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Audiological results in a group of children with microcephalia by congenital Zika virus syndrome

Resultados audiológicos em um grupo de crianças com microcefalia pela síndrome congênita do Zika virus

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ABSTRACT

Purpose: to investigate the hearing of children with microcephaly due to congenital Zika virus syndrome. **Methods**: the sample consisted of eleven children with microcephaly due to the congenital Zika virus syndrome. The collection was carried out in the first semester of 2017 until the first semester of 2018. Procedures performed: otorhinolaryngological and audiological evaluation: observation of auditory behavior and visual reinforcement audiometry; immittance testing, transient evoked otoacoustic emissions, brainstem auditory evoked potential, and auditory steady-state evoked potential with narrow band CE-chirp stimulus. The behavioral responses were compared with the responses of the auditory steady-state evoked potential. **Results:** eleven children presented responses as expected for age in the behavioral assessment, with 20 dB bilaterally for tones calibrated in the field at frequencies of 500 Hz, 1kHz, 2 kHz, 4 kHz, with 2 children being able to perform field audiometry with bilateral earphone insertion. Regarding the transient evoked otoacoustic emissions, all presented responses in both ears, ten children had tympanometry type A and one had type Ar tympanometry. Regarding the auditory evoked potential, 8 children had results within the normal range, with a minimum level of response at 20 dBnHL bilaterally. In the auditory steady-state evoked potential, 6 children had a minimum response level of 500 Hz, 1 kHz, 2 kHz, and 4 kHz, bilaterally, at 20 dBnHL. **Conclusion:** the children did not present sensorineural hearing loss.

Keywords: hearing; hearing loss; evoked potentials; microcephaly; Zika virus

RESUMO

Objetivo: investigar a audição de crianças com microcefalia pela síndrome congênita do Zika vírus. **Métodos:** a amostra foi composta de 11 crianças com microcefalia causada pela síndrome congênita do Zika vírus. A coleta teve início no primeiro semestre de 2017, sendo finalizada no primeiro semestre de 2018. Procedimentos realizados: avaliação otorrinolaringológica e audiológica: observação do comportamento auditivo e audiometria de reforço visual; imitanciometria, emissões otoacústicas evocadas por estímulo transiente, potencial evocado auditivo de tronco encefálico por via áerea e potencial evocado auditivo por estado estável com estímulo *narrow band CE-chirp*. As respostas comportamentais foram comparadas com as respostas do potencial evocado auditivo de estado estável. **Resultados**: apresentaram respostas centro do esperado para idade, na avaliação comportamental 11 crianças, com 20 dB bilateralmente para tons calibrados em campo, nas frequências de 500 Hz, 1 kHz, 2 kHz e 4 kHz, sendo que 2 delas conseguiram realizar a audiometria em campo com fone de inserção bilateralmente. Em relação às emissões otoacústicas, todas tiveram respostas presentes em ambas as orelhas, 10 crianças apresentaram timpanometria tipo A e uma (1) do tipo Ar. Quanto ao potencial evocado auditivo, as 8 crianças avaliadas apresentaram resultados dentro da normalidade, com nível mínimo de respostas em 20 dBNAn bilateralmente. No potencial evocado auditivo de estado estável, 6 crianças avaliadas apresentaram nível mínimo derespostas em 500 Hz, 1 kHz, 2 kHz e 4kHz, em 20 dBNAn, bilateralmente. **Conclusão**: as crianças avaliadas não apresentaram perda auditiva neurossensorial.

Palavras-chave: audição; perda auditiva; potenciais evocados; microcefalia; Zika vírus

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INTRODUCTION

In June 2016, Brazil registered the occurrence of 8,029 cases of microcephaly and/or other changes in the central nervous system (CNS). The geographical region with the highest occurrence was the Northeast, with 74.4% (n = 2070) of the reported cases[1]. In the state of Sergipe, for example, between 2015-2016, 128 cases of microcephaly were confirmed. In 2017, there was a reduction to just 11, and in 2018, two suspected cases[1-3].

Considering that the prevalence of microcephaly in 2010, in the country, was 5.7/100 thousand, with a 20-fold increase in 2015, changing to 8,039/100 thousand and, based on the recent discoveries made in Brazil[4] regarding the relationship of this condition with the Zika virus (ZIKV) infection in the intrauterine period, the Ministry of Health[5] recommended that pregnant women adopt preventive measures to combat the *Aedes aegypti* mosquito.

The characteristic of microcephaly is a head circumference below the normal average for age and sex, with inadequate development. It can be of congenital origin or occur in the first years of life, from a mild to a severe degree, leading to alterations in cognitive development, delayed motor and speech functions, hyperactivity, convulsions, coordination and balance difficulties, and also other brain or neurological conditions[6,7].

Children with congenital Zika virus syndrome, besides the aforementioned alterations, have greater dysphagic, visual, and auditory complications, and melodic changes in crying[8].

That said, the World Health Organization (WHO)[9] that all neonates with microcephaly perform evaluation and monitoring of child development, including audiological diagnosis and monitoring up to the age of 3[10,11].

Congenital ZIKV syndrome is a risk indicator for hearing loss[10-12]. The protocol to be adopted for this population, initially, is the brainstem auditory evoked potential (BAEP). In the BAEP, there is the possibility of using new stimuli, such as the chirp generation: Ichirp, CE-chirp, LS chirp, and narrow band CE-chirp (NB CE-chirp). These stimuli allow better visualization in the BAEP morphology when compared to the click stimulus. Besides the BAEP, new stimuli are also used in the auditory steady-state evoked potential[11,13-16].

Thus, the objective of this research was to describe the results of behavioral and electrophysiological assessments of hearing in children with microcephaly caused by congenital Zika virus syndrome.

METHODS

This is a cross-sectional, analytical, and observational study, approved by the Research Ethics Committee Involving Human Beings at the *Universidade Federal de Sergipe* (CAAE 60891716600005546). The Free and Informed Consent Form (FICF) was delivered to parents or guardians, with all research procedures being informed and the possibility of, at any time, giving up participating.

The study took place in two locations: a) the Audiology Outpatient Clinic of the undergraduate course in Speech, Language and Hearing Sciences at the *Universidade Federal de Sergipe*, Professor Antônio Garcia Filho university campus, in the city of Lagarto, state of Sergipe. The outpatient clinic provides specific assistance for children with microcephaly, who are evaluated and monitored in the areas of hearing and early stimulation, language, and orofacial motricity; b) After the audiological evaluation at the school clinic, the children who underwent the BAEP were referred to a *Basic Health Unit* (UBS) to perform the ASSEP NB CE-chirp exam near their homes, in the city of Itabaiana, state of Sergipe.

The children with microcephaly were referred to the university's Early Stimulation Outpatient Clinic for audiological evaluation. From the initial group of 15 children, four were excluded for not completing the exams, due to recurring absences and hospitalizations. The collection of these 11 children began in February 2017 and was performed until July 2018.

As for the eligibility, the inclusion criteria considered children with microcephaly with confirmed serology for congenital ZIKV syndrome. This serology was carried out by a major biomedical science institute in the country and took place due to a partnership between the state and the institute, which confirmed the transmission among all children in the sample, aged between 0 (zero) and 3 years old, who performed the audiological evaluation. The exclusion criteria adopted were: colds, flu, and/or obstruction in the external auditory canal.

Procedures

The following procedures were performed, including behavioral and objective hearing examinations and guidelines for the reevaluation of hearing/retesting: otorhinolaryngological evaluation (consisting of clinical examination and otoscopy), meatoscopy, immittance testing, according to the Jerger[17] classification, and audiometry.

The audiological evaluation procedures performed vary according to age, the condition of cognitive, visual, and neuromotor development of the evaluated child:

Meatoscopy: visual inspection of the child's external auditory meatus to verify impediments to the audiological examination.

Immittance testing: performed to assess the integrity of the middle ear and the tympanic membrane, the curves were classified as type A (normal mobility of the tympanic-ossicular system); type Ad (hypermobility of the tympanic-ossicular system); type Ar (low mobility of the tympanic-ossicular system); type B (absence of mobility of the tympanic-ossicular system), and type C (air pressure of the middle ear deviated to negative pressure). Regarding the stapedial reflexes, they were considered present at normal levels when they occurred between 70 and 100 dB above the airway threshold and absent when they did not occur until the maximum output of the device[17,18].

Audiometry: used to assess the subject's peripheral auditory system and auditory threshold using the Northern and Downs classification[19].

Auditory behavioral observation audiometry (BOA) 0-6 months: performed in children up to 6 months of age to assess the auditory development. The following musical instruments were used: shaker, reco-reco, rattle, plate, *agogô*, in addition to calibrated pure tones and the research of the cochleopalpebral reflex (CPR), with the *agogô*.

Visual reinforcement audiometry (VRA): this is an audiometry conditioned to visual reinforcement, in a free field with an insertion earphone, performed in children from 6 months to 3 years old. The child remains in the acoustic cabin, sitting on the guardian's lap, and, when he/she pays attention to the examiner, a sound stimulus is presented through a sound box and the child's response is accompanied by visual stimuli.

Air-conducted Brainstem auditory evoked potential: air-conducted clicks at 60, 40, and 20 dBnHL. To perform this examination, the child was in natural sleep, lying on the stretcher or the mother's lap. Then, the hygiene of the skin on the forehead and the mastoids was initiated with an abrasive paste (Nuprep®) to remove the oiliness and facilitate the fixation of the surface electrodes. The electrodes were placed on the right (A) and left (B) mastoids; the active electrodes in Fz and the ground in FPz - placed on the forehead. The click stimulus was then presented using an Ear Tone 3A insertion earphone. In this study, the electrodes used were from the Meditrace 200® brand. For recording the latencies and amplitudes I, III, and V of the waves, the parameters used were: presentation rate of 27.7/sec; number of stimuli 2000, 20 ms window; 100-3000 Hz filter with alternating polarity[15].

Auditory steady-state evoked potential (ASSEP): the frequencies evaluated were 500, 1000, 2000, and 4000 Hz, bilaterally, making the recording process faster. The record of 20 dBnHL was automatically detected by the equipment, with modulation rates close to 90 Hz, with a correction factor by the manufacturer. The stimulus used was the narrow band (NB) CE-chirp in the four frequencies, bilaterally, at different repetition rates, close to 90 Hz, with air-conducted periodic responses in the frequency domain. The recording's impedance was below 3k Ω . The exam lasted, on average, for seven minutes, with the time automatically recorded by the software equipment.

Otoacoustic emissions: otoacoustic emissions evoked by transient stimulus were used and the average response and noise ratio (S/N) greater than or equal to 3 dB was considered at frequencies of 1.0 and 1.5 kHz. The S/N ratio greater or equal to 6 dB was considered in the frequencies of 2.0, 3.0 and 4.0 kHz[20].

Instruments

Initially, the researcher conducted an interview to collect data to characterize the study subjects concerning the following aspects: prenatal, birth, gender data, health history; neuropsychomotor, auditory, and language complaints, health monitoring, and family history of hearing loss.

For the hearing assessment, the following equipment was used: otoscope Pochet Júnior 22840 (Welch Allyn); audiometer model AD-629B, Interacoustics, with TDH earphones and free field; Intelligent Hearing System - IHS equipment for recording the BAEP; EP 25 equipment for ASSEP registration, with NB CE-chirp stimulus; Interacoustics immittanciometer AT 235, and the Otodynamics portable equipment of otoacoustic emissions Otoport.

DATA ANALYSIS

After the data collection, the results were tabulated in an Excel 2010 spreadsheet (Microsoft Office® program) and, then, a descriptive statistical analysis was performed, regarding the variables: child's and mother's age, gender, onset period of the hearing loss, microcephaly etiology, and socioeconomic conditions. Besides, the researchers also used Excel 2010 software, SPSS V20, and Minitap 16.

Subsequently, the findings were interpreted to categorize hearing as normal, conductive or sensorineural and; also, as to the degree, whether mild, moderate, severe, or deep.

The examinations performed - field audiometry, BAEP, ASSEP NB CE-chirp, otoacoustic emissions, and immittance testing - were tabulated in an Excel 2010 spreadsheet and, subsequently, statistical tests verified whether the sample had a normal distribution or not.

The following statistical tests were used: t-Student, Fisher's exact, Equality of Two Proportions, Confidence Interval for Mean and p-value. The level of significance adopted by the researchers was 5%.

RESULTS

Of the 11 children evaluated in this sample, 27.3% (n = 3) were females and 72.7% (n = 8) were males, with a p-value of 0.033. During the audiological evaluation, the mean age was 27 years and 4 months (± 4.1) old, with a minimum of 18 months and a maximum of 32 months. Regarding the head circumference (HC) at birth, the average was 30 cm, with a maximum value of 31 cm and a minimum of 28 cm.

Regarding the mothers' perception of children's hearing acuity, 100% reported that they listened well (n = 11).

As for the assessment of the auditory behavior, all children performed the audiological assessment at 500 Hz, 1 kHz, 2 kHz, and 4 kHz in the field, with responses present in all frequencies up to 20 dB. Of the total sample, 2 were able to perform audiometry with visual reinforcement with a bilateral earphone, obtaining responses at all frequencies, bilaterally, in 15 dB.

As for the results of otoacoustic emissions by transient stimulus (TOAE), there was a greater number of absences of responses at the lower frequencies, specifically in the 1 kHz frequency band bilaterally, without statistical difference. (Table 1).

As for stapedial reflexes, one (1) child showed exacerbated irritability in all attempts, making it impossible to continue with the procedure. Table 2 shows the distribution of the stapedial reflexes.

In tympanometry, 10 children presented a type A curve, bilaterally, and one (1) child presented type Ar curve, bilaterally, which was reassessed in three different moments. The curve, however, remained the same, although all other tests were within normal limits. Table 3 presents the distribution of the tympanometric curves.

As for BAEP, 72.7% of the children (n = 8) managed to complete the exam in natural sleep and 27.8% (n = 3) were unable to complete it. These 8 children presented the BAEP at 20 dBnHL, bilaterally.

After performing the BAEP, the children performed the ASSEP NB CE-chirp. Of the general BAEP sample, composed of 8 children, 6 returned for the ASSEP NB CE-chirp.

As for this test, the 6 children were examined in natural sleep, responding at 500 Hz, 1 kHz, 2 kHz, and 4 kHz at 20 dBnHL, bilaterally, with a correction factor according to the manufacturer, as Table 4 shows.

In Table 5, one can visualize the complete description of the entire battery of tests performed and their respective results.

Table 1. Comparison of the distribution of otoacoustic emissions by transient stimulus

Frequency		Right Ear		Left Ear		P value
		N	%	N	%	
1 kHz	Present	1	9.1%	0	0.0%	0.306
	Absent	10	90.9%	11	100%	
1.5 kHz	Present	7	63.6%	7	63.6%	1.000
	Absent	4	36.4%	4	36.4%	
2 kHz	Present	5	45.5%	4	36.4%	0.665
	Absent	6	54.5%	7	63.6%	
3 kHz	Present	11	100%	11	100%	1.000
	Absent	0	0.0%	0	0.0%	
4 kHz	Present	11	100%	11	100%	1.000
	Absent	0	0.0%	0	0.0%	

Source: Research Data
Subtitle: N = number of subjects; % = percentage

Table 2. Distribution of the stapedial reflex in the right and left ears

REFL RE/LE	N	%
Not performed	1	9.1
Present	10	90.9

Source: Research Data
Subtitle: REFL = stapedial reflex; RE = right ear; LE = left ear; N = number of subjects; % = percentage

Table 3. Distribution of the tympanometric curve in the right and left ears

TIMP RE/LE	N	%	P value
Curve A	10	90.9	**<0.001**
Curve As	1	9.1	

Source: Research Data
Subtitle: TIMP = tympanometric; RE = right ear; LE = left ear; N = number of subjects; % = percentage

Table 4. Distribution of responses of auditory steady-state evoked potential with narrow band CE-chirp stimulus

ASSEP NB CE-chirp	N	Correction Factor	No Correction Factor
500 Hz	6	20 dBnHL	40 dBnHL
1 kHz	6	20 dBnHL	35 dBnHL
2 kHz	6	20 dBnHL	25 dBnHL
4 kHz	6	20 dBnHL	25 dBnHL

Source: Research Data
Subtitle: ASSEP NB CE-chirp = auditory steady-state evoked potential with narrow band CE-chirp stimulus; N = number of subjects

DISCUSSION

Microcephaly is already a risk variable for hearing loss and this sample showed another indicator: the congenital infection called Congenital Zika Virus Syndrome. As in Brazil, this infection evokes the need for studies that investigate various aspects of children's development, such as audiological assessment and monitoring of the affected population[10]. Few studies describing the effects of congenital infection on hearing with a significant sample can be found in the literature[8,12,21]. In the long run, new research results may contribute to the understanding of these problems.

In 2015, in Brazil, a survey[12] of great scientific significance was carried out and described the infantile audiological diagnosis resulting from the Zika virus syndrome epidemic. The sample consisted of 70 children, aged from 0 (zero) to 10 months. Initially, the BAEP was performed, using the click stimulus and a normal response when the V wave reproducibility occurred at 35 dBnHL. In altered cases in the initial BAEP, the brainstem auditory evoked potential exam was performed by a specific frequencies (BAEP-SF) of 500 Hz and 2000 Hz. The sensorineural hearing impairment findings in this sample were 5.8% (n = 4).

Regarding the field observation of auditory behavior, the 11 children evaluated responded bilaterally at the frequencies presented, 500 Hz, 1 kHz, 2 kHz, and 4 kHz. However, only two performed the audiometry with visual reinforcement, making it possible to use the insertion earphone. Three children presented visual impairment, a limiting factor for performing the visual reinforcement audiometry.

A study analyzed a PubMed database with 599 publications, 36 of which were selected with the following main findings: hypoplasia of the optic nerve, macular atrophy, cataracts, and visual and auditory changes[22]. This population has a greater neuropsychomotor delay, which hinders the performance of this exam, presenting a higher difficulty degree. As expected, these children presented greater motor and visual impairments. Due to this factor, some adaptations are required in the audiological behavioral assessment, such as the presentation of stimuli with a longer duration[1,6,19,22,23].

It is important to note that, even with all the technologies available in the area of Audiology, the audiological behavioral

Table 5. Full description of the entire battery of tests performed and the results (N=11)

GENDER	AGE	TOAE RE/LE	BAEP	ASSEP	TIMP RE/LE	BOA 500Hz	BOA 1kHz	BOA 2kHz	BOA 4kHz	VRA
M	29 months	P	1	1	A	1	1	1	1	X
M	27 months	P	1	1	A	1	1	1	1	X
F	23 months	P	X	X	A	1	1	1	1	1#
M	26 months	P	1	X	A	1	1	1	1	X
M	18 months	P	X	X	A	1	1	1	1	X
M	32 months	P	1	1	A	1	1	1	1	X
M	31 months	P	1	1	A	1	1	1	1	X
M	30 months	P	1	1	A	1	1	1	1	1#
M	26 months	P	X	X	A	1	1	1	1	X
M	31 months	P	1	1	Ar	1	1	1	1	X
F	28 months	P	1	X	A	1	1	1	1	X

Subtitle: F= female, M= male; TOAE = otoacoustic emissions evoked by transient stimulus; BAEP = brainstem auditory evoked potentials; ASSEP = auditory steady-state evoked potentials; TIMP = tympanometric; LE = left ear; RE = right ear; BOA = behavioral observation audiometry; VRA = visual reinforcement audiometry; A = tympanometric type A; Ar = tympanometric type Ar; P = presente reflex; 1 = normal; P = present; 1= BOA present answer; 1# = VRA with 500 Hz, 1 kHz, 2 kHz, 4 kHz earphones; X= not performed ; Number of childrenassessed= n=11 assessment of the child population is fundamental, considered a gold standard. To perform it, the speech therapist must be well-trained, both in assessing normal children, as well as those with neurological disorders, always using the recommended protocol for this population. The sample evaluated in this study showed responses within the expected results for age[19].

In the results of otoacoustic emissions by transient stimulus (TOAE), there was a greater number of absences of responses at the lower frequencies, specifically in the 1 kHz frequency band, bilaterally. These findings are in accordance with other studies, which also observed changes in responses at the frequency of 1kHz. One of them researched a sample composed of 284 neonates who underwent TOAEs, with a higher percentage of failure (90.1%) being observed in the frequency of 1 kHz. According to the authors, such failures may be due to environmental and physiological noises. The population evaluated in this study displayed noises resulting from swallowing and breathing, which would justify the absence of responses at 1 kHz[24,25].

In another study conducted with a sample of 43 children with CZVS, there was an absence of responses in the TOAE in 13 of them[21]. With the TOAEs, it was possible to analyze the cochlear function quickly, objectively, and non-invasively; this procedure being very important in clinical practice to perform the crosscheck[20,26].

In the present study, regarding tympanometry, ten children had type A curves, with mobility within the normal range of the tympanic-ossicular system. One child presented a type Ar curve only in the right ear, with a low mobility characteristic of the tympanic-ossicular system[17]; and the other audiological exams were normal. In the literature regarding this population, there is no record of an alteration found in the tympanometry exam with this characteristic, with only the presence of arthrogryposis being reported - a set of alterations in the joints that can justify this change[22,27].

The audiological evaluation of this population is of paramount importance, being recommended by several class entities and researchers, as it presents risk indicators for hearing loss and microcephaly resulting from ZIKV[1,9-11].

In the literature, it is observed[12] a relationship between ZIKV and cases of microcephaly, which are characterized by cranioencephalic malformations and which can cause auditory changes, especially in the central nervous system. In the eight children evaluated with BAEP, the integrity of the peripheral auditory pathway and a minimum level of responses at 20 dBnHL were seen, bilaterally. Another study described the integrity of the auditory pathway[28].

As for the ASSEP NB CE-chirp, the six children presented responses at 500 Hz, 1 kHz, 2 kHz, and 4 kHz, bilaterally at 20 dBnHL, which is in accordance with the results of other studies on the child population, agreeing with the auditory behavioral assessment. The performance of the ASSEP for children, especially in the neurological population, is extremely relevant, since it provides reliable information regarding the minimum level of responses, being important in cases of hearing loss of different configurations, specifically of conductive, and sensorineural frequencies, requiring the adaptation of sound amplification devices[13-15].

Regarding the use of new stimuli in the CE-chirp auditory steady-state evoked potential, it is important to highlight that the present study is the first one to investigate them in this population, demonstrating their effectiveness, since they reduce the time in exam performance. The detection of responses in the ASSEP is automatic and, if the maximum noise parameters are respected, the performance time can be only seven minutes. As it is a population with greater visual and neurological impairment, with possible inaccuracies regarding the behavioral responses, the use of objective electrophysiological measures is essential.

Regarding the 2015 outbreak, the WHO[9], in addition to recommending, as mentioned, that all neonates with ZIKV perform the assessment and monitoring of development in childhood, adopted guidelines for this population, such as conducting neonatal hearing screening through the potential auditory evoked, otorhinolaryngological and audiological evaluation at 7 and 12 months, besides monitoring children of mothers with ZIKV until 3 years old. In 2017, the organization decreed the end of the Public Health emergency resulting from ZIKV and its association with microcephaly and other neurological disorders.

The Joint Committee on Infant Hearing[10] also described that the congenital infection known as Congenital Zika Virus Syndrome is a risk indicator for hearing loss in newborns and children, highlighting the importance of the initial hearing screening protocol with BAEP, in addition to the audiological monitoring of this population.

In Brazil, the scenario was atypical, as the country was not prepared enough to carry out these procedures. Even today, universal neonatal hearing screening has not been implemented ubiquitously in the country, nor are there enough services with electrophysiological exam equipment for this assessment, which greatly limits the attendance of this population.

Currently, children with congenital ZIKV syndrome are referred for evaluation and monitoring in the services created, with 51 teams from the Family Health Support Center (NASF) and 67 Specialized Rehabilitation Centers (CER) to meet this demand (Ministry of Health, 2017)[2,29]. Since 2015, 127 health services have been accredited, representing an expansion of care and monitoring by the Unified Health System (SUS). Of these, 63% are concentrated in the Northeast region, which is the most affected region of Brazil[2,29].

Since the congenital Zika virus syndrome is a risk indicator for hearing loss, it is important to identify this condition as early as possible, to enable immediate intervention, offering conditions for the development of speech, language, sociability, psychism, and the child's educational process, allowing for more favorable prognosis in these fields.

All children with congenital ZIKV syndrome must undergo audiological monitoring until the third year of life, due to the risk indicators for hearing loss, as recommended by several class entities.

As seen, microcephaly due to congenital ZIKV syndrome can affect hearing, cognition, and neuropsychomotor activity, requiring researchers to evaluate and systematize the data related to changes in the child's nervous system and, consequently, in the auditory system. Further studies in this area are needed to contribute to new protocols for assessment and early intervention.

CONCLUSION

In this study, the children evaluated did not present sensorineural hearing loss, keeping hearing levels within the normal range.

REFERENCES

1. Brasil. Ministério da Saúde [Internet]. Brasília: Ministério da Saúde; 2016 [citado em 2016 Jun. 29]. Disponível em: https://www.saude.gov.br/images/pdf/2016/junho/22/Informe-Epidemiol--gico-n---31--SE-24-2016--20jun2016-18h39.pdf
2. Brasil. Ministério da Saúde. Informe Epidemiológico nº 52 até a semana Epidemiológico nº 47 (2017: 20/11 a 26/11/2016) [Internet]. Brasília: Ministério da Saúde; 2016 [citado em 2016 Jun. 29]. Disponível em: www.saude.gov.br
3. Sergipe. Informe Epidemiológico ano III nº 12, dados de 2018 até 07/07/2018 [Internet]. 2020 Mai. Disponível em: https://saude.se.gov.br/wp-content/uploads/2018/07/Inform_Seman_12_-Micro_Chik_Dengue_Zika_Semana.27-2018-1.pdf
4. Besnard M, Lastere S, Teissier A, Cao-Lormeau V, Musso D. Evidence of perinatal transmission of Zika virus, French Polynesia, December 2013 and February 2014. Euro Surveill. 2014;19(13):20751. http://dx.doi.org/10.2807/1560-7917.ES2014.19.13.20751. PMid:24721538.
5. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Protocolo de atenção à saúde e resposta à ocorrência de microcefalia relacionada à infecção pelo vírus Zika. Brasília: Ministério da Saúde; 2016.
6. Guedes-Granzotti RB, César CPHAR, Oliveira PF, Silva K, Dornelas R, Domenis DR, et al. Impactos da síndrome congênita do zika vírus para o desenvolvimento infantil. In: Cesar DJ, Meneguetti D, Martins FA, Silva REG. Saúde da criança e do adolescente: epidemiologia, doenças infecciosas e parasitárias. Rio Branco: Stricto Sensu; 2019. p. 64-77.
7. National Institute of Neurological Disorders and Stroke [Internet]. 2016 [citado em 2016 Dez. 10]. Disponível em: http://www.nindis.nih.gov
8. Rosa BCS, Jesus LS, Guedes-Granzotti RB, César CPHAR, Paranhos LR, Lewis DR. Crianças com síndrome congênita pelo Zika vírus apresentam alterações fonoaudiológicas? – Uma revisão sistemática de estudos observacionais. In: Anais do X Congresso Internacional de Fonoaudiologia; 2019; Belo Horizonte. Brasília: Conselho Federal de Fonoaudiologia; 2019.
9. WHO: World Health Organization [Internet]. Geneva: WHO; 2019 [citado em 2018 Jul. 16]. Disponível em: http://www.who.int/en/
10. JCHI: Joint Committee of Infant Hearing. Position statement: principles and guidelines for early hearing detection and intervention programs. Pediatrics. 2019;4(2):1-44.
11. Lewis DR, Marone SAM, Mendes BCA, Cruz OLM, Nobrega M. Comitê Multiprofissional em Saúde Auditiva – COMUSA. Rev Bras Otorrinolaringol (Engl Ed). 2010;76(1):121-8.
12. Leal MC, Muniz LF, Ferreira TSA, Santos CM, Almeida LC, Linden VVD, et al. Hearing Loss Infants with Microcephaly and Evidence of Congenital Zika Virus Infection – Brazil, November 2015 –May 2016. Morbidity and Mortality Weekly Report (MMWR). 2016;65(34):917-19.
13. Elberling C, Don M, Cebulla M, Stürzebecher E. Auditory steady- state responses to chirp stimuli based on cochlear traveling wave delay. J Acoust Soc Am. 2007;122(5):2772-85. http://dx.doi.org/10.1121/1.2783985. PMid:18189568.
14. Lee MY, Ahn SY, Lee HJ, Jung JY, Rhee CK, Suh MW. Narrow band CE-Chirp auditory steady-state response is more reliable than the conventional ASSR in predicting the behavioral hearing threshold. Auris Nasus Larynx. 2016;43(3):259-68. http://dx.doi.org/10.1016/j.anl.2015.09.013. PMid:26526641.
15. Rodrigues GRI. Estímulos CE-Chirp e narrow band na avaliação eletrofisiológica da audição: resultados clínicos em neonatos, lactentes e crianças [tese]. São Paulo: Pontifícia Universidade Católica de São Paulo; 2012.
16. Rosa BCS, Cesar CP, Cabral A, Santos M, Santos R. Potencial Evocado Auditivo de Tronco Encefálico com os estímulos clique e Ichirp. Revista Distúrbios da Comunicação. 2018;30(1):52-9.
17. Jerger J. Clinical experience with impedance audiometry. Arch Otolaryngol. 1970;92(4):311-24. http://dx.doi.org/10.1001/archotol.1970.04310040005002. PMid:5455571.
18. Gelfand AS. The contraleteral acoustic reflex threshold. In: Silman S. Acoustics reflex: basic principles and clinical aplications. Academic Press: Orlando; 1984. p. 137-86. http://dx.doi.org/10.1016/B978-0-12-643450-7.50010-X.
19. Northern JL, Downs MP. Audição na Infância. 5ªed. Rio de Janeiro: Guanabara Koogan; 2005.
20. Kemp DT. Stimulated acoustic emissions from within the human auditory system. J Acoust Soc Am. 1978;64(5):1386-91. http://dx.doi.org/10.1121/1.382104. PMid:744838.
21. Leite RFP, Santos MSA, Ribeiro EM, Pessoa ALS, Lewis R, Giacheti CM, et al. Triagem auditiva de crianças com síndrome congênita pelo vírus Zika atendidas em Fortaleza, Ceará, 2016. Epidemiol Serv Saude. 2018;27(4):e2017553. http://dx.doi.org/10.5123/S1679-49742018000400002. PMid:30427400.
22. Rocha NACF, Campos AC, Rocha FCF, Silva FPS. Microcephaly and Zika virus: neuroradiological aspects, clinical findings and a proposed framework for early evaluation of child development. Infant Behav Dev. 2017;49:70-82. http://dx.doi.org/10.1016/j.infbeh.2017.07.002. PMid:28755567.
23. Coronado R, Ruíz MA, Arjonilla GJ, Roig-Quilis M. Concordancia entre una función de crecimiento del perímetro cefálico y la discapacidad intelectual em relación con la etiología de la microcefalia. An Pediatr (Barc). 2015;83(2):109-16. http://dx.doi.org/10.1016/j.anpedi.2014.10.030. PMid:25534043.
24. Tazinazzio TG, Diniz TA, Marba STM, Colella-Santos MF. Emissões otoacústicas e medidas de imitância acústica com tons de sonda de 226 e 1000Hz em lactentes. Rev CEFAC. 2011;13(3):479-88. http://dx.doi.org/10.1590/S1516-18462010005000138.
25. Côrtes-Andrade IF, Bento DV, Lewis DR. Emissões otoacústicas evocadas por estímulo transiente: protocolos de triagem auditiva neonatal. Rev CEFAC. 2013;15(3):521-7. http://dx.doi.org/10.1590/S1516-18462012005000062.
26. Gold T, Hearing II. The physical basis of the action of the cochlea. Proc R Soc Lond B Biol Sci. 1948;135:4928.
27. Alvino ACMI, Mello LRM, Oliveira JAMM. Associação de artrogripose em neonatos com microcefalia pelo Zika vírus – série de casos. Rev Bras Saúde Mater Infant. 2016;16(Supl. 1):S83-8. https://doi.org/10.1590/1806-9304201600s100007.
28. Abramov DM, Saad T, Gomes-Junior SC, Silva DS, Araújo I, Moreira MEL, et al. Auditory brainstem function in microcephaly related to Zika virus infection. American Academy of Neurology. 2018;90:1-9.
29. Portal Ministério da Saúde [Internet]. 2019 [citado em 2020 Maio 27]. Disponível em: https://www.saude.gov.br/saude-de-a-z/zika-virus