

# Analysis of the coverage of neonatal hearing screening in Northeast Brazil

## Análise da cobertura da triagem auditiva neonatal no Nordeste brasileiro

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### ABSTRACT

**Introduction:** Universal Neonatal Hearing Screening (UNHS) is the recommended screening test for hearing loss diagnosis. **Purpose:** To perform a spatial analysis of the coverage of the Neonatal Hearing Screening (NHS) in the Northeastern of Brazil and to verify the possible association of the coverage with the number of Speech-Language Pathology and Audiology (SLPA) maternities and reference centers in hearing health. **Methods:** The reference population was of live newborns registered in the Live Birth Information System (*Sistema de Informação sobre Nascidos Vivos* - SINASC). For the data collection, electronic banks were set up in the Health Information Systems. Exploratory spatial analysis was performed using TabWin software; Descriptive statistical analysis: absolute and relative distribution and weighted mean calculation; Analytical, using Chi-square and Fisher's Exact tests, in which a significance level of 0.05 was adopted. **Results:** There was similarity throughout the Northeastern, regarding the low coverage of the NHS. The highest indices were concentrated in specific areas and there was a homogenous distribution among states. However, the states of Piauí and Paraíba stand out as to the frequency of coverage in municipalities with the NHS service. It was found an association between the coverage and the number of maternities, Speech-Language Pathology and Audiology and centers of reference in hearing health. **Conclusion:** The low coverage of the triage prevails throughout the Northeastern, and the best coverages are found in peculiar areas, where the large population centers are located. There was association with the lack of Speech-Language Pathology and Audiology enrolled in the Unified Health System, centers of reference in hearing health and the number of maternities.

**Keywords:** Hearing; Hearing loss; Neonatal screening; Unified health system; Information systems

### RESUMO

**Introdução:** A Triagem Auditiva Neonatal Universal (TANU) é o exame de rastreamento recomendado para diagnóstico da perda auditiva. **Objetivo:** Realizar análise espacial da cobertura da Triagem Auditiva Neonatal na Região Nordeste do Brasil e verificar possível associação da cobertura com o número de fonoaudiólogos, maternidades e centros de referência em saúde auditiva. **Métodos:** A população de referência foi de recém-nascidos vivos, registrados no Sistema de Informação sobre Nascidos Vivos (SINASC). Para o levantamento de dados, foram utilizados bancos eletrônicos dispostos nos Sistemas de Informação em Saúde. Realizou-se análise espacial exploratória, usando o *software* TabWin; análise estatística descritiva: distribuição absoluta e relativa e cálculo de média ponderada; análise, por meio dos testes Qui-quadrado e Exato de Fischer, na qual adotou-se nível de significância de 0,05. **Resultados:** Houve semelhança em todo o Nordeste, quanto à baixa cobertura da TAN. Os maiores índices se concentraram em áreas pontuais e observou-se distribuição homogênea entre os estados. Porém, os estados do Piauí e Paraíba se destacaram quanto à frequência da cobertura nos municípios com o serviço da TAN. Constatou-se associação entre a cobertura e o número de maternidades, fonoaudiólogos e centros de referência em saúde auditiva. **Conclusão:** A baixa cobertura da triagem predomina em todo o território do Nordeste e as melhores coberturas se encontram em áreas peculiares, onde se localizam os grandes centros populacionais. Houve associação com a carência de profissionais fonoaudiólogos inseridos no Sistema Único de Saúde, centros de referência em saúde auditiva e número de maternidades.

**Palavras-chave:** Audição; Perda auditiva; Triagem neonatal; Sistema Único de Saúde; Sistemas de informação

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## INTRODUCTION

Universal newborn hearing screening (UNHS), known as “little ear test” (teste da orelhinha), is a recommended screening tool for early diagnosis of hearing loss and should be applied before the newborn’s hospital discharge<sup>(1)</sup>. It is considered the first step to a program which should be carried out, preferentially, before the first month of life and offers multidisciplinary diagnostic assessment up to three months old. In case of hearing loss confirmation, intervention processes using hearing amplification and rehabilitation which must be initiated before completing six months of life<sup>(2)</sup>.

In 2010, the law n° 12.303 made screening using evoked otoacoustic emission (EOA) in all babies born in maternities and hospitals<sup>(1)</sup> mandatory in Brazil, enabling an enhancement in the integrity of health assistance during childhood and in particular in users of the “Unified Health System” (*Sistema Único de Saúde - SUS*).

Research shows a consensus towards the importance of universal screening, namely, newborns’ screening indices should be better than 95%. However, universal access to SUS users is not yet a reality in Brazil<sup>(3,4)</sup>.

The current national index of universal screening is 37.5%<sup>(5)</sup>, representing an inferior benchmark than the one recommended and endorsed by the Multiprofessional Committee on Hearing Health (*Comitê Multiprofissional em Saúde Auditiva - COMUSA*)<sup>(6)</sup> and by the Joint Committee on Infant Hearing<sup>(7)</sup>.

Among the current challenges in newborn hearing screening (NHS) in the Brazilian scenario, there are the non-compliance to the program and the variability between protocols within different services. This last one makes the analysis and the comparison between programs difficult<sup>(8)</sup>.

Spatial analysis can provide a visual evaluation of the distribution pattern of an event through maps. Studies<sup>(3,5)</sup> using this methodology, show a growth in NHS coverage in all geographic regions of Brazil over time with emphasis on the northeastern region, after the implementation of Federal law n° 12.303/2010. However, the authors observed that this specific region has the least coverage rate when compared to the others.

As the northeastern region is recognized for its large territorial extent and for its considerable social inequalities<sup>(9)</sup>, it is possible that SUS users have to deal with difficulties when accessing health services<sup>(5)</sup>. In order to identify and understand the hindrances that may contribute to these findings, this region requires a meticulous evaluation.

Within this context, we perceived the importance of exploring the northeastern region and its counties, using secondary data, considering the lack of scientific discussions around NHS coverage and accessibility to hearing health in Brazil.

Therefore the main objective of this study was to perform

a spatial analysis of the NHS coverage in the northeastern region of Brazil and to verify a possible association between the number of Speech-Language Pathology and Audiology (SLPA), maternities and reference centers in hearing health.

## METHODS

This research is a transversal and ecological study, with a qualitative and quantitative analysis, which operational type is defined as aggregate. The unit of analysis was the municipality, in its total 1,794 municipalities, which constitute the nine states of the northeastern Region of Brazil - representing the research scenario.

The referred population consisted of newborns, retrieved from the Live Birth Information System (*Sistema de Informação sobre Nascidos Vivos - SINASC*), from January to December 2014.

For data collection, the following electronic resources were used: Ambulatory Information System (*Sistema de Informação Ambulatorial - SIA-SUS*), SINASC, Beneficiaries Information System (*Sistema de Informações de Beneficiários - SIB*) National Agency for Supplementary Health (*Agência Nacional de Saúde Suplementar - ANS*) and the National Registry of Health Establishments (*Cadastro Nacional de Estabelecimentos de Saúde - CNES*).

As the geographic area, the northeastern region of Brazil was selected based on the platform of the Department of Informatics of SUS in the SIA-SUS, broken down by the analysis unit “municipality” and, as a screening period, January to December 2015. The procedure selected was “Otoacoustic Emissions for Hearing Screening”, which the reference code is 0211070149. With this search, we found the number of procedures per municipality.

The disparity between the period of analysis of live births (2014) and number of triads (2015) did not interfere in the research, since both refer to the most current available data in the Health Information Systems, during the realization of the data collection between June and July of 2016. In addition, there was no significant change in the number of live births in the population, from year to year.

In the SIB / ANS, the total coverage of the supplementary health care was identified, by the number of children up to 1 year, covered by health insurance, from January to December 2015, by municipality, so they could be excluded from the calculation of the portion of the population which uses SUS, due to the great variation in the national territory.

The coverage of NHS for the live births, SUS users, was calculated using the following formula: Percentage of Neonatal Hearing Screening coverage =  $nNHS / nLB - nHI \times 100$ , where nNHS corresponds to the number of EOAs for Hearing Screening approved by SUS, nLB corresponds to the number of Live Births and nHP corresponds to the population covered by Health Insurance.

Other data collected by municipality, through consultation at the CNES, were: number of maternities, reference centers in hearing health and number of SLPA who attended SUS.

First, data was compiled and organized in a database, using Excel® and then transferred to a statistical software to carry out the analysis.

In order to obtain the visual identification of the coverage of the NHS in the municipalities of the Northeastern states, the exploratory spatial analysis was carried out, through georeferencing of the data, in which the creation of the coverage map of NHS in the northeastern region was accomplished by TabWin software, made available by the Department of Informatics of the Ministry of Health. Its coverage was categorized into four groups to specify their estimate in the geographic areas of the map. In this, the magnitude of the coverage percentages was identified by the intensity in the gray color levels, it means the darker the color, the higher is the UNHS coverage in the indicated municipality.

In addition, a descriptive statistical analysis of the qualitative variables was carried out by means of the absolute and relative distribution. The coverage was distributed in four categories (0-25%, 25-50%, 50-75% and 75-270,3%), so that better data uniformity could be provided, the last category was related to the maximum found value. For analysis of the quantitative variables, we used the weighted average, based on the gross data of the screening coverage.

The analysis of the relationship between qualitative and quantitative variables was made using Chi-Square and Fisher’s exact test. The independent variables of the number of maternities, number of SLPA and number of reference centres in hearing health were categorized as “none” and “one or more than one”, and the dependent variable of NHS coverage in two groups: of less than 50% and greater than 50%. A significance level of 0.05 (95%) was adopted.

According to Resolution 466/12 of the National Health Council, public data with no human beings identification do not have to be submitted to an ethics committee in research, preserving the right to publish the sources without exposure to risk or harm.

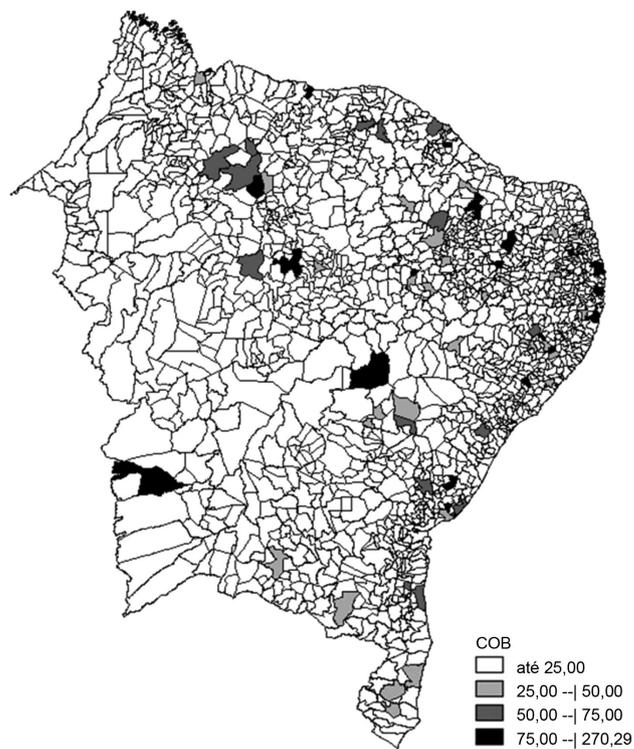
**RESULTS**

Information systems in health allow the analysis of NHS coverage in those 1794 municipalities belonging to the 9 northeastern States in Brazil and considering, as well, the total amount of 3813 SLPA working at SUS, 302 maternities and 42 reference centers in health.

The exploratory spatial analysis, using the map, shows a predominant low distribution of NHS coverage (0-25%) throughout all the northeastern territory, in particular in the States of Maranhão, Piauí and Bahia. On the other hand, the municipalities situated in the east of Maranhão reveal a coverage between 50%-75%, as do some other municipalities

in the northeastern part of Ceará, metropolitan region of Fortaleza and western Potiguar.

Coverage above 75% can be found in unique areas at the coastal zone, where the leading urban centers are located (Figure 1).



Subtitle: COV = coverage

**Figure 1.** Spatial distribution of Neonatal Hearing Screening coverage in the Northeast of Brazil, in the year 2015

A quantitative description of NHS coverage for each correspondent category and municipality is presented in Table 1.

**Table 1.** Description in percentage and by category of Neonatal Hearing Screening coverage in the municipalities of the Brazilian Northeast

NHS coverage	Nº of municipalities
0-25%	1,720
25-50%	36
50-75%	15
75-270.3%	23
Total	1,794

Subtitle: NHS = Neonatal Hearing Screening

In relation to the characterization of NHS coverage in the northeastern states of Brazil, little difference in coverage frequency between each state could be observed. However, the States of Piauí and Paraíba stand out regarding the coverage frequency in the municipalities that have NHS services, showing results of 102.06% and 83.36% respectively (Table 2).

In relation to the association between NHS coverage and the number of maternities, the coverage of 50% or more was related with the presence of one or more maternities in the municipality. In spite of the lack of maternities, the hospitals that carry out NHS, revealed a high frequency (68.2%) in coverage with indices equal to or above 50% (Table 3).

Besides that, it was pointed out a relation between NHS coverage and the lack of SLPA working at SUS and reference centres of hearing health. When coverage was equal or less than 50% there was an absence of SLPA professionals locally.

## DISCUSSION

Universal newborn hearing screening (UNHS) is part of a combination of actions that aim a complete health assessment during childhood<sup>(10)</sup>, Stablished as the primary strategy and the most efficient way to diagnose hearing loss at birth<sup>(11)</sup>.

In order for this assistance to reach the population which uses SUS, adjustments and structuring of all public health care network, is fundamental<sup>(5)</sup>.

Throughout this study it became obvious that the NHS goals are not achieved by the SUS. Although an over 75% coverage exists in specific areas, low NHS coverage indices stand out in the northeastern territory, providing confirmation on recent findings in the literature<sup>(3,5)</sup>.

Maranhão, Piauí and Bahia are the states with the largest territorial extent and those which show the highest concentration of coverage deficiency. Probably different aspects contribute in an important way to this gap, such as absent public resources, lack of institutional investment and inadequate structuring of health services, besides an insufficient number of professionals<sup>(3)</sup>.

Coverage and the amount of maternities in the northeastern cities revealed an ongoing association, showing that those

**Table 2.** Absolute and relative distribution and weighted mean of Neonatal Hearing Screening coverage, according to the Northeast Brazilian states

States	Municipalities	Municipalities with NHS (n)	NHS coverage by state (%)	Weighted average coverage of municipalities with NHS in %
Maranhão	217	7	1.72	53.37
Piauí	224	5	2.28	102.06
Ceará	184	23	3.91	28.45
Rio Grande do Norte	167	8	2.16	45.19
Paraíba	223	10	3.73	83.36
Pernambuco	185	15	5.03	62.06
Alagoas	102	6	3.52	59.91
Sergipe	75	3	1.45	36.46
Bahia	417	23	2.73	49.58

**Subtitle:** NHS = Neonatal Hearing Screening

**Table 3.** Relation of Neonatal Hearing Screening coverage with number of maternities, Speech-Language Pathology and Audiology in the Unified Health System and reference centers in hearing health in the Northeast of Brazil

		NHS coverage		p-value
		≤ 50% n (%)	≥ 50% n (%)	
Nº of maternities	None	490 (90.6)	15 (68.2)	≤ 0.01*
	One or more than one	51 (9.4)	7 (31.8)	
Nº of SLPA in SUS	None	263 (48.3)	3 (13.6)	≤ 0.01**
	One or more than one	281 (51.7)	19 (86.4)	
Nº of reference centers in hearing health	None	530 (97.4)	19 (86.4)	≤ 0.05**
	One or more than one	14 (2.6)	3 (13.6)	

\* Chi-square test

\*\* Exact Fischer test

**Subtitle:** NHS = Neonatal Hearing Screening; SLPA= Speech-Language Pathology and Audiology; HUS = Health Unic System

municipalities which offered NHS with at least one SLPA, had a better coverage. So, it may be assumed that NHS programs are conducted in nearby municipalities with a limited number of SLPA who engulf the different demands from their neighborhood.

The SLPA is the professional responsible for NHS<sup>(12)</sup>. So, an unequal distribution, together with a reduced number of professionals working in public services, may contribute directly to the low NHS coverage in the northeastern region<sup>(8)</sup>.

In the years of 2000, 2005 and 2010 there was an evolution in the speech-language and audiology area that can be observed when analyzing the procedures accomplished by the SLPA professionals. A significant growth (181,8%) in the number of these professionals can be detected. In spite of these advances, there is still an unequal distribution in all Brazilian territory<sup>(13)</sup>. The southeastern region stood out in relation to the percentage of professionals, while the north and northeast trail behind national percentages throughout all years.

It could be stated that the distribution of reference centres in health was mostly concentrated in private and philanthropic institutions, with only 34% represented by public networks, showing a major incidence on the south and southeast regions of Brazil<sup>(14)</sup>. Therefore, the existence of an unequal distribution of this service in the northeastern regions can be reaffirmed<sup>(15)</sup>.

In this manner, it is possible to verify that, although a progress in NHS coverage could be identified in Brazil since the arising of a nacional program of newborn screening (Programa Nacional de triagem Neonatal (PNTN)) in 2011<sup>(16)</sup>, regional inequalities in coverage within the inter and intra regional level could be detected and continue nowadays, particularly in the northeastern region<sup>(3,5)</sup>.

Therefore, the population tends to experience greater difficulties in accessing health services<sup>(5)</sup>, seeking for assistance in other regions - entailing an increase in treatment expenses, as for exemple, through transportation, an assistance offered by the government for "far from domicile" treatments (*Tratamento fora do domicilio* - TFD)<sup>(17)</sup>.

That being said, it was also veified a major concentration of NHS program in specific municipalities only, those, functioning with indices above 75%, as revealed by this research.

Coverage above 100% must be pointed out. This incident can be explained by considering the possibility that NHS programs have to screen newborns from nearby townships or cities. Furthermore, no code for NHS retesting is available at SIA-SUS, so the same child might have been registered twice, overestimating the indices<sup>(18)</sup>. The occurrence of digital errors may be another explanation<sup>(19)</sup>.

Literature agrees on the evidence that the State of Paraíba<sup>(3,5)</sup> maintains the best indices of NHS coverage among all northeastern Brazilian states, different from the results we obtained. This contradiction may be justified by the different analysis units used in distinguished studies, as for example:

Federal units, intermediate regions of urban articulation - according to the sequence of studies cited above - and, in this research, the applied unit was the municipality, making a more detailed investigation about northeastern coverage possible.

The hypothesis assumed, was that the best percentual NHS values would be encountered in the coastal area, explained by the centralization of urban and economic development which enables a greater capital concentration and consequently a rise in health service<sup>(9)</sup>. Brazilian NHS reality lies way beyond other international scenarios. In 2003, in the USA, the expectancy of a 95% coverage was achieved in 76% of the States with NHS legislation and in 26% of the States without NHS legislation<sup>(20)</sup>. Currently all 50 States and 7 territories have NHS programs with a mean national coverage of 91%<sup>(21)</sup>.

Another international research, carried out in an Israeli hospital<sup>(22)</sup>, obtained a coverage of 94.8% in only two years of program. A Spanish hospital achieved a 95.64% rate of coverage, screening 26.717 out of 27.935 newborns<sup>(23)</sup>.

It is notorious that Brazil, with all its geographical regions, needs to keep trying to advance in hearing health politics and in developing strategies to facilitate access and an adequate distribution to and of health services.

UNHS's success depends, as well, on the support and cooperation of health professionals, as for example nurses and pediatricians, and their positive attitude towards the UNH, as it helps with an efficient and complete children's assistance<sup>(24)</sup>.

In view of the above considerations, the importance of vigilance in health must be pointed out as this information contributes to the evaluation of NHS implementation<sup>(3)</sup>.

The use of a health information systems enabled a low cost research with easy access to a considerable amount of data and culminated in a large analysis of population coverage. Therefore this type of study can be used as a strong allied for research purposes in SLPA, as these secondary sources support surveys on differential diagnosis and action plans<sup>(25)</sup>. Nevertheless, some fragilities, using this resource, must me mentioned, as for example bias due to the delay in updating public data<sup>(3)</sup>, inadequate professional management of the system<sup>(26)</sup> and failure in computing new procedures. As a result, sub registrations of information or a super estimation in notification of procedures may be generated<sup>(3)</sup>. Publications within this subject field are still scarce. The limitations did not compromise this study or obfuscate its value, but being aware of them enhanced the comprehension of the results<sup>(3)</sup>.

Going forward, we suggest to continue scientific discussions using this kind of resource, exploiting other objects of analysis in relation to NHS in Brazilian geographical regions.

## CONCLUSION

Neonatal Hearing Screening reveals a predominant coverage below 25% in all northeastern Brazilian territory and

the best indices can be encountered in specific areas, where large population centres are located. The association between the lack of Speech-Language Pathology and Audiology into the Health Unic System, reference centres in hearing health and the number of maternities could be established.

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