Archives of Current Research International

Volume 25, Issue 10, Page 128-136, 2025; Article no.ACRI.145896
ISSN: 2454-7077

Profile of Patients Diagnosed with Measles and Associated Vaccination Trends in Pará, Brazil (2016–2021)

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Authors' contributions

This work was carried out in collaboration among all authors. Author LMGS, as team leader, actively conducted database searches and analyses, and contributed to writing and revisions. Author LBP also participated in database searches and analyses, as well as in writing and revising the manuscript. Author ACMO was responsible for database construction, statistical analysis, and writing the results and discussion sections. Author CMP contributed to writing, formatting, table construction, and ensuring compliance with journal guidelines. Author AAP was involved in database construction, statistical analysis, and drafting the results and discussion. Author APSC assisted in data interpretation, writing of the results, and final considerations. Authors ALQA and FLJ participated in conducting the study and preparing the manuscript. Author SCRS, as co-supervisor, contributed to the development of the research topic and objectives, guided the methodology, and provided critical revisions to the manuscript. Author IMNM, as principal supervisor, was involved in the development of the research topic and objectives, guided the methodology, reviewed the manuscript thoroughly, and oversaw the overall writing and preparation process. All authors read and approved the final manuscript.

Article Information

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Cite as: *Laís Miléo Gomes Sá, Letícia Barreiros Pires, Ana Clara Moura de Oliveira, Camila Miranda Pereira, Amanda Almeida Perez, Ananda Paula da Silva Cordeiro, Ana Luísa Queiroz da Azevedo, Felipe Lima Jacob, Silvana Cristina Rodrigues da Silva, and Ismaelino Mauro Nunes Magno. 2025. "Profile of Patients Diagnosed With Measles and Associated Vaccination Trends in Pará, Brazil (2016–2021)". Archives of Current Research International 25 (10):128–136. https://doi.org/10.9734/acri/2025/v25i101554.*

DOI: https://doi.org/10.9734/acri/2025/v25i101554

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/145896

Original Research Article

Received: 06/08/2025
Published: 11/10/2025

ABSTRACT

Aims: This study aimed to analyze the epidemiological profile of patients diagnosed with measles in the state of Pará, Brazil, from 2016 to 2021, focusing on vaccination coverage and temporal trends in disease incidence.
Study Design: Observational, descriptive, ecological, and temporal study based on secondary data.
Place and Duration of Study: The study was conducted in the state of Pará, located in the Brazilian Amazon region, using data from 2016 to 2021.
Methodology: Data were obtained from the Information System for Notifiable Diseases (SINAN) and the National Immunization Program Information System (SI-PNI), accessed through the DataSUS TabNet platform. Variables included year of notification, age group (0–14 years), disease classification, outcome, and vaccination status.
Results: A total of 1,879 measles cases were confirmed in Pará between 2016 and 2021, with the highest number in 2020 (1,572 cases). The Metropolitan I region recorded the largest share of cases, while deaths represented only 0.47% of outcomes. Vaccination coverage declined after 2019, coinciding with a rise in measles incidence.
Conclusion: The study highlights the association between reduced vaccination coverage and measles resurgence, emphasizing the need for sustained immunization efforts, public education, and continuous epidemiological surveillance to prevent the reemergence of vaccine-preventable diseases.

Keywords: Measles; vaccination; Pará; epidemiological profile; DataSUS.

1. INTRODUCTION

Measles is a febrile exanthematous disease, highly contagious, acute, and self-limiting. It has a viral etiology and primarily affects children between 6 months and 5 years of age. It is among the leading causes of morbidity and mortality in children under 5 years old and can be prevented through immunization with the MMR (measles, mumps, and rubella) and MMRV (measles, mumps, rubella, and varicella) vaccines (Lima et al., 2020).

In the global context, according to the World Health Organization (WHO), measles remains a disease that affects several countries, including some in Europe, such as Greece, the United Kingdom, and the Czech Republic. Since 2019, these countries have reported an increased number of measles cases and lost their previously achieved measles elimination status (Brasil 2017, 2018; Masresha et al., 2023).

In Brazil, in 1992, the government set goals to eradicate measles by the year 2000 through the National Measles Elimination Plan. This goal was achieved, and in 2016 the country received the certificate of elimination of measles virus circulation, making Brazil a measles-free country (Brasil, 2018 and 2019; Rodrigues et al., 2020).

However, in 2018, Brazil once again reported new measles cases. Initially, two states in the Northern region (Roraima and Amazonas) identified new infectious cases, which led Brazil to lose the eradication certificate granted by the Pan American Health Organization (PAHO) in 2016, after reporting more than 100,000 new cases (Carvalho et al., 2019; Xavier et al., 2019; Zonin et al., 2021).

Vaccination is a key pillar in the fight against and prevention of new measles cases. Thus, in 1992, strategies were implemented through the National Measles Elimination Plan, including ensuring vaccination coverage greater than 95% in children under one year of age. The official immunization schedule consists of the first dose of the MMR vaccine (measles, rubella, and mumps) administered at 12 months of age, followed by a booster with the MMRV vaccine (measles, rubella, mumps, and varicella) at 15 months (Brasil, 2019; Wandeley et al., 2021).

Studies indicate that the COVID-19 pandemic intensified inequality in access to healthcare across different Brazilian regions, further reducing access to healthcare centers and consequently lowering vaccination coverage, leaving municipalities and regions even more misaligned with the national panorama (Sato et al., 2023).

Considering that, until 2018, immunoprevention established by the Ministry of Health with MMR and MMRV vaccines at 12 and 15 months, respectively, had enabled Brazil to achieve PAHO certification for the elimination of measles virus circulation, the loss of this certification led to changes in strategy. Thus, in August 2019, the "Zero Dose" of the MMR vaccine was introduced, administered between 6 and 11 months of age, with the aim of increasing early vaccination coverage across different regions and helping reduce measles cases in the country (Brasil, 2022a; Brasil, 2022b).

Another existing measure is the administration of immunoglobulins, used when there are contraindications to vaccination in contacts within less than six days. Therefore, this study aimed to analyze the profile of patients diagnosed with measles in the state of Pará, in the age group of 0–14 years, during the period from 2016 to 2021.

2. METHODOLOGY

The study complied with the ethical principles established by the Brazilian National Health Council and was exempt from review by the Research Ethics Committee of Centro Universitário do Pará, as it was based on secondary, publicly available, and de-identified data, in accordance with Article 26, items III and V, of Resolution No. 674, dated May 6, 2022. This is an observational, descriptive, ecological, and temporal study based on data publicly available from DataSUS, referring to the 2018 measles epidemic. The study was conducted in the state of Pará, located entirely within the Amazon region (Costa et al., 2011; IBGE, 2014).

The variables selected for analysis included: year of notification (2016–2021), health region of residence (Pará), age group at diagnosis (0–14 years), final classification (measles), disease outcome, and confirmation criteria. In addition, vaccination data were analyzed, including the measles-mumps-rubella (MMR), measles-mumps-rubella-varicella (MMRV) vaccines, age group (0–14 years), year (2016–2021), and vaccination status (PA). Records of children diagnosed with measles in the state of Pará were included, while records with unknown disease outcomes were excluded.

Information was obtained through the Information System for Notifiable Diseases (SINAN) and the National Immunization Program Information System (SI-PNI), both accessed via the TabNet platform, a public data tabulation tool of DataSUS. The SINAN system records and monitors cases of diseases and conditions of compulsory notification throughout Brazil, allowing the tracking of epidemiological profiles and supporting surveillance and health planning actions. The SI-PNI, in turn, records and monitors immunization activities nationwide, compiling data on administered doses, vaccination coverage, and target populations, thereby enabling the evaluation of immunization strategies. DataSUS, the informatics department of the Brazilian Unified Health System (SUS), is responsible for making these health databases publicly available and providing technical and statistical support for epidemiological research and public health analyses.

The data used in this study were collected from notification forms and investigation records of diseases included in the national list of notifiable conditions, grouped by state and municipality. Database queries were performed between August 6, 2023, and January 9, 2024. After extraction, tables were converted to Excel 7.0 format for organization and analysis.

3. RESULTS AND DISCUSSION

Between 2016 and 2021, a total of 1,879 measles cases were confirmed in the state of Pará among individuals aged 0–14 years.

Regarding the data presented in Table 1, it can be observed that the highest number of

confirmed measles cases in the state of Pará during the analyzed period occurred in the Metropolitan I region (844), followed by the Marajó II (252) and Tocantins (229) regions. Conversely, the lowest number of confirmed cases was recorded in the Araguaia (2), Tapajós (3), and Xingu (13) regions.

With respect to the analyzed years, it is evident that 2020 registered a considerable increase in the total number of reported cases (1,572), whereas 2018 was the year with the fewest reported measles cases (48).

In all analyzed age groups (Table 2), the predominant outcome of the observed cases was recovery (1,754), followed by death due to the reported condition (9) and, lastly, death due to another cause (1), excluding the ignored cases (115). In other words, 93.3% of the total cases evolved to recovery. Therefore, death due to the reported condition accounted for less than 1% of cases (0.47%).

Table 1. Confirmed measles cases by year of notification and Health Region of Residence (CIR) in the state of Pará, 2016–2021

Health Region (CIR) of residence	2018	2019	2020	2021	Total
Araguaia	-	1	1	-	2
Lower Amazonas	36	27	3	2	68
Carajás	-	22	94	-	116
Lago de Tucuruí	-	-	36	-	36
Metropolitan I	9	125	706	4	844
Metropolitan II	-	5	17	2	24
Metropolitan III	-	8	104	4	116
River Caetés	-	-	89	1	90
Tapajós	3	-	-	-	3
Tocantins	-	5	222	2	229
Health Region (CIR) of residence	**2018**	**2019**	**2020**	**2021**	**Total**
Xingu	-	1	11	1	13
Marajó I	-	1	46	3	86
Marajó II	-	-	243	9	252
Total	48	195	1572	64	1879

Table 2. Distribution of measles cases by age group in the state of Pará, 2016–2021

Age Group	Ignored/Blank	Cure	Death due to the reported condition	Death due to another cause	Total
<1 Again	44	762	5	1	812
1-4 years	33	460	3	-	496
5-9 years	15	256	-	-	271
10-14 years old	23	276	1	-	300
Total	115	1754	9	1	1879

Table 3. Total doses of MMR and MMRV vaccines administered between 2016 and 2021 in the state of Pará compared with the number of reported cases

Year	MMR (Measles, Mumps, Rubella)	MMRV (Measles, Mumps, Rubella, Varicella)	Total (Doses Administered)	Total Number of Cases
2016	132188	84062	216250	0
2017	131891	87402	219293	0
2018	241345	81808	323153	48
2019	217541	102820	320361	195
2020	171129	75006	246135	1572
2021	174648	3864	178512	64
Total	1068742	434962	1503704	1879

Table 4. MMR vaccine doses administered to age groups between 0 and 14 years, from 2016 to 2021, in the state of Pará

Age Group	2016	2017	2018	2019	2020	2021	Total
< 1 years	896	1091	1443	55842	44142	27445	130859
1 years	105432	106747	139778	131280	99967	126316	709520
2 years	7159	7438	36174	10695	7163	13036	81665
3 years	3109	2938	30969	6337	3789	2987	50129
4 years	10528	5132	30082	7450	4964	2709	60865
5 years	-	474	-	-	-	-	474
6 years	-	467	-	-	-	-	467
7 years	-	363	-	-	-	-	363
8 years	-	352	-	-	-	-	352
9 years	-	409	-	-	-	-	409
10 years	-	662	-	-	-	-	662
11 anos	-	651	-	-	-	-	651
12 years	5064	3766	2899	5937	11104	2155	30925
13 years	-	605	-	-	-	-	605
14 years	-	796	-	-	-	-	796
Total	132188	131891	241345	217541	171129	174648	1068742

With regard to the number of doses administered of the MMR and MMRV vaccines during the period from 2016 to 2021 (Table 3), it was observed that in the state of Pará immunization with the MMR vaccine predominated in all years analyzed (1,068,742) when compared with MMRV immunization (434,962). Furthermore, the highest number of isolated doses of MMR was administered in 2018 (241,345). In the same year, the highest total number of doses administered in Pará was also recorded (323,153).

On the other hand, the highest rate of isolated administration of the MMRV vaccine occurred in 2019 (102,820) compared with the other years of vaccination.

Subsequently, the years with the lowest numbers of total doses administered were 2021, with 178,512 doses, followed by 2016 (216,250) and 2017 (219,293).

In addition, comparatively, in 2018 new measles cases were reported in the state of Pará (48), marking the reappearance of the disease in the region. Nevertheless, in that same year, the highest number of MMR and MMRV doses was administered (323,153). Conversely, in 2020 the highest number of cases (1,572) was observed, together with one of the lowest numbers of vaccine doses (246,135), when compared with 2018 and 2019.

Regarding the administration of MMR vaccine doses (Table 4), the age group with the highest number of doses administered was 1 year old (709,520), while the lowest was at 8 years old (352).

In addition, a significant increase in the number of vaccine doses administered to children under 1 year of age was observed after 2018, which recorded 1,443 doses, reaching the highest value in 2019 (55,842). This trend continued in the following years, with (44,142) doses administered in 2020 and in 2021 (27.445).

In light of the above, the measles panorama in the state of Pará underwent changes from 2016 and 2017 until 2021, which is directly related to the state's vaccination coverage.

During the study period, no measles cases were reported in 2016 and 2017. However, from 2018 onwards, cases of the disease were again recorded, with 2020 being the year with the highest number of reported measles cases in Pará. One study indicates that these findings align with several contributing factors, such as the population's false perception that vaccination is no longer necessary due to the disappearance of the disease, reflecting a considerable lack of awareness regarding the importance of vaccination and its mechanisms of action (Zorzetto, 2018; Costa et al., 2018).

Additionally, in 2018, the arrival of Venezuelan immigrants, particularly in the

Northern Region, impacted the health scenario, both in terms of public health system overload and the emergence of new measles cases after its prior eradication. Furthermore, a relationship was observed between vaccination coverage and the SARS-CoV-2 pandemic period, with a significant 20% reduction in childhood vaccination during social isolation, although the decline had already been noticeable before the COVID-19 pandemic (Ferraciolli, Magalhães, and Fernandes, 2020; Brasil, 2020; Silveira et al., 2021).

This study corroborates the finding that the proportion of deaths due to comorbidity was 0.47%, a small number, among measles cases by age group in Pará from 2016 to 2021 (Brasil, 2022; Loureiro et al., 2023).

The "Zero Dose" strategy, implemented in 2019 by the Ministry of Health, involves vaccinating children aged 6 to 11 months with a single MMR dose, without replacing the first dose (D1) recommended by the vaccination schedule at 12 months, with the aim of reducing the occurrence of severe cases and measles-related deaths (Garcia et al., 2020; Parra et al., 2022).

The findings of the present study are consistent with these data, given that the number of MMR doses administered to children under 1 year in Pará in 2019 corresponded to 42.67% (55,842/130,859) of the total MMR doses administered during the entire period analyzed (2016–2021) for this age group, marking 2019 as the year with the highest number of MMR immunizations in children under 1 year (Souza and Júnior, 2020; Gasperini et al., 2022).

Public awareness and the strengthening of immunization strategies are fundamental to preventing the resurgence of previously controlled diseases.

The results presented demonstrate strong alignment with national and international scientific literature discussing contemporary challenges related to declining vaccination coverage and the reemergence of vaccine-preventable diseases. The resurgence of measles cases in Pará is consistent with studies highlighting vaccine hesitancy, public misinformation, and structural inequalities as critical factors compromising the effectiveness of immunization policies.

Moreover, the data reinforce the relevance of strategies such as the "Zero Dose," whose positive impacts have also been documented in international studies. This research contributes original knowledge by quantifying and contextualizing the incidence of measles in the pediatric population of Pará during a critical period, revealing specific gaps in vaccination coverage and proposing concrete paths for intervention.

By engaging with updated and relevant references, the study expands the understanding of the epidemiological dynamics of measles and reaffirms its alignment with the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education) by highlighting the importance of educational campaigns and awareness strategies, and SDG 10 (Reduced Inequalities), contributing to a global debate on health equity, epidemiological surveillance, and the promotion of evidence-based practices.

This manuscript provides a valuable contribution to the scientific community by offering a comprehensive temporal and epidemiological analysis of measles resurgence in a previously disease-free region. By integrating vaccination coverage data with socio-behavioral and structural determinants, it enhances understanding of the complex interactions driving vaccine-preventable disease outbreaks. The study also serves as an evidence-based reference for policymakers and researchers seeking to design more effective immunization and health education strategies. Furthermore, its methodological approach demonstrates the potential of using secondary public health data to monitor trends and guide timely interventions in similar epidemiological contexts.

4. CONCLUSION

The findings of this study underscore the vulnerability of the pediatric population to the reemergence of measles in the state of Pará, directly linked to declining vaccination coverage and weaknesses in prevention strategies. Temporal analysis revealed the influence of structural, social, and behavioral factors on the epidemiological dynamics of the disease,

emphasizing the need for continuous and coordinated immunization actions.

To reverse this scenario, it is essential to strengthen booster vaccination campaigns, enhance routine monitoring, and invest in educational initiatives that build vaccine confidence and ensure equitable access to healthcare services. These actions align with the Sustainable Development Goals (SDGs 3 and 10), contributing to the reduction of regional inequalities and the strengthening of global health resilience.

This study also serves as a model for the use of secondary public health data to effectively assess temporal and regional disease trends. Moreover, it reinforces the importance of continuous surveillance, public awareness, and coordinated health interventions to prevent the resurgence of previously eliminated diseases.

Finally, the importance of long-term surveillance is highlighted to enable early outbreak detection and guide effective preventive measures.

CONSENT

The authors declare that this research did not require the use of questionnaires or patient consent, since the data were obtained from Ministry of Health databases, that is, publicly available data. Therefore, no direct or indirect contact with individuals was necessary, as the information provided consists only of quantitative and epidemiological percentages, with no personal data that could lead to identification.

ETHICAL APPROVAL

The authors declare that this research was exempt from ethics committee review, as it involved the use of aggregated data from databases without the possibility of individual identification. Such exemption generally applies to studies that do not present direct or indirect risks to human subjects or that use publicly accessible data, as is the case in this work, in accordance with the regulations of the Brazilian National Health Council (CNS), specifically Resolution No. 510/2016, Article 26, items III and V, of Resolution No. 674, dated May 6, 2022.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/145896