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Artigo Original

Newborn Hearing Screening: association between coverage, and the availability of speech therapists and equipment in Brazil

Triagem Auditiva Neonatal: associação entre a cobertura, oferta de fonoaudiólogos e equipamentos no Brasil

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Keywords

Hearing
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ABSTRACT

Purpose: To determine the coverage of newborn hearing screening (NHS) and its association with the availability of speech therapists in the National Health System (SUS) and equipment in the states of Brazil in 2012 and 2018. **Methods:** This is a descriptive ecological time series study with the Brazilian states and live births as units of analysis. An exploratory analysis of newborn hearing screening coverage and descriptive data analysis were performed. Spearman's correlation coefficient was used to measure the strength and direction of the association between two ranked variables. **Results:** Coverage in Brazil increased from 24.1% to 67.6%. Better coverage was observed in the South and Southeast regions in 2012, and in the former and Mato Grosso state (MS) in 2018. The average number of speech therapists was 4.79 and 8.9 / 100,000 inhabitants in 2012 and 2018, respectively. The index of "transient evoked otoacoustic emission" equipment was below 1 / 100,000 inhabitants in the two years in all the states of the country. **Conclusion:** Screening coverage increased in Brazil, albeit below the recommended level, and is related to rising number of speech therapists in the SUS. Spatial distribution is heterogeneous throughout the country.

Descritores

Audição
Triagem Neonatal
Recém-Nascido
Equipamentos e Provisões
Sistema Único de Saúde
Sistemas de Informação em Saúde

RESUMO

Objetivo: Verificar a cobertura da triagem auditiva neonatal e sua associação com a quantidade de Fonoaudiólogos no SUS e de equipamentos disponíveis nas unidades federativas do Brasil nos anos de 2012 e 2018. **Método:** O estudo é do tipo ecológico descritivo de séries temporais tendo como unidade de análise as Unidades de Federação do Brasil e os nascidos-vivos. Foi realizada a análise exploratória da cobertura da triagem auditiva neonatal e análise descritiva dos dados. O coeficiente de correlação do ranking de Spearman foi usado para medir a força e direção de associação entre duas variáveis ranqueadas. **Resultados:** A COB no Brasil apresentou evolução de 24,1% para 67,6%. Observaram-se melhores coberturas estão nas Regiões Sul e Sudeste em 2012 e no ano de 2018 destacando-se a Região Sul e o estado do MS. A média do índice de fonoaudiólogos foi de 4,79 e 8,9/100.000 habitantes, respectivamente para os anos de 2012 e 2018. O índice da oferta de equipamentos de "Emissões Otoacústicas Evocadas Transientes" se manteve abaixo de 1/100.000 habitantes nos dois anos e em todas as unidades federativas do país. **Conclusão:** A cobertura da triagem apresentou um aumento no Brasil, porém ainda abaixo do recomendado e está relacionada com o aumento da inserção de fonoaudiólogos no SUS. A distribuição espacial se apresenta heterogênea em todo seu território.

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INTRODUCTION

It is estimated that one to three and two to four of every 1000 newborns with no risk and at risk, respectively, are born deaf worldwide[1], a high number that requires screening and correct auditory diagnosis.

Since there are no studies in Brazil on the prevalence of hearing loss in childhood, it is impossible to estimate the number of screened children that failed the examination and were diagnosed with some disorder. A few literature studies have been conducted on Hearing Screening Programs[2-4], where most newborn hearing screenings occurred in public maternity hospitals, either in the bed or outpatient clinic, and the majority do not achieve the ideal 95% coverage. There are also differences in the protocols applied, time to perform newborn hearing screening (NHS) and the location where the result of the examination is recorded.

In general, NHS occurs heterogeneously in Brazil, each facility with its own protocol, according to the demand and its management system[5], making it difficult to obtain a general pattern of how screening occurs as well as its national coverage. In addition, there are few studies on the demand for speech therapists and the amount of evoked otoacoustic emission equipment available in public health facilities, essential factors for NHS programs.

According to Resolution no. 260 of June 10, 2000, which governs speech therapists in newborn hearing screening of the Federal Council of Speech Therapy[6], speech therapists are the professionals qualified to implement and execute NHS programs in Brazilian maternity wards. As such, it is important to know the demand for these public health professionals, given that they are largely responsible for childhood auditory health in the country.

Knowing the availability of the devices used by these professionals during hearing screening makes it possible to determine its distribution in the country, given that it is the main equipment used in the newborn hearing test[7] and an important indicator of national hearing screening coverage.

In 2012, the Brazilian Ministry of Health published national hearing screening guidelines, in which one of the quality criteria is 95% coverage of screened live births, with the goal of reaching 100% of this population[8]. This recommendation is also based on international guidelines[9]. For this reason, ascertaining hearing screening coverage in Brazil is important to determine whether early assessment of newborn hearing is being effectively conducted.

Data obtained in the literature on the Brazilian Newborn Screening Program showed a hearing test prevalence of 65.8% in the country, demonstrating inequalities in per capita family income, region of residence and the use of public or private health services, influenced by economic development and per capita public health expenditures[10].

Thus, the aim of the present study was to determine newborn hearing screening coverage and the influence of the number of speech therapists in the SUS and equipment available for auditory screening in the states of Brazil between 2012 and 2018.

METHOD

This is a descriptive ecological time series study, with the states of Brazil as units of analysis. The population consisted of live births in the country in 2012 and 2018.

Since this is a secondary study containing public data without identifying human beings, it did not require Research Ethics Committee approval.

For data collection, the following electronic databanks were surveyed: the SUS Outpatient Information System (SUS-OIS), the National Registry of Health Establishments (NRHE), the Information System on Live Births (ISLB), the Information System of Beneficiaries (ISB) of the National Agency for Supplementary Health (NASH) and the Brazilian Institute of Geography and Statistics (BIGS).

The data were collected between 2012 and 2018. This period is related to the publication of the Ministry of Health's Newborn Hearing Screening Guidelines (2012) and data on newborns available up to 2018 through DATASUS.

DATASUS data were accessed through the link "Informações de Saúde ("Health Information) (TABNET)". SUS Outpatient production of the evoked otoacoustic emission examination for hearing screening was accessed at the link "Assistência a Saúde", ("Health Care"); the number of live births was obtained from "Estatísticas Vitais" (Vital Statistics) and the amount of equipment and number of professionals through the CNES by accessing "Recursos Físicos - Equipamentos" e "Recursos Humanos - Profissionais" (Physical Resources – Equipment and Human Resources – Professionals), respectively. With respect to the estimated population, the IBGE provides estimation tables for each year that were published in the Federal Official Gazette (FOG). Finally, in the SIB/ANS, the number of children up to 1 year old covered by health plans was identified, in order to eliminate them from the calculation of those enrolled in the SUS. All the variables were obtained in 2012 and 2018 by state.

Hearing screening coverage (COV) in the SUS was calculated using the following formula: COV = nTA x 100 / LBUS - NHP, where nTA is the number of otoacoustic emissions (OAEs) for hearing screening approved by the SUS per state and year, LBSUS the number of live births and NHP the population covered by health plans. The percentage of speech therapists working in the SUS was calculated by the number of speech therapists in the country and the number of professionals present in the SUS ever year.

Moreover, the number of speech therapists and equipment available in the SUS, per state, were measured. Spearman's coefficient was used to obtain these indicators, applying the following calculation methods: No. of speech therapists in the SUS, in year X, in state X x 100,000 inhabitants/population of state X in year X, in which the number of professionals working in the SUS each year and in each state was identified. The same method was used to obtain the amount of equipment available in the public health service, using the formula: No. of devices in the SUS, in year X, in state X x 100,000 inhabitants/population of state X in year X.

Finally, the increase in speech therapists in the public health system was calculated using the following formula:

(The number of speech therapists in the SUS in 2018- the number of speech therapists in the SUS in 2012)/the number of speech therapists in the SUS in 2012.

The same formula was used to calculate the number of evoked otoacoustic emission devices in the public health service.

The data were initially tabulated in a Microsoft Excel spreadsheet, followed by descriptive data analysis. Next, the tab program for Windows (TabWin) was used to create three coverage maps for exploratory analysis, in which grey level intensity is directly related to the magnitude of the percentages, that is, the darker the color, the higher the values. Finally, two tables were created to show the number of speech therapists working in the SUS and the number of devices available and their increase, respectively, per state in 2012 and 2018.

Spearman's coefficient was used for statistical analysis to observe whether there is a correlation between the number of speech therapists in the SUS, the number of devices available and the increase in newborn hearing screening coverage for 2012 and 2018.

RESULTS

Newborn hearing screening coverage in Brazil increased from 24.1 to 67.6%, representing a rise of approximately 180%, obtaining an average of 45.8% between 2012 and 2018. Minimum and maximum coverage was 0 and 66.48% for the states of Acre and Rio Grande do Sul, respectively, in 2012, and 0 and 114.1% in 2018, inAmapá and Mato Grosso do Sul states, respectively. The number of live births remained constant during the period.

Exploratory spatial analysis of screening percentage coverage in the 26 states and Federal District is illustrated on the two maps below for 2012 and 2018 (Figure 1). Light greys predominate in the first map, with the best coverage in the South and southeast regions, particularly the states of Paraíba and Amazonas, with 57.6 and 47.89% respectively. The second map shows a change in color tone for states in the Northeast and Midwest, the coverage in the South remained the same, while Mato Grosso do Sul state displayed the best coverage in the country.

The average number of speech therapists during the study period was 4.79 and 8.9/100,000 inhabitants, for 2012 and 2018 respectively. In addition, the number of speech therapists in the SUS increased in all the states. Paraná and Minas Gerais states exhibited the best index per 100,000 inhabitants, reaching more than 7/100,000 inhabitants (Table 1).

The number of transient evoked otoacoustic emission devices available for newborn hearing screening in the SUS remained below 1/100,000 inhabitants throughout the study period and in all the states. Nevertheless, there was progress over time, since the average index was 0.16 and 0.30/100.000 inhabitants for 2012 and 2018, respectively. The state of Amapá had a null index every year of the study and Mato Grosso do Sul obtained the best index (0.76/100,000 inhabitants in 2018). In addition, Roraima, Tocantins and Sergipe had null indices in 2012, but exhibited indices other than zero in 2018 (Table 2).

In regard to the increase in speech therapists per 100,000 inhabitants in the SUS (Table 1), none of the states showed a decline during the study period, while Sergipe (314%) obtained the highest increase of all the states.

In terms of the increase in transient evoked otoacoustic emission devices per 100,000 inhabitants, Goiás (567%) exhibited the highest rise between 2012 and 2018, in contrast to Acre (-13%) and Amazonas (-47%) (Table 2).

Statistical analysis showed a moderate correlation (0.45) between the number of speech therapists in the SUS and the increase in NHS coverage in 2012 (Figure 2) and a strong correlation (0.63) in 2018 (Figure 3).

DISCUSSION

The results of the present study demonstrate a considerable increase in NHS coverage in Brazil, albeit below the level recommended in the national and international literature, and that there are inequities between the states. The increased

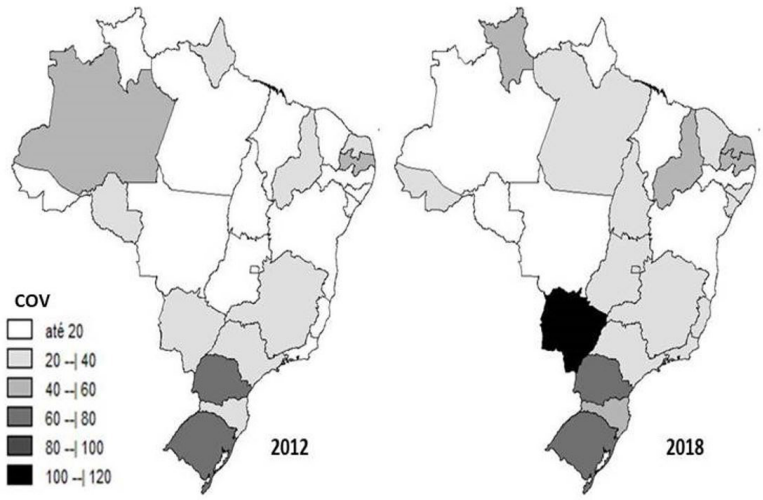
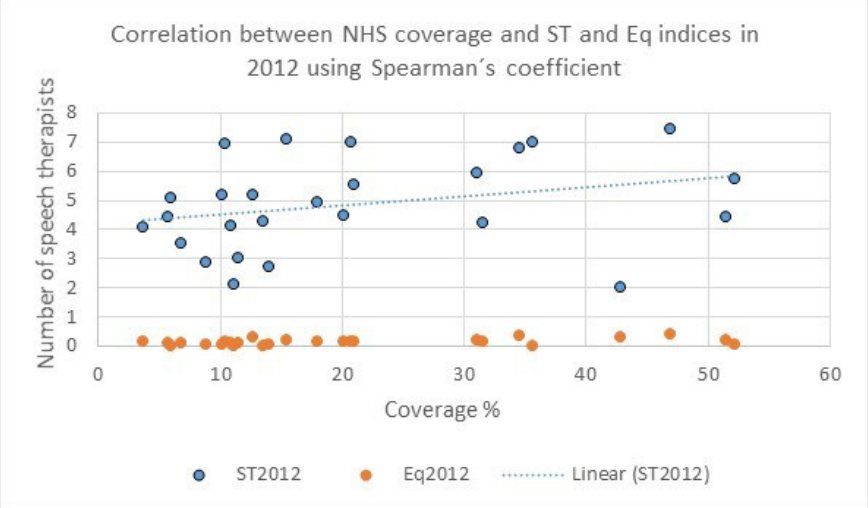


Figure 1. Spatial distribution of percent newborn screening coverage between 2012 and 2018 per state in Brazil

Table 1. Number of speech therapists working in the SUS per 100,000 inhabitants and the increase in each state between 2012 and 2018. Brazil

State	Number of speech therapists in the SUS	Number of speech therapists in the SUS	Increase in the number of speech therapists in the SUS
	2012	2018	2012-2018
Rondônia	4.21	6.49	54%
Acre	3.29	5.64	71%
Amazonas	2.03	4.41	117%
Roraima	4.26	11.62	173%
Pará	2.70	5.2	93%
Amapá	7.01	10.61	51%
Tocantins	5.08	9.45	86%
Maranhão	2.84	6.62	133%
Piauí	4.49	11	145%
Ceará	4.10	6.07	48%
Rio Grande do Norte	5.51	11.01	100%
Paraíba	5.74	11.69	104%
Pernambuco	4.43	8.41	90%
Alagoas	4.93	11.17	127%
Sergipe	2.13	8.82	314%
Bahia	3.01	6.51	116%
Minas Gerais	7.00	12.1	73%
Espírito Santo	5.17	7.7	49%
Rio de Janeiro	6.94	10.04	45%
São Paulo	7.11	10.11	42%
Paraná	7.42	12.1	63%
Santa Catarina	5.95	11.6	95%
Rio Grande do Sul	4.40	9.8	123%
Mato Grosso do Sul	6.79	10.04	48%
Mato Grosso	4.08	6.65	63%
Goiás	5.20	9.02	73%
Federal District	3.51	6.29	79%



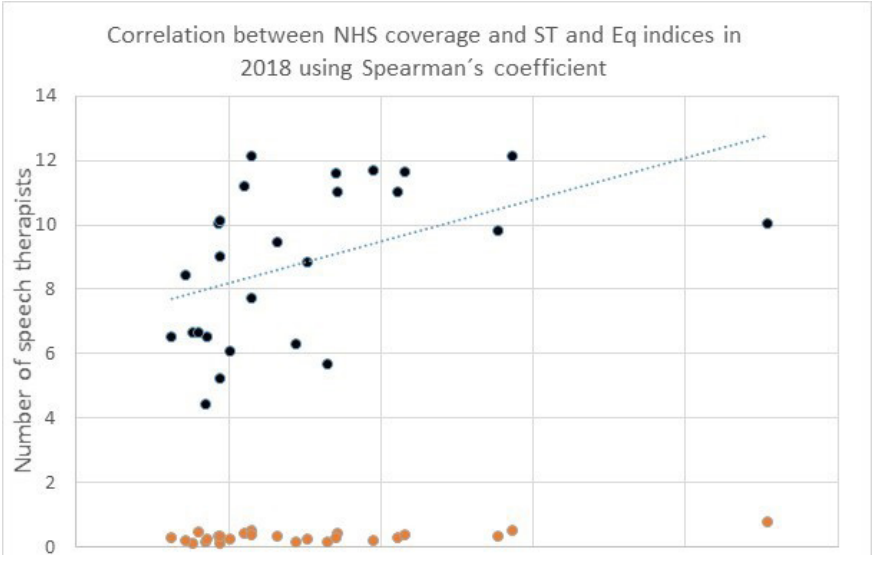
Caption: Eq = equipment index. ST = speech therapist index.
Figure 2. Correlation between NHS coverage, increase in speech therapists (ST) and equipment (Eq) in the SUS in 2012. Brazil.

coverage was accompanied by a slight rise in the number of speech therapists and devices to perform screening in the SUS of most states. Despite the correlation in 2012 and 2018, this increase indicates that other factors may have contributed to the results obtained during the study period, such as the motivation and commitment of all the professionals involved in newborn hearing screening.

The increase in coverage is noteworthy, albeit slow and unequal, corroborating other studies[11,12]. Only Mato Grosso do Sul complied with Law no 12.303/2010, which mandates

Table 2. Number of transient evoked otoacoustic emission (EOAE) devices for every 100,000 inhabitants and the relative increase in devices in the SUS in each state in 2012 and 2018. Brazil

State	Number of EOAE devices in the SUS	Number of EOAE devices in the SUS	Increase in the number of EOAE devices in the SUS
	2012	2018	2012-2018
Rondônia	0.13	0.28	126%
Acre	0.13	0.12	-13%
Amazonas	0.28	0.15	-47%
Roraima	-	0.35	
Pará	0.06	0.11	65%
Amapá	-	-	-
Tocantins	-	0.32	
Maranhão	0.04	0.11	155%
Piauí	0.13	0.28	118%
Ceará	0.07	0.24	248%
Rio Grande do Norte	0.12	0.43	248%
Paraíba	0.05	0.2	282%
Pernambuco	0.09	0.18	100%
Alagoas	0.16	0.39	148%
Sergipe	-	0.22	
Bahia	0.10	0.22	119%
Minas Gerais	0.16	0.37	134%
Espírito Santo	0.28	0.5	80%
Rio de Janeiro	0.15	0.3	105%
São Paulo	0.21	0.31	48%
Paraná	0.38	0.48	26%
Santa Catarina	0.19	0.28	50%
Rio Grande do Sul	0.21	0.34	61%
Mato Grosso do Sul	0.36	0.76	113%
Mato Grosso	0.16	0.44	172%
Goiás	0.03	0.22	567%
Federal District	0.08	0.13	78%



Caption: Eq = equipment index. ST = speech therapist index
Figure 3. Correlation between NHS coverage, increase in speech therapists and equipment in the SUS in 2018. Brazil

otoacoustic emission testing for all newborns[7], while the programs of all other states exhibited shortcomings[8].

The increase in hearing screening coverage in the country occurred in nearly all the states, and seems to rise with the number of speech therapists employed by the SUS.

With respect to the number of professionals in the SUS, more were hired during the study period, along with the creation of new undergraduate courses in Brazil. Historically, these courses have been concentrated in the Southeast and scarce in the North. However, since 2008/2009, the number of courses

and places have declined in the Southeast and increased in the Northeast and South of the country. In addition, the broadening of knowledge and dissemination of the profession in the areas of its competency[13], the creation of health policies or programs, such as the National Policy for Auditory Care and Health at School Program, as well as the enlargement of Centers for the Support of Family Health and the Living Without Limits Program, favored the greater presence of speech therapy in the SUS[14], in accordance Federal Law no. 12.303/2010[7].

Including speech therapists at the tertiary care level of the SUS, primarily in areas where NHS usually occurs, such as university hospitals, and state and municipal maternity hospitals, enhances the knowledge of health teams and favors greater patient participation[5,15]. Knowledge is imparted through prevention and promotion measures regarding the importance of newborn hearing screening for the early detection of possible auditory changes and language development.

It was found that patient participation in hearing screening programs is important since they help raise the coverage index, but may be subject to external influences that are not related to speech therapists in the health services, namely, the socioeconomic and cultural factors of families, such as the distance between their home and the health facility, mother's schooling level, family income, lack of interest, prolonged stay of the child in the ICU and the use of ototoxic medication[5,16-18].

The rise in the number of speech therapists working in the SUS has varied between states since 2000. Nevertheless, a difference in the concentration of these professionals can be observed between the states and regions, contributing to the poor distribution of speech therapy services[14], thereby affecting hearing screening coverage in live births, given that most newborn hearing screenings occur in public maternity hospitals, few of which achieve the recommended level of 95% of newborns screened[5].

The number of speech therapists increased in the public sector between 2008 and 2013, but this rise occurred heterogeneously, depending on factors such as good indicators, good human development index (HDI), economic resources, number of undergraduate speech therapy courses, and local laws and policies[13,19,20]. This increase, albeit heterogeneous, can be observed in the number of speech therapists employed in the public health services.

A greater rise occurred in some of the states of the North and Northeast, namely Roraima, Maranhão, Piauí, Sergipe and Alagoas, considered regions with low HDI that receive lower health transfer payments. This did not occur in more developed states, such as São Paulo and Rio de Janeiro, which showed no significant change during the study period.

The association between an increase in speech therapists in the national health system and greater NHS coverage shows that these professionals are relevant in the public health sector, corroborating literature findings of their key role in orienting doctors, nurses and social workers regarding the importance of newborn hearing screening coverage[21].

It is known that Brazilian speech therapists have multiple duties in the maternity ward, such as performing NHS, and stimulating and monitoring at-risk babies. Thus, accumulating tasks may reduce their time available to communicate with parents and guide the newborn hearing screening team[22].

Federal Decree 7.612 of 2011 established the National Plan for the Rights of People with Disabilities – Living Without Limits, created the Care Network for People with Disability, and qualified hearing healthcare services, supplying financial resources to purchase hearing screening equipment for maternity wards[23]. There was also a low index of transient evoked otoacoustic emission tests in relation to the number of inhabitants of all the states, showing a shortage of physical resources in terms of the population of the country and the number of live births, which can be explained by the insufficient federal transfer payments, low participation of health administrators, and heterogeneous speech therapist concentration in the SUS[14,24].

These transfer payments and the lack of research and reliable statistics on auditory disorders and their long-term economic cost are both national and international barriers[25], and essential to the proper functioning of the hearing screening program.

The balance between speech therapists and equipment exhibits a good relation with coverage (COV). In the Northeast we underscore Paraíba state, which obtained the best COV in 2012 (57.86%), but fell to only 44.6% of newborns at the end of the study period. This decline may be associated with the fact that although the state exhibited one of the best indices of speech therapists in the SUS per 100,000 inhabitants, the increase was small when compared to the other states and the equipment index was one of the lowest of all the states, despite the increase.

By contrast, Mato Grosso do Sul increased from 39.1% COV in 2012 to 114.1% in 2018. This good result may be associated with the increase in equipment used for hearing screening and the constant number of speech therapists/100,000 inhabitants. In 2015, the University Hospital of the Federal University of Mato Grosso do Sul acquired new equipment and hired speech therapists for NHS, which may have contributed to this rise[26].

The higher than 100% obtained may be justified by newborn hearing screening in neighboring states, a result reported in the literature. Moreover, inherent to this study is the absence of a retest code in the outpatient information system (SIA), where the same newborn may be recorded twice when submitted to retesting, which would overestimate the value[20].

However, it cannot be inferred that only these two variables may have influenced the increased or decreased COV in these states. Thus, access to these services and the type of procedures used must also be assessed.

This study corroborates the context of the SUS in the last 30 years, where the number of services and professionals, in addition to their access, have increased. It is important to underscore the challenges encountered, including the public-private relation in providing health services, the marked regional inequalities and underfunding[27].

This is the first Brazilian study in the area of audiology to conduct a survey of the equipment available in the SUS, which is important in assessing the quality of access to health services in the country[28].

The literature provides a number of categories for the purpose of quality of access, availability being one of the most common,

which reflects the existence of health services and resources in an amount and quality compatible with patient needs and in the manner in which the resources are organized[28].

This study reveals the difficult access to newborn hearing screening, due to the low coverage and shortage of speech therapists and equipment in most of the states. Unequal distribution was also observed in a multicenter project in terms of availability in all the regions of Brazil such as the unavailability of some services and doctors, not sharing responsibilities and information in a timely manner and a waiting list for necessary products and services[29].

Finally, ecological studies have limitations, since the information is collected from a public database, subject to missing information or incorrect data recording of the variables under study.

More in-depth studies of newborn hearing screening in Brazil are needed in order to analyze the barriers and facilitators in the programs, as well as the use of the brainstem auditory evoked potential test in screening.

CONCLUSION

Newborn hearing screening coverage reached an average of 67.6% in 2018 in Brazil, a value still below that recommended by the Ministry of Health. The distribution is heterogeneous, primarily in the Northeastern, Midwestern and Northern states.

The rise in screening coverage is associated with the increase in the number of speech therapists in the SUS. The greater investment in equipment was not related to NHS coverage, and variables other than those assessed in the present study may have contributed to this increase.

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Author´s contributions

TSO and MRRD contributed to the collection and analysis of the data, as well as in writing the article. HGC guided all stages of the work.