

DOI: <http://dx.doi.org/10.31365/issn.2595-1769.2026.0385>

Infant mortality from vaccine-preventable diseases in Brazil: an analysis of deaths between 2010 and 2023

Mortalidade infantil por doenças imunopreveníveis no Brasil: uma análise dos óbitos entre 2010 e 2023

Mortalidad infantil por enfermedades prevenibles mediante vacunación en Brasil: un análisis de las muertes entre 2010 y 2023

Eduardo Augusto Pereira Fischer^{1,2}Letícia Farias de Souza^{1,3}¹Universidade Federal do Paraná. Curitiba-PR, Brasil.²ORCID: <https://orcid.org/0000-0003-2702-1410>³ORCID: <https://orcid.org/0009-0002-9179-4733>**Corresponding author:**

Eduardo Augusto Pereira Fischer

E-mail: fischereduardoap@gmail.com**ABSTRACT**

Introduction: The National Immunization Program has established itself as one of the most relevant public health interventions, resulting in a significant reduction in the number of cases and deaths from vaccine-preventable diseases over the decades. However, paradoxically, new challenges have emerged due to declining vaccination coverage and the potential reemergence of controlled diseases. **Objectives:** To evaluate, based on aggregated data, infant deaths from vaccine-preventable infectious diseases in Brazil between 2010 and 2023. **Methods:** This was a cross-sectional, descriptive, and retrospective study. Data on infant deaths (0 to 4 years old) were collected from the Sistema de Informação de Agravos de Notificação (SINAN), which is available through the Departamento de Informática do Sistema Único de Saúde (DATASUS). The variables analyzed were the associated pathology (ICD-10) and the region of notification. **Results:** A total of 657 deaths from vaccine preventable diseases were reported during the period. Whooping cough (ICD-10: A37) was the main cause, accounting for 68% of the total. The highest numbers of deaths from whooping cough occurred in 2014, 2012, and 2013. Varicella (ICD-10: B01) was a frequent cause of death, with 580 cases recorded in the analyzed period, most of them occurring before the introduction of the vaccine. **Conclusion:** Whooping cough was the vaccine-preventable infection responsible for the highest number of infant deaths in Brazil during the analyzed period. The data reinforce the fundamental importance of infant vaccination and epidemiological surveillance strategies.

Keywords: Infant Mortality; Vaccines; Immunization Programs.

RESUMO

Introdução: O Programa Nacional de Imunização consolidou-se como uma das mais relevantes intervenções em saúde pública, resultando em uma redução significativa no número de casos e óbitos por doenças imunopreveníveis ao longo das décadas. Entretanto, de modo paradoxal, novos desafios surgiram, diante da queda nas coberturas vacinais e do potencial reemergente de doenças controladas. **Objetivos:** Avaliar, a partir de dados agregados, os óbitos infantis por doenças infecciosas imunopreveníveis no Brasil entre 2010 e 2023. **Métodos:** Estudo transversal, descritivo e retrospectivo, com coleta de dados de óbitos infantis (0 a 4 anos) notificados no Sistema de Informação de Agravos de Notificação (SINAN), disponibilizados através do Departamento de Informática do Sistema Único de Saúde (DATASUS). As variáveis analisadas foram a patologia associada (CID-10) e a região de notificação. **Resultados:** Foram notificados 657 óbitos por doenças imunopreveníveis no período, com a coqueluche (CID-10: A37) sendo a principal causa, respondendo por 68% do total. Os maiores números de óbitos por coqueluche ocorreram em 2014, 2012 e 2013. Varicela (CID-10: B01) foi causa frequente de óbitos, com 580 registrados no período analisado, a maioria antes da introdução de sua vacina. **Conclusão:** A coqueluche foi a infecção imunoprevenível responsável pelo maior número de óbitos infantis no Brasil no período analisado. Os dados reforçam a importância fundamental da vacinação infantil e de estratégias de vigilância epidemiológica.

Palavras-Chave: Mortalidade Infantil; Vacinas; Programas de Imunização.

RESUMEN

Introducción: El Programa Nacional de Inmunizaciones se ha consolidado como una de las intervenciones de salud pública más relevantes, resultando en una reducción significativa del número de casos y muertes por enfermedades prevenibles por vacunación a lo largo de las décadas. Sin embargo, paradójicamente, han surgido nuevos desafíos, dada la disminución de la cobertura de vacunación y la posibilidad de resurgimiento de enfermedades controladas. **Objetivos:** Evaluar, utilizando datos agregados, las muertes infantiles por enfermedades infecciosas prevenibles por vacunación en Brasil entre 2010 y 2023. **Métodos:** Estudio transversal, descriptivo y retrospectivo, que recopiló datos sobre muertes infantiles (0 a 4 años) notificadas en el Sistema de Información de Enfermedades de Declaración Obligatoria (SINAN), disponible a través del Departamento de Informática del Sistema Único de Salud (DATASUS). Las variables analizadas fueron la patología asociada (CIE-10) y la región de notificación. **Resultados:** Se reportaron 657 muertes por enfermedades prevenibles mediante vacunación durante el período, siendo la tos ferina (CIE-10: A37) la principal causa, representando el 68% del total. El mayor número de muertes por tos ferina se registró en 2014, 2012 y 2013. La varicela (CIE-10: B01) fue una causa frecuente de muerte, con 580 registradas en el período analizado, la mayoría antes de la introducción de su vacuna. **Conclusión:** La tos ferina fue la infección prevenible mediante vacunación responsable del mayor número de muertes infantiles en Brasil durante el período analizado. Los datos refuerzan la importancia fundamental de la vacunación infantil y las estrategias de vigilancia epidemiológica.

Palabras Clave: Mortalidad infantil; Vacunas; Programas de inmunización.

INTRODUCTION

The Brazilian Ministry of Health's National Immunization Program (Programa Nacional de Imunizações - PNI) includes a set of essential vaccines for the prevention of various diseases, among which are those of interest to this study, which are the diseases considered vaccine-preventable according to the National System of Notifiable Diseases' (Sistema de Informações de Agravos de Notificação – SINAN) list and varicella. Thus, the pentavalent vaccine (DTP/HB/Hib), administered at 2, 4, and 6 months of age, protects against diphtheria, tetanus, pertussis, *Haemophilus influenzae* type B, and hepatitis B. The vaccine against acute poliomyelitis (IPV - inactivated) is given in 3 doses in the same months. For protection against measles, mumps, and rubella, the MMR (measles, mumps, rubella) vaccine is recommended at 12 months, while the MMRV (measles, mumps, rubella, varicella) vaccine, which also protects against varicella, is administered at 15 months. DTP vaccine boosters are recommended at 15 months and 4 years, as well as dT vaccine boosters from 7 years of age, to maintain immunity against diphtheria, tetanus, and pertussis. A second dose of the varicella vaccine is also administered at 4 years of age.¹

The PNI, created in 1973, has established itself as one of the most relevant public health interventions, resulting in a significant reduction in the number of cases and deaths from vaccine-preventable diseases over the decades. However, paradoxically, new challenges have emerged. An ecological study that analyzed vaccination coverage rates in children under 12 months of age between 2013 and 2020, for example, demonstrated a significant reduction over the years. In 2020, the country recorded the lowest vaccination coverage rate, with an average of 75.07% compared to 84.44% the previous year.² Given the decline in vaccination coverage and the potential for the re-emergence of controlled diseases, this study aimed to evaluate, using aggregated data, infant deaths from vaccine-preventable infectious diseases in Brazil between 2010 and 2023.

METHODS

This is a descriptive and retrospective study. Data on infant deaths (0 to 4 years) from 2010 to 2023 were collected in Brazil from information in the SINAN, available from the Information Technology Department of the Unified Health System (DATASUS).³ Data associated with the following categories of the International Classification of Diseases (ICD-10) were selected: measles (B05), rubella (B06), mumps (B26), diphtheria (A36), tetanus (A33, A34, A35), pertussis (A37), acute poliomyelitis (A80). The search for mortality related to varicella (B01) was carried out separately, as it was not listed in the SINAN database as a vaccine-preventable disease, possibly because its vaccine was not included in the PNI until 2013. The variables analyzed were the associated ICD-10 code and the notification region.

This work does not require approval from a research ethics committee, as it uses secondary, publicly accessible, and aggregated data that do not allow for the individual identification of patients. The data were analyzed using descriptive statistics, and a graph was created using Microsoft Excel software. For the bibliographic basis, the Scientific Electronic Library Online (SciELO) and PubMed databases were used.

RESULTS

Between 2010 and 2023, 657 deaths from vaccine-preventable diseases were reported. The years 2014, 2013, and 2012 stood out with the highest numbers, with 149, 107, and 102 deaths, respectively. The years 2021 and 2022 recorded the lowest total values, with 9 deaths each. Regarding the regions, the Southeast and Northeast presented the highest numbers, with 273 and 154 deaths, respectively, followed by the North (95), South (75), and Central-West (60).

Analyzing the pathologies associated with the deaths, 480 (73%) were caused by diphtheria, tetanus, or pertussis, which are covered by the Pentavalent vaccine, applied at

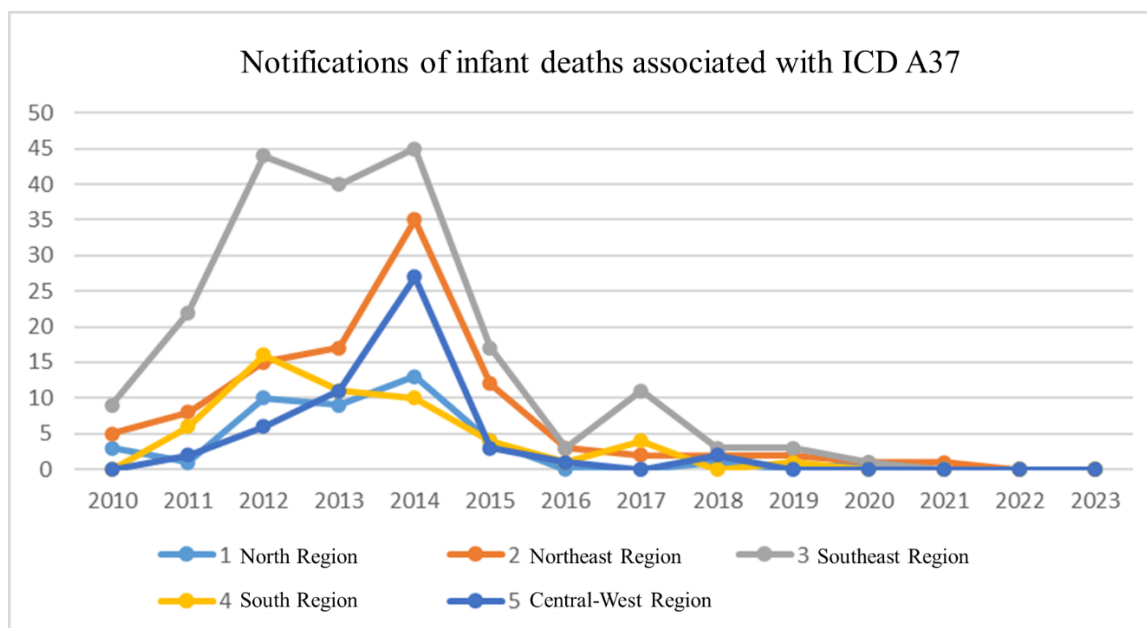


2, 4, and 6 months, and by the DTP vaccine, with boosters at 15 months and 4 years. Of these, 448 deaths (68% of the total) were caused by a single ICD-10 code: A37, referring to pertussis. Considering only this pathology, the years with the highest numbers were 2014 (130 deaths), 2012 (91) and 2013 (88). In the years 2022 and 2023, no deaths from pertussis were reported.

Deaths from pertussis occurred almost entirely in the age group up to 4 years old,

representing 97.8% of total deaths, while the proportion of total cases in this age group was 76.1%. The highest lethality occurred in 2010, with 4.56%, followed by 2011, with 3.23%. In 2014, with the highest absolute number of deaths, the lethality was 2.53%.

Graph 1 - Notifications of infant deaths associated with ICD A37 (Pertussis) registered in the Notifiable Diseases Information System (SINAN) according to regions of Brazil, 2010 to 2023



Source: SINAN, 2025.

Regarding measles, rubella, and mumps, 25 deaths were reported across these three pathologies during the period. No deaths associated with acute poliomyelitis were recorded.

Chickenpox (ICD-10 B01) - analyzed separately from the list of vaccine-preventable diseases prepared by SINAN - is associated with 580 deaths in children up to 4 years of age, with 160 in children under 1 year old (27.58%). Of the total, 302 cases were reported in the Southeast Region; North, 76; Northeast, 103; South, 44;

and Central-West, 55. The years with the highest number of deaths from chickenpox were 2011 (117), 2010 (111), and 2012 (88). The years 2020 to 2023 recorded 8 deaths from chickenpox in total. Between 2010 and 2012, that is, before the introduction of the tetravalent vaccine, there were 316 deaths from chickenpox, corresponding to 54.48% of the deaths in the period analyzed.

DISCUSSION

The findings of this study demonstrate that pertussis remains the leading cause of infant mortality from vaccine-preventable diseases in Brazil, even with the availability of vaccination. This result is consistent with international literature, which discusses the “resurgence of pertussis” in countries with high vaccination coverage. The absence of deaths in 2022 and 2023 may be related to the sanitary measures of the COVID-19 pandemic, such as social distancing, which also apply to the prevention of pertussis. However, the pandemic context also negatively affected vaccination coverage, which represents a risk for future re-emergence.

Studies such as that of Medeiros et al.⁴ have already pointed out that the confirmation of pertussis cases is closely related to non-vaccination or incomplete vaccination, with children under 6 months being the most affected. The high concentration of deaths in regions such as the Southeast and Northeast, as observed in our data, reflects regional disparities in the burden of vaccine-preventable diseases, as highlighted by Silva et al.⁵ The authors emphasize that the North and Northeast regions, despite progress, still face higher mortality rates and lower vaccination coverage compared to the other regions.

Other countries besides Brazil also face the challenge of a resurgence of pertussis, such as the USA, the United Kingdom, and Australia, which, although maintaining high vaccination coverage, have shown a considerable increase in cases since 2010, about 30 years after achieving control of the disease.^{4,6} In this context, there has been an increase in the proportion of affected adolescents and adults, raising hypotheses about the loss of immunogenicity over time since vaccination and possible mutations of the etiological agent due to the selective pressure exerted by vaccination.⁷ Also listed as contributing factors to the lower immunogenicity of the acellular pertussis component, used in most developed countries,⁶ is the reduced targeting of vaccination efforts towards adults who have contact with children whose vaccination schedule is still incomplete (parents, healthcare professionals, adolescents).⁷ The

challenge of pertussis in countries with high vaccination coverage is multifactorial and well documented in the literature. Factors such as the rapid decline in vaccine efficacy (particularly of the acellular vaccine) and the change in the age distribution of the disease are reinforced by a comprehensive systematic review and meta-analysis on the efficacy of the pertussis vaccine.⁸ In contrast, vaccination has demonstrated substantial success in relation to varicella, with universal vaccination resulting in a marked reduction in the incidence of the disease, hospitalizations, and pediatric mortality.⁹

In Brazil, most confirmed cases of pertussis still occur in children with incomplete or absent vaccination schedules.^{4,6} Considering the greater susceptibility of infants, especially those under 6 months of age, vaccination of pregnant women with the acellular pertussis component from the twentieth week of gestation is important in order to promote passive immunization of newborns until they receive the first dose of the vaccine, which has led to a reduction in the incidence of hospitalizations for pertussis in infants under 1 year of age in Southern Brazil,¹⁰ when comparing the period before and after the introduction of this action by the Ministry of Health in 2014.

The resurgence of pertussis is a multifactorial phenomenon, influenced by genetic mutations of *Bordetella pertussis*, by the decrease in immunity over time after vaccination, and by improvements in surveillance and diagnostic capacity, whose scope extends beyond national borders and is also manifested in other countries.^{5,11} The results of this study reinforce the need for continuous epidemiological surveillance and the maintenance of high vaccination coverage to sustain disease control.

Starting in 2013, the varicella vaccine – another important cause of vaccine-preventable deaths in Brazil – was introduced into the PNI, originally through the tetravalent vaccine, which is administered at 15 months of age. In 2018, a second dose of varicella was also introduced at 4 years of age. Although SINAN data for vaccine-preventable deaths do not include varicella, the authors chose to include it in the analysis,



considering its epidemiological relevance¹² and the fact that, with the introduction of its vaccine into the PNI in 2013, it is preventable through immunization.

Since the start of varicella immunization in 2013, a reduction in deaths from this disease has been observed. Comparing the annual average of varicella deaths between 2010 and 2012 (105.33 deaths per year) with the annual average between 2014 and 2016 (41.33 deaths per year), a reduction of 60.76% is observed in this parameter. In addition to the significant drop in varicella-related deaths after the introduction of vaccination, there was also a decrease in hospital admission and mortality rates, especially in the 1-4 year age group, which is precisely the target group for vaccination and which has the highest number of deaths.¹³ The trend of reduced mortality and hospital admissions after the introduction of vaccination is observed not only in Brazil, but also in other Latin American countries and territories that have adopted the strategy of mass vaccination in the pediatric population, such as Costa Rica and Uruguay.¹⁴

CONCLUSION

Whooping cough was the vaccine-preventable infection responsible for the highest number of infant deaths in Brazil during the analyzed period, associated with 68% of all notifications, as was varicella. Although varicella is not analyzed as a vaccine-preventable disease by SINAN, it can be considered as such from 2013 onwards, with the introduction of its vaccine as part of the tetravalent vaccine in the PNI, corresponding to 264 deaths between 2013 and 2023, and 580 deaths between 2010 and 2023. The data reinforce the fundamental role of childhood vaccination in reducing mortality and the urgency of strengthening the National Immunization Program. The persistence of deaths from whooping cough and varicella, despite the availability of vaccines, highlights the need to improve public health strategies.

This study emphasizes the importance of action in health education, in the active search for children with incomplete vaccination schedules, and in the rigorous monitoring of cases, aiming at

the prevention of avoidable deaths. Future research should investigate the regional and socioeconomic barriers that impede access to vaccination.

REFERENCES

1. Ministério da Saúde (Brasil). Programa Nacional de Imunizações: Calendário Nacional de Vacinação da Criança [Internet]. Brasília: Ministério da Saúde; 2024 [acesso em 13 fev 2025]. Disponível em: <https://www.gov.br/saude/pt-br/vacinacao/calendario>.
2. Souza JFA, Silva TPR, Duarte CK, Gryscek AL de FPL, Duarte ED, Matozinhos FP. Strategies for expanding vaccination coverage in children in Brazil: systematic literature review. *Rev Bras Enferm.* 2024;77(6):e20230343. doi: 10.1590/0034-7167-2023-0343.
3. Sistema de Informação de Agravos de Notificação - SINAN. Óbitos Infantis - Brasil - Notificações Registradas: banco de dados [Internet]. Brasília: DATASUS; 2025 [acesso em 14 fev 2025]. Disponível em: <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/inf10uf.def>.
4. Medeiros ATN, Cavalcante CAA, Souza NL, Ferreira MAF. Reemergência da coqueluche: perfil epidemiológico dos casos confirmados. *Cad Saúde Colet.* 2017;25(4):453-9. doi: 10.1590/1414-462X201700040069.
5. Liu Y, Yu D, Wang K, Ye Q. Global resurgence of pertussis: A perspective from China. *J Infect.* 2024 Nov;89(5):106289. doi: 10.1016/j.jinf.2024.106289. PMID: 39357571.
6. Borba RCN, Vidal VM, Moreira LO. The re-emergency and persistence of vaccine preventable diseases. *An Acad Bras Cienc.* 2015;87(2 Suppl):1311-22. doi:10.1590/0001-3765201520140663.
7. Torres RS, Santos TZ, Torres RA, Pereira VV, Fávero LA, Filho OR, et al. Resurgence of pertussis at the age of vaccination: clinical, epidemiological, and molecular aspects. *J Pediatr (Rio J).* 2015;91(4):333-8.
8. Wilkinson K, Righolt CH, Elliott LJ, Fanella S, Mahmud SM. Pertussis vaccine effectiveness and duration of protection - A systematic review



and meta-analysis. *Vaccine*. 2021 May 27;39(23):3120-3130. doi: 10.1016/j.vaccine.2021.04.032. Epub 2021 Apr 30. PMID: 33934917.

9. Gershon AA, Gershon MD. A fresh look at varicella vaccination. *Hum Vaccin Immunother*. 2025 Dec;21(1):2488099. doi: 10.1080/21645515.2025.2488099. Epub 2025 Apr 15. PMID: 40231570; PMCID: PMC12001543.

10. Silva SD, Friedrich F, Bitencourt LTG, Ceretta LB, Soratto J. Hospitalização por coqueluche em crianças no período pré e pós-implantação da vacina dTpa para gestantes. *Cad Saúde Colet*, 2021;29(3):344-350. <https://doi.org/10.1590/1414-462X202129030289>

11. Hu Y, Guo M, Meng Q, Yu D, Yao K. Rising pertussis cases and deaths in China: current trends and clinical solutions. *Emerg Microbes Infect*. 2024;13:2389086. doi:10.1080/22221751.2024.2389086

12. Martino Mota A, Carvalho-Costa FA. Varicella zoster virus related deaths and hospitalizations before the introduction of universal vaccination with the tetraviral vaccine. *J Pediatr (Rio J)*. 2016;92(4):361-6. doi:10.1016/j.jped.2015.10.003

13. Ribeiro MZ, Kupek E, Ribeiro PV, Pinheiro CE. Impact of the tetra viral vaccine introduction on varicella morbidity and mortality in the Brazilian macro regions. *J Pediatr (Rio J)*. 2020;96(6):702-9. doi:10.1016/j.jped.2019.10.009

14. Arlant LHF, Pirez Garcia MC, Avila Agüero ML, Cashat M, Parellada CI, Wolfson LJ. Burden of varicella in Latin America and the Caribbean: findings from a systematic literature review. *BMC Public Health*. 2019;19:528. doi:10.1186/s12889-019-6795-0

Associate Editor:

Clemax Couto Sant Anna

ORCID: <https://orcid.org/0000-0001-8732-8065>

Scientific Editor:

Fernanda Pinto Mariz

ORCID: <https://orcid.org/0000-0002-6981-2352>

Editor:

Sociedade de Pediatria do Rio de Janeiro – SOPERJ

E-mail: secretaria@soperj.org.br

Financial support:

None.

Availability of research data:

The underlying content of the research text is contained in the article.

Conflict of interests:

None.

Authors' contributions:

EAP Fischer: statistical analysis, data collection, conceptualization, resource management, project management, investigation, methodology, writing - preparation of the original, writing - revision and editing, supervision, visualization.

LF de Souza: statistical analysis, data collection, conceptualization, resource management, project management, investigation, methodology, writing - preparation of the original, writing - revision and editing, supervision, visualization.

