

DYNAMICS OF TRIPLE VIRAL VACCINE COVERAGE AND COVID-19 IN BRAZIL, FROM 1994 TO 2022 AND POSSIBLE IMPACTS ON POPULATION HEALTH

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Abstract: In Brazil, the Ministry of Health has had the National Immunization Program (PNI) since 1973, created with the aim of reducing the incidence of vaccine-preventable diseases by making vaccines available. The reappearance of anti-vaccine movements has encouraged vaccine hesitancy and negatively impacted vaccine coverage, leading to outbreaks of vaccine-preventable diseases that were previously controlled. Also, with the advent of the COVID-19 pandemic, the need for social isolation also had a negative impact on vaccine campaigns. The objective of this work is to draw an overview of the vaccination coverage records of the Triple Viral Vaccine, from 1994 to August 2022, and of the COVID-19 Vaccine since its implementation, to build a parallel between both and to discuss the probable causes and repercussions of the epidemiological scenario of each one. Through an ecological analytical study, numbers of confirmed cases of each of these diseases were analyzed, as well as their respective vaccination coverage, associating the results with the reemergence of anti-vaccine movements and the pandemic context associated with COVID-19.

Keywords: Vaccine. Vaccination. Vaccination Coverage.

INTRODUCTION

Vaccines are an extremely effective method of immunization, and their production is based both on the use of the attenuated or inactivated etiological agent, as well as fragments thereof, with the aim of providing an immune response in the host, protecting it against future diseases. *al.*, 2016)

The first vaccine was developed in 1796 by Edward Jenner against smallpox. His work represented the first scientific attempt to control an infectious disease through the use of a vaccine. (BARQUET; DOMINGO, 1997) Over the years and with the advancement of

medicine and molecular biology, several types of vaccines could be developed and, thus, this method of immunization is seen as an individual and collective prevention strategy, and also as an investment in health due to its significant impact on disease prevention. (NÓVOA et al., 2020; PLOTKIN, 2005)

In Brazil, the Ministry of Health has had the National Immunization Program (PNI), since 1973, created with the aim of reducing the incidence of vaccine-preventable diseases, as well as the deaths caused by them. (MACHADO et al., 2020) In addition of acting in the fight, control and eradication of diseases, the program offers more than 300 million annual doses of immunobiologicals, with 96% of the vaccines offered by the Unified Health System (SUS), made in the national territory or in the transfer phase. (DOMINGUES; TEIXEIRA, 2013) Due to this broad system, polio, diphtheria and pertussis are diseases that could be eradicated in the country. (BRAZIL. MINISTRY OF HEALTH, 2013)

The possibility of equal access to vaccination for the Brazilian population constitutes another foundation of the National Immunization Program, providing a reduction in immunization coverage inequalities between regions and is in accordance with the principle of universality of the SUS, described in Article 7 of Law number 8,080 of the Federal Constitution. (DOMINGUES; TEIXEIRA, 2013) Associated with this, media campaigns that encourage vaccination in the national media also help to reduce variations in vaccine adherence at different age and economic levels. (BARBIERI et al., 2013)

However, certain diseases have resurfaced after the growth of anti-vaccination movements, in which many people opt for vaccine refusal. This movement is not a recent phenomenon, considering the Vaccine Revolt in 1904 in Rio de Janeiro, at a historical

moment when society still lacked information about the benefits of vaccines. (LEVI, 2013) This movement lost strength over the years as knowledge and confidence in this prevention strategy gained strength, through scientific and epidemiological evidence. (LAGO, 2018)

However, in 1998, the journal "*The Lancet*" published a note stating that the vaccine against measles, mumps and rubella was related to the development of autism and inflammatory bowel disease. As a consequence, several outbreaks occurred causing numerous deaths. (LAGO, 2018) After some time, scientific studies proved the opposite, and even "*The Lancet*", in 2010, published a note correcting the mistake of the first publication. Even with proof, the opposing groups remained with their motivations and continued to deny vaccines. (SUCCI, 2018)

This decision to vaccinate or not includes social, personal, religious and cultural factors, leveraged on social media, often accompanied by the so-called Fake News, that is, the spread of false information about its purpose and effectiveness, and even the fear of being vaccinated. possible side effects. (SATO, 2018; SUCCI, 2018) The very effect of vaccines in reducing illnesses contributed to this scenario, since today many people are unaware of the devastating effects of diseases such as smallpox and polio, which reduces the value vaccines for these people. (QUEIROZ, et al., 2013)

In addition, vaccine hesitancy, understood as the delay in accepting or refusing the vaccine, regardless of availability in the health system, has resulted in a decrease in the number of people vaccinated, enhancing outbreaks of vaccine-preventable diseases, previously controlled. (LEVI, 2013; SATO, 2018) The coverage rate of the triple viral vaccine, which protects against measles, rubella and mumps, reached 96% of children in 2015, dropped to 84% in 2017 and allowed the return of infection

to the country. (ZORZETTO, 2018) The states of Roraima and Amazonas, for example, have been suffering measles outbreaks, with more than 1500 cases confirmed in the first 8 months of 2018, as a direct consequence of the decrease in vaccination coverage. (SATO, 2018) According to PNI data for the year In 2019, Brazil suffered a drop in vaccination coverage in children, not reaching the target for the main vaccines recommended for this population group, with the vaccination rate for 2019 being the worst since the year 2000. (DIAS, 2020)

In 2011, the World Health Organization pointed out a model that includes "3 Cs" for the characterization of this behavior. (SATO, 2018) The first C would be confidence in the credibility of the vaccine, its effectiveness, its safety and the health system that makes it available. (SATO, 2018) Complacency refers to the second C, encompassing the low perception of the risks of preventable diseases, disregarding the vaccine as necessary, and, finally, the third C of convenience of availability and accessibility of vaccines and services (SATO, 2018) Thus, the increase in vaccination coverage rates is one of the greatest challenges of Public Health in the fight against vaccine-preventable diseases. (LAGO, 2018; QUEIROZ et al., 2013)

As much as the advent of vaccination reflects a scientific advance of the 20th century, the term vaccine hesitancy remains in the spotlight. This way, the study of the reasons and degree of this term are essential in the planning of strategies to be incorporated by the health system, with the purpose of circumventing the challenges of Public Health in the fight against vaccine-preventable diseases. (LAGO, 2018; QUEIROZ et al, 2013)

Given this scenario, this study aims to analyze the immunization coverage record of the Immunization Program (PNI) of vaccine-preventable diseases in Brazil, from 2010 to

2020, comparing coverage in the municipality of Sorocaba and the state of São Paulo across the country. In addition, since vaccination is an extremely relevant strategy for the health system due to its significant impact on disease prevention, the present study also intends to relate possible declines in the vaccination coverage rate, such as the advent of the anti-vaccination movement and the impact of COVID-19 pandemic.

OBJECTIVES

The objective of this work is to draw an overview of the vaccination coverage records of the Triple Viral Vaccine, from 1994 to August 2022, and of the COVID-19 Vaccine since its implementation, to build a parallel between both and to discuss the probable causes and repercussions of the epidemiological scenario of each.

Specific objectives:

- Tracing the history of implementation of vaccination programs and their impact on the incidence of vaccine-preventable diseases;
- Discuss the factors that impact vaccine adherence;
- Characterize the vaccine coverage of the Triple Viral Vaccine from 1994 to the present day
- Characterize the vaccination coverage of the COVID-19 Vaccine since its implementation until the present moment
- Confronting the dynamics of vaccination coverage and the concomitant records of the incidence of vaccine-preventable diseases;
- Analyze the impact of the pandemic period on vaccination coverage in Brazil and in the State of São Paulo;

METHODOLOGY

This is an ecological analytical study. The research was carried out using data on the number of confirmed cases of Measles and the vaccination coverage rate in the State of São Paulo and in Brazil, from 1994 to the present day, and on the number of confirmed cases of COVID-19 in the period from July from 2020 to January 2022 and vaccination coverage rate from January 2021 to July 2022, also in the State of São Paulo and in Brazil, comparing information obtained. Such data were analyzed and subsequently translated into tables using Microsoft Office Word 2019 and Microsoft Office Excel 2019 programs.

Data were extracted from the National Immunization Program Assessment Information System (SIAPI) and the Notifiable Diseases Information System (SINAN), accessed on the website of the Department of Informatics of the Unified Health System (DATASUS), referring to periods mentioned above or according to the availability of data and publications on the subject. Thus, the information collected is in the public domain, with unrestricted access, to which there is no identification of the individuals participating in the investigation, with no need for appreciation by the Ethics and Research Committee. Quantitative data were analyzed descriptively, considering official information and discussed in view of the current scenario of the pandemic and the risks of impacts on the population pointed out in the literature.

RESULTS

From 1994 to 1997, there was a sharp increase in confirmed cases of measles in Brazil, increasing from 53 to 8,523 confirmations. However, in the following year, 1998, no new measles cases were observed in Brazil (Table 1). In these same periods of time, it can be inferred that vaccination coverage was below the target recommended by the SUS and

the National Immunization Program (PNI), corroborating the increase in cases (Table 2). In 1994 there was a vaccination coverage of 71.37%, followed by 86.86% in 1995 and 80.40% in 1997, that is, below 95% coverage.

| Year | Number of confirmed measles cases in Brazil | Number of confirmed cases of COVID-19 in Brazil |
|-------------|---|---|
| 1994 | 53 | - |
| 1995 | 21 | - |
| 1996 | 55 | - |
| 1997 | 8.523 | - |
| 1998 | 0 | - |
| 1999 | ND | - |
| 2000 | 33 | - |
| 2001-2005 | 57 | - |
| 2007-2009 | 0 | - |
| 2010-2012 | 114 | - |
| 2013-2015 | 1.310 | - |
| 2016 | 0 | - |
| 2017 | 0 | - |
| 2018 | 9.325 | - |
| 2019 | 20.901 | - |
| 2020 | 8.448 | 53.264 |
| 2021 | 672 | 56.988 |
| August 2022 | 19 | 123.196 |

Table 1. Number of measles and COVID-19 cases in Brazil

ND: data not available;

The years 2000 to 2012 were a period in which numbers referring to measles cases remained at lower levels, from 53 to 114 new cases, showing minimal variation, resulting from good vaccination coverage in the country, which maintained its goal 95% coverage of the total population.

However, from 2013 to 2015, the number of measles cases in Brazil increased again, with a record of 1,310 cases. When analyzing the numbers referring to vaccination coverage in those years, in fact, there was a drop in the percentages for those years, below the stipulated target for disease control.

Furthermore, it was from 2018 onwards

that confirmed cases of measles in Brazil began to increase significantly once again, totaling 9,328 cases and 20,901 in 2019. In 2018, vaccination coverage remained below the recommended targets, being 92.61 % referring to the first dose of triple viral vaccine, 76.89% referring to the second dose of triple viral vaccine and a tiny 33.26% referring to tetra viral vaccine.

In 2019, there was a slight increase in coverage rates, with 93.12% referring to the first dose of MMR, 81.55% referring to the second dose of MMR and 34.24% referring to tetravirus. However, despite this slight increase, it was not possible to contain the increase in contamination of individuals with the measles virus in Brazil.

Between 2019 and 2020, due to the emergence of the COVID-19 pandemic, it was possible to observe, based on the data collected, that vaccine coverage in general for diseases decreased drastically, causing the country to register in 2019 a coverage of 73, 44% and in 2020 67.27%. Based on the information obtained, 2021 was the worst year for general vaccination coverage in Brazil, with only 59.85%.

Thus, based on the information obtained in tables 1 and 2, there are three moments in which measles cases were significant in the country, namely in 1997, between 2013 and 2015 and from 2018 to 2020, in which the country obtained Insufficient vaccination coverage compared to the stipulated targets.

Regarding the exclusive data on COVID-19, there was a progressive increase in cases of the disease, even though vaccination for the disease had begun (Table 3). From the information collected, in general, the vaccination coverage over the semesters regarding the first dose, presents adherence percentages, somewhat high, although below the recommended target.

However, as the progression to the second

| Year | Vaccination coverage in Brazil (%) | Measles Vaccination Coverage in Brazil (%) | Triple Viral D1 Vaccination Coverage in Brazil (%) | Triple Viral D2 Vaccination Coverage in Brazil (%) | Tetra Viral Vaccination Coverage in Brazil (%) |
|----------|------------------------------------|--|--|--|--|
| 1994 | 38,27 | 71,37 | ND | ND | NI |
| 1995 | 45,71 | 86,86 | ND | ND | NI |
| 1996 | 50,01 | 80,40 | ND | ND | NI |
| 1997 | 68,95 | 108,61 | ND | ND | NI |
| 1998 | 70,65 | 95,26 | ND | ND | NI |
| 1999 | 86,57 | 99,31 | ND | ND | NI |
| Year | Vaccination coverage in Brazil (%) | Measles Vaccination Coverage in Brazil (%) | Triple Viral D1 Vaccination Coverage in Brazil (%) | Triple Viral D2 Vaccination Coverage in Brazil (%) | Tetra Viral Vaccination Coverage in Brazil (%) |
| 2000 | 76,50 | 105,35 | 77,50 | ND | NI |
| 2001 | 79,85 | 103,84 | 88,43 | ND | NI |
| 2002 | 76,09 | 96,02 | 96,92 | ND | NI |
| 2003 | 72,97 | 4,06 | 112,95 | ND | NI |
| 2004 | 82,79 | VS | 110,93 | ND | NI |
| 2005 | 77,04 | VS | 106,55 | ND | NI |
| 2006 | 76,12 | VS | 105,35 | ND | NI |
| 2007 | 76,94 | VS | 106,80 | ND | NI |
| 2008 | 74,32 | VS | 99,81 | ND | NI |
| 2009 | 76,52 | VS | 103,74 | ND | NI |
| 2010 | 74,66 | VS | 99,93 | ND | NI |
| 2011 | 85,31 | VS | 102,39 | ND | NI |
| 2012 | 77,32 | VS | 99,50 | ND | NI |
| 2013 | 73,29 | VS | 107,46 | 68,87 | 34,19 |
| 2014 | 86,31 | VS | 112,80 | 92,88 | 90,19 |
| 2015 | 95,07 | VS | 96,07 | 79,94 | 77,37 |
| 2016 | 50,44 | VS | 95,41 | 76,71 | 79,04 |
| 2017 | 72,93 | VS | 86,24 | 72,94 | 35,44 |
| 2018 | 77,13 | VS | 92,61 | 76,89 | 33,26 |
| 2019 | 73,44 | VS | 93,12 | 81,55 | 34,24 |
| 2020 | 67,27 | VS | 79,71 | 62,91 | 20,72 |
| 2021 | 59,85 | VS | 73,49 | 51,66 | 5,74 |
| 08/ 2022 | 41,16 | VS | 48,24 | 31,10 | 4,44 |

Table 2. Measles, triple viral and tetra viral vaccine coverage in Brazil

ND: data not available; NI: vaccine not implemented on schedule; VS: vaccine replaced on calendar.

and third doses occurred, a significant drop can be seen, especially in relation to the period of July 2021, from 85.80% of vaccination coverage of the second dose or single dose to only 13.80 % referring to the third dose.

Regarding vaccine refusal, no data were found in the selected articles regarding the rates of people who refused to be vaccinated in the country. It is known that vaccine refusal helps to increase the number of cases of diseases.

| Year | Vaccine coverage of CO-VID-19 D1(%) | Vaccination coverage of COVID-19 D2 or Single Dose(%) | Vaccine Coverage for COVID-19 D3(%) |
|--------------|-------------------------------------|---|-------------------------------------|
| July 2020 | - | - | - |
| January 2021 | 89,00 | 74,10 | - |
| July 2021 | 92,00 | 85,80 | 8,70 |
| January 2022 | 79,00 | 80,00 | 13,80 |
| July 2022 | 80,10 | 68,00 | 43,60 |

Table 3. Vaccination coverage of COVID-19 in Brazil

DISCUSSION

Measles is an acute infectious disease, caused by an RNA virus, with high transmissibility, that is, a single infected person is capable of transmitting the virus to 12 to 18 other people. Nowadays, it has as a prophylaxis of greater safety and effectiveness, a specific vaccine for this virus. (MACHADO et al., 2020)

In Brazil, since 1968, measles has become a notifiable disease due to its high morbidity and mortality. (NÓVOA et al., 2020;) Its vaccine was introduced for the first time in the 1960s, as the number of cases was alarming at that time. (PLOTKIN, 2005) Thus, measles represented a major public health challenge, precisely because of such endemic behavior, causing annual and uncontrolled outbreaks in the country. (BARQUET; DOMINGO, 1997)

In 1973, the National Immunization Program (PNI) was implemented in the

country, with the objective of organizing, implementing and evaluating immunization actions throughout the country. (DOMINGUES; TEIXEIRA, 2013) In 1986, Brazil registered 129,942 cases of measles, of which 6,864 were in the State of São Paulo alone, configuring one of the biggest epidemics at the time, which encouraged campaigns for vaccination and combating the elimination of measles, reaching a result of 96% of vaccination coverage and a reduction in the number of notified cases to 7,934 in the country and 39 in the State of São Paulo.

Even with the strategies implemented by the government to strengthen the fight against measles, it was in the period from 1994 to 1997 that the number of confirmed cases of this disease was again alarming in the country, with an increase from 53 to 8,523 confirmations. In addition, vaccination coverage in the same period was below the target of 95%, recommended by SUS (Unified Health System) and the National Immunization Program, recording a total of 71.37% in 1994, followed by 86.86% in 1995 and 1980, 40% in 1997.

The best explanation for the exponential growth in the number of confirmed measles cases and the consequent drop in vaccination coverage observed during this period can be attributed to the anti-vaccination movement. This movement is not recent, considering the Vaccine Revolt, in 1904, in Rio de Janeiro, at a historical moment when society still lacked information about the benefits of vaccines. (LEVI, 2013) This movement lost strength over the years as knowledge and confidence in this prevention strategy gained strength, through scientific and epidemiological evidence. (LAGO, 2018)

However, it was in 1998 that the magazine “*The Lancet*” published a note stating that the vaccine against measles, mumps and rubella were related to the development of autism

and intestinal inflammatory disease. (LAGO, 2018) This publication was the trigger for the resurgence of the anti-vaccination movement at the time, corroborating the resurgence of measles in Brazil. (SUCCI, 2018) Given this context, it was necessary for the country to mobilize, through new vaccination campaigns, with the aim of interrupting the spread of the measles virus and increasing vaccination coverage rates. In 1995, the Indiscriminate Monitoring Campaign was instituted, which encouraged the vaccination of the population. (BARBIERI et al., 2013) The results of this initiative were only observed later, in which in the years 2000 to 2012, the numbers referring to new measles cases remained low, from 53 to 114 new cases, showing minimal variation, resulting from good vaccination coverage in the country, which maintained its target of 95% coverage of the total population.

However, from 2013 to 2015, there was again an increase in the number of measles cases in Brazil, with a record of 1,310 cases. And, when analyzing the numbers referring to vaccination coverage in those years, in fact, there was a drop in percentages, below the stipulated target for disease control.

Again, the anti-vaccine movement resurfaced with more force, and in the new context, which included social, personal, religious and even cultural factors potentiated in social media, often accompanied by Fake News, that is, the spread of false information about its purpose and efficacy, associated with fear of side effects. (SUCCI, 2018) The world health organization pointed out a model that includes “3 Cs” for the characterization of this behavior. (SATO, 2018).

The first C would be confidence in the credibility of the vaccine, its effectiveness, its safety and the health system that makes it available. Complacency refers to the second C, encompassing the low perception of the risks of preventable diseases, disregarding the

vaccine as necessary. Finally, the third C of convenience of availability and accessibility of vaccines and health services. (SATO, 2018) Thus, raising vaccination coverage rates is one of the greatest challenges for Public Health in the fight against vaccine-preventable diseases.

Despite this, it was necessary for the country to mobilize once again with strategies for appropriate control, elimination and eradication, including new vaccination campaigns, expansion of routine vaccination services, epidemiological and laboratory surveillance, in order to achieve the stipulated goal. (ZORZETTO, 2018) The actions had such an effect that in 2016 there was such a significant reduction in the number of measles cases, which culminated in the elimination of the virus circulation. This fact resulted in the certificate of eradication of the measles disease in Brazil, granted by the world health organization.

Despite all efforts dedicated to eradicating measles, in the years that followed, the country once again recorded a significant increase in the number of confirmed cases, with 9,328 cases in 2018 and 20,901 in 2019. Vaccination coverage remained below targets 95% and recorded a total of 92.61% of the first dose of MMR, 76.89% of the second dose of MMR and a tiny 33.26% referring to the tetraviral vaccine.

During these years, a migratory wave of Venezuelans may have contributed to the increase in the number of cases, since, due to the lack of a strong immunization program in their country of origin, they were not immunized, resulting in the recirculation of the virus and, consequently, helped spread the virus to the unvaccinated. (LAGO, 2018; QUEIROZ et al., 2013) In addition, anti-vaccination movements and vaccine hesitation were and have been the co-authors of the increase in outbreaks, as they encourage non-vaccination, negatively impacting vaccine

coverage.

In 2020 there was a significant decline in the number of measles cases, a fact that coincided with the COVID-19 pandemic, caused by the virus known as SARS-COV 2, which required social isolation measures and mandatory use of PPE, precisely because of its extremely fast transmission capacity. All the measures adopted as a way to contain the SARS-COV 2 virus, collaborated to reduce the transmission of the measles virus itself. (PROCIANOY, 2022)

However, the pandemic generated a negative impact that was evident in the progression of periodic vaccination campaigns, causing the country to register coverage of 73.44% in 2019, 67.27% in 2020, and 2021 as the worst year of general vaccination coverage, with a record of only 59.85%. Linked to this, its influence in the field of care and health affected the detection, notification, investigation and diagnosis of cases, impairing the quality of measles surveillance, as well as other preventable diseases.

With regard to the exclusive data on COVID-19, there is a progressive increase in cases of the disease, even with the start of vaccination. (OLIVEIRA, 2021) This fact can be explained by the easing of social isolation, associated with the introduction of vaccination, mainly from January 2021. (CASTRO, 2021) In general, vaccination coverage in Brazil, over the semesters related to the first dose, have somewhat high adherence percentages, although below the recommended target.

However, as the progression to the second and third doses occurred, a significant drop can be seen, especially in relation to the period of July 2021, from 85.80% of vaccination coverage of the second dose or single dose to only 13, 80% referring to the third dose.

Unfortunately, this scenario is a consequence, once again, of the anti-

vaccination movement that has resurfaced and has had negative impacts on the control of yet another disease. (OLIVEIRA, 2021) As much as the advent of vaccination reflects a scientific advance of the 20th century, the term vaccine hesitancy remains a highlight. Thus, the study of the reasons and the degree of this term are essential for planning strategies to be incorporated by the health system, with the purpose of circumventing the challenges of Public Health in the fight against vaccine-preventable diseases.

CONCLUSION

The data researched and the publications raised bring to the discussion the impacting factors on vaccine adherence, confronting the dynamics of vaccine coverage, the concomitant records of the incidence of vaccine-preventable diseases and the influence of the pandemic period on vaccine coverage in Brazil and in the State of São Paulo.

Based on the analysis of the number of confirmed measles cases during the period from 1994 to August 2022, it can be seen that the periods in which there was the highest number of measles cases in Brazil occurred in the years 1997, between 2013 and 2015 and between the year 2018 to 2020. In addition, it was during these same periods that data regarding vaccination coverage were below the stipulated target of 95%.

With this, it is possible to conclude that there is a clear association between the rise of anti-vaccine movements and vaccine hesitancy with the fall in vaccine coverage and the consequent resurgence of vaccine-preventable diseases, which were previously controlled. Furthermore, it can be said that the period of the COVID-19 pandemic was also a factor that contributed to the drop in vaccination coverage.

Thus, it is extremely important to establish public health strategies to circumvent the

challenges faced in the fight against vaccine-preventable diseases, either by encouraging the vaccine campaign or by studying the anti-

vaccination movements themselves, with the aim of establishing a health plan that is not so negatively affected.

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