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Polio vaccine coverage in the Northeast region of Brazil in the first year of the Covid-19 pandemic

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Abstract

Polio has been eliminated in Brazil since the 1990s, attributed to the success of vaccination campaigns in the country, with the last case recorded in 1989. However, low vaccination coverage is one of the warning factors for the return of wild virus circulation in the country and the permanent sequelae caused by the virus, thus requiring continuous monitoring in the territory. This study aimed to analyze the spatial distribution of Polio vaccine coverage (VC) in the Northeast region of Brazil in 2020 in terms of the VC target ≥95%. The public data for the VC Rate indicator was obtained from the National Immunization Program Information System on the DATASUS website. The results up to the time of extraction show the Northeast Region with coverage of 71.8% below the target, with the lowest VC rate recorded in the state of Maranhão (60.1%) and the highest in Ceará (86.9%). The State of Maranhão, also presented a greater number of municipalities in a critical situation (23.5%), with vaccination coverage ≤50%. Spatial data show a tendency to group municipalities with high vaccination coverage in some states in the region, but it does not alter the conclusion that in 2020 the population under one year of old was in a vulnerability situation regarding the reintroduction of the wild virus in most of the municipalities in the states of that region and in the other Brazilian states.

Keywords

Spatial analysis, indicator, flaccid paralysis

Introduction

Polio, a highly contagious disease, characterized by a clinical picture of flaccid paralysis with sudden onset, has as its etiological agent the poliovirus, belonging to the Enterovirus genus, Picornaviridae family, composed of three serotypes 1, 2 and 3, with human as a reservoir. Transmission occurs mainly by

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direct, person-to-person contact, via the fecal-oral route, or by objects, food, and water contaminated by feces of patients or carriers, and also, via the oral-oral route, by droplets of secretions from the oropharynx to the talking, coughing or sneezing (Ministry of Health, 2010). There is no cure for the disease, only prevention by vaccines

This disease has been eliminated in Brazil since the 1990s, with its last case in 1989, as a result of the success of vaccination campaigns in the country. The circulation of the wild virus was eliminated, but factors such as poor housing conditions, poor personal hygiene and the high number of children in the same house can favor the transmission of poliovirus (Ministry of Health, 2010).

The low Vaccination Coverage (VC) is also an alert factor, in the return of the wild virus circulation in the country and/or the emergence of Vaccine-Derived Poliovirus (VDPV). According to the Brazilian Society of Tropical Medicine, in a report on the danger of the reintroduction of polio, researchers draw attention to the low vaccination coverage, which favors the weakened live virus from oral vaccines to continue to multiply in the human intestine (rare, but possible), change genetically to the point of regaining the ability to cause paralysis and spread in those who have not been vaccinated. The outbreaks recorded in South African countries, for example, originated from the vaccine-derived poliovirus, unlike the only two countries Pakistan and Afghanistan that still have remaining strains of wild poliovirus in their territory (SBMT, 2020).

Brazil in 2015, published the "Polio Eradication Plan: Strategy in Brazil" with the general objective of achieving the global polio eradication target, containing six specific objectives: to create the National Certification Committee for Polio Eradication; strengthen the Epidemiological Surveillance of Acute Flaccid Paralysis (AFP ES); replacing the trivalent attenuated oral vaccine with the bivalent one; perform laboratory containment of the poliovirus; gradually implement poliovirus Environmental Surveillance; and effectively mobilize health professionals and civil society to disseminate the new strategy (Ministry of Health, 2015).

In addition to the possible interaction and genetic change, epidemiological research suggests that live attenuated vaccines such as the oral polio vaccine (OPV) may result in the induction of non-specific effects on the immune system (Blok, Arts, Crevel, Benn, & Netea, 2015). but it can also protect against other types of viruses (Higgins et al., 2016; Aaby e Benn 2017; Upfill-Brown et. al., 2017) (Higgins et al., 2016; Upfill-Brown et al., 2017).

Brazil, however, has introduced the inactivated polio vaccine (IPV) for all babies starting their primary vaccination series since 2012, with the aim of preventing rare cases of vaccine-associated paralytic polio, ensuring equitable access to IPV and preparing for the future cessation of OPV after global eradication, with due continuous monitoring to achieve high vaccination coverage (Domingues et al., 2016).

However, Brazilian states and municipalities have particular characteristics that range from cultures, geographic, economic, environmental and social barriers in a single country, and listening to them is the first step towards successful implementation and operationalization of monitoring and evaluation tools in relation to the Polio Eradication Plan: Strategy in Brazil.

In this context, this exploratory work, with a focus on the territory, aimed to analyze the indicator of polio vaccine coverage, from 2016 to 2020, in the Northeast region, to verify the achievement of the vaccination coverage target (≥95 %) in this region.

Methodology

The Information System of the National Immunization Program (IS-NIP) of the Ministry of Health was used as a data source, with consultation of public data, available at the link (http://sipni.datasus.gov.br/si-pni-web/faces/inicio.jsf), selecting the Tabnet option (vaccination coverage) and the variables of interest: Municipality-line; Year-column; Vaccination coverage- content; Years 2016 to 2020 - Period; Polio – Immune's option.

The Vaccination Coverage (VC) indicator for Polio is calculated by the Ministry of Health team, based on the number of doses applied of the immunobiological agent for polio registered in the IS-NIP divided by the population under one year old from the Live Birth System database (SINASC) multiplied by 100. The target of 95%, recommended by the WHO and adopted by the NIP, was used to consider low coverage (< 95%) or high coverage (≥95%).

Possible inconsistencies and/or missing were verified using the Epi InfoTM software from the Center of Disease Control and Prevention (CDC) and the Microsoft Excel spreadsheet editor, which analyzed the coverage frequencies for each municipality. The maps with the results of the Polio vaccine coverage were elaborated with RStudio, software free of integrated development environment for R and with the packages: geobr, ggplot, ggspatial, ggrepe.

Results

The Polio vaccine coverage in Brazil in 2020, until November 23, 2021, was 76.0%, lower than the vaccination coverage achieved in the years 2016 to 2019. According to live birth data, made available by the Ministry da Health in 2020, 1,722,907 children were born (Ministry of Health, 2020), of these possibly 416,943 children were not vaccinated for polio in the country.

Among the 27 Federation Units (Table 1), there is a predominance of Polio VC between 51% and 94% (yellow color) lower than the agreed target (≥95%). The states that reached the vaccination target (green color) were: Rondônia from 2016 to 2019, Ceará from 2016 to 2018; Alagoas, Minas Gerais and Mato Grosso do Sul in 2018 and Santa Catarina in 2017. However, in 2020 none of the states reached the Polio VC target. Among the states, Amapá has the lowest vaccination coverage (41.9%) in 2020 (red color), while Santa Catarina had the best VC (88.3%) in the same year.

The Northeast region reached a coverage of 71.8% in 2020, the lowest recorded in the analyzed period (2016-2019) and the maximum recorded was 90.0% in 2019. Among the states, the variation in coverage in 2020, was 60.1% the minimum in the state of Maranhão and 86.8% the maximum for the State of Ceará, the median between the states was 71.5%, below the Brazilian median.

Own preparation. **Source**: IS-NIP.

resents a summary of the situation of municipalities by states in the Northeast region. The state with the largest number of municipalities is Bahia (417) and the smallest is Sergipe with 75 municipalities. The states in the Northeast region had municipalities with vaccination coverage lower than 50%, considered to be at high risk for the recirculation of the wild virus. The state with the highest number of municipalities in this situation is Maranhão: 23.5% of its municipalities have coverage less than or equal to 50%, and the lowest percentage of municipalities in this situation was recorded in the states of Ceará (6.0%). and Paraíba (7.2%).

It was also observed that in all states, there are municipalities with a record of vaccination coverage above 100%. The state of Alagoas had the lowest percentage of municipalities (10.8%) with coverage

Table 1. Polio vaccine coverage in the FUs of Brazil in 2016- 2020.

Unidade da Federação	2016	2017	2018	2019	2020
Rondônia	105,4	108,2	101,9	98,3	82,0
Acre	71,3	74,0	78,3	81,7	62,8
Amazonas	76,2	76,4	79,3	83,3	67,4
Roraima	88,5	90,5	79,8	79,8	72,9
Pará	63,2	67,6	69,1	72,7	59,2
Amapá	47,6	63,2	68,7	73,0	41,9
Tocantins	84,8	86,1	91,7	88,2	83,8
Maranhão	69,4	74,3	80,6	75,7	60,1
Piauí	70,7	78,1	83,7	81,9	71,5
Ceará	107,9	97,3	111,1	93,5	86,9
Rio Grande do Norte	70,3	69,5	90,3	80,7	69,6
Paraíba	85,5	82,3	92,3	92,6	72,6
Pernambuco	90,4	84,7	94,7	85,6	71,7
Alagoas	80,1	83,9	96,1	87,9	72,1
Sergipe	78,3	79,0	89,7	80,9	70,6
Bahia	70,7	78,3	78,3	74,8	69,7
Minas Gerais	88,3	87,1	97,8	88,5	85,9
Espírito Santo	89,3	83,2	91,0	86,7	81,6
Rio de Janeiro	89,9	88,8	87,5	73,6	55,3
São Paulo	83,8	87,7	92,6	86,6	82,0
Paraná	87,5	90,4	90,9	89,7	86,1
Santa Catarina	92,1	95,1	94,6	93,7	88,3
Rio Grande do Sul	84,5	85,7	85,7	85,1	84,8
Mato Grosso do Sul	93,8	91,5	96,0	94,4	81,9
Mato Grosso	90,6	84,1	90,3	85,8	80,8
Goiás	82,1	81,6	85,5	81,5	77,8
Distrito Federal	136,8	84,4	86,0	84,3	81,5
Brasil	84,4	84,7	89,5	84,2	76,0

Own preparation. Source: IS-NIP.

above 100%, while the state of Paraíba had the highest percentage of municipalities in this situation (34.5%).

In 2018, there was an advance in the distribution of municipalities in the state and Alagoas, with VC equal to or greater than 95%, but in 2019 it is possible to see a territorial reduction of this protection, and in 2020 few municipalities with coverage above 95%, restricted to 37 municipalities (20%), some of which border areas with other states (Figure 1)

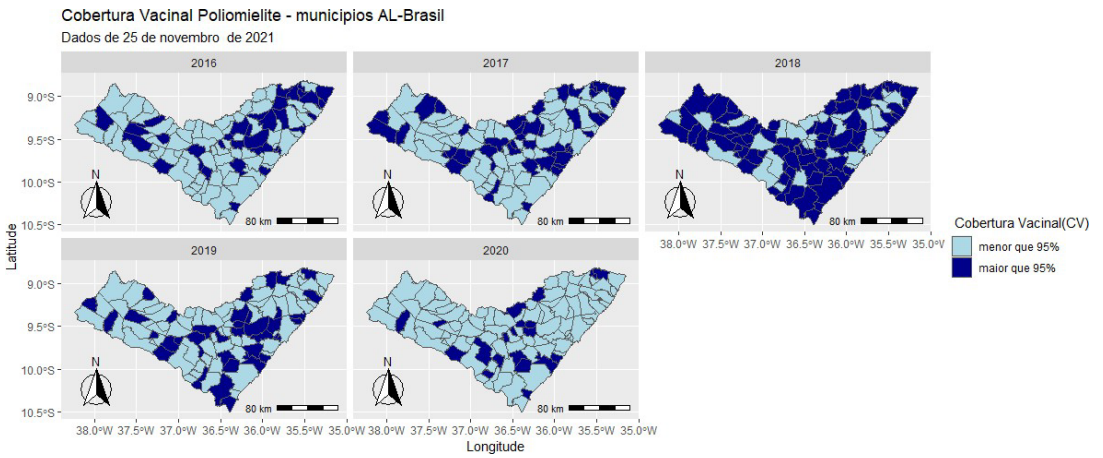


Figure 2. Polio vaccine coverage in the municipalities in the state of Alagoas from 2016 to 2020. Own preparation. Source: IS-NIP.

In the state of Bahia, the highest concentration of municipalities, with coverage equal to or greater than 95%, are located close to the limits of the states of Minas Gerais, Tocantins, Goiás and to neighboring municipalities, totaling 88 (21%) of the 417 municipalities in the state in 2020. In previous years, the largest territorial coverage was in the years 2018 and 2019 (Figure 2).

One of the states with the highest distribution of municipalities with vaccination coverage equal to or greater than 95%, in 2020, both in the interior of the state and in its coastal region and in neighboring municipalities, was Ceará, of the 184 municipalities, 59 (32%) are with coverage ≥ 95%. In the municipalities of this state, the effect of the pandemic is clear when compared to other years, with most of its territory with a target of VC achieved. Municipalities that for two consecutive years failed to inform (NA- in grey) the vaccination coverage in the country's official system (Figure 3) draws attention.

While the state of Maranhão has 217 municipalities, only 36 (16%) of its municipalities achieved vaccination coverage equal to and/or greater than 95% in 2020. Although the other years also did not show

Table 1. 2. Descriptive analysis of vaccination coverage information for the 1,794 municipalities by state in the Northeast region of Brazil in 2020.

State	Number of municipalities			Vaccination coverage data (%)			
	By State	With data	Without data	≤ 50%	51% to 94%	95% to 100%	> 100%
Maranhão	217	217	0	30(13.8)	132(60.8)	11(5.1)	23(9.8)
Piauí	224	224	0	51(23.5)	130(58.0)	12(5.4)	62(27.7)
Ceará	184	184	0	20(8.9)	114(62.0)	16(8.7)	43(23.4)
Rio Grande do Norte	167	166	1	11(6.0)	105(63.2)	2(1.2)	45(27.1)
Paraíba	223	223	0	16(7.2)	111(49.8)	19(8.5)	77(34.5)
Pernambuco	185	185	0	20(10.8)	112(60.5)	16(8.6)	37(20.0)
Alagoas	102	102	0	11(10.8)	71(69.6)	9(8.8)	11(10.8)
Sergipe	75	75	0	8(10.7)	45(60)	6(8.0)	16(21.3)
Bahia	417	417	0	35(8.4)	294(70.5)	26(6.2)	62(14.9)

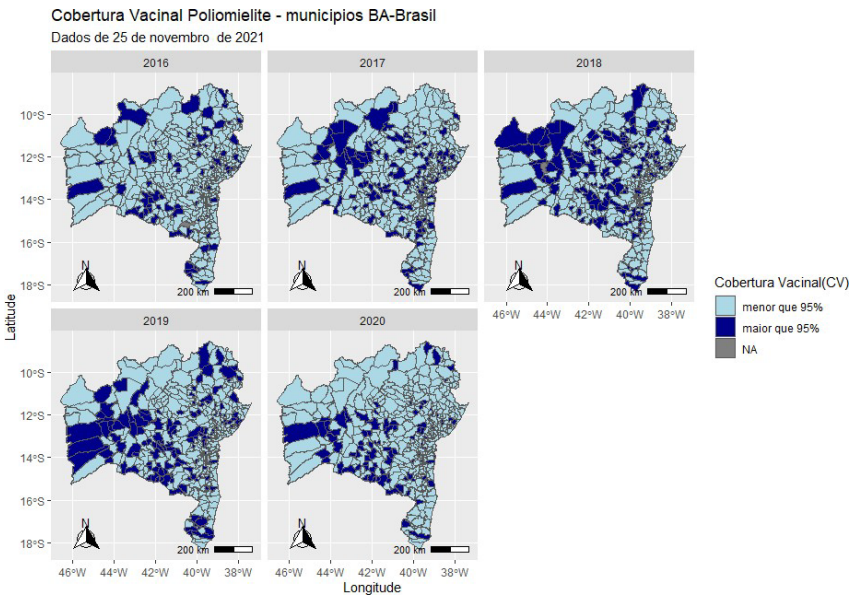


Figure 3. Polio vaccine coverage in the municipalities of Bahia from 2016 to 2020. Own preparation. Source: IS-NIP.

an advance, the best VCs are repeated in border municipalities or neighboring municipalities[1]. In Figure 4, in 2020 these municipalities are randomly distributed in the state or are neighboring municipalities.

In the state of Paraíba, 223 (43%) municipalities that reached the target (≧95%) in 2020, and are distributed throughout the state, however, the cluster of neighboring municipalities with good vaccination coverage is noteworthy. This state had the highest percentage of municipalities with good vaccination coverage in 2020 when compared to other states in the northeast region of the country. However, the most critical years were 2020 and 2017 (Figure 5).

In 2020, of the 185 municipalities in the state of Pernambuco, 53% (29%) reached the target of polio vaccine coverage ($\geq$ 95%). These are visualized in dark blue, forming small clusters in the state, as they are mostly neighboring municipalities and/or municipalities close to the states of Ceará and Paraíba. However, this was one of the years with the lowest distribution of municipalities with reaching the target, as well as in 2017 (Figure 6).

In the state of Piauí, with 224 municipalities, 74(33%) of these in 2020 had coverage (≥95%), forming clusters of bordering municipalities throughout the state. The best performance of vaccination against Polio occurred in 2017 when compared to the other years. However, this is one of the states that in 2016 had a municipality that did not inform (NA- in gray) the VC in the country's official system (Figure 7).

The state of Rio Grande do Norte in 2020 was the only state with a municipality without information on polio vaccine coverage (NA – gray color), situation also recorded in 2016 for another municipality in the state. Of the 167 municipalities, 47 (28%) reached the VC target (≥ 95%) in their population of

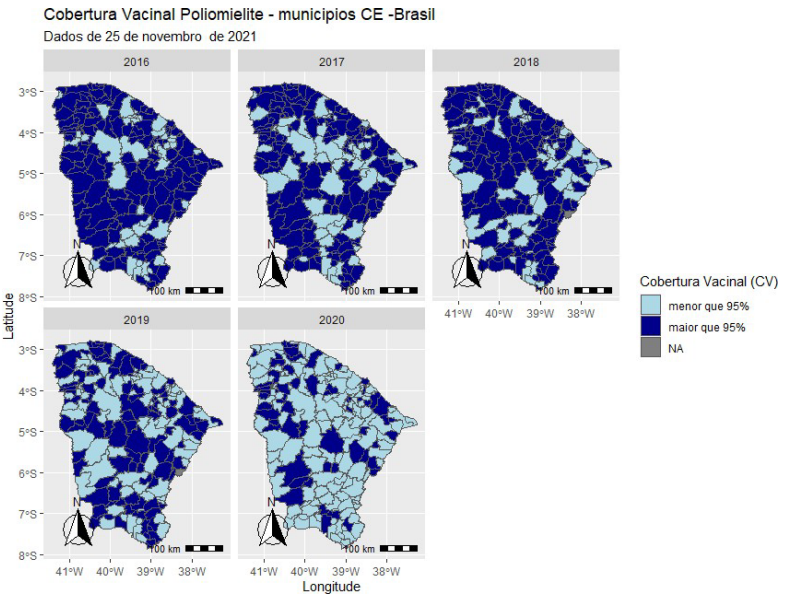


Figure 4. Polio vaccine coverage in the municipalities of Ceará from 2016 to 2020. Own preparation. Source: IS-NIP.

children under one year old. The best coverage was observed in neighboring municipalities in the state in 2020 and the best coverage in the territory was recorded in 2018 (Figure 8).

Sergipe is the state in this region with the fewest municipalities (75), of which only 22 (29%) of the municipalities in 2020 reached the target (≥95%) of VC. The best coverage is predominant in neighboring municipalities in the state, with the exception of three municipalities: Nossa Senhora de Lourdes, Boquim and General Maynard. Not unlike some states, the year 2018 was the one with the highest distribution of municipalities that reached the vaccination target (Figure 9).

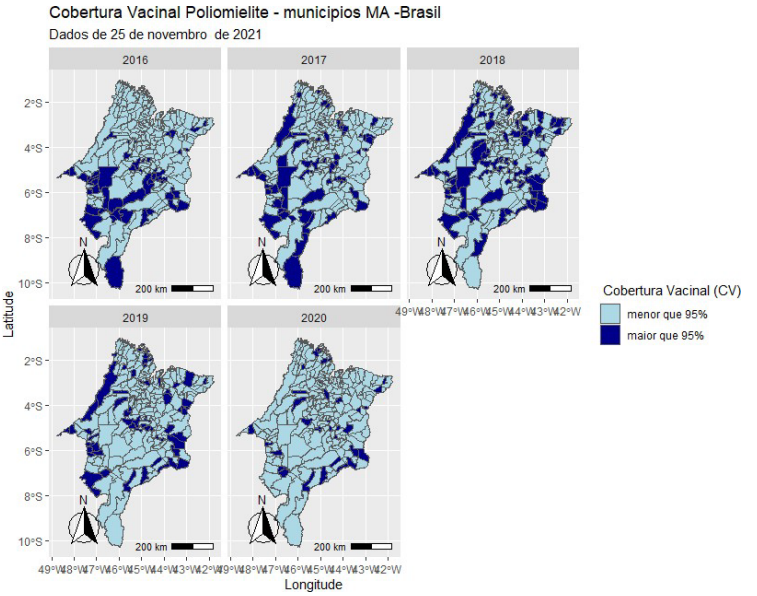
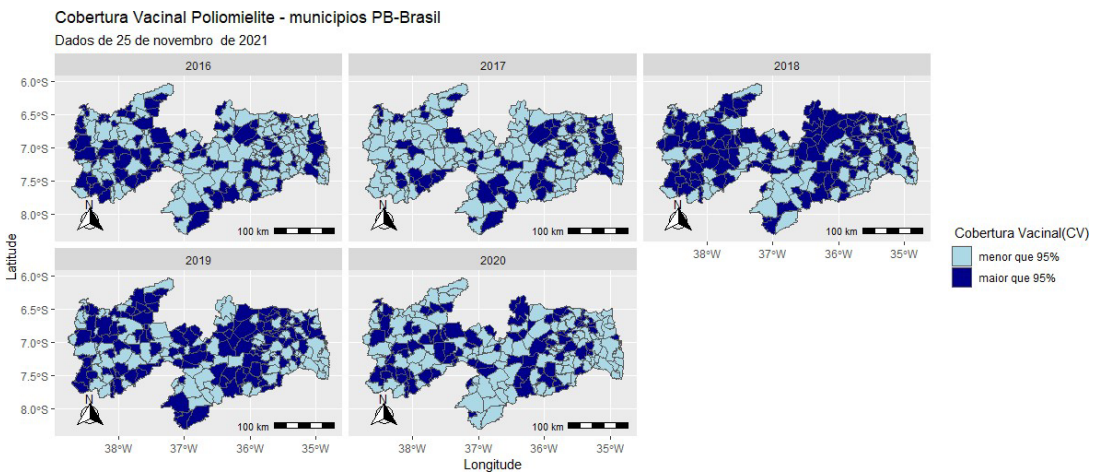


Figure 5. Polio vaccine coverage in the municipalities of Maranhão from 2016 to 2020. Own preparation. Source: IS-NIP.



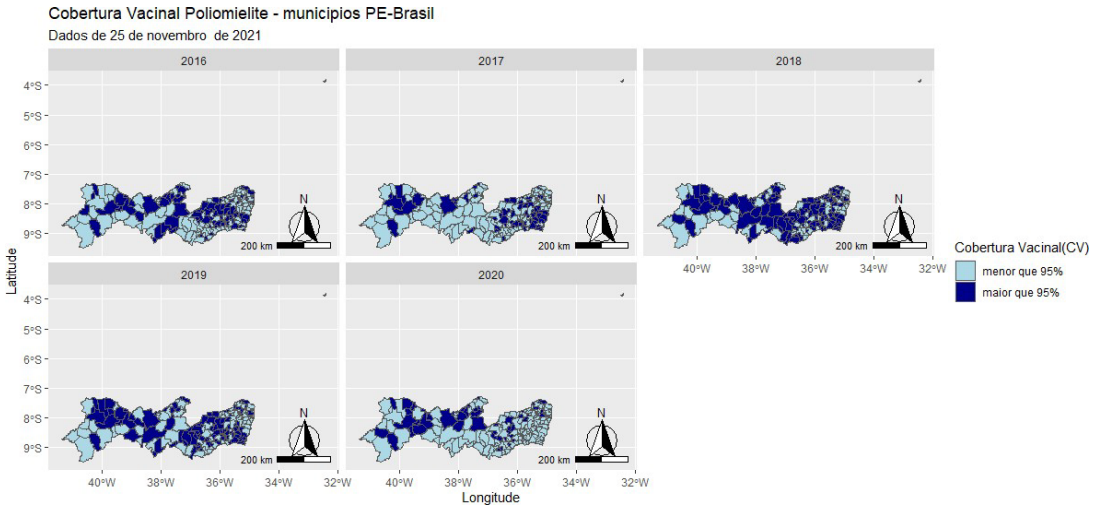


Figure 7. Polio vaccine coverage in the municipalities of Pernambuco from 2016 to 2020. Own preparation. Source: IS-NIP.

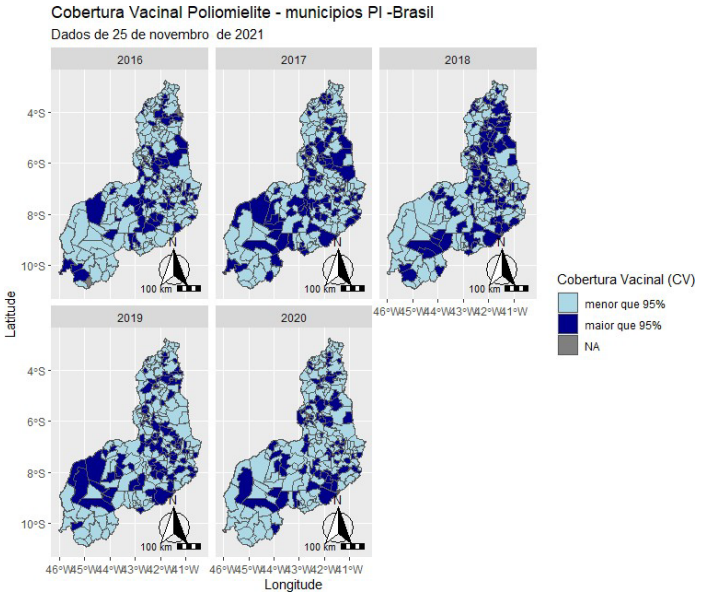


Figure 8. Polio vaccine coverage in the municipalities of the state of Piauí from 2016 to 2020. Own preparation. Source: IS-NIP.

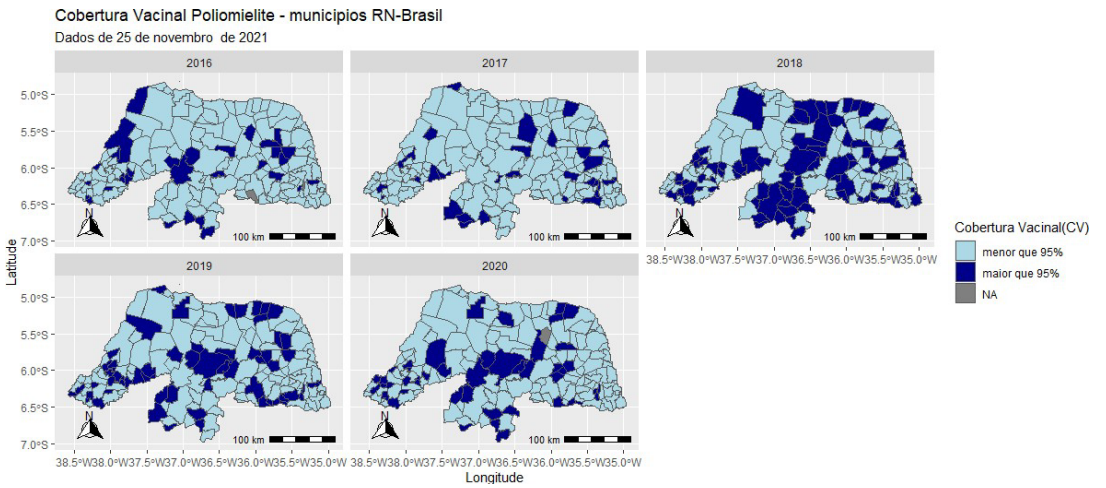


Figure 9. Polio vaccine coverage in the municipalities of the state of Rio Grande do Norte from 2016 to 2020. Own preparation. Source: IS-NIP.

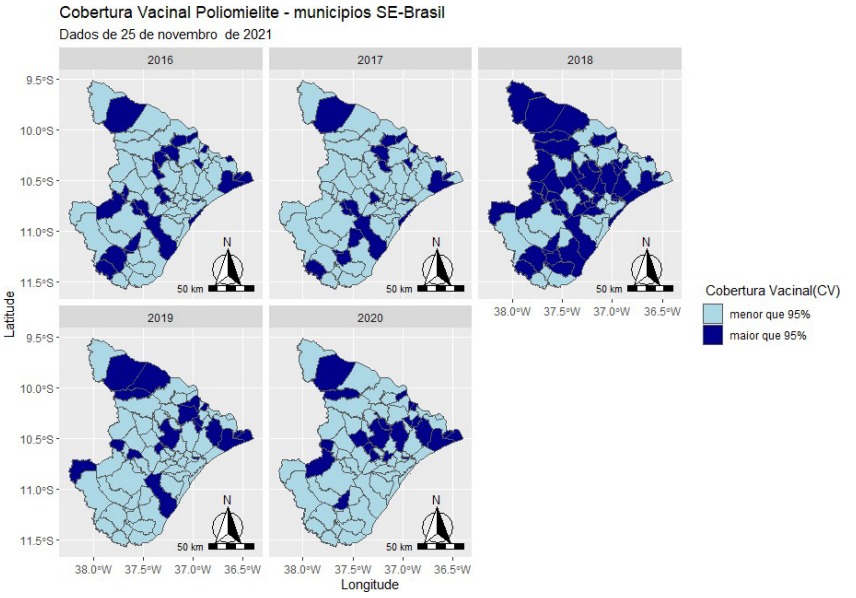


Figure 10. Polio vaccine coverage in the municipalities of the state of Sergipe from 2016 to 2020. Own preparation. Source: IS-NIP.

Final considerations

The 2020 results, for the Northeast region, show the sharp drop in Polio vaccine coverage, which may have been worsened as a result of the pandemic that the country and the world have been experiencing since February 2020. All health actions are aimed at containing the advancement of the SARS-CoV-2 virus and the timely treatment of severe cases, and, consequently, with the interruption or reduction of health actions and services, developed by basic/primary care.

The death results for the year 2020 show the need to strengthen actions and campaigns related to polio in this region. Actions or campaigns with the offer of all vaccines in the SUS calendar suggest a good strategy to reach a large part of the target population. According to health managers in the state of Paraíba, the “D-Day” held in October 2020 favored the increase in Polio coverage that year in the state (Government of the State of Paraiba, 2020). The state of Ceará in the Northeast Region was also one of the states that joined the "D-Day" Vaccination Campaign that took place, also in October 2020, according to news in the digital media. However, information about “D-Day” was not found in the other states in the northeast region of the country.

In 2020, around 214,490 (28.2%) of live births in the Northeast region did not receive the dose for the prevention of polio. It is necessary to verify if the lack of access was determined by the pandemic year that began with the circulation of SARS-CoV2, or if other factors such as the lack of infrastructure in municipalities, remote locations, live births of immigrants or resistance to vaccination contributed with low coverage in the region.

The low vaccination coverage observed in the region may favor the resurgence of the disease, as there is still a high number of municipalities in the states of this region, with coverage below 50%. The investigation and diagnosis of this low coverage in these municipalities are necessary in order to verify which factors and causes these municipalities are in the risk group for the resurgence of the disease.

According to Fugitaet al. (2018), in Brazil, several reasons may be contributing to the low coverage, such as misinformation about the importance of vaccines, the administrative calendar and vaccine hesitancy. A problem that has been occurring with developed nations, and that may also be occurring in Brazil, with a great reach through networks and social media greater than the anti-vaccination movement in relation to the non-importance of recommended vaccines in Brazilian public health.

Municipalities with vaccination coverage above 100%, identified in the northeast region, suggest the possible use of the sum of doses applied by immunobiological, instead of counting the number of vaccinated children, or even inaccuracies in the registration of doses of vaccines applied, especially when implementation of vaccination campaigns.

Spatial data suggest that in some states there are clusters of municipalities with high coverage, while in other states, the municipalities are dispersed, and that both the countryside and the capitals are having problems in achieving polio vaccine coverage. Authors such as Fugita et al. (2018), highlight the need for urgent measures to include increasing vaccination coverage rates and the use of serology for vaccine-preventable diseases as a screening tool to identify patients who need vaccination.

In order to achieve the objectives specified in the Plan since 2015, given the scenario of the vaccination coverage indicator, years with a SARS-Cov-2 pandemic, a prior diagnosis must be carried out with the participation of municipal and/or state managers to identify successful experiences and/or the difficulties encountered in achieving the agreed coverage target. One of the ways to allow all 5,570 Brazilian municipalities to offer their population access to the vaccine in a timely manner and provide the necessary barrier for the non-recirculation of the wild virus in Brazil.

It also highlights that the elaboration of a mitigation plan, a risk matrix and the monitoring plan without the participation of the managers of the municipalities, where the health actions take place, may present difficulties regarding the implementation and operation of these tools by the municipalities. For, according to Minayo (1995), Brazil is formed by several "Brazils". And these particularities must be considered in the elaboration of a mitigation plan and a risk matrix in relation to the disease.

With the persistence of the Pandemic and the interruptions of Primary Care services, a situational analysis will be necessary to assess the interruptions that occurred in 2020 in the immunization program. Having a direct impact on access to services, due to physical distancing and transport reductions, concerns of caregivers and healthcare professionals about exposure to COVID-19 (Shet, Carr, Danovaro-Holliday et al., 2021).

In order to minimize this scenario, states and municipalities in particular should seek recovery strategies to include more immediate activities, such as mass vaccination activities and communication aimed at people with missing vaccine doses, develop a recovery vaccination structure within the vaccination of routine, improving screening of defaulters, training health workers to incorporate recovery strategies into the immunization program, screening children for vaccination status at any health service encounter or at school entry, and expanding age-based eligibility for vaccinations to ensure that unvaccinated older children receive missed vaccines (Muhoza, Danovaro-Holliday, Diallo, etal., 2021).

The data allow us to conclude that the coverage rates of immunizations for Polio in Brazil and in the Northeast region of the country decreased in the midst of the Covid-19 Pandemic, highlighting the risk of the reintroduction of the disease in the region. The VC is also below the global rate estimated for 2020 (83%), which has implications for public health practice and even though there is a high number of municipalities using systems that still notify doses applied instead of individual registration of vaccinated.

The spatial visualization of the VC of the municipalities emphasizes the need for further work to understand the clusters formed, whether they are related to the process of regionalization of the Unified Health System, or whether they are influenced by the bureaucratic political culture, planning deficiency, fragmentation of the system, or even by the anti-vaccination movement that has been advancing in Brazil.

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Bibliographic references

References

A, S., K, D.-H. C., & Mc. (2021). Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3850009

Aaby, P., & Benn, C. S. (2017). Beneficial nonspecific effects of oral polio vaccine (OPV): implications for the cessation of OPV? *Clinical Infectious Diseases*, 420-421.

Blok, B. A., Arts, R. J., Crevel, V. C., Benn, C. S., & Netea, M. G. (2015). Trained innate immunity as underlying mechanism for the long-term, nonspecific effects of vaccines. *Acesso em 23 de abril*

de 2021, *98*, 347-356.

De, C. N., Secretarias, & (conasems), D. S. (n.d.). Retrieved from https://www.conasems.org.br/nota-plano-de-erradicacao-da-poliomelite-no-brasil.Divulgadoem14dejaneirode2016

Domingues, C. M., Fátima, D., Pereira, S. ., Marreiros, A. C. C., Menezes, N., & Flannery, B. (n.d.). Introduction of sequential inactivated polio vaccine-oral polio vaccine schedule for routine infant immunization in Brazil's National Immunization Program. *J Infect Dis*, *1*, 143-151.

Fujita, D., Salvador, F. S., Nali, L. H., Das, Luna, E. J., & Dea. (2018). Decreasing vaccine coverage rates lead to increased vulnerability to the importation of vaccine-preventable diseases in Brazil. *Journa lof Travel Medicine*, *25*(1).

Governo, Do, & Paraíba, D. (n.d.). Retrieved from https://paraiba.pb.gov.br/noticias/paraiba-tem-melhor-cobertura-da-campanha-de-vacinacao-contra-poliomielite-do-nordeste.Publicadoem19deoutubrode2020

Grande, R., Sul, Saúde, D. S. D., & Saúde, D. A. E. (n.d.). Retrieved from https://atencaobasica-admin.rs.gov.br/upload/arquivos/202012/08093414-10-boletim-vacina.pdf.Acessoem20deabrilde2021

Harzing, A. W. (2007). Retrieved from https://harzing.com/resources/publish-or-perish

Higgins, J. P., Soares-Weiser, K., Lopez-Lopez, J. A., Kakourou, A., Chaplin, K., Christensen, H., . . . Reingold, A. L. (2016). Association of BCG, DTP, and measles containing vaccines with childhood mortality: systematic review. *BMJ*, *355*.

Minayo, M. C. S. (1995). *Os muitos brasis: Saúde e população na década de 80*. São Paulo. Rio de Janeiro: Hucitec.

P, D.-H. M., Mc, D., & Ms. (2020). Routine Vaccination Coverage - Worldwide. *MMWR Morb Mortal Wkly Rep*, *70*, 1495-1500.

Saúde, M. D. (n.d.). Retrieved from http://svs.aids.gov.br/dantps/centrais-de-conteudos/paineis-de-monitoramento/natalidade/nascidos-vivos/.Acessoem22deabrilde2021

Saúde, M. D., & Bolso, G. D. (2010). *Doenças infecciosas e parasitárias: Guia de bolso/ministério da saúde, secretaria de vigilância em saúde, departamento de vigilância epidemiológica. 8. ed. rev. - brasília: Ministério da saúde* (I. S. B. T. B. de Saúde, Ed.). Retrieved from https://bvsms.saude.gov.br/bvs/publicacoes/doencas_infecciosas_parasitaria_guia_bolso.pdf.Acessoem22deabrilde2021

Saúde, M. D., & Saúde, S. D. V. E. (2015). *Plano de erradicação da poliomielite: Estratégias*

no brasil. Amo. Retrieved from https://portalarquivos.saude.gov.br/images/pdf/2016/abril/07/Plano-p{ó}lio--Brasil--07-04-2016.pdf .Acessoem22deabrilde2021

Sociedade, De, & Tropical. (n.d.). Retrieved from https://www.sbmt.org.br/portal/perigo-de-reintroducao-da-poliomielite/ .Publicadoem08dejaneirode2020.Acessoem22deabrilde2021

Upfill-Brown, A., Taniuchi, M., Platts-Mills, J. A., Kirkpatrick, B., Burgess, S. L., Oberste, M. S., . . . Petri, W. A. (2017). Nonspecific effects of oral polio vaccine on diarrheal burden and etiology among Bangladeshi infants. *Clinical Infectious Diseases*, *65*, 414-419.