ORIGINAL ARTICLE

GENERAL VACCINATION COVERAGE BEFORE AND DURING THE COVID-19 PANDEMIC IN BRAZIL: A CROSS-SECTIONAL STUDY

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Highlights:

1. The overall vaccination coverage from 2018 to 2021 was 69.4% in Brazil.
2. There is a pronounced decreasing trend in vaccination coverage in the country.
3. Reduction in vaccination coverage in the North and Northeast regions of Brazil.

PRE-PROOF

(as accepted)

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ABSTRACT

OBJECTIVE: The objective of this study is to analyze the general vaccination coverage of all immunobiologicals offered by the National Immunization Program (PNI) before (2018-2019) and during the COVID-19 pandemic (2020-2021) in the Brazilian territory, by region and capital. METHODOLOGY: It was carried out a cross- sectional study, with secondary data from PNI via the Department of Informatics of the Unified Health System (DATASUS). Data were tabulated and submitted to statistical tests, including the *Shapiro-Wilk* test to verify normality and *Pearson* and *Spearman c*orrelation tests. RESULTS: 407,570,811 doses of immunobiologicals were applied in Brazil, the overall average vaccination coverage for the period (2018-2021) was 69.4%, showing a sharp downward trend, which ranged from 75.2% in the pre-pandemic period to 63.7% in the pandemic. CONCLUSION: During the pandemic there was a decrease in national vaccination compared to the period before it, especially in the North and Northeast regions. In this way, the pandemic may have contributed to the reduction of immunizations.

Keywords: vaccination coverage; COVID-19; immunization programs; vaccination.

INTRODUCTION

The World Health Organization (WHO) has emphasized that Vaccine Hesitancy (VH) is one of the 10 greatest threats to global health[1]. VH is a phenomenon that refers to the delay in acceptance or refusal of vaccines, despite their availability in health systems. It is influenced by variables such as confidence, complacency, and convenience, and arises in the historical context of vaccination[2].

Confidence involves issues such as the efficacy and safety of the vaccine, as well as the reliability of the competence of healthcare professionals, the health system, and the legislators who decide when and which vaccines are necessary[3].

The problem of reduced vaccination coverage in Brazil has existed since 2012, mainly influenced by VH and exacerbated by the COVID-19 pandemic[4], which makes the Brazilian population vulnerable to diseases that had already been eradicated in the country[5].

Vaccination is the act of immunization against a certain etiological agent, constituting for the organism the recognition of its pathophysiological mechanism, both for curative and preventive purposes. This interventional activity is crucial for the global control of infectious diseases, saving countless lives, and reducing mortality and the global incidence of preventable diseases[6].

The National Immunization Program (PNI) of Brazil, institutionalized in 1973, is the main coordinator of immunization activities in the country and is a Brazilian heritage of international reference, as one of the largest vaccination programs in the world. The implementation of the program guarantees all Brazilians access to all vaccines considered to be of evident cost-effectiveness and cost-benefit for public health in its decentralizing character, which ensured harmony in the relationship between the state spheres and the health care networks[7].

Data on vaccination coverage can be monitored through the system. For this, access to information and health data is granted by the Access to Information Law - LAI (Law No. 12,527/2011) which regulates the constitutional right to access public information. This system is operationalized by the Department of Informatics of the Unified Health System (DATASUS) and the Information System of the National Immunization Program (SI-PNI), both managed by the Department of Epidemiological Surveillance, the Secretariat of Health Surveillance (SVS), of the Ministry of Health (MS), in conjunction with the State Health Secretariats and the Municipal Health Secretariats[7].

The World Health Organization (WHO) has as a priority the vaccination plans to ensure the population's right to physical and mental health, as prescribed in its immunization agenda for 2030[8]. However, during the years 2010 to 2014, the National Surveillance System (SNV) of the PNI, pointed to a decrease in coverage in Brazil, mainly in the following vaccines: triple viral, Bacillus Calmette-Guérin (BCG), inactivated injectable trivalent polio vaccine (IPV) and bivalent oral polio vaccine (OPV)[9].

A large portion of immunobiologicals is offered for free, through actions that cover the collective throughout the national territory, through Primary Health Care (PHC). Some factors can influence the vaccination coverage goals and present lower indicators in some regions, such as social inequality and the precariousness of health services[10].

A global study in 23 countries in 2021 showed that 24.8% of the 23,000 respondents reported not accepting the vaccine[11], while in Brazil[12] it was observed in 10.5% (18,250) of the respondents in a study. Of these, 6.7% (11,575) would only agree to be vaccinated depending on the available vaccine, 2.5% (4,401) did not intend to be vaccinated, and 1.3% (2,274) were unsure, showing that VH can influence the indicators, in addition, there is also misinformation, especially related to fake news during the period and the infodemic, with mass erroneous information. The deficit in vaccination coverage is a major problem for public health and collective health, as it increases the likelihood of the re-emergence of preventable diseases through immunization[13-14].

In recent years, another major and main aggravating factor was the COVID-19 pandemic, considered a public health emergency, the Ministry of Health (MS) determined social isolation as a way to contain the spread of the virus, which reduced the search for health promotion and prevention services, such as vaccination campaigns. However, there was already a reduction in vaccination coverage before the pandemic period, which worsened further during this period, with outbreaks of diseases that were considered eradicated in the country[15].

This study becomes relevant by performing a descriptive analysis with two bi-annual periods with distinct characteristics and within a scientific-methodological and statistical perspective of the vaccination coverage data in the inter-regional scenarios of the country. The objective of this study was to analyze the overall vaccination coverage of the immunobiologicals offered by the PNI before (2018-2019) and during the COVID-19 pandemic (2020-2021) in the Brazilian territory, by region and capital.

METHOD

This is a retrospective, descriptive, and analytical cross-sectional study[16] using secondary data on vaccination coverage by Brazilian regions and capitals from 2018 to 2021, in order to evaluate the variation in immunization two years before (2018 and 2019) and two years of the highest waves (2020 and 2021) of the COVID-19 pandemic.

Vaccination coverage data in Brazil recorded in the National Immunization Program (PNI) for the years 2018 to 2021 were included, which shows 407,570,811 doses of immunobiologicals applied to the population of children, pregnant women, adults and the elderly. Data recorded in this system prior to or after the analysis of this study were excluded.

The independent variable was defined as the year of occurrence, whether it is part of the pre- or post-pandemic period, and the dependent variable was vaccination coverage by region and capital.

The data were obtained from the electronic portal of the Department of Informatics of the Unified Health System (DATASUS), via Tabnet, in the Health Care tab, which includes information on Immunizations, by doses applied, coverage and dropout rate, considering the immunobiologicals that are part of the National Vaccination Program, described as follows: hepatitis B vaccine (HB), human rotavirus oral vaccine (VORH), conjugate meningococcal C vaccine (Meningo C), conjugate meningococcal ACWY vaccine (ACWY), adsorbed diphtheria, tetanus, pertussis, hepatitis B (recombinant) and Haemophilus Influenzae B (conjugate) Penta vaccine (DTP +HB+ Hib), 10-valent conjugate pneumococcal vaccine (Pncc10V), polio (IPV), polio (OPV), yellow fever vaccine (YF), hepatitis A vaccine (HA), triple viral vaccine, tetravalent vaccine (MMR+V), triple bacterial vaccine (DTP), adult-type double bacterial vaccine (dT), adsorbed diphtheria, tetanus and pertussis (acellular) adult-type vaccine (dTpa) and infant acellular triple bacterial vaccine (DTaP).

Accordingly, population data were accessed in the demographic and sociodemographic information section of the Brazilian Institute of Geography and Statistics (IBGE), referring to the resident population in the states and capitals in each of the years analyzed in this study.

In order to reduce information bias, incomplete data related to vaccination coverage were not included in the research. In addition, efforts were made to use data that were adequately representative of the study population.

Initially, the data were downloaded, tabulated, and organized to conduct descriptive statistics, using raw frequencies and percentages. The normality of the data was verified using the *Shapiro-Wilk* test, and *Pearson* and *Spearman* correlation tests were performed. The data were analyzed using the *Statistical Package for the Social Sciences* (SPSS) software, version 20.0, and the graphical representations, with their trend lines and equations, were executed using the *Microsoft Excel* 2016 software.

Vaccination coverage was calculated by dividing the number of doses applied of the indicated dose (1st, 2nd, 3rd dose or single dose, depending on the vaccine) by the target population, multiplied by 100. The percentage of variation in vaccination coverage, in turn, was estimated using the equation:

$$\frac{Vaccination\ coverage\ before\ the\ COVID{-}19\ pandemic - Vaccination\ coverage\ during\ the\ COVID{-}19\ pandemic}{Vaccination\ coverage\ before\ the\ COVID{-}19\ pandemic}\ x\ 100$$

For the analysis of the temporal evolution of coverage in the five regions, the Microsoft Excel 365 Copilot, which combines large language models (LLMs), was used. To this end, the annual percentage change (APC) was calculated using a 95% confidence interval (95% CI), where a negative APC value indicates a decreasing trend and a positive value indicates an increasing trend.

Linear scatter plots were created for each region, where each inflection point added to the temporal model represents a change in the linear trend. The slope interception formula ($y = mx + b$) was used, which is used when the slope of the line to be examined is known and the given point is also the y-intercept (0, b). In the formula, b represents the y-value of the y-intercept point. Its interpretation is to present in the graphs the variation between the number of vaccines applied and the year, where the R^2 (which can range from 0% to 1%, which translates to 0% = 1% and 1% = 100%) points to the variation in the number of doses applied by the year of application.

The study does not require approval by a Research Ethics Committee, since it integrates data from the public domain, freely accessible, combined with the impossibility of identifying the sample.

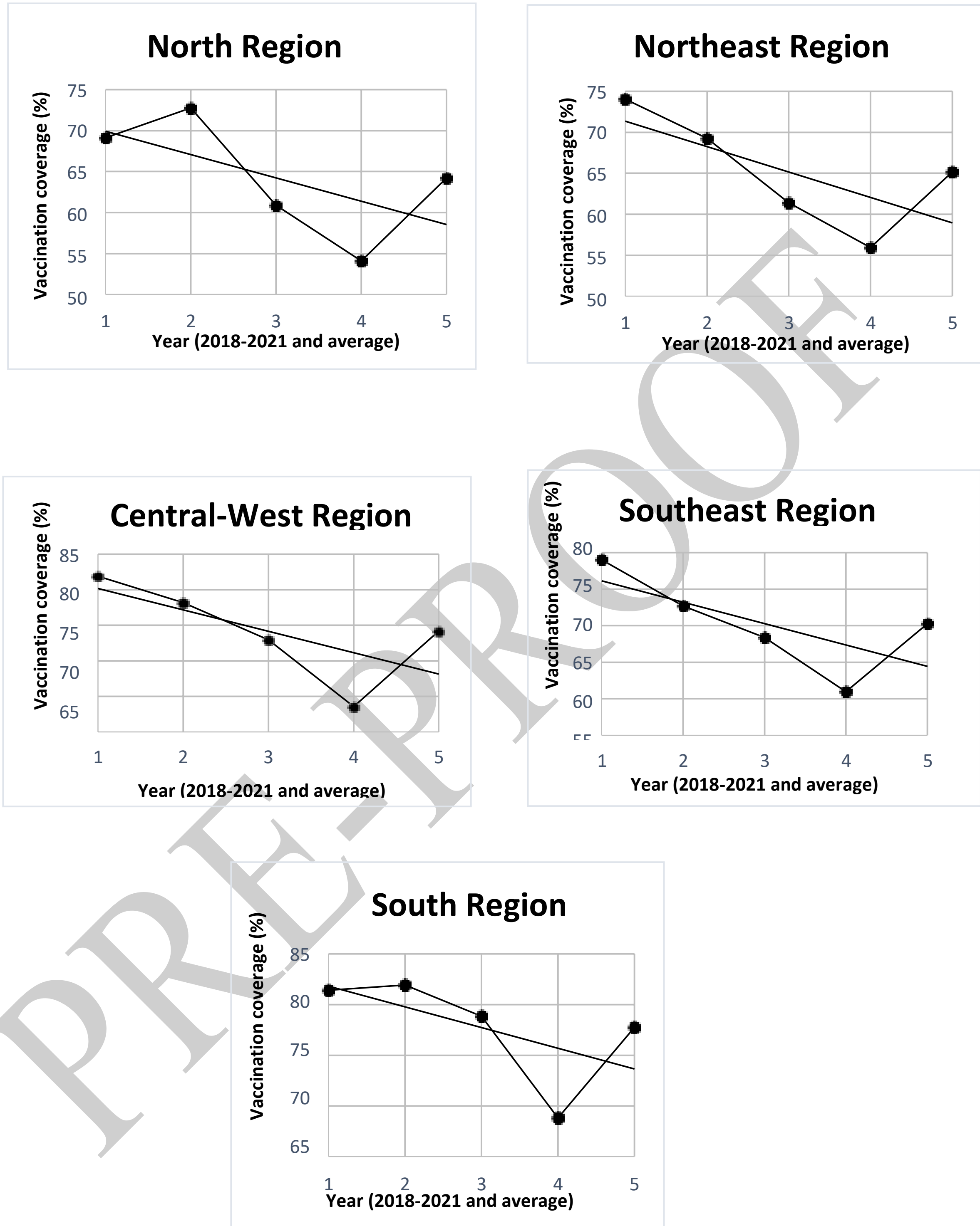
RESULTS

Between 2018 and 2021, 407,570,811 doses of immunobiologicals were administered in Brazil, in the North (39,520,718), Northeast (104,179,949), South (62,102,911), Southeast (169,667,527) and Midwest (32,099,706) regions, respectively. All immunobiologicals registered in the system during this period were included.

The overall average vaccination coverage from 2018 to 2021 was 69.4%, exhibiting a pronounced decreasing trend, varying from 75.2% in the pre-pandemic period (2018-2019) to 63.7% during the pandemic (2020-2021), reflecting the possible impact of COVID-19 on Brazilian immunization rates.

In Figure 1, the linear scatter plot details the behavior of vaccination coverage in the regions of the country, with emphasis on the drop in coverage in the North and Northeast regions. In addition, the following slope interception values were obtained: North region ($R^2 = 0.3853$), Southeast region ($R^2 = 0.4953$), South region ($R^2 = 0.3728$), Northeast region ($R^2 = 0.496$) and Midwest region ($R^2 = 0.4777$).

Figure 1 – Temporal trend of vaccination coverage (n=407,570,811) by Brazilian region from 2018 to 2021, Brazil, 2018-2021.



In Table 1, when comparing the data on vaccination coverage in the Brazilian territory, between the pre-pandemic period (2018 and 2019) and the COVID-19 pandemic period (2020 and 2021), a positive and moderate correlation (*Spearman*'s R=0.60) and statistical significance (p=0.002) were evidenced.

When analyzing the North region, with data from the capitals, a positive and strong correlation (*Pearson*'s R=0.71) was evidenced, but there was no statistical significance (p=0.074). Similarly, in the Northeast, a positive and moderate correlation (*Pearson*'s R=0.62) was evidenced, but there was no statistical significance (p=0.074).

In the Southeast, a positive and moderate correlation (*Pearson*'s R=0.52) was evidenced, but there was no statistical significance (p=0.479). In the Midwest, a negative and very strong correlation (*Pearson*'s R=-0.95) was evidenced, but there was no statistical significance (p=0.207). Finally, a positive and very strong correlation (*Pearson*'s R=0.99) was evidenced in the South region, but there was no statistical significance (p=0.079).

Table 1 – Brazilian vaccination coverage (n= 407,570,811) from 2018 to 2021, according to the five regions of the country and capitals, Brazil, 2018-2021.

Capitals	**2018-2019**	**2020-2021**	**Variation (%)**	**P *Shapiro-Wilk***	**R de *Spearman***	**P- value**
Brazil	75,2	63,7	- 15,2	0.141/0.048	0.597	0.002
North Region	70,9	57,4	- 19,0	0.561/0.596	0.710	0.074
Porto Velho	63,0	76,4	-21,4			
Rio Branco	59,4	79,3	-33,5			
Manaus	69,8	77,3	-10,8			
Boa Vista	65,4	84,8	-29,7			
Belém	50,7	66,8	-31,7			
Macapá	40,8	66,1	-62,3			
Palmas	72,3	74,4	-3,0			
				P *Shapiro-Wilk*	**R de *Pearson***	**P- value**
Northeast Region	71,6	58,6	- 18,1	0.791/0.428	0.622	0.074
São Luís	35,2	55,9	-58,9			
Teresina	60,6	66,2	-9,3			
Fortaleza	70,4	85,2	-21,1			
Natal	62,0	71,9	-16,1			
João Pessoa	46,9	78,6	-67,4			
Recife	57,1	68,1	-19,4			
Maceió	64,0	68,5	-7,1			
Aracaju	56,1	66,0	-17,8			
Salvador	49,3	66,3	-34,7			
				P *Shapiro-Wilk*	**R de *Pearson***	**P- value**
Southeast Region	75,6	64,5	- 14,6	0.851/0.923	0.521	0.479
Belo Horizonte	76,9	79,8	-3,8			
Vitória	72,2	85,4	-18,3			
Rio de Janeiro	65,5	70,1	-7,1			
São Paulo	61,3	77,6	-26,7			
				P *Shapiro-Wilk*	**R de *Pearson***	**P- value**
South Region	81,65	73,8	- 9,6	0.689/0.450	0.992	0.079
Curitiba	73,1	78,2	-7,1			
Florianópolis	56,6	54,8	3,0			
Porto Alegre	67,2	72,5	-8,1			
				P *Shapiro-Wilk*	**R de *Pearson***	**P- value**
Central-West Region	79,9	68,2	- 14,6	0.767/0.146	-0.948	0.207
Campo Grande	62,9	105,8	-68,4			
Cuiabá	64,9	70,2	-8,4			
Goiânia	66,2	66,9	-1,1			

The variation between periods reflected a reduction in vaccination coverage by 15.2% in the Brazilian territory, highlighting a significant decrease in the North (-19.0%) and Northeast (-18.1%) regions, with noteworthy declines in the capitals of João Pessoa (PB-Paraíba) (-67.4%) and Macapá (AP-Amapá) (-62.3%). In other regions of the country, São Paulo (SP-São Paulo) stood out in the Southeast region with a reduction of -26.7%, Campo Grande (MS-Mato Grosso do Sul) in the Central-West with -68.4%, and Porto Alegre (RS-Rio

Grande do Sul) in the South with -8.1%.

In Table 2, when comparing vaccination coverage data in the Brazilian territory according to the type of immunobiological, between the period before (2018 and 2019) and during the COVID-19 pandemic (2020 and 2021), a strong positive correlation (*Spearman*'s R=0.81) and statistical significance (p<0.001) were evident. The data generally reflect the worsening problem of Brazilian vaccination coverage during the COVID-19 pandemic, with a decrease in DTP booster dose by 60.8% and in dT by 53.6%.

Table 2 - Brazilian vaccination coverage (n= 407,570,811) from 2018 to 2021 according to the type of immunobiological, Brazil, 2018-2021.

Immunobiological	**2018-2019**	**2020-2021**	**Variation (%)**	**P *Shapiro-Wilk***	**R de *Spearman***	**P- value**
				0.011/<.001	0.809	<.001
Hepatitis B vaccine (HB) - first dose	93,2	73,3	-21,4			
Human rotavirus vaccine (HRV)	83,5	63,2	-24,2			
Conjugated meningococcal C vaccine (MenC)	88,4	73,9	-16,4			
Hepatitis B vaccine (HB)	88,0	74,8	-15,0			
Adsorbed diphtheria, tetanus, pertussis, hepatitis B (recombinant), and Haemophilus influenzae type b (conjugated) vaccine (DTP+HB+Hib) - Pentavalent	79,7	73,9	-7,3			
10-valent pneumococcal conjugate vaccine (Pncc10V)	79,6	73,9	-7,2			
Inactivated injectable trivalent polio vaccine (IPV)	92,2	77,4	-16,0			
Oral bivalent oral polio vaccine (OPV) - booster dose at 4 years of age	86,9	73,1	-15,9			
Yellow fever vaccine (YF)	66,0	60,8	-7,9			
Hepatitis A vaccine (HAV)	61,0	57,5	-5,7			
10-valent pneumococcal conjugate vaccine (PnCC10V) - first booster	83,9	71,0	-15,3			
Meningococcal (Conjugated) Vaccine (ACWY)	82,7	68,4	-17,3			
Oral bivalent oral polio vaccine (OPV) - booster dose at 15 months of age	83,0	72,0	-13,3			
Measles, mumps, and rubella vaccine (MMR) - first dose	73,7	64,2	-13,0			
Measles, mumps, and rubella vaccine (MMR) - second dose	92,9	77,3	-16,7			
Quadrivalent vaccine (MMRV+VZ)	79,2	57,8	-27,1			
Diphtheria, tetanus, and pertussis (combined) vaccine (DTP) - first booster	33,8	13,2	-60,8			
Diphtheria, tetanus, and pertussis (combined) vaccine (DTP)	61,1	65,5	7,1			
Adsorbed diphtheria and tetanus toxoids (adult type) (dT) and Acellular pertussis (DTPa) vaccine	65,2	69,6	6,8			
Adsorbed diphtheria, tetanus, and acellular pertussis (adult type) (dTpa) vaccine	45,0	20,9	-53,6			

It was observed that during the pandemic period, there were significant declines in immunobiologicals. An example of this was the reduction of 27.1% in coverage for MMRV+VZ, followed by HRV, with a reduction of 24.2%, as well as HB and MenC vaccines, with reductions of 21.4% and 16.4%, respectively.

In Table 3, when comparing vaccination coverage data in the Brazilian territory according to the type of immunobiological and across the five regions of the country between the years 2018 to 2019 and 2020 to 2021, disparities in vaccination rates for DTP and dT persisted, even in wealthier regions such as the South and Southeast, with reductions of 47.1% and 78.4% for the former, respectively, reaching decreases of 90.2% in the Northeast region. However, the reduction in vaccination coverage affects other immunobiologicals, such as HA, with a 35.8% decrease in the Northeast region, HRV, with a decrease of 25.4% in the Central-West region, and MMRV+VZ, with a decrease of 24.1% in the Southeast region.

Table 3 – Brazilian vaccination coverage (n= 407,570,811) from 2018 to 2021 according to the type of immunobiological and across the five regions of Brazil, Brazil, 2018-2021.

	North			Northeast			Southeast			South			Central-West		
	2018-2019	2020-2021	Δ	2018-2019	2020-2021	Δ	2018-2019	2020-2021	Δ	2018-2019	2020-2021	Δ	2018-2019	2020-2021	Δ
Hepatitis B vaccine (HB) - first dose	93,0	77,4	-16,8	85,2	69,8	-18,0	93,2	70,5	-24,3	91,1	80,8	-11,3	98,0	78,1	-20,3
Human rotavirus vaccine (HRV)	86,8	71,4	-17,7	79,1	65,9	-16,6	81,3	56,9	-29,9	74,7	65,8	-11,9	94,1	70,2	-25,4
Conjugated meningococcal C vaccine (MenC)	79,8	65,3	-18,2	72,6	70,2	-3,3	89,7	74,5	-16,9	91,6	83,1	-9,3	88,7	78,2	-11,9
Hepatitis B vaccine (HB)	79,2	67,9	-14,2	73,6	71,1	-3,3	88,7	74,8	-15,7	91,0	82,9	-8,9	89,2	79,4	-11,0
Adsorbed diphtheria, tetanus, pertussis, hepatitis B (recombinant), and Haemophilus influenzae type b (conjugated) vaccine (DTP+HB+Hib) - Pentavalent	70,8	62,5	-11,7	66,6	68,4	2,6	80,7	76,8	-4,8	82,1	79,5	-3,2	79,3	76,8	-3,1
10-valent pneumococcal conjugate vaccine (Pncc10V)	70,8	62,5	-11,7	66,6	68,4	2,6	80,7	76,8	-4,8	82,1	79,5	-3,2	79,3	76,8	-3,1
Inactivated injectable trivalent polio vaccine (IPV)	87,4	71,8	-17,8	79,6	74,4	-6,6	92,6	76,9	-17,0	93,0	84,9	-8,7	92,5	82,3	-11,0
Oral bivalent oral polio vaccine (OPV) - booster dose at 4 years of age	78,3	63,2	-19,3	70,8	69,3	-2,0	88,6	74,3	-16,2	89,5	81,9	-8,5	87,0	76,9	-11,7
Yellow fever vaccine (YF)	47,4	46,9	-1,1	47,1	48,4	2,8	74,0	66,7	-9,9	85,8	76,2	-11,1	73,8	69,4	-5,9
Hepatitis A vaccine (HAV)	69,1	53,0	-23,3	61,0	39,2	**-35,8**	69,2	64,8	-6,3	71,2	68,0	-4,5	80,5	67,9	-15,7
10-valent pneumococcal conjugate vaccine (PnCC10V) - first booster	76,4	60,6	-20,7	68,5	65,5	-4,5	85,7	73,6	-14,1	88,9	81,3	-8,6	85,2	74,8	-12,2
Meningococcal (Conjugated) Vaccine (ACWY)	76,8	63,9	-16,8	70,4	65,7	-6,6	82,6	68,2	-17,4	87,5	77,8	-11,0	86,0	75,0	-12,8
Oral bivalent oral polio vaccine (OPV) - booster dose at 15 months of age	75,7	65,6	-13,4	70,6	68,5	-3,0	82,8	72,3	-12,8	87,6	79,9	-8,8	85,7	76,5	-10,7
Measles, mumps, and rubella vaccine (MMR) - first dose	63,8	54,7	-14,3	59,2	57,8	-2,3	75,9	66,7	-12,2	80,3	73,5	-8,4	77,5	68,7	-11,4

Δ: Variation (%)

DISCUSSION

The article analyzed the vaccination coverage of immunobiologicals offered by the National Immunization Program (PNI), before and during the COVID-19 pandemic. A marked downward trend in coverage varied, reflecting the possible impact of COVID-19 on Brazilian immunization rates. Regional analysis showed a significant reduction in vaccination coverage, especially in the North and Northeast regions, with noticeable declines in some capitals, such as João Pessoa and Macapá. Furthermore, analysis by type of immunobiological revealed significant reductions, such as the drop in the DTP booster dose and dT during the pandemic. Vaccination disparities persisted, with some wealthier regions also experiencing substantial reductions in immunization coverage.

This study highlighted that the decline in vaccination coverage in the Brazilian territory was already decreasing before the COVID-19 pandemic. However, during the pandemic period, there was a worsening in the decline of vaccination coverage. The most affected regions were mainly the North and Northeast, which corroborates findings from a Brazilian ecological study analyzing vaccination coverage from 2006 to 2016 for BCG, polio, and measles vaccines, where some states in these regions experienced a more significant vaccination reduction compared to other national regions[6].

Given the research results, it is evident that the North and Northeast regions face additional challenges compared to other regions of Brazil, reflected in lower vaccination coverage rates. Socioeconomic issues, distant health services, and limited access to health and education services are factors that may contribute to these disparities. The COVID-19 pandemic may have exacerbated these inequalities, negatively impacting the health authorities' ability to maintain high immunization rates in these regions[17-18].

In our study, it was observed that the vaccination coverage for HB was close to the vaccination coverage goal (2018-2019); however, from 2020 to 2021, it decreased further, moving away from the vaccination coverage goal recommended by the Ministry of Health, which is 95%[19]. HRV did not achieve acceptable coverage, fluctuating between 83.5% and 63.2% during the period.

Vaccination coverage for MenC, Penta (DTP+HB+Hib), and PnCC10V did not exceed the target proposed by the Ministry of Health since 2018[19]. During the pandemic period, a reduction in the coverage of these vaccines was also observed. Additionally, polio performed well between 2018 and 2019, exceeding 90% during those years. However, in the subsequent years, it fell below (77.4%) the recommended target.

Furthermore, considerable reductions in vaccination success were observed between

2020 and 2021, especially in the vaccination coverage of dT and the DTP booster dose. Low vaccination coverage during the pandemic was also observed worldwide. Several countries, aiming to comply with social distancing measures, temporarily suspended or delayed vaccination campaigns[20].

It is worth noting that low vaccination coverage is directly related to a higher risk of transmission of preventable diseases, as well as the reemergence of diseases once controlled, such as measles and polio[6-21]. Factors such as low family income, insufficient education level, and families with a high number of children can lead to non-vaccination[6].

Other causes for the reduction in vaccination may include VH, characterized by non-acceptance or delayed acceptance of vaccines, despite the availability of access to them, concerns or doubts about the vaccination process, and even the influence of anti-vaccine movements[6,21-22]. Data from research on VH indicated that globally, 1 in 5 children still do not receive routine immunizations, and it is estimated that 1.5 million children still die each year from diseases that could be prevented by vaccines that already exist[23]. This may contribute to the explanation of the study data, where anti-vaccine movements in children emerged with the contribution of fake news propagated and/or read by parents and guardians.

In an American systematic analysis study, routine vaccination coverage of children aged 12-59 months from 204 countries from 1980 to 2019 was evaluated[24]. It was observed that there was a global increase in the percentage of vaccination from 1980 to 2019. Additionally, the global average vaccination coverage in 2019 for the DTP booster dose was 81.6%, which differs from the average found in our study[24].

Researchers from Rio Grande do Sul conducted an ecological study evaluating Brazilian vaccination coverage from 2013 to 2020 for 10 immunobiologicals recommended by the PNI for children up to 12 months of age[21]. In 2020, the lowest average vaccination coverage (75.07%) was obtained, and there was an 11.10% reduction compared to the 2019 average (84,44%)[25]. Furthermore, the study also found that during the COVID-19 pandemic, nine out of ten vaccines analyzed showed a significant reduction in coverage compared to other years. The study also found that the vaccination coverage of the Brazilian territory was already declining, and there was an association of the pandemic with lower vaccination coverage values, which aligns with the findings of our study.

A longitudinal study published in 2020 evaluated vaccination coverage from 1994 to 2019 for all age groups and all immunobiologicals present in DATASUS[26]. A reduction in vaccination coverage of specific vaccines was observed in each region of Brazil, such as OPV in the South region; DTPa, Haemophilus influenzae type B (HiB), and 13-valent pneumococcal (PCV13) vaccine in the Southeast and in the Northeast reduction of the measles-mumps-rubella (MMR) and varicella-zoster virus (VZV) vaccine. Such results differed from those found in our study.

The results of this research are also in line with national and international literature, pointing out that booster doses such as DTP and dT had significant declines, given the Brazilian reality of great territorial diversity, there are mismatches between the formulation of the vaccination plan and its real implementation, marked sociodemographic differences, and diversified characteristics of the regions, indicating the loco-regional health needs of Brazil[16]. This is evidenced by the fact that services may be distant for returning to take booster doses for populations in the North and Northeast compared to the others. This is also reflected in low-income countries compared to wealthy countries[27].

The COVID-19 pandemic through social isolation brought challenges for the implementation of the National Vaccination Schedule but was not the main responsible for the decline in vaccination coverage, as there are records of vaccination reduction before the pandemic[28]. It is essential to verify the causes of vaccination decline according to the context and local reality, develop strategies to increase awareness of vaccine safety, and increase transparency regarding the formulation of the vaccination plan.

The main limitations of the present study are related to the use of secondary data, as there may be incorrect data generation, either due to inadequate completion or lack of precise information provision or late launch of data availability, as real-time updating does not occur[6]. Despite this, it is emphasized that our study carried out an important analysis of vaccination coverage from 2018 to 2021, of all immunobiologicals listed in DATASUS, at the regional and capital levels of the Brazilian territory, and covering vaccination for all age groups.

CONCLUSION

It can be concluded that Brazil experienced a significant reduction in vaccination coverage during the COVID-19 pandemic, especially in the North and Northeast regions and in the capitals João Pessoa and Macapá. Socioeconomic disparities between regions played a crucial role in this decline. The analysis highlights the need for targeted public policies to mitigate these disparities, improve access to healthcare services, and strengthen immunization efforts, especially for those that experienced a decline, such as dT and dTpa, aiming to ensure equitable vaccination coverage across the country, even in times of crisis like the COVID-19 pandemic.

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