvo constituída por 558 niños y se analizó la presencia de coocurrencia entre infecciones u otros indicadores de riesgo de hipoacusia. Se realizó un análisis descriptivo para establecer la frecuencia de hipoacusia con relación a cada infección congénita aislada o asociada a otros indicadores de riesgo. **Resultados:** El 14,40% de los niños tenían reporte de infección congénita aislada o en combinación con otro indicador de riesgo. La frecuencia de hipoacusia fue del 1,25%, con hipoacusia neurosensorial en seis niños (85,71%) y hipoacusia conductiva (14,29%), de los cuales seis fueron bilaterales (85,71%) y uno unilateral (14,29%). Esta frecuencia de hipoacusia se relacionó con el antecedente de citomegalovirus (57,14%), seguido de toxoplasmosis (28,57%) y rubéola con virus zika (14,29%). **Conclusión:** La frecuencia de diagnóstico de hipoacusia fue de 1,25% en niños con reporte de infecciones congénitas.

**Palabras clave:** Niños; Pérdida Auditiva; Diagnóstico Clínico; Anomalías Congénitas; Prevalencia.

## Introduction

The impact of hearing impairment is widely known for its effects on child development. It is estimated that there are 466 million people in the world with hearing loss, representing 6.1% of the world's population, of which 432 million are adults and 34 million are children. There is an estimate that the number of cases will increase if preventive measures are not taken, with numbers around 630 million by 2030 and 900 million by 2050<sup>1</sup>. It has been reported by the World Health Organization that 60% of childhood hearing impairment occurs from preventable causes. This number is even higher in low- and middle-income countries (75%) compared to high-income countries (49%)<sup>2</sup>.

Hearing impairment may be caused by genetic, congenital, or acquired factors. Among the infections that can occur during pregnancy are toxoplasmosis, rubella, cytomegalovirus, herpes, syphilis, and HIV<sup>3</sup>, and hearing impairment can be present at birth or be triggered after birth.

The Joint Committee on Infant Hearing<sup>4</sup> gave attention to cytomegalovirus (CMV) infection given the prevalence of late manifestations of disabling hearing impairment due to congenital CMV. In addition to including Zika virus infection as a risk indicator of hearing loss (RIHL) in conjunction with the other infections already reported.

The high fetal and neonatal morbidity and/or mortality and the presence of important sequelae in affected patients make congenital infections a public health problem, and their prevention, diagnosis, follow-up, and treatment are necessary before, during, and after pregnancy<sup>5</sup>.

Historically, congenital rubella and other infections such as toxoplasmosis, cytomegalovirus, herpes virus, and syphilis are described as causes of congenital hearing loss<sup>6-7</sup> due to exposure during the prenatal period. However, with the evolution of diagnosis and treatment, as well as immunization and educational campaigns, the epidemiology of these diseases has shifted and with it, the incidence of hearing impairment has probably decreased in recent years<sup>8-9</sup>.

The knowledge about the etiologic diagnosis of hearing impairment is a focus of interest for healthcare professionals and services in making healthcare decisions<sup>10</sup>. Such understanding can provide numerous advantages, from the reduction of costly and unnecessary tests, stress reduction for

parents and children, as well as new relevant information for the management of hearing impairment, awareness of coexisting medical problems, and prognosis for the child and family. In addition, these investigations clarify the epidemiological aspects of congenital hearing loss, which may facilitate the planning of an effective hearing health prevention and surveillance program<sup>10</sup>.

Correct etiologic guidance requires a thorough collection of family and personal history, including risk factors and a detailed physical examination, as well as the performance, when necessary and concerning these issues, of relevant complementary tests<sup>10</sup>.

Public hearing health policies in Brazil include the identification of hearing impairment during Neonatal Hearing Screening (NHS), preferably at birth in maternities or within 30 days of life. The referral of babies who fail this screening should occur immediately to Hearing Health Care Services or Hearing Rehabilitation Center for a complete audiological diagnosis<sup>11</sup>. These guidelines apply to babies with a congenital infection history, and even those who pass the Universal Neonatal Hearing Screening (UNHS) are recommended to undergo medical and Speech, Language Pathology assessment<sup>11</sup>, because of the risk of late manifestation audiological changes that may affect hearing, speech, and language<sup>4-5</sup>.

Retrospective data are from a service accredited as high complexity by the Ministry of Health to the Unified Health System. This is a philanthropic institution, which has been operating for 35 years as a reference in the care of people with hearing impairment. It also has agreements with the State and Municipal Education and Social Assistance Secretariats. Its actions are focused on promoting hearing health, by aiming at prevention, diagnosis of hearing impairment, selection and adaptation of hearing aids, and the rehabilitation of the hearing-impaired person. It serves a vast population, from newborns to the elderly, besides referring users to other services, particularly the Cochlear Implant Program accredited to SUS in the same state.

Based on the above and considering the representativeness of this service, this study was designed to retrospectively verify the frequency of hearing loss in children with congenital infection reports.

## Method

### *Study design and sample*

This is a cross-sectional and retrospective study. It was carried out from the database of children seen at a service accredited to SUS in the age range of 0 to 3 years from September 2011 to July 2019. The Ethics and Research in Human Beings Committee of University Hospital Onofre Lopes approved the study under opinion no. 3,127,251, and the signature of the Informed Consent Form (ICF) was waived since the data extracted were from the institution's database. There was the Service's consent for the use of the Hearing Electrophysiology Sector's database, as this is one of the sectors in which all children pass at least once in the service's care flow.

To compose the study sample it was necessary to consult the institution's database and select the children according to the following criteria: children who were admitted to the service between the ages of 0 and 3 years with the presence of congenital infection reported and/or confirmed as an indicator of risk for hearing loss based on the Joint Committee of Infant Hearing<sup>4</sup> and who had completed the audiological evaluations; subjects who did not meet these criteria were excluded.

All congenital infections were characterized by the family members' report of the disease and/or confirmatory examination in the prenatal or perinatal period, being notified in the Institution's database. Therefore, children with reported or confirmed history of the following congenital infections were included: cytomegalovirus, herpes, rubella, syphilis, toxoplasmosis, HIV, and Zika virus. This criterion was adopted due to the impossibility of access to serological and confirmatory tests of congenital infections not always reported in the database or available in the children's medical records. For the audiological evaluation, the tests performed in the service's routine child audiological evaluation were considered, which included: behavioral audiometry, immittance testing, Evoked Otoacoustic Emissions (EOAE), and Brainstem Auditory Evoked Potential (BAEP).

### *Data collection and analysis*

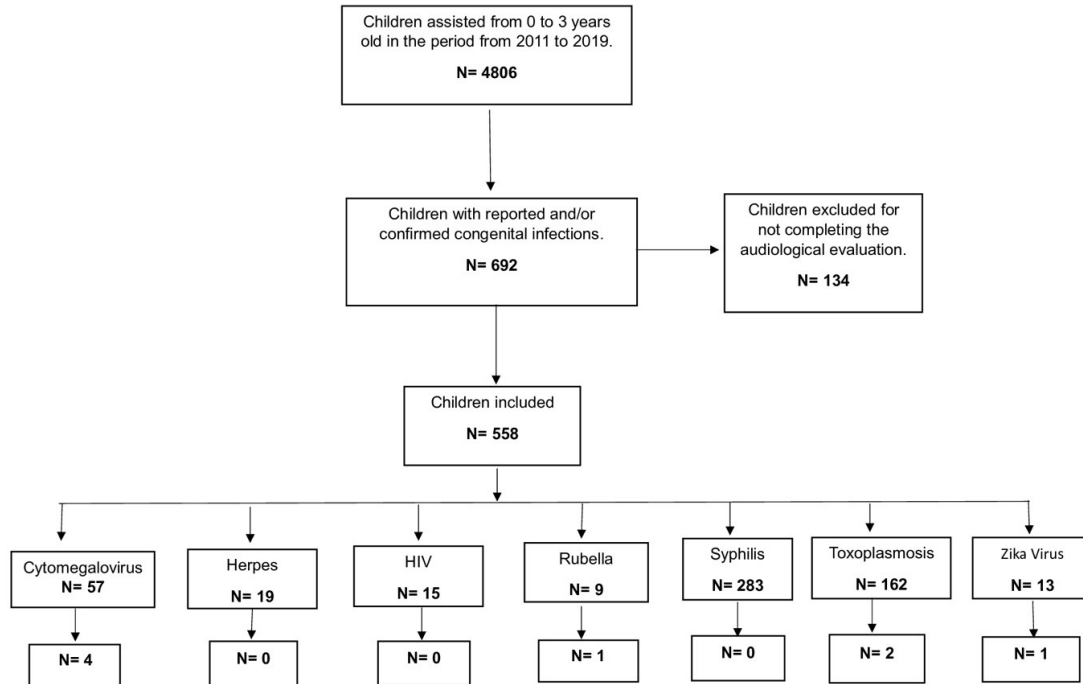
Data collection was performed by accessing the information in the database recorded in a Microsoft Excel® spreadsheet. Initially, the children who were admitted to the service in the age group 0 to 3 years from September 2011 to July 2019 were identified. Subsequently, it was verified which children had the presence of the following reported or confirmed congenital infections: cytomegalovirus, herpes, rubella, syphilis, toxoplasmosis, HIV, and Zika virus<sup>4</sup>.

Then, from these children, the following information was collected: gender, entry care service age, place of origin, congenital infection reported and/or confirmed, and audiological evaluation results. The help of an institution's employee was necessary to complement the data that were unavailable in the digital database. These data were related to the detailing of the results of behavioral audiometry, immittance tests, EOAE, and BAEP research. Information on the presence of other RIHL<sup>4</sup> was also collected from the database.

After entering all indicators in a new Excel® spreadsheet, we performed the percentage analysis to establish the frequency of the report of each congenital infection in isolation and co-occurrence with each other or with other RIHLs. In cases of hearing loss, it was characterized by type and degree following the World Health Organization classification<sup>12</sup>.

## Results

In this study, it was found that a total of 4806 children in the age group of 0 to 3 years attended the institution in the period from September 2011 to July 2019. From this initial sample, 692 (14.40%) children had a history of suspected or confirmed congenital infections alone or in combination with other RIHL from the data recorded in the institution's database, and 134 (19.36%) children were excluded for not presenting completion of the audiological evaluation. Therefore, the sample of this study consisted of 558 children (Figure 1).



**Figure 1.** Flowchart of the sample regarding congenital infection reporting history and hearing loss presence.

Table 1 shows that males were the majority with 311 children (55.73%) and regarding the age at which the children were admitted to the care service, the age range from 0 to 12 months was the most frequent (97.13%). As for the origin of these children, the capital Natal and the neighboring cities such as São Gonçalo do Amarante, Parnamirim, Macaíba, Ceará-Mirim, Extremoz e São José de

Mipibu were the ones that presented the largest registries, having the largest flow of referrals from hospitals, maternities, and basic health units for audiological evaluation and/or auditory monitoring of these children. Regarding the scope of care, it was verified that the institution attended 41.91% of the cities in the state of Rio Grande do Norte.

**Table 1.** Characterization of the sample as to gender, entry in care service age and origin of the sample

Features	Children N (%)
<b>Gender</b>	
Male	331 (55,73%)
Female	247 (44,26%)
<b>Entry in care service age</b>	
0 - 12 months	542 (97,13%)
13 - 24 months	14 (2,50%)
25 - 36 months	2 (0,35%)
<b>Source</b>	
Natal	364 (65,23%)
São Gonçalo do Amarante	22 (3,94%)
Parnamirim	21 (3,76%)
Macaíba	20 (3,58%)
Ceará-Mirim	6 (1,07%)
Santa Cruz	6 (1,07%)
Municipalities with five children each	20 (3,58%)
Municipalities with four children each	24 (4,30%)
Municipalities with three children each	18 (3,22%)
Municipalities with two children each	26 (4,65%)
Municipalities with one child each	31 (5,55%)

Legend: Municipalities (4) with five children each: Extremoz, São José de Mipibu, Serra Caiada, Senador Elói de Souza. Municipalities (6) with four children each: Currais Novos, Lajes Pintada, Nísia Floresta, Parelhas, Riachuelo, Touros. Municipalities (6) with three children each: Carnaúbas dos Dantas, Montanhas, Nova Cruz, Tangara, Tibau do Sul, Vera Cruz. Counties (13) with two children each: Acari, Angicos, Assú, Baía Formosa, Bom Jesus, Brejinho, Goianinha, Jundiá, Poço Branco, Mossoró, Rio Barbosa, Santana dos Matos, São Paulo do Potengi. Municipalities (31) with one child each: Alto do Rodrigues, Barcelona, Boa Saúde, Caicó, Campo Redondo, Guamaré, Itajá, Jandaira, Japi, João Câmara, Lagoa das Pedras, Lagoa dos Velhos, Lagoa Nova, Lajes, Macau, Maracajuá, Pedro Avelino, Pureza, Santa Maria, Santo Antônio, São Bento do Trairi, São João do Sabugi, São José de Campestre, São Pedro, São Tomé, Senador Georgino Avelino, Serra de São Bento, Serrinha, Tenente Laurentino, Umarizal, Várzea.

It was found that the congenital infections that presented the highest frequency in isolation were congenital syphilis, with a result history of 239 cases (42.83%), followed by toxoplasmosis with 139 cases (24.91%) and cytomegalovirus with 44

(7.88%) (Table 2). The infection that presented more co-occurrences was Zika Virus, mainly associated with microcephaly and with other RIHL, besides one case associated with rubella infection.

**Table 2.** Frequency of confirmation or report of congenital infections alone or co-occurring with each other and with other indicators.

Infection Congenital	Isolated N (%)	Co-occurrence N (%)	Total N (%)
Syphilis	239 (42,83%)	44 (7,88%)	283 (50,72%)
Toxoplasmosis	139 (24,91%)	23 (4,12%)	162 (29,03%)
Cytomegalovirus	44 (7,88%)	12 (2,15%)	57 (10,21%)
Herpes	18 (3,2%)	1 (0,2%)	19 (3,40%)
HIV	12 (2,1%)	3 (0,58%)	15 (2,69%)
Zika Virus	3 (0,53%)	10 (1,79%)	13 (2,33%)
Rubella	5 (0,8%)	4 (0,7%)	9 (1,62%)

Source: Data from the children served from 2011 to 2019 at the institution.

Regarding audiological diagnosis, in the sample of 558 children, 551 (98.74%) had results within normal standards and seven (1.25%) children were diagnosed with hearing loss. Sensorineural hearing loss was identified in six (85.71%) of these children, and one (14.29%) had a conductive hearing loss; six were bilateral (85.71%) and one

was unilateral (14.29%). The results regarding the degree were analyzed by ears with hearing loss (13) and not by the number of children in the sample with hearing loss (7). Table 3 shows the degree of hearing loss and its relation to congenital infections in the sample studied.

**Table 3.** Characterization of the degree of hearing impairment per ear of the children according to congenital infections.

Audiological diagnosis	Associated congenital infections			
	Toxoplasmosis N (%)	Cytomegalovirus N (%)	Rubella N (%)	Zika vírus N (%)
<b>Slight Loss</b>				
O.D	1 (7,14%)	0	0	0
O.E	1 (7,14%)	0	0	0
<b>Moderate Loss</b>				
O.D	0	0	0	0
O.E	0	1 (7,14%)	0	0
<b>Severe Loss</b>				
O.D	1 (7,14%)	1 (7,14%)	0	0
O.E	1 (7,14%)	0	0	0
<b>Deep Loss</b>				
O.D	0	2 (14,28%)	1 (7,14%)	1 (7,14%)
O.E	0	3 (21,42%)	1 (7,14%)	1 (7,14%)
Total:	4 (26,57%)	7 (50,00%)	2(14,28%)	2 (14,28%)
TOTAL: 15*				

Legend: R.O. - right ear; L.O. - left ear.

Note: \* The co-occurrence of rubella and Zika virus infections were present in one case of bilateral hearing impairment, and the possible etiology of the hearing loss could not be determined, so it was described in both infections and total at the end of 15 ears

The other infections that were not reported, such as Syphilis, HIV, and Herpes did not show an association with the presence of hearing impairment. All children with reports of the congenital infections described in Table 3 and the presence of hearing loss showed in the database history the presence of other associated RIHLs and the co-

occurrence of congenital infections between them. The most recurrent associated RIHLs were a length of stay in neonatal ICU (4), mechanical ventilation (3), and craniofacial malformations (3).

Chart 1 lists the other risk factors associated with the congenital infections found.

**Chart 1.** Congenital infections associated with other RIHL in hearing-loss children.

<b>Congenital infections and the presence of other RIHL</b>
Toxoplasmosis, cleft lip and palate
Toxoplasmosis, ICU > 5 days, mechanical ventilation *
Cytomegalovirus, ICU > 5 days, microcephaly, use of ototoxic medication **.
Cytomegalovirus and ICU > 5 DAYS.
Cytomegalovirus, ICU > 5 days, mechanical ventilation, and use of ototoxic medication. **
Isolated cytomegalovirus
Rubella, Zika virus, mechanical ventilation, microcephaly.

Legend: RIHL - risk indicator of hearing loss; ICU - intensive care unit.

Note: \* It is noteworthy that in the case of toxoplasmosis infection, with ICU for more than 5 days and mechanical ventilation, the occurrence of hyperbilirubinemia with treatment by phototherapy was present. \*\* And in the two cases of cytomegalovirus infection with ICU for more than 5 days and association with other risk indicators the occurrence of prematurity and hyperbilirubinemia with treatment by phototherapy was present.

It was not possible to identify the incidence of new cases in association with congenital infections annually from September 2011 to July 2019. However, it was possible to observe that in the year 2011, two hearing-impaired children with congenital cytomegalovirus infection were identified and subsequently, in the year 2017, two new cases of hearing impairment from the same reported infection were also evidenced. When comparing the presence of congenital infections and cases of hearing impairment throughout the period studied, it was found that in the years 2013 and 2015 was found respectively, toxoplasmosis associated with cleft lip and palate and Zika virus (associated with rubella and microcephaly) and in 2018, a case of toxoplasmosis with ICU, hyperbilirubinemia and mechanical ventilation associated.

## Discussion

The results of the present study showed that 14.40% of the children from 0 to 3 years of age seen at the Service in the period studied presented a report of congenital infection alone or in combination with another RIHL. Of these, 1.25% of the children related to the report and/or confirmation of congenital infections had hearing loss. This percentage can be considered low but is compatible with evidence in the literature<sup>13</sup>. Another study<sup>14</sup> found that hearing loss was higher in the group of children with other risk indicators, with no significant correlation with congenital infections.

Among the children who completed the audiological diagnosis, 97.13% had their first evaluation in the first year of life. This percentage of children aged 0 to 12 months may be associated with most

referrals coming from maternities, hospitals, and health units. This situation may reflect the knowledge of healthcare professionals and services about the importance of NHS and the identification of RIHL, as well as the need for monitoring and early intervention in cases of hearing loss in children with a history of congenital infections<sup>15</sup>.

Regarding confirmed hearing loss, it was found that sensorineural and profound hearing loss had the highest frequency in congenital infections associated with other RIHL, however, a mild conductive hearing loss (14.29%) was observed in association with toxoplasmosis and the malformation indicator (cleft lip and palate). The presence of cleft lip and palate must be the cause of conductive hearing loss because of changes in the soft palate physiology which helps in the aeration by the middle ear auditory tube. These alterations end up being the cause of fluctuating conductive hearing loss in children with cleft lip and palate<sup>16</sup>. Although it is more common to report the presence of neural hearing loss<sup>17</sup> stemming from toxoplasmosis, there are reports in a literature review<sup>7</sup> of 10.55% to 20% of conductive alterations. Only in one of the children, the cytomegalovirus infection presented alone a sensorineural type hearing loss of profound degree, and in another child that there was a co-occurrence of infections between rubella and Zika Virus, presenting a bilateral profound degree sensorineural hearing loss (14.29%). It was not possible to determine the etiological factor in hearing loss in this last case, so it was described as being from both infections, besides having in this case the association with microcephaly.

The RIHLs associated with congenital infections in this study corroborate a study<sup>18</sup>, which





found that among the most frequent RIHLs in preterm infants, there were 65.52% of cases of stay in the neonatal ICU for more than five days, followed by use of ototoxic medication (48.28%), use of mechanical ventilation (39.66%), and hyperbilirubinemia (46.55%). It is worth stressing that the presence in the clinical history of congenital infection is already considered a risk indicator for hearing loss, and added to this, the presence of other indicators increases the probability of hearing loss, and for this reason the importance of the etiological investigation about hearing loss in these subjects<sup>18</sup>.

It is noteworthy that of the four confirmed cases of hearing loss with a history of CMV, only one had an isolated report of CMV presence. In the others, there were other associated RIHL, and in all of them, a NICU stay of more than 5 days was common. A study found that neonatal ICU stay was the most prevalent risk factor during the comparison of risk indicators over four years in an NHS program in preterm newborns and that mechanical ventilation showed an increase in the number of cases, being recurrent during the period that the child stays in the neonatal ICU, finding an increase from 24,6% cases in 2000 to 40.2% in 2004<sup>19</sup>. The authors concluded that the increase in survival of neonates with complications at birth, among them children with congenital infections at birth, is due to the procedures required and performed during NICU stay, and as a result, the possibility of different risk indicators and causes of hearing impairment in this infant population<sup>19</sup>.

However, even though the results of this study may show a reduced prevalence in most of the infections studied, it was observed that four of the seven cases of hearing impairment were related to congenital cytomegalovirus infection. This has been considered, currently, the most common cause of hearing impairment due to congenital infection in the child population<sup>20</sup>.

Cytomegalovirus infection has a high occurrence in Brazil and worldwide and represents a major health challenge due to the few actions regarding prevention, identification, control, and intervention<sup>19</sup>. In addition, it is the only one of the infections reported here that is not on the list of diseases of compulsory notification of epidemiological surveillance in Brazil, and with that less understanding of the effects on the health of individuals infected with CMV<sup>19,22</sup>. Regarding the systematic screening of infection during pregnancy, there are

controversies about its performance, especially about serological tests IgM and IgG anti-CMV, this is because most women have already been infected and are asymptomatic, as well as to the low sensitivity and specificity of these tests<sup>22</sup>. The most current studies and consensus consider routine screening during pregnancy unnecessary; however, they defend that serologic screening for CMV in children should occur as a way to identify and help in the management, follow-up of symptoms, and late sequelae of potentially infected babies<sup>6-23</sup>. Preventive measures are still the main form of disease control, reinforcing hygiene habits after contact with urine and saliva of children under three years of age, virus excretory potentials, and guidelines for the prevention of sexual transmission of CMV because there is, to date, no maternal treatment that prevents or reduces the chance of fetal transmission that has been approved for use<sup>20-22-23</sup>. Hearing loss due to CMV is progressive and late-onset (between 12 and 24 months).

Unlike cytomegalovirus infection, toxoplasmosis infection has presented in recent years clear definitions in the actions to identify and combat congenital toxoplasmosis. In this sense, serological screening is recommended for all pregnant persons during the first prenatal visit since early diagnosis allows for appropriate intervention still in the gestational period, with preventive measures and treatment in case of congenital infection. In addition, all newborns of mothers with suspected or confirmed toxoplasmosis infection should undergo laboratory tests and complementary evaluations to detect, monitor, and intervene in possible sequelae resulting from congenital toxoplasmosis<sup>22</sup>.

It was possible to verify in our study a total of nine cases of congenital rubella, with one confirmed case of hearing loss associated with the Zika Virus. The reduced frequency of hearing loss cases related to congenital rubella can be justified by the emergence of the rubella vaccine and its incorporation in public immunization policies and the vaccination calendar in Brazil. Currently, there is no indication to perform the diagnosis during prenatal care in asymptomatic pregnant persons, however, concerning mothers who during the gestational period do not present in the vaccination booklet proof of vaccination against rubella and/or who were not immunized as children, IgG research for rubella will be requested during prenatal care. If the result is negative, vaccination against rubella



should be indicated, given the theoretical risk of the child developing Congenital Rubella Syndrome in the neonatal period<sup>24</sup>.

However, the resulting complications and association with congenital malformations, besides to the risk of hearing impairment related to Zika virus infection, is a reality. Mainly after the identification of the virus during the epidemic of the disease that occurred in Brazil in 2015. In this research, there was one confirmed case of Zika Virus and Rubella associated with microcephaly.

It is also noteworthy that of the seven cases with hearing loss, three had an association with craniofacial syndromes, two microcephaly, and one cleft lip and palate. These data corroborate the literature<sup>24</sup>, which verified that craniofacial malformations are one of the indicators of the study with a significant association with the result of failure in hearing screening; furthermore, in another study<sup>13</sup> the presence of hearing impairment was confirmed in one case, of craniofacial malformation.

In the Northeast region specifically, leading to cases of microcephaly in newborns and results in greater attention from national and international health agencies for the integrated follow-up and monitoring of this infection in children and pregnant women<sup>24-26</sup>. Recently, the diseases caused by the transmission mosquito *Aedes aegypti* is a great challenge for public health since they share several similar clinical signs, and these diseases have a seasonal character, i.e., with a greater occurrence in warmer periods and with rain in Brazil, added to the difficulty in identifying suspected cases, in early diagnosis and the implementation of prevention and control actions, may hinder the adoption of appropriate clinical management and, consequently, predispose to the occurrence of severe forms of the disease, leading even to deaths<sup>24</sup>. In this sense, the Ministry of Health reinforces the importance of vector control of the transmission agent through educational actions with the population and improvement of basic sanitation, in addition to investigation through serological tests and prenatal follow-up in pregnancies considered at risk and with suspected cases for Zika<sup>24-26</sup>.

Congenital infections and in particular Sexually Transmitted Infections during the last years have had an advance concerning diagnostic and treatment methods, especially regarding the treatment of HIV-infected mothers, the adequate diagnosis and treatment of congenital syphilis, and

also a greater understanding of the risk of infections by herpes simplex<sup>9</sup>. The combination of early diagnosis through rapid tests and the medications used to treat syphilis and HIV during pregnancy can reflect in the reduction and elimination of vertical transmission from mother to fetus. Prevention measures also include HIV and syphilis testing during routine prenatal care, preferably in the first trimester of pregnancy, at the beginning of the third trimester, and upon admission for delivery, to provide early diagnosis, as well as clinical and laboratory examination of exposed children, in addition to not breastfeeding in cases of mothers with HIV, are actions used to reduce the risks present in these infections<sup>27</sup>.

Regarding the report of each congenital infection, 50.71% of children with congenital syphilis with no confirmation of hearing impairment were observed. These data corroborate the epidemiological bulletin of the Secretariat of Health Surveillance<sup>26</sup> which points out that there was in the period from 2003 to 2017 an increase in the incidence of congenital syphilis from 1.7 to 8.6 cases per thousand live births and that even with an increase in the expansion of rapid testing, diagnosis, assistance and treatment, the high incidence of syphilis in Brazil and the world is still a challenge for public health. The findings of non-confirmation of hearing loss were also compatible with another study<sup>28</sup>, which found results within normality standards in audiological diagnosis through BAEP in children with congenital syphilis and with confirmed serology; however, they stressed that these children must be followed up employing longitudinal follow-up to check for possible late-onset hearing loss. These findings may also be reflecting results from neonatal treatment carried out in all babies with congenital syphilis diagnosed soon after birth and who are not discharged from the hospital without intravenous drug treatment, considering the mandatory requirement that all parturient women are tested for syphilis and, when reagent, they are treated, and their children are also tested, investigated and, if necessary, treated.

Regarding Zika Virus infection, 2.33% (13) cases were identified in the institution's database, with only one case of hearing loss in this research. These data were compatible with research<sup>29</sup>, which did not find in the hearing screening and hearing follow-up, the presence of hearing impairment until two years old in children of infected mothers.



However, it differed from a study<sup>30</sup> that found four cases of sensorineural hearing loss, all with severe microcephaly. One should be aware that the studied institution, together with the other services of the state responsible for the evaluation and follow-up of these children, and distribution among the specialized rehabilitation centers and hearing health services of the state may have occurred, besides the possibility of not following up and continuity of hearing monitoring of these children who had a congenital infection by Zika Virus after the neonatal hearing screening.

The results found show that hearing impairments related to congenital infections have a low frequency and a tendency to decline. This fact may be related to current advances in prevention and control actions developed so far for the assessment, intervention, and monitoring of these diseases. However, congenital infections are still considered public health problems, especially in countries with low rates of immunization, as well as in the absence of notifications and preventive actions in maternal and child health care, regarding the detection of infections during pregnancy and diagnostic methods applicable to mothers, fetuses, and babies who may have been infected.

The Joint Committee on Infant Hearing<sup>4</sup> highlights that children with congenital infections may present late-onset hearing loss; therefore, there is a need for further studies and information on audiological evaluation and follow-up of these children after the first years of life, and we cannot rule out the possibility of problems in the future regarding the hearing abilities and language development of these children.

Finally, the limitations of the study include the impossibility of analyzing the auditory follow-up and monitoring of the sample studied, the number of children who did not complete the audiological evaluation, and in some cases the presence of infection was only established through the family's report regarding exposure to these infections studied without supporting tests. Moreover, because these data refer to a single hearing health service in the state, making it impossible to generalize the results for the general population of children with congenital infections, as well as the reduced hearing loss percentage also made it difficult to analyze the incidence of new cases of hearing impairment related to congenital infections based on the years analyzed, mainly because of the limited informa-

tion available in the database regarding the follow-up and monitoring of these children and without the possibility of expanding the discussions regarding audiological evaluations beyond the first year of life, as a way to have more information regarding the follow-up and emergence of late hearing loss in this population and to understand and discuss the interference of congenital infections in the hearing of these children.

The results of the present study show a low frequency of hearing loss related to congenital infections. It is not possible to say that all children had confirmed congenital infection because one of the affirmative criteria is serological tests carried out on both the mother and the child; therefore, the need to carry out other studies regarding the frequency of other risk indicators for hearing loss in cases of confirmed hearing loss, as a way to investigate and have more information about the determining factors for hearing loss in this population of children.

## Conclusion

The frequency of hearing loss was 1.25% in children related to the report and/or confirmation of congenital infections with the presence of a sensorineural hearing loss in six children (85.71%) and a conductive hearing loss (14.29%), of which six were bilateral (85.71%) and one unilateral (14.29%). It is noteworthy, therefore, that 98.74% of the sample studied with a history of congenital infections reported results within normality standards in audiological evaluations.

The present study adds to other studies already done and to be done on the importance of investigating hearing loss in congenital infections, as a way of providing information to health professionals and services on the most current evidence of these infections and the proper planning and management of this population, as a way of developing evidence-based clinical practice and contributing to the processes of surveillance and health management.

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