Original Article

# Analysis of hospital admissions for measles in Brazil and correlation with vaccination coverage

## Análise das internações hospitalares por sarampo no Brasil e correlação com cobertura vacinal

## Análisis de las internaciones hospitalarias por sarampión en Brasil y la correlación con la cobertura de vacunación

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## Abstract

**Objective:** The objective was to analyze hospital admissions for measles in regions of Brazil and its correlation with vaccination coverage.

**Methods:** This is an epidemiological study with a quantitative approach. The data analyzed comprised people vaccinated and admitted to hospital for measles throughout Brazil from January 2011 to December 2020.

**Results:** Graphs were made, and descriptive and exploratory statistical analysis was used. Between 2011 and 2020, there was a total of 2,724 hospital admissions for measles in Brazil, with a rate of 1.32 per 1,000,000 inhabitants.

**Conclusion:** The year 2018 presented the greatest variation between vaccination coverage and the number of hospital admissions for measles since 2011.

## Resumo

**Objetivo:** Analisar as internações hospitalares por sarampo em regiões do Brasil e sua correlação com a cobertura vacinal.

**Métodos:** Trata-se de estudo epidemiológico com abordagem quantitativa. Os dados analisados abrangeram pessoas vacinadas e internadas por sarampo em todo o Brasil no período de janeiro de 2011 a dezembro de 2020.

**Resultados:** Foram confeccionados gráficos e utilizada análise estatística descritiva e exploratória. Entre 2011 e 2020, houve um total de 2.724 internações hospitalares por sarampo no Brasil, com taxa de 1,32 por 1.000.000 de habitantes.

**Conclusão:** O ano de 2018 apresentou a maior variação entre a cobertura vacinal e o número de internações por sarampo desde 2011.

## Resumen

**Objetivo:** Analizar las internaciones hospitalarias por sarampión en regiones de Brasil y su correlación con la cobertura de vacunación.

**Métodos:** Se trata de un estudio epidemiológico con enfoque cuantitativo. Los datos analizados incluyen personas vacunadas e internadas por sarampión en todo Brasil durante el período de enero de 2011 a diciembre de 2020.

**Resultados:** Se elaboraron gráficos y se utilizó el análisis estadístico descriptivo y exploratorio. Entre 2011 y 2020, hubo un total de 2.724 internaciones hospitalarias por sarampión en Brasil, con una tasa de 1,32 por 1.000.000 de habitantes.

**Conclusión:** El año 2018 presentó una mayor variación entre la cobertura de vacunación y el número de internaciones por sarampión desde 2011.

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**Conflicts to interest:** none to declare.

## Introduction

Measles is an acute, highly contagious and potentially fatal exanthematous febrile disease caused by the RNA virus (paramyxovirus) easily transmitted by air through nasopharyngeal secretions expelled in speech, cough, sneezing or breathing. The virus can be transmitted four to six days before or four days after the onset of the rash. The disease is characterized by high fever, cough, runny nose, conjunctivitis and morbilliform skin rash, representing an important cause of hospital admission, morbidity and infant mortality.[1-3]

The measles vaccine has been available since 1963, when measles was a common disease among children and caused about 2.6 million deaths per year. However, even after the availability of the vaccine in 1963 until 1991, Brazil faced nine epidemics, each in a 2-year interval. In 1994, at the 24th Pan-American Health Conference, the health ministers of each of the American countries approved Resolution CSP24.R16, which set the goal of eliminating measles in the Americas by the year 2000.[3-5]

Measles prophylaxis occurs by vaccination, which is indicated at 12 months and 15 months of life, combined with mumps and rubella vaccines (MMR - measles, mumps, rubella). This vaccine can also be administered at times when follow-up campaigns for measles vaccination occur. Only those with a record of two doses applied after 12 months of age are considered adequately treated.[6-8]

It is estimated that, from 2000 to 2017, measles vaccination prevented approximately 21.1 million deaths worldwide. Currently, measles accounts for about 44% of the 1.7 million preventable deaths from vaccines among children annually. The number of deaths from the disease fell 80% from 545,000 in 2000 to 110,000 in 2017.[5]

In 2016, Brazil received the certificate of elimination of measles virus circulation by the World Health Organization (WHO), declaring the Americas a measles-free region. Despite the wide vaccination coverage, outbreaks of the disease have been observed when there are 3% to 7% of susceptible individuals in the population, i.e., unvaccinated individuals. In January 2018, cases imported from Venezuela triggered major outbreaks in Roraima and Amazonas, Brazil, where vaccination coverage was below the 95% needed. In relation to age group, in both states, the highest incidence rate of the disease is concentrated among children from six months to four years old. In 2019, Brazil lost its certification due to registration of cases for more than 12 months in the national territory.[9-12]

The number of measles cases reported in the world grew by about 300% in the first three months of 2019, when compared to the same months in 2018, and the WHO identified 112,163 measles cases reported from 170 countries. Although the vast majority of cases occur in countries with fragile health systems, vaccine refusal has emerged as a risk factor and one of the top 10 health threats in 2019.[13,14]

The increase in the number of measles cases has drawn the attention of all health systems around the world, mainly because it is a disease in the process of being eradicated and has been immunized since 1963. Since it is a recent event, few studies are justifying the increase in the number of measles cases in the world. The topic is important because it is a disease with great potential for epidemic outbreaks, with vaccination being the most effective method to combat measles. In this context, this study aimed to analyze hospital admissions for measles in regions of Brazil and its correlation with vaccination coverage.

## Methods

This is an epidemiological, descriptive and quantitative study. The data analyzed in the study comprised people vaccinated or admitted to hospital for measles throughout Brazil, being separated by geographic regions (North, Northeast, Southeast, South and Midwest). The free and online Brazilian Health System (SUS) Department of Informatics (DATASUS) database was used as a source for collecting population data, hospital admission, and vaccination coverage against measles. DATASUS is an agency of the Department of Strategic and Participatory Management of the Ministry of Health, with the responsibility of collecting, processing and disseminating health information.[14] The

SUS Hospital Information System (SIH-SUS) provided data on hospital admissions for measles (ICD 10-B05), and the Brazilian National Immunization Program (SI-PNI), on MMR and measles, mumps and rubella and varicella (MMRV) vaccine coverage.

Data collection in DATASUS took place from October to November 2021, and the period collected for the research was from January 2011 to December 2020. The variables used in the studies were sex and race of people reported by measles, year, region, vaccination coverage and measles morbidity. Population data on hospital morbidity served as the basis for calculating the general morbidity rate (GMR) due to measles per 1,000,000 inhabitants - hospital admission rate (GMR/1,000,000 inhabit). The choice of using the GMR for one million inhabitants was made as a comparison with other international studies in the area, described in the study, which use the same methodology.

The collected data were transported to Excel® and reviewed and pre-codified, and tables were constructed. Graphs of temporal trend for Brazil and regions, to explain the evolution of the indicators over the studied period, were made using the Graphpad Prism® software. Statistical tests were defined according to data distribution, so the D-Agostino-Pearson or Shapiro-Wilk test verified the distribution. The comparison of results with two parameters was performed using t-test, and the other results were compared using one-way ANOVA followed by Tukey or Kruskal-Wallis post-test followed by Dunn's post-test. Moreover, the Pearson correlation coefficient was calculated, which typifies the association between two quantitative variables, and varies between values -1 and 1. Value 0 (zero) means that there is no linear relation; value 1 indicates a perfect linear relation; and value -1 also indicates a perfect but inverse linear relationship. This value was inserted in the graph on the comparison between measles hospital admission and vaccination coverage. The results were considered significant when p-value was $< 0.05$.

The study data are of secondary origin, and were analyzed in an aggregate manner, without identifying individuals. As they are open access and free of charge, it is not necessary to authorize their use.

## Results

Between 2011 and 2020, there was a total of 2,724 hospital admissions for measles in Brazil, of which 1,433 (52.6%) were male and 1,291 (47.4%) were female. The highest incidence was among brown people, followed by white, black, yellow, indigenous and ignored, with 1,376 (50.5%), 497 (18.3%), 38 (1.4%), 27 (1%), 9 (0.3%) and 776 (28.5%) hospital admissions, respectively. In relation to age group, children under one year had the highest incidence of hospital admission for measles, with 1,015 reported cases (37.2%) from 2011 to 2020, and the North region was responsible for reporting 431 of such cases (42.4%). Adults aged 25 to 29 years had the highest number of reported hospital admissions for measles between 30 and 80 years or older, with 145 hospital admissions reported (5.3%) during the years of research. Table 1 shows the number of hospital admissions for measles and the measles hospital admission rate of 1.32 per 1 million inhabitants in Brazil in the period and year, respectively.

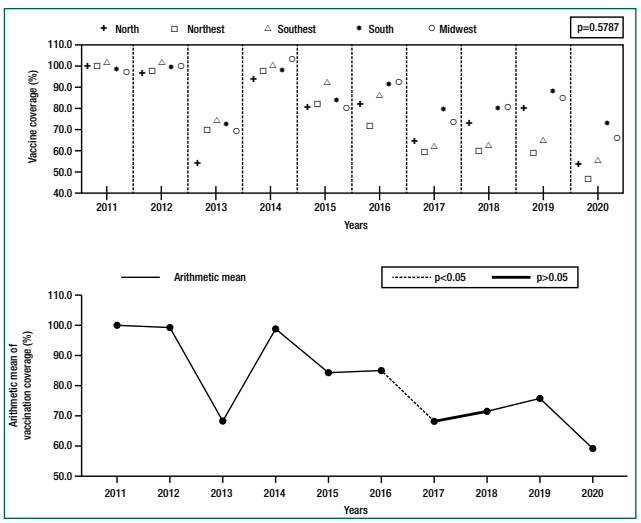
In 2018, there was a total of 891 (32.7%) hospital admissions for measles in Brazil, 829 more cases compared to 2017 (2.3%), and the highest number of hospital admissions since 2011, through the highest rate of hospital admission for measles (4.25) compared to previous and subsequent years (Table 1). Northern Brazil had the highest number of hospital admissions for measles (92%) in 2018, in addition to being the region with the highest number of patients admitted to hospital for the disease (30.1%), from 2011 to 2020. In the time series, shown in figure 1, 2018 had a mean of 71.4% of vaccination coverage rates in Brazil, which, when compared to 2017 (68%), did not show a significant increase ($p > 0.05$). However, when comparing 2016 (85%) and 2017, it was observed a significant decrease in the vaccine coverage percentage in the country ($p < 0.05$).

The regions that had the lowest vaccination coverage rates in 2017 were the North (64.8%), Northeast (59%) and Southeast (62%). In 2018, Northeast (60%) and Southeast (62.9%) remained the regions with the lowest vaccination coverage rates, even though rates had increased since the previous year (Figure 1). The analysis between

**Table 1.** Number of hospital admissions for measles according to regions of Brazil and hospital admission rate for measles per year

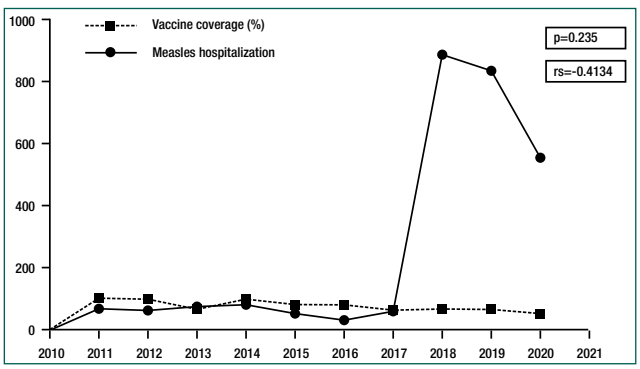
| Year | Region | | | | | Brazil | Hospital admission rate per 1 million inhabitants (Year) |
|---|---|---|---|---|---|---|---|
| | North (N %) | Northeast | Southeast | South | Midwest | | |
| 2011 | 4 (0.3%) | 11 (2.5%) | 8 (0.9%) | 42 (30.2%) | 5 (11.4%) | 70 (2.6%) | 0.35 |
| 2012 | 2 (0.2%) | 23 (5.2%) | 19 (2.2%) | 16 (11.5%) | 3 (6.8%) | 63 (2.3%) | 0.31 |
| 2013 | 3 (0.2%) | 55 (12.5%) | 5 (0.6%) | 6 (4.3%) | 7 (15.9%) | 76 (2.8%) | 0.37 |
| 2014 | 3 (0.2%) | 73 (16.5%) | 4 (0.5%) | 2 (1.4%) | 1 (2.3%) | 83 (3%) | 0.40 |
| 2015 | 1 (0.1%) | 44 (10%) | 5 (0.6%) | 4 (2.9%) | 1 (2.3%) | 55 (2%) | 0.26 |
| 2016 | 4 (0.3%) | 25 (5.7%) | 2 (0.2%) | 2 (1.4%) | - | 33 (1.2%) | 0.16 |
| 2017 | - | 56 (12.7%) | 2 (0.2%) | 4 (2.9%) | 1 (2.3%) | 63 (2.3%) | 0.30 |
| 2018 | 820 (67%) | 26 (5.9%) | 30 (3.4%) | 14 (10.1%) | 1 (2.3%) | 891 (32.7%) | 4.25 |
| 2019 | 29 (2.4%) | 97 (22%) | 662 (75.6%) | 25 (18%) | 20 (45.5%) | 833 (30.6%) | 3.95 |
| 2020 | 359 (29.3%) | 30 (6.8%) | 139 (15.9%) | 24 (17.3%) | 5 (11.4%) | 557 (20.4%) | 2.62 |
| Total | 1225 | 440 | 876 | 139 | 44 | 2724 | (Mean: 1.32) |

Source: Data taken from DATASUS through the Hospital Information System (HIS) on hospital admissions for measles in regions of Brazil from 2011 to 2020. Brasília (DF): DATASUS; [citado 2021 Nov 11]. Disponível em: <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/niuf.def>




Source: Data taken from DATASUS through the Brazilian National Immunization Program (PNI) on measles, mumps and rubella and measles, mumps and rubella and varicella vaccine coverage in regions of Brazil from 2011 to 2020. Brasília (DF): DATASUS; [citado 2021 Nov 11]. Disponível em: <http://tabnet.datasus.gov.br/cgi/webtabx.exe?bd_pni/cpnibr.def>
*ANOVA One-way comparison test (p > 0.0001) and Turkey posttest (#). One-way *ANOVA* comparison test (p=0 .5787).

**Figure 1.** D1 and D2 measles, mumps and rubella and measles, mumps and rubella and varicella vaccine coverage rate in regions of Brazil from 2011 to 2020 and arithmetic mean of D1 and D2 (%) of measles, mumps and rubella vaccine coverage




Source: Data taken from DATASUS through the Brazilian National Immunization Program (PNI) on D1 and D2 on measles, mumps and rubella and measles, mumps and rubella and varicella vaccine coverage and through reports from HIS on hospital admissions for measles in regions of Brazil from 2011 to 2020. Brasília (DF): DATASUS; [citado 2021 Nov 8]. Disponível em: <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sih/cnv/niuf.def>.
* Pearson correlation test (p= 0.235), Spearman's coefficient (rs= -0.4134).

**Figure 2.** Correlation between the number of measles hospital admissions and vaccination coverage (%) of D1 and D2 of measles, mumps and rubella and measles, mumps and rubella and varicella

the correlation of hospital admissions for measles and vaccination coverage between 2011 and 2020 by Pearson's correlation obtained p-value=0.235, and although not significant, showed that there is a negative and inversely proportional relationship (-0.4134), i.e., when vaccination coverage decreased, the number of hospital admissions increased and vice-versa (Figure 2). Since 2016, there has been a significant decrease in vaccination coverage (83.7%) for 2017 (64.8%), with an increase of 30 hospital admissions for measles per year. Thus, 2018 presented the greatest variation between vaccination coverage and the number of hospital admissions for measles since 2011.

## Discussion

In Brazil, in the last ten years, there have been 2,724 hospital admissions for measles, with 891 cases only in 2018. Globally, in the same year, there were 259,165 cases, corresponding to 29% of measles reports in 2013 and 2018, with the highest

global incidence since 2013 (46/1 million inhabitants). The five countries with the highest number of cases were Ukraine (53 218), Pakistan (32 921), Madagascar (23,558), India (22,068) and the Philippines (20,764). The European region reported 82,596 cases, with an incidence of 89.5/1 million inhabitants, the highest incidence since 2009. The Americas reported a total of 16,514 confirmed cases of measles, with a higher incidence of cases in Brazil (10,262), Venezuela (5,643) and the United States (349).[15-17]

In Brazil, a considerable increase in the number of hospital admissions for measles refers to extreme concern, since the Ministry of Health reported that in July 2015 the state of Ceará had the last case of measles in Brazil. Soon thereafter, in 2016, Brazil received a certificate from WHO to eliminate measles virus circulation in the country. The PNI provides for that all Brazilian municipalities must meet the goal of 95% vaccination coverage for measles. However, this is not the reality presented in most Brazilian regions, since the vaccination coverage of the states that presented epidemiological measles outbreaks in 2018 was lower than recommended.[11-19]

The measles epidemic that occurred in Brazil in 2018 was due to the presence of individuals susceptible to the disease, either by non-vaccination or by incomplete vaccination schedule. Measles vaccination coverage in Brazil has fallen significantly since 2017 (64.8%), as shown in the results of this study, especially in the North (64.8%), Northeast (60%) and Southeast (62.9%).[20]

At the national level, the 95% coverage goal was not reached for both doses of measles vaccines in 2017. And at the regional level, the North had the lowest coverage homogeneity estimates for the first dose of measles-containing vaccines in Brazil, due to considerable reductions in coverage since 2007. The year 2018 showed an increase in vaccination coverage rates (67.8%) compared to 2017 (64%), however not significant (p >0.0001), not reaching the vaccine coverage goals established by WHO.[21,22]

The years 2020 and 2021 had the lowest vaccination coverage rates recorded in the North region at 68.8% and 68%, a case that has been repeating since 2015, with one of the highest casualties in the country. The year 2018 had its first measles outbreak in the North region, with 9,237 confirmed cases.[22]

The most recent studies, although still few, bring the importance, in Brazil, of monitoring measles vaccine coverage homogeneity at national, regional and state levels, as it allows identifying areas with higher risk of spread of measles, which must have their populations vaccinated.[23-25]

Although the 2018 measles outbreak was linked to cases imported from Venezuela, Lebanon and Europe, as the viral genotype identified is the same as those in these countries, the regions that border Venezuela and had contact with Venezuelan immigrants, North and Northeast had lower vaccination coverage than recommended by the Ministry of Health, favoring the spread of the virus.[25,26]

Nevertheless, from February 6 to November 3, 2018, 8,070 cases were reported as suspected in Manaus, Northern Brazil, as 5,917 were under investigation, 1,613 were confirmed and 468 were dismissed, all of them confirmed cases in Brazilian individuals. Thus, the fact that Venezuelan immigrants entered the north of the country and are carriers of the viral genotype does not become the main factor in the increase in the number of cases in the region and subsequently in the country.[27]

Globally, the causes of resurgence of measles during 2018 are multifactorial, as they vary by country. However, countries with fragile immunization systems were responsible for most cases of measles reported during this period. Nevertheless, the international travel of infected people, including foreign visitors and immunized residents facilitated the international spread of measles. Measles vaccination coverage rates have been decreasing in Brazil since 2017, and even though there was an increase curve in 2019 (70%), in 2020 it decreased again (55.25%). Thus, there are few studies that present factors related to vaccination coverage reduction, since the only method of preventing measles is through vaccination, and its reduction promotes epidemiological outbreaks of the disease.[28]

More recent studies have discussed how vaccine hesitation, anti-vaccine movements and fake news actively contribute to vaccine coverage reduction

in Brazil, mainly by increased incorrect health information shared especially on the internet. False information dissemination about vaccines on social networks, as related to serious adverse events, influences many people not to vaccinate their children and not to vaccinate themselves, increasing the number of susceptible cases, facilitating the resurgence of diseases that have already been eliminated. This phenomenon is not a new concern for researchers from European and North American countries, but in Brazil it has become increasingly evident.[29-31]

This study has limitations when discussing the numbers of confirmed cases in Brazil from 2011 to 2020, because DATASUS, used as a source for data collection for the study, did not have updated epidemiological information, presenting only the numbers of measles cases in Brazil until 2014. Thus, it was necessary to use SIH-SUS to collect data, limiting statistical results and discussion compared to other international and national studies on the subject.

## Conclusion

The analysis of this study showed that from 2018 onwards there was a significant increase in hospital admissions due to measles in Brazil, with the North region being the most prominent. Measles vaccination coverage, from 2016 to 2018, showed evident falls, with the North, Northeast and Southeast regions having the lowest vaccine coverage rates in the country. Hospital admission for measles and vaccination coverage had a negative, inversely proportional correlation. Increased measles case incident may be related to decrease in vaccination coverage rates; therefore, decrease in vaccination coverage rates needs to be deepened. As a culturally and socially diverse country, Brazil needs to have epidemiological monitoring in the state, regional and national levels, especially when it comes to diseases such as measles, which have a rapid spread. In addition to measles vaccination campaigns increasing at a national level through not only the vaccination itself, but through health education related to the disease, its risk factors, the high mortality rate and the importance of vaccination for prevention, avoiding dissemination of misinformation health information: the fake news. National movements such as these can provide increased measles vaccination coverage in Brazil and control of new outbreaks and possible epidemics of the disease.

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## Collaborations

Silva MEP, Furlan MCR, Uliana CH, Santos Júnior AG and Barreto MS contributed to study design, data analysis and interpretation, article writing, relevant critical review of intellectual content and approval of the final version to be published.

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