Promoção da Saúde
DOI: 10.17765/2176-9206.2024v17n4.e12803

Vaccination Coverage in children under two years of age in a medium-sized municipality, 2010-2022

Cobertura Vacinal em crianças menores de dois anos em município de médio porte, 2010-2022

João Victor Rodrigues Tamura Borges[1*], Giovanna de Freitas Ferreira[2], Matheus Henryque Fernandes Siqueira Nunes[3], Claudinéia de Araújo[4], Juliana Helena Chávez-Pavoni[5], Patrícia de Lima Lemos[6]

[1]Undergraduate student in Medicine at the Federal University of Rondonópolis. Rondonópolis (MT), Brazil; [2]Bachelor's degree in Medicine from the Federal University of Rondonópolis. Rondonópolis (MT), Brazil; [3]Bachelor's degree in Medicine from the Federal University of Rondonópolis. Rondonópolis (MT), Brazil; [4]PhD in Sciences from the Federal University of São Paulo. São Paulo (SP), Brazil; [5]PhD in Basic and Applied Immunology from the University of São Paulo – FMRP. Ribeirão Preto (SP), Brazil; [6]PhD in Public Health from the Federal University of Mato Grosso. Cuiabá (MT), Brazil.

***Corresponding author**:João Victor Rodrigues Tamura Borges – *Email*: joao.tamura@aluno.ufr.edu.br

ABSTRACT
The objective of the study was to evaluate vaccination coverage (VC) in children under two years of age in the municipality of Rondonópolis-MT. An ecological time-series study was conducted to evaluate the vaccination coverage, between 2010 and 2022, of ten immunobiological agents indicated for this age group. Secondary data were obtained from the free access websites of the Ministry of Health, Department of Informatics of the Unified Health System (DATASUS). A decrease in VC was identified for most immunobiological agents evaluated, especially in 2020, during the COVID-19 pandemic. In the period considered, a CV value of approximately 80% was obtained. In addition to the observed decrease, half of the immunogens showed a decreasing trend, while the others showed stationary trends during the study period. The decrease in VC may have resulted from vaccine hesitancy, which may have intensified during the pandemic, which characterizes the weakening of public health policies and requires efforts to increase VC rates.

Keywords: Vaccination coverage. COVID-19. Child Health. Basic Health Indicators.

RESUMO
O objetivo do estudo foi avaliar a cobertura vacinal (CV) em crianças menores de dois anos no município de Rondonópolis-MT. Realizou-se um estudo ecológico de série temporal para avaliação da cobertura vacinal, entre 2010 a 2022, de dez imunobiológicos indicados para a faixa-etária. Foram utilizados dados secundários, buscando-se em sítios eletrônicos de acesso livre do Ministério da Saúde, Departamento de Informática do Sistema Único de Saúde (DATASUS). Identificou-se queda das CV para a maioria dos imunobiológicos avaliados, sobretudo em 2020, durante a pandemia da COVID-19. No período considerado obteve-se valor de CV em torno de 80%. Além da queda observada, metade dos imunógenos apresentaram tendência decrescente, enquanto os demais apresentaram tendências estacionárias durante o período estudado. A queda nas CV pode resultar da hesitação vacinal, que pode ter sido intensificada na pandemia, o que caracteriza fragilização de políticas públicas de saúde e requer esforços para aumentar as taxas de CV.

Palavras-chave: Saúde. Saúde coletiva. Promoção da saúde.

INTRODUCTION

Vaccination is currently one of the most cost-effective public health interventions, saving approximately two to three million lives each year. As a direct result of this strategy, smallpox was eradicated worldwide in 1980, while polio eradication may be achieved in the near future. In addition, with the use of vaccination, deaths caused by measles decreased by 73% worldwide between 2000 and 2018, saving approximately 23.2 million children's lives[1].

The initiatives for the globalization of vaccination strategies came from the World Health Organization (WHO), which, in 1974, established the expansion of a worldwide immunization program to ensure that all children were immunized against diphtheria, tetanus, pertussis, and polio. and measles and tuberculosis. Since then, immunization programs around the world have been expanded with the inclusion of other immunizing agents to minimize the impact and deaths of infectious-contagious diseases[2].

In Brazil, the National Immunization Program (PNI) was established in 1973 and is widely recognized for its significant contributions to the eradication and control of vaccine-preventable diseases such as smallpox, polio and measles. The PNI ensures the universal and free supply of 45 immunobiologicals, including 19 vaccines integrated into the regular schedule for all age groups. Additionally, it conducts annual vaccination campaigns to combat various infectious diseases, including influenza, COVID-19, and polio[3].

In recent decades, the PNI has integrated recent information technologies, such as the National Immunization Program Information System (SI-PNI), and expanded the vaccination schedule. Currently, the national childhood vaccination schedule includes 15 immunobiological agents, nine of which are intended for children under one year of age and six for children under two years of age, with the aim of preventing approximately 17 diseases[4].

To assess the effectiveness of PNI initiatives, the Ministry of Health established indicators that include vaccination coverage (VC), the proportion of abandonment and the homogeneity rate. VC evaluation can be performed considering the type of vaccine, age group, geographic area and dose, establishing a relationship between the target population, based on census data, live births or the chosen population, and the number of administered doses[5].

CV calculations were performed using daily records, consolidated monthly bulletins from the vaccination rooms or field surveys. The analysis of vaccination coverage makes it possible to investigate the implementation and effectiveness of public policies, identify immunological vulnerabilities in the population and reveal strengths and weaknesses in the vaccination process. One of the priority goals of the PNI is to achieve adequate vaccination coverage, defined as a minimum percentage of approximately 90%[5].

In the last decade, studies have shown a worrying trend in the decline of immunization coverage (VC) rates among children up to two years of age, both in Brazil and in various parts of the world. National and international studies show decreases in VC, especially from 2015 onward. In addition, the negative impact of the COVID-19 pandemic has also been identified regarding routine childhood vaccination[6,7].

The WHO, in partnership with UNICEF, estimates and monitors the global percentage of VCs considering national immunization programs based on administrative data and specific characteristics of each country annually. In this estimate, the first year of a child's life stands out, in which many vaccines should be administered. A significant decrease in VC worldwide was observed during the pandemic through this monitoring. In 2023, this analysis showed that the VC of some immunizers, such as the diphtheria, tetanus, pertussis (DTP) vaccine, showed a slight increase in 2022 (89%) compared to 2021 (86%) for most countries. However, this increase was still less than the 90% observed in 2019 before the COVID-19 pandemic. This phenomenon was also observed for other vaccines, such as those against hepatitis B and tuberculosis, especially in developing countries, which are among the 194 countries that make up the WHO. Thus, it is evident that even with the increase in VC levels

after the pandemic, most countries are being affected by vaccine hesitancy, and this phenomenon is more pronounced in countries with economic and social vulnerability[2].

Importantly, immunization is one of the most effective strategies for preventing childhood morbidity and mortality, especially in children up to two years of age. For immunization to be effective, it is crucial to follow the recommended vaccination schedule for each age group. Furthermore, it is important to note that delays in vaccination can be equally harmful to the omission of vaccination, increasing the chances of the child developing disease. This scenario entails a greater risk for the community in terms of outbreaks or epidemics, especially in the case of single-dose vaccines, in which the lack of administration results in the total absence of protection[4].

With the decline in VC over the last few years, it is essential to monitor this indicator to guide public health strategies and policies. In addition, it is believed that the COVID-19 pandemic may have negatively affected VC indicators worldwide. Therefore, the objective of this study was to evaluate vaccination coverage in children under two years of age in the municipality of Rondonópolis-MT during the period from 2010 to 2022.

METHODOLOGY

This was an ecological, time-series study based on information on vaccine doses administered to children up to two years of age in Rondonópolis from 2010 to 2022. Secondary data were obtained from the National Immunization Program (PNI), available in the Information System from the PNI of the Department of Informatics of the Unified Health System (DATASUS)[8]. Rondonópolis is a Brazilian municipality in the state of Mato Grosso, located in the southeastern region of the state, 210 km from the capital Cuiabá. The estimated population of the municipality in 2022 was 244,911 inhabitants. This municipality has the second highest gross domestic product in the state, in addition to being a care center in the southern region of the state, consisting of 19 municipalities with a total of 452,564 inhabitants[9].

The variables collected were the number of doses available in DATASUS of the following vaccines included in the National Vaccination Calendar for children up to two years of age, according to Chart 1. Due to changes in the National Immunization Calendar during the study period (2010-2022), some vaccines have data available at certain intervals, in addition to changes in the proposed scheme. All these details were considered and are presented in Chart 1.

Chart 1. Vaccines, diseases prevented, considered doses and observations of changes in the vaccination schedule of the National Immunization Program of the Ministry of Health to consider VC in the period from 2010-2022.

Vaccine	Disease Prevented	Considered Doses	Observation
BCG	Severe forms of tuberculosis (miliary and meningeal)	One dose	
HB	Hepatitis B	One dose	
	Diphteria, tetanus, whooping cough, hepatites B and infections by *Haemophilus influenzae b*		
			2010,2011 and 2012 (DTP+Hib) tetravalent
Pentavalent		1st and 3rd dose	2013 (DTP+HB+Hib) pentavalent
			2010, 2011, 2012 and 2015 (sequential OPV)
OPV/IPV	Poliomyelitis	1st and 3rd dose	2013 e 2014
			(sequential IPV/OPV)
			2016
			(sequential IPV)
Human Rotavirus	Rotavirus	1st and 2nd dose	
Meningococcal C	Invasive disease caused by *Neisseria meningitidis* serogroup C	1st and 2nd dose	
10-Valent Pneumococcal	Invasive infections (such as meningitidis and pneumonia) and acute otites media caused by the 10 serotypes of *Streptococus pneumoniae*	1st and 2nd dose	
YF	Yellow Fever	One dose	
HA	Hepatitis A	One dose	Starting from 2015
MMR	Measles, mumps and rubella	One dose	

Note: chart adapted from the National Immunization Program.

We examined the parameters of vaccination coverage (VC) by immunobiological agent, proportion of abandonment (PA) and the index of loss to follow-up in children in relation to the administration of the BCG vaccine in a single dose and of the third dose of the pentavalent vaccine (DTP)/HB/Hib.

The VC of each vaccine was determined by dividing the number of applied doses required to complete the schedule of each vaccine by the number of live births in each municipality and specific year, multiplied by 100. In calculating the VC, the single dose or the first dose represented the numerator for the BCG, MMR, YF, HA and HB vaccines. For the Human Rotavirus, Meningococcal C and Pneumococcal 10 vaccines, the numerator considered was the number of second doses, and for the Pentavalent and OPV/IPV vaccines, the number of third doses was used. Data on live births were obtained from the Information System on Live Births (SINASC)[10].

The VC was considered adequate when it reached the goals stipulated by the National Immunization Program (PNI): 90% for the BCG and Human Rotavirus vaccines; 95% for the Meningococcal C, Pneumococcal 10, Pentavalent, OPV/IPV, MMR, HA and HB vaccines; and 100% for the YF vaccine due to its endemicity.

The proportion of abandonment (PA) was defined as the percentage of individuals who started the multidose vaccination schedule but did not complete it. This measure was estimated as the difference between the number of first doses and the number of last doses applied divided by the number of first doses and multiplied by 100[11]. Thus, PA was calculated for the HRV, Meningococcal C, Pneumococcal 10, Pentavalent and OPV/IPV vaccines. The categories of low (less than 5%), medium (between 5% and 10%) and high (greater than 10%) were used as parameters, following the guidelines of the National Immunization Program (PNI)[12].

Loss of follow-up was estimated as the difference in the number of third doses of pentavalent (recommended at six months) compared to the total number of a single dose of BCG (recommended at birth).

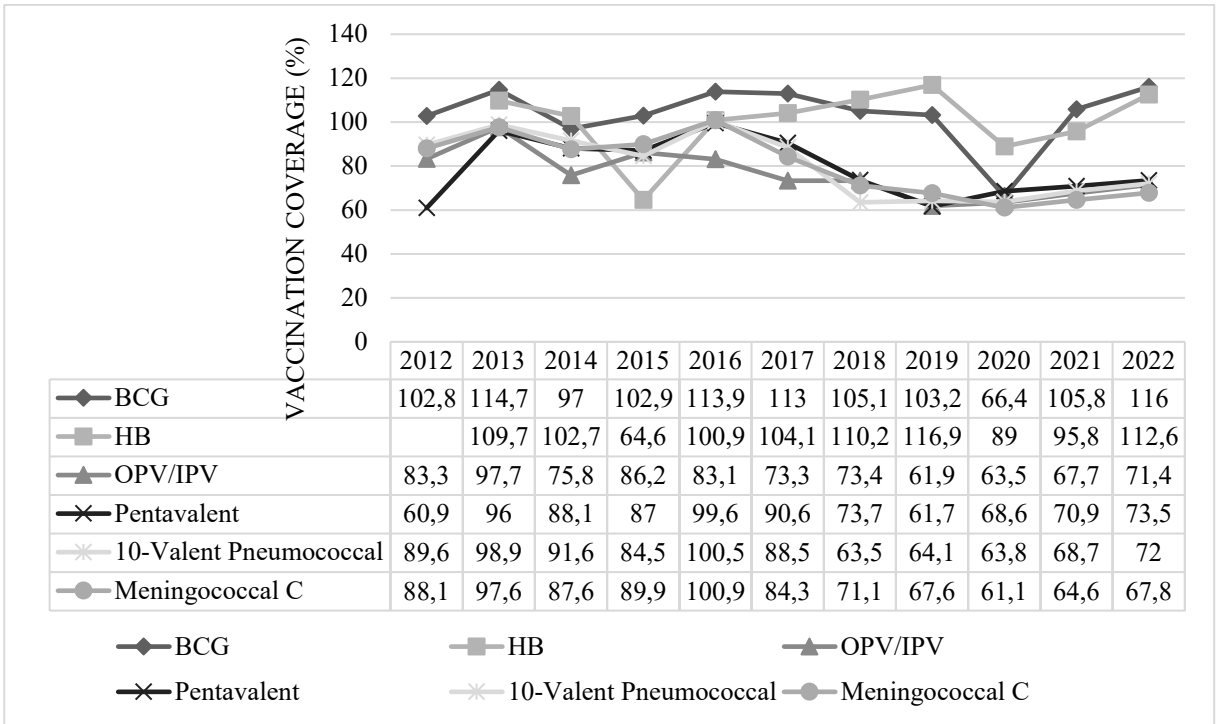
Using statistical data analysis software (Stata, 14.0, StataCorp LP, College Station, USA), the Prais-Winsten linear regression model was applied to analyze the temporal evolution of the indicators of vaccination coverage (VC) and proportion of abandonment (PA). The means and medians of the proportions were obtained for each vaccine indicator. The annual percentage changes (APVs) and their 95% confidence intervals (95% CIs) were calculated. An upward trend was considered when $p < 0.05$ and the regression coefficient was positive (+), a decreasing trend was considered when $p < 0.05$ and the coefficient was considered negative (-), and a stationary trend was considered when $p > 0.05$. The significance level adopted was 5%.

This research project adhered to the ethical guidelines established by Resolution No. 466 of the National Health Council (CNS).

RESULTS

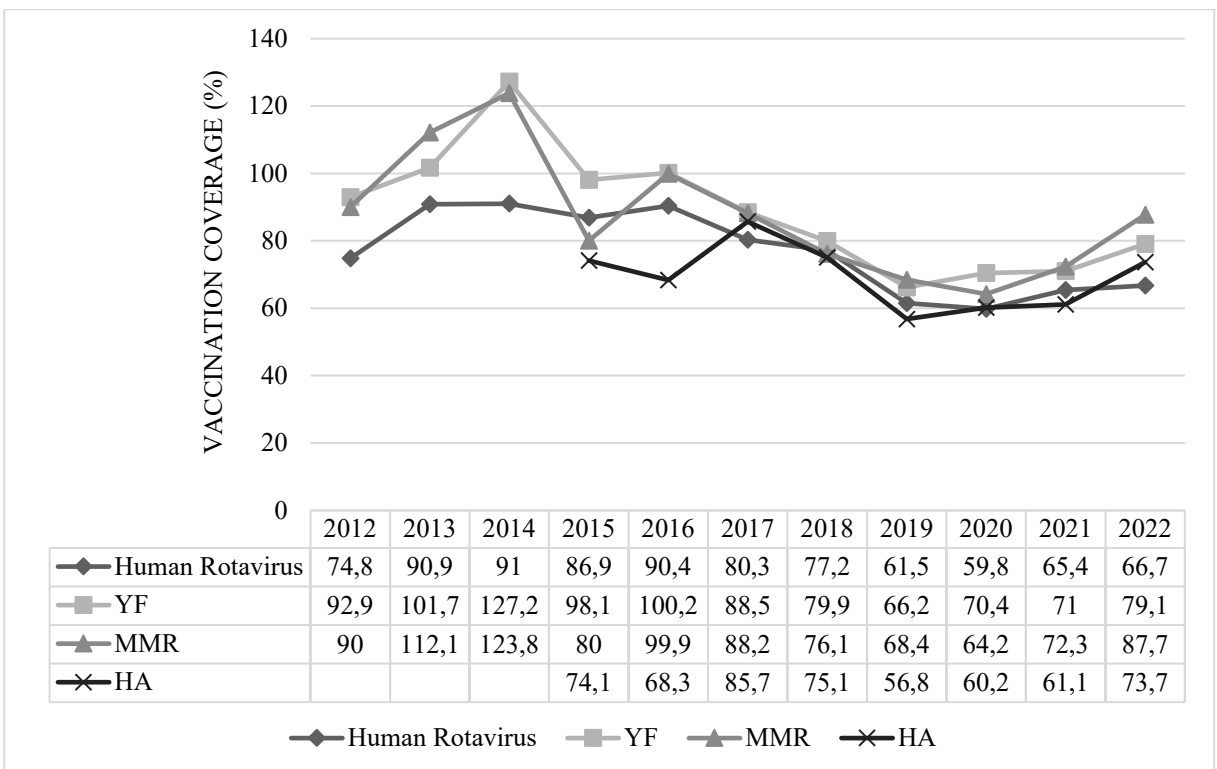
Figures 1 and 2 show the VC of all ten vaccines over 13 years (2010 to 2022). For the YF, MMR, OPV/IPV, pentavalent, BCG, Pneumococcal 10 and Human Rotavirus vaccines, the doses applied since 2010 were considered, while for the HB vaccine, the doses applied since 2013, against HA from 2015, and against Meningococcal C, as of 2011.

VC rates of approximately 80% were observed throughout the period for most of the vaccines analyzed (Chart 1). However, there were variations, such as a decrease in 2015, followed by an increase or stabilization in 2016. From 2017 to 2020, there was a continuous decline, with a slight increase beginning in 2021. For the BCG vaccine, there was a significant decline in 2020, and in 2022, the last year analyzed, this vaccine had the highest VC (116.0%). Of the set of vaccines analyzed, the lowest VC was presented by the HA vaccine in 2019. The second vaccine with the lowest percentage of VC for the period was the Human Rotavirus vaccine (59.8%) in 2020 (Figure 1 and 2).



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BCG	102,8	114,7	97	102,9	113,9	113	105,1	103,2	66,4	105,8	116
HB		109,7	102,7	64,6	100,9	104,1	110,2	116,9	89	95,8	112,6
OPV/IPV	83,3	97,7	75,8	86,2	83,1	73,3	73,4	61,9	63,5	67,7	71,4
Pentavalent	60,9	96	88,1	87	99,6	90,6	73,7	61,7	68,6	70,9	73,5
10-Valent Pneumococcal	89,6	98,9	91,6	84,5	100,5	88,5	63,5	64,1	63,8	68,7	72
Meningococcal C	88,1	97,6	87,6	89,9	100,9	84,3	71,1	67,6	61,1	64,6	67,8

Figure 1. Vaccination Coverage of children under two years old in the National Immunization Program, Rondonópolis, Mato Grosso, 2010-2022.
Fonte: Information System of the National Immunization Program.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Human Rotavirus	74,8	90,9	91	86,9	90,4	80,3	77,2	61,5	59,8	65,4	66,7
YF	92,9	101,7	127,2	98,1	100,2	88,5	79,9	66,2	70,4	71	79,1
MMR	90	112,1	123,8	80	99,9	88,2	76,1	68,4	64,2	72,3	87,7
HA				74,1	68,3	85,7	75,1	56,8	60,2	61,1	73,7

Figure 2. Vaccination Coverage of children under two years old in the National Immunization Program, Rondonópolis, Mato Grosso, 2010-2022.
Fonte: Information System of the National Immunization Program.

The YF vaccine was below the VC target in the first year (VC = 92.9% in 2012), reaching the PNI target in the two subsequent years (VC = 101.7% in 2013 and VC = 127.2% in 2014). In 2015, it declined (VC = 98.1%) and reached the target in the following year, 2016 (VC = 100.2%), with a decline starting in 2017 (VC = 88.5%). It reached the lowest VC (66.2%) in 2019 and increased in the following years (Figure 1 and 2).

The Meningococcal C vaccine reached the recommended target only in 2013 (VC = 97.6%), and in 2016 (VC = 100.9%), it declined between 2017 and 2020, when it reached the lowest VCs (VC = 84.3%). in 2017, and CV = 61.1% in 2020). The MMR vaccine started the series below the target (VC = 90% in 2012) but reached it in 2013 (VC = 112.1%), 2014 (VC = 123.8%) and 2016 (VC = 99. 9%). There was a decrease until 2020 (VC = 64.2%), with increases in 2021 (VC = 72.3%) and 2022 (VC = 87.7%) (Figure 1 and 2).

The lowest values of the time series were observed for the OPV/IPV vaccine, which only reached the goal in 2013 (VC = 97.7%), decreasing in the following years, with the lowest value in 2019 (VC = 97.7%). 61.9%), and in the last three years, the values were even lower (VC = 63.5% in 2020; VC = 67.7% in 2021; VC = 71.4% in 2022) (Figure 1).

The tetravalent/pentavalent vaccine started the series with low VC (60.9% in 2012), a consistent increase in 2013 (VC = 96.0%), followed by a decrease in the two subsequent years (VC = 88.1% in 2014; CV = 87.0% in 2015). In 2016, it reached the maximum VC value (99.6%), decreased until 2019 (VC = 61.7%) and increased until 2022 (VC = 73.5%). The BCG vaccine showed high VC during the first eight years, especially in 2012 (VC = 102.8%) and 2019 (VC = 103.2%), but it decreased considerably to below the target in 2020 (VC = 66.4%), after which it increased again until 2022, when it reached the highest VC of the series (116.0%) (Figure 1).

The Pneumococcal 10 vaccine started with VC = 89.6% in 2010 and later reached the target in 2013 (VC = 98.9%) and 2016 (VC = 100.5%). In the following four years, there was a decrease (VC = 88.5% in 2017; VC = 63.5% in 2018; VC = 64.1% in 2019 and VC = 63.8% in 2020) and a slight increase in the last two years (CV = 68.7% in 2021 and CV = 72.0% in 2022). The prevalence of the Human Rotavirus vaccine reached the target in 2013 (VC = 90.9%), 2014 (VC = 91.0%) and 2016 (VC = 90.4%), decreased in the following years until it reached the lowest VC in 2020 (59.8%) and remained below 70.0% in the last two years, VC = 65.4% in 2021 and VC = 66.7% in 2022 (Figures 1 and 2).

Regarding the HB vaccine, the VC in the starting year of the series was 112.6% (2013). However, in the two subsequent years, there was a consecutive decrease (VC = 95.8% in 2014 and VC = 64.6% in 2015). As of 2016, the prevalence of this vaccine remained high (VC = 100.9%), with the highest VC in 2019 (116.9%). In 2020, there was a considerable decrease in VC for the HB vaccine (VC = 89.0%), followed by an increase in the last two years (VC = 102.7% in 2021 and VC = 109.7% in 2022). For the HA vaccine, the target was not reached throughout the historical series, which started with VC = 74.1% in 2015 and reached its maximum value in 2017 (VC = 85.7%). In the last three years of the series, there was a slight increase (VC = 60.2% in 2020; VC = 61.1% in 2021 and VC = 73.7% in 2022) (Figure 1 and 2).

Regarding vaccines for children up to two years of age and the period considered, a decreasing trend was observed for the VCs of AF, Meningococcal C, MMR, OPV/IPV and Pneumococcal 10. Stationary behavior in the temporal trend analysis of VC was verified for the HB, pentavalent, BCG, Human Rotavirus and HA vaccines. The most significant annual percentage changes (APVs) were detected for the vaccines against MMR (APV= -4.05; p= 0.021), Meningococcal C (APV= -3.97; p= 0.008) and YF (APV= - 3.96; p = 0.025) (Table 1).

Table 1. Temporal trend of indicators from the National Vaccination Program for Children under two years old. Rondonópolis, Mato Grosso, Brazil, 2010-2022.

PNI Indicators	2012 (%)	2022 (%)	Average	p-value	VPA€	Trend
Vaccination Coverage (VC)						
YF	93,0	79,0	88,1	**0,025**	-3,96	**decreasing**
Meningococcal C	88,0	68,0	80,05	**0,008**	-3,97	**decreasing**
MMR	90,0	88,0	87,5	**0,021**	-4,05	**decreasing**
HB[1]	112,0[1]	110,0	100,6	0,535	-1,16	stationary
OPV/IPV	83,0	71,0	76,1	**0,001**	-3,37	**decreasing**
Pentavalent	61,0	73,0	79,1	0,463	-1,4	stationary
BCG	103,0	116,0	103,7	0,513	-0,95	stationary
10- Valent Pneumococcal	90,0	72,0	80,5	**0,022**	-3,78	**decreasing**
Human Rotavirus	75,0	67,0	76,8	0,063	-2,8	stationary
HA[2]	74,0[2]	74,0	69,4	0,346	-2,19	stationary
Proportion of Abandonment for multi-dose Vaccine Schedules (PA)						
Meningococcal C	-3,26	6,8	3,3	0,856	1,12	stationary
OPV/IPV	-27,9	2,96	2,6	0,715	-4,04	stationary
10- valent pneumococcal	1,2	-0,26	5,0	0,750	-3,41	stationary
Pentavalent	-1,04	-1,3	2,8	0,068	-18,88	stationary
Human Rotavirus	15,7	3,8	5,4	**0,004**	-10,48	**decreasing**

€Annual Percentage Variation (APV); [1]available from 2013; [2]used from 2015.
Source: Information System of the National Immunization Program.

For the five vaccines that require multiple doses, the proportion of abandonment (PA) showed a stationary trend for the Meningococcal C (APV = 1.12%; p = 0.856), OPV/IPV (APV = -4.04%; p = 0.715), Pneumococcal 10 (VPA = -3.41%; p = 0.740) and Pentavalent (VPA = -18.88%; p = 0.068) vaccines. However, the Human Rotavirus vaccine showed a decreasing trend in PA (VPA = -10.48%; p = 0.004) (Table 1).

Table 2 presents the performance of the BCG and Pentavalent vaccines through the representation of the loss to follow-up of the child in the regular vaccination program. During the series, the highest percentages of patients lost to follow-up were observed in 2018 (PS=31.4%), 2019 (PS=41.5%), 2021 (PS=34.9%) and 2022 (PS =42.5%).

Table 2. Population under two years old, doses administered, Vaccination Coverage and Child Follow-up Loss, according to single dose BCG Vaccination and third doses of pentavalent vaccine, Rondonópolis, Mato Grosso, Brasil, 2010-2022.

Year	BCG		Pentavalent		Lost to Follow-up Doses	% Lost to Follow-up
	No. Of 1st dose	Vaccination Coverage	No. Of 3rd dose	Vaccination Coverage		
2013	4.241	114,7	3.551	96	690	18,7
2014	3.915	97	3.555	88,1	360	8,9
2015	4.139	102,9	3.501	87	638	15,9
2016	4.223	113,9	3.694	99,6	529	14,3
2017	4.478	113	3.593	90,6	885	22,4
2018	4.278	105,1	2.998	73,7	1.280	31,4
2019	4.154	103,2	2.483	61,7	1.671	41,5
2020	2.540	66,4	2.626	68,6	-86	-2,2
2021	4.145	105,8	2.778	70,9	1.367	34,9
2022	4.359	116	2.764	73,5	1.595	42,5

Source: Information System of the National Immunization Program.

DISCUSSION

From 10 years of age onward, downward trends and stationary behavior were observed in the VC indices of children up to two years of age. VC instability and decrease were also observed in other studies that considered the last few years, in Brazil[4,13-18] and in other countries[2,19,20].

Such downward trends could be explained by different conditions and associated factors. The study revealed a high percentage of timely incomplete vaccination schedules (82.0%) for children up to 12 months of age in the municipality of Rondonópolis-MT. In this study, the presence of one or more siblings in the household (OR: 3.18; 95% CI 1.75–5.76) and not having received a visit from a community health agent in the last 30 days remained independently associated with the incompleteness of the scheme. (OR 1.93; 95% CI 1.04–3.57). In this regard, the researchers reinforce the active search for children with vaccination delays in relation to the recommended interval for each vaccine, in addition to the need to strengthen the bond with the team. Strategy of Family Health (FHS) and caregivers of children[21].

It should be noted that the period analyzed in the present study encompasses the occurrence of the COVID-19 pandemic, which began in 2020. This fact required the implementation of social distancing measures to reduce the transmission of the virus, which resulted in limited attendance in person at services worldwide, including for childhood vaccination. In addition, there was a growing dissemination of disinformation and fake news on social media, combined with a controversial political scenario, which favored vaccination hesitation. Thus, there was a marked decrease in VC during the pandemic in Brazil, as well as globally[13,19,20].

In the USA, there was a significant decline in vaccination coverage, especially in children under two years of age, with disease onset recorded in the week after the declaration of a national emergency[22]. In England, a few weeks after the implementation of social isolation measures, a decrease of 19.8% was identified in the applied doses of the MMR vaccine compared to the same period in 2019[6].

In Brazil, a national survey covering the period 2012-2021 also revealed a decrease in

childhood vaccination coverage before and after the COVID-19 pandemic. In addition to the low rates of childhood CV identified, this study revealed heterogeneity in this indicator among Brazilian municipalities, especially in the North and Northeast Regions[4]. Considering the year of onset of the pandemic (2020) compared to the previous year (2019), our results also showed a significant decrease in VC related to the BCG and HB vaccines.

Regarding MMR, an immunobiological agent that prevents measles, a national study revealed that since 2016, the VC goal for this vaccine has not been reached in all regions of Brazil, which is associated with an increase in the number of cases in certain regions[2] . Regarding this disease, two factors need to be highlighted: the loss of the measles elimination certificate in 2019 and the onset of the COVID-19 pandemic in 2020, aggravating the drop in VCs[23].

In addition, a study of the temporal trend of vaccination coverage and the proportion of MMR noncompliance throughout the national territory revealed that VC was less than 95% between 2015 and 2021, with stationary and decreasing trends in the federative units. The percentage of FUs who dropped out ranged from 22.2% (2014) to 37.4% (2021)[24]. Our results showed a decreasing trend in the period evaluated for the MMR vaccine, with the lowest VC in 2019 and 2020 (Figure 2), which agrees with the findings of the national studies mentioned above.

Poliomyelitis eradication was certified by the WHO in 1994 in the Americas and in 36 countries in the Western Pacific in the 2000s, including China and Australia. In 2002, Europe and India were declared free of the circulation of poliomyelitis, and this was declared in 2014. In 2020, Africa received an eradication certificate, leaving in the world only two countries with endemic regions, Pakistan and Afghanistan. In 2022, the circulation of the type two virus derived from the polio vaccine (POV) was recorded in Israel, the United Kingdom, the United States and Canada. In this context, until polio is completely eradicated from the planet, contagion by the wild virus and the risk of infection by the virus derived from attenuated vaccines remain possible. This fact reinforces once again the importance of achieving high vaccination coverage for this disease[25].

In this study, there was a significant downward trend in the VC of the OPV/IPV vaccine, as observed in a study using data from all regions of Brazil[3]. Another national time series study between 2011 and 2021 corroborated the findings of a marked decrease in VC against poliomyelitis after the pandemic, especially in states and regions with greater social vulnerability[24]. Analyses of the temporal and spatial distribution of poliomyelitis vaccine coverage throughout Brazil revealed a decrease from 89.2% in 1997 to 61.3% in 2021[26;] this value is very close to that observed in our study from 1997-2019 to 2021 (Figure 1).

Evaluation of VC for Meningococcal C in relation to the number of cases of this disease in Brazil between 2008 and 2022 revealed a 50.0% decrease in the number of cases reported. Considering that the vaccine was implemented in the PNI in 2010, from that year onward, an exponential growth of VC was identified until 2022. Additionally, in the same study, between 2013 and 2016, there was a decrease in the incidence of the disease and an increase in VC, especially in the Midwest (102.9%)[27.] An increase in VC for Meningococcal C in our study between 2013 and 2016 was also observed, with records of falls from that year.

Regarding the occurrence of yellow fever, cases of urban disease have not been recorded in Brazil since 1942; however, cases related to the sylvatic cycle of the disease are still reported, which is related to low VC. Given that the investigated municipality covers an endemic area and that the VC goal should be 100%, the results observed are worrising because there has been a decrease in VC since 2016 in the municipality of Rondonópolis-MT. Another investigation regarding vaccination coverage and yellow fever morbidity and mortality rates in Brazil between 2016 and 2020 showed an increase in hospitalizations and deaths in Brazilian regions with VC below the target, especially in the Southeast Region. Therefore, only with adequate VC will it be possible to avoid deaths and hospitalizations due to the disease, both in endemic and nonendemic areas[28].

Regarding the Pneumococcal 10 vaccine, since its introduction into the PNI in 2010, there

has been a significant reduction in the number of reported cases and sequelae[4]. A study that evaluated the impact of pneumococcal vaccination in Latin America revealed an 87.7% reduction in hospitalizations due to meningitis and an 83.3% reduction in hospitalizations due to invasive pneumococcal disease in the analyzed countries[29]. The VC of Pneumo10 in Rondonópolis during the study period showed a significant decrease starting in 2017, remaining below 70%. Such VC values in children up to two years of age are a cause for concern because pneumococcal disease has high morbidity and mortality in this age group.

A study covering the Brazilian regions showed that the use of vaccination is directly proportional to the reduction in hospital admissions related to diarrhea and gastroenteritis and deaths from rotavirus in children under five years of age. In addition, an increase in the VC rate of the Human Rotavirus vaccine was observed in all states of the country in the last 12 years, especially in the North, Northeast and Midwest Regions[30]. Our results show a stationary trend in relation to the VC of the Human Rotavirus in the analyzed period. Notably, there was a considerable decrease in VC in 2020 (58.9%). On the other hand, the PA for the Human Rotavirus vaccine decreased during the study period, indicating greater adherence to the vaccination schedule.

The temporal trend analysis of VC makes it possible to identify and define the best strategies to increase VC, especially during the first two years of life, when the largest number of vaccines according to the PNI are designed. Some factors, such as vaccine hesitancy, fake news, and antivaccine movements, intensified with the COVID-19 pandemic.

Therefore, monitoring VC combined with temporal trend studies is essential to mitigate the risk of returning from previously controlled infectious diseases, especially among the most vulnerable populations, and to verify heterogeneous VC among regions of the country.

We emphasize that this study gathers relevant data on the monitoring of VC in children under two years of age for a long period of time (2010-2022), in addition to considering an important municipality in the state of Mato Grosso with great economic and social impact. . With the results obtained, it was possible to identify significant decreases in the VC of certain vaccines, with special attention given to OPV/IPV throughout the study period. Significant decreases were also observed for BCG and the pentavalent vaccine, especially after the COVID-19 pandemic. Therefore, the practical implication of this study is to provide subsidies for the planning of more effective actions to increase the VC rates of these vaccines.

CONCLUSION

In conclusion, when analyzing VC in children under 2 years of age in the municipality of Rondonópolis during the period from 2010 to 2022, an average value of 80% was obtained, considering the ten vaccines analyzed. This percentage is less than that recommended by the PNI, indicating the risk of the emergence of controllable infectious-contagious diseases. Therefore, these results make it possible to review more effective strategies aimed at health promotion and disease prevention, especially to increase adherence to vaccination. The importance of health communication with clear, quality and scientifically based information that is widely accessible to the entire population is emphasized as a supporting pillar in the field of public health, disease prevention and health promotion policies.

REFERENCES

1. Fundo das Nações Unidas para a Infância [Internet]. Nova Iorque, EUA: UNICEF; c2023 [acessado 2023 Sept 1] Immunization coverage. 2020. Disponível em: https://data.unicef.org/resources/immunization-coverage-are-we-losing-ground/

2. Kaur G, Danovaro-Holliday MC, Mwinnyaa G, Gacic-Dobo M, Francis L, Grevendonk J, et al. Routine Vaccination Coverage — Worldwide, 2022. MMWR Morb Mortal Wkly Rep [Internet]. 2023[acessado 2024 Apr 1]; 72:1155–1161. Disponível em: https://www.cdc.gov/mmwr/volumes/72/wr/

mm7243a1.htm?s_cid=mm7243a1_w doi: https://doi.org/10.15585/mmwr.mm7243a1

3. Homma A, Martins RM, Leal MLF, Freire MS, Couto AR. Atualização em vacinas, imunizações e inovação tecnológica. Ciênc Saúde Coletiva [Internet]. 2011[acessado 2024 Mar 3]; 16:445-58. Disponível em: https://www.scielo.br/j/csc/a/b73nrTDDntFsBPvcRqHPfxR/?lang=pt doi: https://doi.org/10.1590/S1413-81232011000200008

4. Domingues CMA, da Silva Teixeira AM, de Moraes JC. Cobertura vacinal em crianças no período antes e durante a pandemia da COVID-19 no Brasil: uma análise de séries temporais e revisão da literatura. J Pediatr (Rio J) [Internet]. 2023 [acessado 2024 Fev 23]; 99(1):12-21. Disponível em: https://www.sciencedirect.com/science/article/pii/S0021755722001280?via%3Dihub doi: https://doi.org/10.1016/j.jped.2022.11.004

5. Silva BS, Coelho HV, Cavalcante RB, Oliveira VC, Guimarães EAA. Evaluation study of the National Immunization Program Information System. Rev Bras Enferm [Internet]. 2018 [acessado 2022 Nov 23]; 71(1):615-24. Disponível em: https://www.scielo.br/j/reben/a/3cQHDpgfpDgKBLXL4dwGDhM/?lang=en doi: https://doi.org/10.1590/0034-7167-2017-0601

6. McDonald HI, Tessier E, White JM, Woodruff M, Knowles C, Bates C, et al. Early impact of the coronavirus disease (COVID-19) pandemic and physical distancing measures on routine childhood vaccinations in England, January to April 2020. Euro Surveill [Internet]. 2020 [acessado 2024 Mar 23]; 25(19):2000848. Disponível em: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.19.2000848 doi: https://doi.org/10.2807/1560-7917.es.2020.25.19.2000848

7. Silva TMR, Sá ACMGN, Vieira EWR, Prates EJS, Beinner MA, Matozinhos FP. Number of doses of Measles-Mumps-Rubella vaccine applied in Brazil before and during the COVID-19 pandemic. BMC Infect Dis [Internet]. 2021 [acessado 2024 Mar 26]; 21(1):1237. Disponível em: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-021-06927-6 doi: https://doi.org/10.1186/s12879-021-06927-6

8. Ministério da Saúde. Imunização – doses aplicadas [Internet]. Brasília: MS; c2022. [acessado 2023 Nov. 10]. Disponível em: http://tabnet.datasus.gov.br/cgi/dhdat.exe?bd_pni/dpnibr.def

9. Instituto Brasileiro de Geografia e Estatística (IBGE). Estimativas da população residente [Internet]. Brasília: MS; c2023 [acessado 2023 Nov 16]. Disponível em: http://www.ibge.gov.br

10. Ministério da Saúde. Sistema de Informações sobre Nascidos Vivos (SINASC) [Internet]. Brasília: MS; 2023 [acessado 2023 Nov 17]. Disponível em: https://datasus.saude.gov.br/nascidos-vivos-desde-1994

11. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis. Manual de normas e procedimentos para vacinação. [Internet]. Brasília: MS; 2014 [acessado 2023 Nov 20]. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/manual_procedimentos_vacinacao.pdf

12. Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Análise em Saúde e Vigilância de Doenças não Transmissíveis. Saúde Brasil 2019: uma análise da situação de saúde com enfoque nas doenças imunopreveníveis e na imunização. [Internet]. Brasília: MS; 2019 [acessado 2023 Nov 20]. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/saude_brasil_2019_analise_situacao.pdf

13. Procianoy GS, Rossini Júnior F, Lied AF, Jung LFPP, Souza MCSC. Impacto da pandemia do COVID-19 na vacinação de crianças de até um ano de idade: um estudo

ecológico. Ciência & Saúde Coletiva [Internet]. 2022 [acessado 2023 Nov 20]; 27(3):969-978. Disponível em: https://www.scielo.br/j/csc/a/HRMwSZF7GT96MMx7pBTJfkD/?lang=pt doi: https://doi.org/10.1590/1413-81232022273.20082021

14. Cunha NSP, Fahrat SCL, Olinda RS, Braga ALF, Barbieri CLA, Paplona YAP, et al. Spatial analysis of vaccine coverage on the first year of life in the northeast of Brazil. BMC Public Health [Internet]. 2022 [acessado 2023 Nov 20]; 22:1204. Disponível em: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-13589-9 doi: https://doi.org/10.1186/s12889-022-13589-9

15. Donalisio MR, Boing AC, Sato AP, Martinez EZ, Xavier MO, Almeida RLF, et al. Vacinação contra poliomielite no Brasil de 2011 a 2021: sucessos, reveses e desafios futuros. Ciência & Saúde Coletiva [Internet]. 2023 [acessado 2023 Dez 20]; 28(2):337-350. Disponível em: https://www.scielo.br/j/csc/a/Z6HShtzCPMHj5smMWj9yvTc/?lang=pt doi: https://doi.org/10.1590/1413-81232023282.17842022

16. Marinho CV, Queiroz RCS, Araujo WRM, Tonello AS, Thomaz EBAF. Indicadores do Programa Nacional de Imunizações em menores de um ano: tendência temporal no Maranhão, Brasil, 2010 a 2021. Ciência & Saúde Coletiva [Internet]. 2023[acessado 2023 Dez 20]; 28(2):337-350. Disponível em: https://www.scielo.br/j/csc/a/pX6fG9mj7fB4cMcMYqYXM9R/?lang=pt doi: https://doi.org/10.1590/1413-81232023288.07312023

17. Sato APS, Boing AC, Almeida RLF, Xavier MO, Moreira RS, Martinez EZ, et al. Vacinação do sarampo no Brasil: onde estivemos e para onde vamos? Ciência & Saúde Coletiva [Internet]. 2023 [acessado 2024 Fev 20]; 28(2):351-362. Disponível em: https://www.scielo.br/j/csc/a/J668gWXsNPfWMFbBNSgp75j/?lang=pt doi: https://doi.org/10.1590/1413-81232023282.19172022

18. Palmieri IGS, Lima LV, Pavinati G, Silva JAP, Marcon SS, Sato APS, et al. Cobertura vacinal da tríplice viral e poliomielite no Brasil 2011-2021: tendência temporal e dependência espacial. Rev Bras Epidemiol [Internet]. 2023 [acessado 2024 Fev 20]; 26:e230047. Disponível em: https://www.scielo.br/j/rbepid/a/HCj3VRxYqB9yCkWzw5LgvBN/?lang=pt doi: https://doi.org/10.1590/1980-549720230047.2

19. Hirabayashi K. The impact of COVID-19 on the routine vaccinations: refletions during World Immunization Week 2020 [Internet]. Bangkok (THA): UNICEF-East Asia and Pacific; 2020 [citado 2023 Mar 10]. Disponível em: https://www.unicef.org/eap/stories/impact-covid-19-routine-vaccinations

20. Saxena S, Skirrow H, Bedford H. Routine vaccination during covid-19 pandemic response. BMJ [Internet]. 2020[acessado 2024 Fev 20]; 369:m2392. Disponível em: https://www.bmj.com/content/369/bmj.m2392 doi: https://doi.org/10.1136/bmj.m2392

21. Lemos PL, Oliveira Jr GJ, de Souza NF, da Silva IM, de Paula IP, da Silva KC, et al. Fatores associados ao esquema vacinal oportuno incompleto até os 12 meses de idade Rondonópolis Mato Grosso. Rev Paul Pediatr [Internet]. 2022 [acessado 2023 Fev 20]; 40:e2020300. Disponível em: https://www.scielo.br/j/rpp/a/dC8h6pzKGbhDJmYxfM9jnzx/?lang=en doi: https://doi.org/10.1590/1984-0462/2022/40/2020300

22. Sato APS. Pandemic and vaccine coverage: challenges of returning to schools. Rev Saúde Pública [Internet]. 2020[acessado 2022 Oct 20]; 54:115. Disponível em: https://www.scielo.br/j/rsp/a/FkQQsNnvMMBkxP5Frj5KGgD/?lang=en doi:

https://doi.org/10.11606/s1518-8787.2020054003142

23. Ministério da Saúde (MS). Plano de ação para interrupção da circulação do vírus do sarampo: monitoramento e reverificação da sua eliminação no Brasil, 2022. [Internet]. Brasília: MS; 2022 [acessado 2024 Fev 20]. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/interrupcao_ciruculacao_virus_sarampo.pdf

24. Moura LL, Neto M, Souza-Santos R. Tendência temporal da taxa de abandono e da cobertura da vacina tríplice viral no Brasil, 2014-2021. Epidemiol Serv Saude [Internet]. 2023[acessado 2024 Fev 20]; 32(3):e2023117. Disponível em: https://www.scielo.br/j/ress/a/mS6xyfQbkzvK4TfRcsN5HCs/?lang=pt doi: https://doi.org/10.1590/S2237-96222023000300004.PT

25. Martini M, Orsini D. The ghost of polio haunts us once again. The appeal of the scientific community is clear: "Vaccinate your kids today!". Vaccine [Internet]. 2023 [acessado 2024 Mar 13]; 14;41(36):5338-5341. Disponível em: https://www.sciencedirect.com/science/article/abs/pii/S0264410X23008502?via%3Dihub doi: https://doi.org/10.1016/j.vaccine.2023.07.029

26. Maciel NS, Braga HMFG, Moura FJN, Luzia FJM, Sousa IES, Rouberte ESC. Temporal and spatial distribution of polio vaccine coverage in Brazil between 1997 and 2021. Rev Bras Epidemiol [Internet]. 2023 [acessado 2024 Mar 13]; 28;26:e230037. Disponível em: https://www.scielo.br/j/rbepid/a/krC3GzcMHsBQdtKkHVvCkjw/?lang=en doi: https://doi.org/10.1590/1980-549720230037

27. Silva TA, Celestino JH, Rocha FC, Silva Neto FA, Maia DO, Ferreira TB, et al. O impacto da cobertura vacinal contra a meningite meningocócica C sobre o número de casos de meningite C no Brasil entre 2008 e 2022. Braz J Infect Dis [Internet]. 2023 [acessado 2024 Mar 13]; 27(1):103101. Disponível em: https://www.sciencedirect.com/science/article/pii/S1413867023003616?via%3Dihub doi: https://doi.org/10.1016/j.bjid.2023.103101

28. Sobral MAF, Eich AAG, Silveira DMH, Orfão NH, Monteiro JC. Febre amarela no Brasil: A relação da cobertura vacinal com os índices de morbimortalidade. Research Society and Development [Internet]. 2023[acessado 2024 Mar 13];1 2(13):e33121344188. Disponível em: https://rsdjournal.org/index.php/rsd/article/view/44188 doi:https://doi.org/10.33448/rsd-v12i13.44188

29. Oliveira LH, Camacho LA, Coutinho ES, Martinez-Silveira MS, Carvalho AF, Ruiz-Matus C, et al. Impact and effectiveness of 10 and 13-valent pneumococcal conjugate vaccines on hospitalization and mortality in children aged less than 5 years in Latin American countries: a systematic review. PLoS One [Internet]. 2016 [acessado 2024 Mar 15]; 11:e0166736. Disponível em: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0166736 doi: https://doi.org/10.1371/journal.pone.0166736

30. Gomes RNS, Fonseca PIMN, Rodrigues A, Pereira C, Gomes VTS, Carvalho Filha FSS. Influência da vacina contra o rotavírus humano em hospitalizações por gastroenterite em crianças no Brasil. Texto Contexto Enferm [Internet]. 2021 [acessado 2024 Mar 15]; 30:e20200354. Disponível em: https://www.scielo.br/j/tce/a/gnvpV5xfzvMrWmZKsX74d4M/?lang=en doi: https://doi.org/10.1590/1980-265X-TCE-2020-0354

Received: 15 May. 2024
Accepted: 19 June. 2024