

Spatial Analysis Of Polio Vaccination Coverage During The COVID-19 Pandemic

Análise Espacial da Cobertura Vacinal Contra o Poliovírus Durante a Pandemia de COVID-19

Análisis Espacial de La Cobertura de Vacunación Contra La Polio Durante La Pandemia de COVID-19

RESUMO

Objetivo: Analisar a distribuição espacial da cobertura vacinal contra a poliomielite antes e durante a pandemia de COVID-19 no Brasil. **Método:** Estudo ecológico com dados do Programa Nacional de Imunizações entre 2011–2019 e 2020–2021. As coberturas vacinais foram tabuladas para 27 unidades federativas e comparadas pelos testes U de Mann-Whitney (5% de significância) e variação percentual da mediana. A análise espacial, utilizando malhas municipais, identificou clusters (alto-alto; baixo-baixo; alto-baixo; baixo-alto) de redução significativa da cobertura. **Resultados:** Predominaram aglomerados alto-alto nas Regiões Norte e Nordeste, com reduções entre 22% e 83%. A Região Sul concentrou clusters baixo-baixo. **Conclusão:** Houve redução da cobertura da vacina contra a poliomielite durante a pandemia, intensificando desigualdades socio-regionais e aumentando o risco de reintrodução do poliovírus no país.

DESCRIPTORES: Vacina contra Poliovirus; Programas de Imunização; COVID-19; Brasil; Enfermagem.

ABSTRACT

Objective: To analyze the spatial distribution of polio vaccination coverage before and during the COVID-19 pandemic in Brazil. **Method:** Ecological study using data from the National Immunization Program between 2011–2019 and 2020–2021. Vaccination coverage was tabulated for 27 federative units and compared using the Mann-Whitney U test (5% significance) and percentage change from the median. Spatial analysis, using municipal grids, identified clusters (high-high; low-low; high-low; low-high) of significant reduction in coverage. **Results:** High-high clusters predominated in the North and Northeast Regions, with reductions between 22% and 83%. The South Region concentrated low-low clusters. **Conclusion:** There was a reduction in polio vaccination coverage during the pandemic, intensifying socio-regional inequalities and increasing the risk of reintroduction of the poliovirus in the country.

DESCRIPTORS: Poliovirus Vaccine; Immunization Programs; COVID-19; Brazil; Nursing.

RESUMEN

Objetivo: Analizar la distribución espacial de la cobertura de vacunación contra la polio antes y durante la pandemia de COVID-19 en Brasil. **Método:** Estudio ecológico con datos del Programa Nacional de Inmunizaciones entre 2011–2019 y 2020–2021. La cobertura de vacunación se tabuló para 27 unidades federativas y se comparó mediante la prueba U de Mann-Whitney (significancia del 5%) y el cambio porcentual de la mediana. El análisis espacial, utilizando cuadrículas municipales, identificó conglomerados (alto-alto; bajo-bajo; alto-bajo; bajo-alto) de reducción significativa en la cobertura. **Resultados:** Los conglomerados alto-alto predominaron en las regiones Norte y Nordeste, con reducciones entre el 22% y el 83%. La Región Sur concentró conglomerados bajo-bajo. **Conclusión:** Hubo una reducción en la cobertura de vacunación contra la polio durante la pandemia, intensificando las desigualdades socioregionales y aumentando el riesgo de reintroducción del poliovirus en el país.

DESCRIPTORES: Vacuna contra el Poliovirus; Programas de Inmunización; COVID-19; Brasil; Enfermería.

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INTRODUCTION

During the COVID-19 pandemic, many countries interrupted immunization campaigns against infectious diseases in order to prioritize the fight against coronavirus^(1,2). This resulted in increased risk for the population due to the chance of recirculation of infectious diseases that had previously been controlled or eliminated in some countries⁽²⁾.

Among the infectious diseases that have been eliminated from the Americas, polio, caused by the poliovirus and known as infantile paralysis, stands out. The immunization of children under five years of age with the oral polio vaccine (OPV) and the inactivated polio vaccine (IPV) has interrupted the autochthonous transmission of poliovirus in almost all regions of the world^(3,4). However, there has been an increase in the number of children susceptible to poliovirus in Latin America, which has characterized Brazil as being at high risk for its spread⁽⁵⁾.

In Brazil, polio vaccination coverage is not uniform: there are areas with low recommended vaccination coverage for children, mainly in the North and Northeast regions⁽⁶⁾. Low coverage of vaccines that prevent polio threatens the achievement of a polio-free world by 2026, a goal set out in the Polio Eradication Strategy 2022–2026⁽³⁾. Studies are needed to identify pockets of low vaccination coverage in Brazil, using the situation prior to the COVID-19 pandemic as a reference for comparison^(7,8).

This study aimed to analyze polio vaccine coverage in children before and during the COVID-19 pandemic in Brazil.

METHOD

This is an ecological study that analyzed polio vaccine coverage (PVC) in children aged zero to four years, from 2011 to 2019 (pre-pandemic) and 2020 to 2021 (pandemic), using data from the National Immunization Program Information System (SI-PNI). Both VIP and VOP vaccines were considered due to their coexistence in the vaccination schedule during part of the period analyzed. The following formula was used to calculate PVP coverage:

$$\text{VCP coverage} = \frac{\text{Total number of VIP and VOP vaccine doses administered in a given location and year}}{\text{Population in the target age group in the same location and year}} \times 100.$$

The average coverage in the pre-pandemic and pandemic periods was calculated, and the differences between them were evaluated using the Mann-Whitney U test, considering IIQ and significance of 5%. Spatial analysis techniques were used with municipal grids, and LISA (Local Indicators of Spatial Association) cartograms were developed to identify statistically significant clusters ($p < 0.05$) of the low-low, high-high, high-low, and low-high types, according to traditional classification. The significance of the Local Moran Index (LMI) was defined based on 999 permutations, adopting $p \leq 0.05$ ⁽⁹⁾.

Spatial analyses were performed using GeoDa (1.20.0.8) and QGIS (3.18.3) software, while statistics were performed using Stata version 16.0, adopting a significance level of 5% (0.05).

Cartograms were prepared to present the clusters formed by municipalities that showed statistical significance ($p < 0.05$) in the reduction in VCP coverage. Low-low (dark blue) spatial clusters were displayed, formed by municipalities with low reduction in vaccination coverage and surrounded

by municipalities with the same behavior; high-high (dark red), formed by municipalities with a reduction in vaccination coverage and surrounded by similar municipalities; high-low (municipalities with a high reduction in vaccination coverage surrounded by municipalities that showed a low reduction in vaccination coverage), and low-high (municipalities with a low reduction in vaccination coverage surrounded by municipalities with a high reduction in vaccination coverage).

As the data is public, aggregated, secondary, and anonymized, the study does not require review by a Research Ethics Committee, in accordance with CNS Resolution No. 510/2016.

RESULTS

From January 2011 to December 2020, VCP coverage in Brazil was 75.17% ($_{95\%CI} 67.18 - 80.99$), and during the COVID-19 pandemic, from 2020 to 2021, the median vaccination coverage was 61.21% (52.38 – 68.17) ($p=0.000$), corresponding to a reduction of 18.57%.

All regions showed a statistically significant reduction in the median vaccination coverage of VCPs during social distancing measures.

All 27 Federal Units (UF) showed a statistically significant reduction in median vaccination coverage, ranging from 3.4% in Piauí ($p=0.027$) to 38.50% in Roraima ($p=0.000$) (Table 1).

Table 1- Median and percentage variation of the median coverage of polio vaccines in Brazil, between January 2011 and December 2019 and January 2020 and December 2021. National Immunization Program, Brazil.

Tabela 1 - Bloco de requisitos e seus conteúdos em conformidade com a RDC 72/2009 abarcadas pela pesquisa

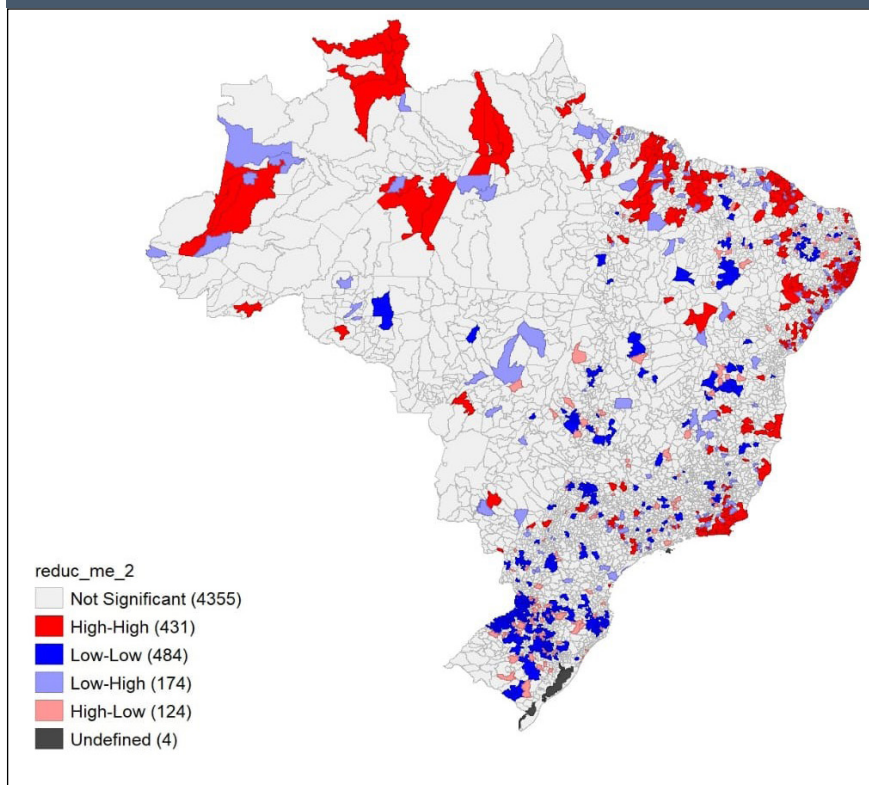
% of median vaccination coverage (P25-P75)				
Regions and states	Before	During	Variation (%)	p*
	Jan/2011 to Dec/2019	Jan/2020 to Dec/2021		
BRAZIL	75,17 (67,18 - 80,99)	61,21 (52,38 - 68,17)	-18,57	0,000
NORTH	71,18 (62,12 - 77,73)	53,41 (45,465 - 65,345)	-24,96	0,000
AC	67,93 (62,6 - 70,08)	46,81 (43,26 - 53,67)	-31,09	0,000
AP	44,42 (38,40 - 61,37)	36,66 (32,1 - 42,93)	-17,47	0,002
AM	77,02 (68,19 - 81,18)	57,85 (51,49 - 61,59)	-24,89	0,000
PA	58,89 (53,14 - 62,35)	47,68 (43,94 - 50,13)	-19,035	0,000
RO	76,88 (75,26 - 79,73)	68,23 (65,88 - 75,98)	-11,25	0,000
RR	82,44 (71,51 - 86,21)	50,70 (47,66 - 62,40)	-38,50	0,000
TO	75,77 (71,90 - 79,06)	72,02 (69,45 - 74,38)	-4,95	0,009
NORTHEAST	71,20 (63,95 - 79,44)	56,90 (52,29 - 61,25)	-20,08	0,000
AL	81,79 (80,61 - 85,95)	57,35 (55,91 - 61,73)	-29,88	0,000
BA	60,11 (55,28 - 63,52)	42,77 (40,63 - 51,01)	-28,85	0,000
CE	84,11 (79,88 - 88,72)	62,19 (60,61 - 74,16)	-26,06	0,000
MA	65,29 (62,01 - 68,93)	47,19 (44,21 - 49,96)	-27,72	0,000
PB	75,45 (67,69 - 81,59)	56,15 (54,59 - 61,95)	-25,58	0,000
PE	75,59 (71,10 - 77,78)	53,34 (52,39 - 56,57)	-29,44	0,000
PI	65,71 (63,12 - 70,18)	63,43 (60,28 - 66,25)	-3,46	0,027
RN	67,28 (61,97 - 73,73)	57,55 (54,13 - 59,05)	-14,46	0,000
SE	73,11 (64,58 - 76,45)	58,18 (54,99 - 59,14)	-20,42	0,000
MIDWEST	77,08 (72,77 - 81,77)	66,65 (64,03 - 71,34)	-13,53	0,000
DF	78,42 (75,27 - 79,14)	70,81 (69,09 - 72,93)	-9,70	0,000
GO	75,45 (72,43 - 78,94)	61,94 (57,96 - 64,60)	-17,91	0,000
MT	72,60 (69,22 - 75,85)	65,37 (64,22 - 68,30)	-9,96	0,000
MS	89,96 (79,55 - 95,73)	67,48 (65,17 - 71,92)	-24,99	0,000
Southeast	77,96 (69,02 - 81,40)	64,82 (49,49 - 69,80)	-16,85	0,000
ES	79,46 (71,54 - 80,91)	63,02 (61,09 - 64,87)	-20,69	0,000
MG	83,53 (77,01 - 84,48)	68,78 (65,90 - 77,06)	-17,66	0,000
RJ	61,16 (55,85 - 73,87)	43,97 (40,84 - 44,79)	-28,11	0,000
SP	78,30 (71,50 - 81,00)	69,71 (68,15 - 72,50)	-10,97	0,001
SOUTH	80,34 (77,89 - 83,96)	72,00 (64,50 - 77,65)	-10,38	0,000
PR	79,26 (71,74 - 81,88)	64,15 (58,74 - 69,20)	-19,06	0,000
SC	83,95 (80,63 - 86,66)	76,13 (74,83 - 82,06)	-9,32	0,000
RS	79,47 (75,91 - 82,75)	66,52 (65,09 - 77,04)	-16,30	0,000

Note: p= Percentile; * Mann-Whitney test
(difference between medians).

Spatial analysis shows a predominance of high-high spatial clusters in the North and Northeast regions of

the country, while low-low clusters predominated in the South. (Figure 1)

Figure 1 - LISA Cluster Map - Distribution of spatial clusters of reductions in VCP coverage during the COVID-19 pandemic in Brazilian municipalities, from 2011 to 2021.



DISCUSSION

During the COVID-19 pandemic, there was a significant reduction in the median vaccination coverage in the five regions of Brazil: North (-24.98%), Northeast (-20.08%), Midwest (-13.53%), Southeast (-16.85%), and South (-10.38%) and in the 27 states, mainly in Roraima (-38.50%), Acre (-31.09%), Alagoas (-29.88%), and Pernambuco (-29.44%). High-high spatial clusters (reduction between 22.0% and 83.0%) predominated in the North and Northeast regions of Brazil, highlighting the high number of children susceptible to poliomyelitis in these regions of the country.

Starting in 1988, mass immunization with OPV and IPV vaccines⁽¹⁰⁾ enabled a 99% reduction in the overall polio rate^(2,11). In 1994, the Re-

gion of the Americas was the first to be declared free of polio, due to systematic vaccination against polio by the PNI, which offers free VIP at 2, 4, and 6 months and a booster at 15 months, with an annual target of 95% coverage of the target population^(3,4,12). Although vaccination strategies against wild poliovirus type 2 (WPV-2) and type 3 (WPV-3) are in place worldwide, type 1 (WPV-1) still circulates in Afghanistan and Pakistan^(2,3,13).

In 2019, the average vaccination coverage in Brazil did not reach the target of 95%, a situation that was aggravated by the COVID-19 pandemic⁽⁵⁾, which impacted the coverage of recommended childhood vaccines, exacerbating historical differences in vaccination coverage between regions of the country^(6,12,14). The North and Northeast stand out, with reductions

of 24.96% and 22.08% in VCP coverage, respectively. This is due to inequalities in access to health services in these regions, traditionally marked by lower immunization indicators^(14,15).

Historically, in addition to the pandemic, several factors have reduced vaccination coverage, such as vaccine hesitancy, which can be explained by the false perception that infectious diseases are controlled or have been eliminated and therefore do not pose a risk to children, and the unavailability of some immunobiologicals in primary care services^(12,15).

CONCLUSION

There was evidence of a reduction in polio vaccine coverage in children in Brazil during the COVID-19 pandemic, which accentuated inequalities in the coverage of vaccines that prevent polio. Thus, this study may guide priority vaccination strategies for locations with the worst polio vaccine coverage indicators to prevent its return to the country.

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