Original article
Araujo TKA, Maranhão TA, Frota MMC, Sousa GJB, Rocha MIF, Pereira MLD, et al. Trend and prediction of congenital syphilis in Brazil in the 21st century: A time series study.
Rev Gaúcha Enferm. 2026;47:e20250112.
https://doi.org/10.1590/1983-1447.2026.20250112.en

Trend and prediction of congenital syphilis in Brazil in the 21st century: A time series study

Tendência e predição da sífilis congênita no Brasil no século XXI: Um estudo de séries temporais

Tendencia y predicción de la sífilis congénita en Brasil en el siglo XXI: Un estudio de series temporales

Thalis Kennedy Azevedo de Araujo[a] https://orcid.org/0000-0002-2404-6404
Thatiana Araujo Maranhão[b] https://orcid.org/0000-0003-4003-1365
Maria Madalena Cardoso da Frota[c] https://orcid.org/0000-0003-1538-0037
George Jó Bezerra Sousa[d] https://orcid.org/0000-0003-0291-6613
Maria Izabel Félix Rocha[e] https://orcid.org/0000-0003-3134-0959
Maria Lúcia Duarte Pereira[f] https://orcid.org/0000-0003-0079-5248
Luís Felipe Oliveira Ferreira[b] https://orcid.org/0000-0002-2982-894X
José Cláudio Garcia Lira Neto[g] https://orcid.org/0000-0003-2777-1406

How to cite this article:

Araujo TKA, Maranhão TA, Frota MMC, Sousa GJB, Rocha MIF, Pereira MLD, et al. Trend and prediction of congenital syphilis in Brazil in the 21st century: A time series study. Rev Gaúcha Enferm. 2026;47:e20250112. https://doi.org/10.1590/1983-1447.2026.20250112.en

[a]Universidade de São Paulo. Faculdade de Medicina. Programa de Pós-Graduação em Saúde Coletiva. São Paulo, São Paulo, Brasil.
[b]Universidade Estadual do Piauí. Faculdade de Enfermagem. Parnaíba, Piauí, Brasil.
[c]Universidade Federal do Maranhão. Hospital Universitário da Universidade Federal do Maranhão. Programa de Residência Multiprofissional em Vigilância em Saúde. São Luís, Maranhão, Brasil.
[d]Coordenação Geral de Vigilância da Hanseníase e Doenças em Eliminação. Ministério da Saúde, Brasília, Distrito Federal, Brasil.
[e]Universidade Federal do Piauí. Programa de Residência Uniprofissional em Enfermagem Obstétrica. Teresina, Piauí, Brasil.
[f]Universidade Estadual do Ceará. Programa de Pós-Graduação em Cuidados Clínicos em Enfermagem e Saúde, Fortaleza, Ceará, Brasil.
[g]Universidade Federal do Piauí. Faculdade de Enfermagem. Floriano, Piauí, Brasil.

ABSTRACT

Objective: To investigate the temporal trend of congenital syphilis in Brazil in the 21st century and to estimate its behavior from 2023 to 2030.
Method: Ecological time series study using secondary data extracted from the Informatics Department of the Unified Health System (DATASUS) from 2001 to 2022. The temporal evolution of congenital syphilis was analyzed using crude incidence calculation and the standardized mean incidence rate. Statistical techniques such as Joinpoint and Autoregressive Integrated Moving Average were used for time-series analysis and case projections.
Results: Over the 22-year period, 302,759 cases of congenital syphilis were reported in Brazil, 51.1% of which occurred between 2017 and 2022. The incidence rate rose from 1.3 in 2001 to 10.3 cases per 1,000 live births in 2022. The temporal analysis showed that four of the five regions showed an increasing trend during the study period. By 2030, projections indicate growth in rates in Brazil (8.3%) and in the following regions: South (11.2%), Southeast (10.5%), North (9.2%), Central-West (8.0%), and Northeast (6.8%).
Conclusion: An increase in incidence rates was observed in Brazil and its regions. The temporal analysis showed an upward trend, and projections through 2030 show an increase in cases.
Descriptors: Congenital syphilis; Infectious disease transmission; Time series studies; Forecasts; Ecological studies.

RESUMO

Objetivo: Investigar a tendência temporal da Sífilis Congênita no Brasil no século XXI e estimar seu comportamento de 2023 a 2030.
Método: Trata-se de um estudo ecológico, de séries temporais, que utilizou dados secundários extraídos do Departamento de Informática do Sistema Único de Saúde no período de 2001 a 2022. Foi realizada a análise da evolução temporal da sífilis congênita utilizando o cálculo de incidência bruta e a taxa de incidência média padronizada. Para as análises de série temporal e projeções dos casos empregaram-se técnicas estatísticas como *Joinpoint* e Média Móvel Integrada Autorregressiva.
Resultados: Ao longo dos 22 anos foram notificados 302.759 casos de sífilis congênita no Brasil, dos quais 51,1% ocorreram de 2017 a 2022. A taxa de incidência subiu de 1,3 em 2001 para 10,3 casos por 1.000 nascidos vivos em 2022. A análise temporal demonstrou que quatro das cinco regiões apresentaram tendência crescente no período estudado. Até 2030, as projeções apontam crescimento das taxas no Brasil (8,3%) e regiões: Sul (11,2%), Sudeste (10,5%), Norte (9,2%), Centro-Oeste (8,0%) e Nordeste (6,8%).
Conclusão: Verificou-se aumento das taxas de incidência no Brasil e regiões. A análise temporal apresentou tendência crescente e as projeções até 2030 mostram aumento dos casos.
Descritores: Sífilis congênita; Transmissão de doença infecciosa; Estudos de séries temporais; Previsões; Estudos ecológicos.

RESUMEN

Objetivo: Investigar la tendencia temporal de la sífilis congénita en Brasil en el siglo XXI y estimar su comportamiento entre 2023 y 2030.
Método: Estudio ecológico de series temporales que utilizó datos secundarios extraídos del Departamento de Informática del Sistema Único de Salud (SUS) entre 2001 y 2022. La evolución temporal de la sífilis congénita se analizó mediante cálculos de incidencia bruta y la tasa de incidencia promedio estandarizada. Se emplearon técnicas estadísticas como *Joinpoint*

y la media móvil integrada autorregresiva para el análisis de series temporales y la proyección de casos.
Resultados: Durante el período de 22 años, se notificaron 302.759 casos de sífilis congénita en Brasil, de los cuales el 51,1% se produjo entre 2017 y 2022. La tasa de incidencia aumentó de 1,3 en 2001 a 10,3 casos por cada 1.000 nacidos vivos en 2022. El análisis temporal mostró que cuatro de las cinco regiones mostraron una tendencia al alza durante el período de estudio. Se proyecta un aumento de las tasas en Brasil y las siguientes regiones hasta 2030: Sur (11,2%), Sudeste (10,5%), Norte (9,2%), Centro-Oeste (8,0%) y Nordeste (6,8%).
Conclusión: Se observó un aumento de las tasas de incidencia en Brasil y sus regiones. El análisis temporal mostró una tendencia al alza, y las proyecciones hasta 2030 muestran un aumento de casos.
Descriptores: Sífilis congénita; Transmisión de enfermedades infecciosas; Estudios de series temporalis; Pronósticos; Estudios ecológicos.

INTRODUCTION

Sexually Transmitted Infections (STI) constitute a relevant public health problem worldwide, capable of causing significant negative repercussions in the sexual and reproductive lives of many individuals. Among these infections, syphilis stands out for its global relevance, being the second leading infectious cause of stillbirth and an avoidable factor for infant morbidity and mortality[1]. Discovered in the 16th century, the disease, caused by the spirochete bacterium *Treponema pallidum* (TP), has been responsible for several epidemiological outbreaks throughout history[2].

As an STI, syphilis transmission occurs through sexual contact in most cases[1]. from the pregnant woman to the fetus, in cases of pregnancy with untreated or inadequately treated syphilis[3], resulting in congenital syphilis (CS). Consequently, CS can cause serious repercussions in fetal health, such as hearing and intellectual impairments, renal, hepatic and splenic alterations, as well as neonatal deaths, abortion and stillbirth[3].

The Ministry of Health (MH), through the Official Gazette of the Union (DOU), defined CS as a notifiable disease in Brazil in December 1986[4]. However, it was only in 1997 that the elimination of vertical transmission of syphilis became a national priority, when the World Health Organization (WHO) established the goal of reducing the incidence rate to 0.5 cases per 1,000 Live Births (LB) worldwide[1].

Nevertheless, in 2022, even with a 2.2% reduction in the number of cases compared to the previous year, the incidence rate was 10.3 cases per 1,000 LB in Brazil[4], a value 20.6 times higher than the previously established target[1]. Therefore, despite being a curable infection and having low-cost treatment, the national scenario of syphilis remains concerning, as it is still far from the globally recommended parameters[3].

However, despite the gaps in monitoring and surveillance of the disease, when compared with other Latin American nations, such as Venezuela, Panama and Honduras, Brazil has several national strategies aimed at reducing syphilis incidence rates[5]. Among them, the implementation of the Alyne Network (*Rede Alyne*) stands out, a new care model focused on the maternal and child population, which aims to reduce maternal and infant mortality while prioritizing ethnic-racial equity[6]. Furthermore, there is the National Plan for the Reduction of Vertical Transmission of HIV and Syphilis and the Congenital Syphilis Elimination Project, both from the Ministry of Health (MH)[3].

In 2018, the WHO proposed as a global objective a 90% reduction in syphilis incidence and mortality rates by 2030[1]. However, Brazilian studies indicate an opposite trend in the country, pointing to a possible increase in the number of cases in the coming years[7,8]. In this context, the present study aims to investigate the temporal trend of CS in Brazil in the 21st century and to estimate its behavior for the period from 2023 to 2030, aiming to contribute to health strategies focused on preventing new cases and containing rates.

METHOD

This is an ecological, time series study, whose geographical area of interest was Brazil. The country has 5,570 municipalities distributed across five macro-regions: Northeast (nine states and 1,793 municipalities), North (seven states and 450 municipalities), Central-West (three states, 466 municipalities and the Federal District), Southeast (four states and 1,668 municipalities) and South (three states and 1,191 municipalities)[9].

Secondary data were used, referring to the period from 2001 to 2022, obtained from the Health Information Systems (*Sistemas de Informação em Saúde* - SIS). Data on CS were collected through the electronic portal of the Department of Informatics of the Unified Health System (*Departamento de Informática do Sistema Único de Saúde* - DATASUS) of the MH, which compiles information on notifications recorded in the Notifiable Diseases Information System (*Sistema de Informação de Agravos de Notificação* - SINAN), fed by notification forms.

Demographic data on the population of Live Births (LB) in Brazil, by macro-region, Federative Unit (FU), and capitals, were obtained from the DATASUS website, based on information recorded in the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos* - SINASC), originating from the Live Birth Declaration, derived from the Live Birth Certificate, a document completed by health professionals. All reported cases and the population of interest were compiled into a single database created using Microsoft Office Excel®, version 2019.

For the exploratory analysis of the epidemiological and clinical profile of CS cases, the following variables were considered: sex, race/color, age group, final diagnosis, region of notification, maternal education, prenatal care attendance, timing of diagnosis, maternal treatment regimen, and partner treatment. These data were presented as absolute and relative frequencies. In addition, the normality of variables was assessed using the Shapiro-Wilk test, considering $p \leq 0.05$ as indicative of normal distribution over the time series.

The temporal evolution of CS was analyzed for Brazil, macro-regions, and Federative Units (FU). Both the crude incidence rate and the standardized mean incidence rate were calculated. The standardized mean rate considers population differences between locations and years analyzed, more accurately representing the real risk of illness throughout the time series and allowing more equitable comparisons of average disease incidence, regardless of changes in the number of LB over time. The formulas are shown below:

Incidence Rate

$$\frac{\text{Number of reported cases in a given location and year}}{\text{Number of LB in the same location and year}} \times 1{,}000$$

Standardized Rate

$$\frac{\text{Total number of reported cases from 2001 to 2022 / Total number of years analyzed (22 years)}}{\text{Average number of LB in the central years of the time series (2011 and 2012)}} \times 1{,}000$$

For the temporal analysis using the Joinpoint method, the absolute numbers recorded each year were tabulated in a Microsoft Office Excel® spreadsheet, version 2019, and imported into the Joinpoint Regression Program®, version 4.6.0.0. This program performs segmented linear regression with logarithmic transformation of the values, testing whether one or more inflection points should be added to the linear model using the Monte Carlo permutation method[10].

Thus, the Annual Percentage Change (APC) and the Average Annual Percent Change (AAPC) were calculated using a 95% confidence interval (95% CI). A significance level of 5% was established to test the null hypothesis that the APC and AAPC of the series are equal to zero. Therefore, results with $p \leq 0.05$ were considered statistically significant, in which a negative value indicates a decreasing trend, while a positive value indicates an increasing trend. When not significant, the analysis indicated a stationary trend(10).

The independent variable was defined as the year of occurrence of CS, and the dependent variable as the annual incidence rate of the disease. For this calculation, the number of cases was used as the numerator and the number of LB as the denominator, considering the coefficient per 1,000 LB. In the analysis, first-order autocorrelation (AR) of the errors was also adopted as a parameter in all analyzed models, since health data present temporal dependence in relation to the previous year(10). Thus, the model AR = 1 was specified.

To perform projections of CS rates in Brazil and in the macro-regions, the statistical time series technique based on the Autoregressive Integrated Moving Average (ARIMA) model was used. Data processing was carried out using MINITAB® software, version 17. At this stage of the study, the dependent variable was the incidence rate, and the independent variable was the year of occurrence.

Before modeling the time series, a graph was constructed to observe the behavior of CS over the years investigated, identifying secular trends, cyclical movements, and seasonality(11). The ARIMA model uses autoregression and moving average to incorporate differential order, to remove trend and/or seasonality in the analyzed time series(12).

ARIMA modeling consists of three parameters (*p, d, q*). Parameter *p* represents the lag periods of the series (autoregression), parameter *d* corresponds to the number of differencing transformations applied to make the series stationary (removal of trend/seasonality), and parameter *q* refers to the lag of the model's error component (moving average), that is, the part of the series that cannot be explained by trend or seasonality(11,12).

In this study, the ARIMA model with parameters (1, 0, 0) was used, as it showed the best fit to the analyzed time series. Parameter $p = 1$ indicates the presence of significant first-order temporal dependence, while $d = 0$ and $q = 0$ demonstrate that differencing was not necessary to make the series stationary, nor was there a relevant contribution from moving average terms. Model selection followed the Box-Jenkins methodology, choosing the one that presented the lowest values for the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Additionally, the Ljung-Box test was applied for residual analysis. Alternative methods, such as Simple and Double Exponential Smoothing, were also tested but showed inferior fit.

For internal validation purposes, the 2022 CS incidence rate was used as a real sample for calculating the Mean Absolute Error (MAE) and the Mean Absolute Percentage Error

(MAPE), which measure, respectively, the average and percentage of errors between the observed and predicted values[11]. Both the MAE and MAPE obtained in the predictions of CS incidence were within acceptable accuracy limits, with errors below 10%. In other words, the model's forecast results showed a difference of less than 10% compared to the actual values, varying according to location.

According to Resolution No. 510, of April 7, 2016, approved by the National Health Council, research using publicly available information does not require evaluation by a Research Ethics Committee (REC). It should be noted that individual identification of the cases analyzed in this study is not possible, since the data were collected in aggregate form. Nevertheless, all ethical and legal aspects applicable to health research were respected.

RESULTS

From 2001 to 2022, 302,759 cases of SC were reported in Brazil, of which the highest proportion of infections occurred among female newborns (NB) (n = 144,099; 50.7%), of mixed race/skin color (n = 146,377; 62.3%), and up to 6 days of life (n = 285,304; 94.5%). Of these individuals, 95.7% (n = 285,304) were diagnosed with recent CS, and the highest proportion resided in the Southeast region of the country (n = 132,886; 44.0%) (Table 1).

Regarding maternal characteristics, it was observed that 36.8% of infected mothers had 4 to 7 years of schooling (n = 79,307). Most had attended prenatal care (n = 239,969; 84.4%), and syphilis was diagnosed during consultations (n = 144,726; 56.2%). In contrast, 58.9% (n = 157,943) of pregnant women underwent inadequate treatment regimens and approximately three out of four partners of these women did not receive any type of treatment (n = 172,771; 77.7%) (Table 1).

Table 1 – Sociodemographic characterization of congenital syphilis cases in Brazil, 2001-2022. Brazil, 2024.

Variable	Total		p-value
	n	%	
Sex*			
Female	144,099	50.7	<0.005
Male	140,376	49.3	<0.005
Total	**284,475**	**100.0**	
Race/Color†			
Brown	146,377	62.3	<0.005
White	72,619	30.8	<0.005

Black	14,591	6.2	0.016
Indigenous	1,028	0.4	0.393
Yellow	805	0.3	0.843
Total	**235,420**	**100.0**	
Age Group‡			
Up to 6 days	285,304	94.5	<0.005
7 to 27 days	7,151	2.4	0.113
28 days to 11 months	5,875	1.9	0.057
12 months to 23 months	3,575	1.2	<0.005
Total	**301,905**	**100.0**	
Final Diagnosis§			
Recent Congenital Syphilis	279,167	95.7	<0.005
Late Congenital Syphilis	849	0.3	0.054
Stillbirth/Syphilitic Abortion	11,573	4.0	0.044
Total	**291,589**	**100.0**	
Region of Notification**			
Southeast	132,886	44.0	<0.005
Northeast	90,806	30.1	0.008
South	35,906	11.9	<0.005
North	25,686	8.5	0.010
Central-West	16,728	5.5	<0.005
Total	**302,012**	**100.0**	
Mother's Education††			
None	3,956	1.8	<0.005
1 to 3 years of schooling	21,451	10.0	<0.005
4 to 7 years of schooling	79,307	36.8	0.051
8 to 11 years of schooling	62,974	29.3	<0.005
12 or more years of schooling	47,602	22.1	<0.005
Total	**215,290**	**100.0**	
Attended Prenatal Care‡‡			
Yes	239,969	84.4	<0.005
No	44,303	15.6	<0.005
Total	**284,272**	**100.0**	
Time of Diagnosis§§			
During prenatal care	144,726	56.2	0.024
At delivery/curettage	92,776	36.0	0.084
After delivery	20,206	7.8	0.028
Total	**257,708**	**100.0**	
Maternal Treatment Regimen***			
Inadequate	157,943	58.9	0.199
Not Performed	87,664	32.7	0.476
Adequate	22,761	8.4	0.421
Total	**268,368**	**100.0**	

Treated Partner‡‡‡			
No	172,771	77.7	0.007
Yes	49,479	22.3	<0.005
Total	**222,250**	**100.0**	

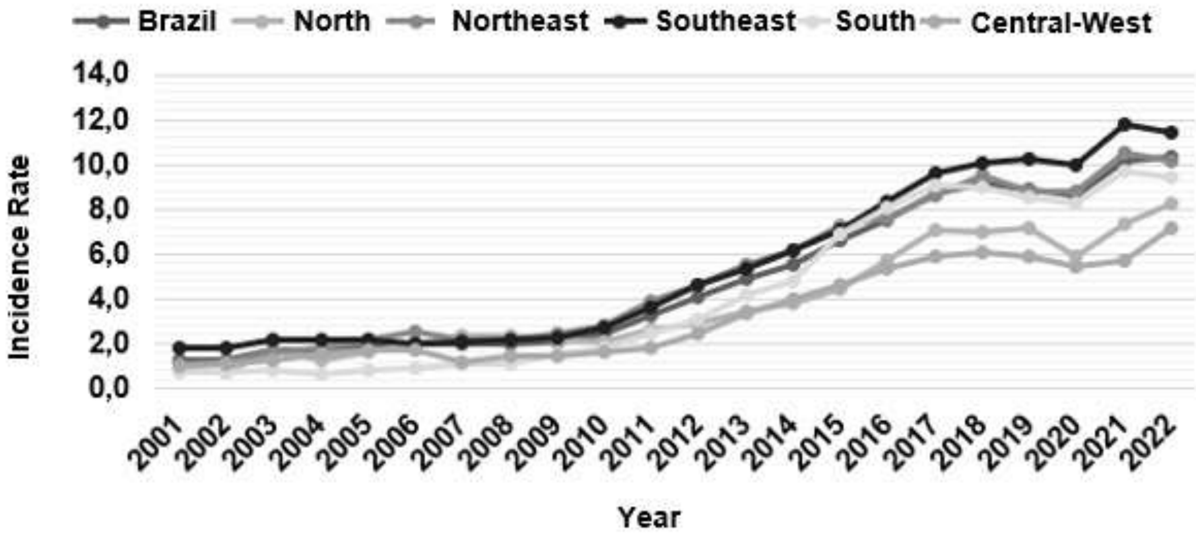
Source: DATASUS, 2024.

* 18,284 cases were excluded because Sex was listed as “Unknown”. †67,339 cases were excluded because Race/Color was listed as “Unknown/Not Filled”. ‡ 854 cases were excluded because they did not fit the desired Age Group. § 11,170 cases were excluded because the Final Diagnosis was listed as “Unknown/Blank”. **747 cases were excluded because the Region of Notification was listed as “Unknown/Blank”. ††87,469 cases were excluded because the Mother’s Education Level was listed as “Unknown/Blank”. ‡‡ 18,487 cases were excluded because Attended Prenatal Care was listed as “Unknown/Blank”. §§ Data obtained from 2007 onwards, and 45,051 cases were excluded because the Time of Diagnosis was listed as “Unknown/Blank”. *** 34,391 cases were excluded because the Maternal Treatment Regimen was listed as “Unknown”. ‡‡‡ 80,509 cases were excluded because the Treated Partner was listed as “Unknown/Blank”.

Overall, an increase in incidence rates was observed in Brazil and its regions over the years, with more than half of the notifications occurring in the last six years alone (n = 154,573; 51.1%). The country presented an average incidence rate of 4.8 cases per 1,000 LB, starting with 1.3 cases per 1,000 LB in 2001 and reaching 10.3 cases per 1,000 LB in 2022, corresponding to a 692.3% increase over the analyzed period. Furthermore, after the sharp decline observed in 2019 and 2020, there was a marked increase in the incidence of CS in Brazil, with the highest rate in the series observed in 2022 (Figure 1).

The Southeast and Northeast regions showed the highest average incidence rates in the country, with 5.4 and 5.1 cases per 1,000 LB, respectively. Meanwhile, the Central-West had the lowest number of cases and the lowest annual incidences in the period studied (n=16,728; 3.2 cases per 1,000 LB). It is worth highlighting the significant increase in the values found when comparing the years 2020 and 2022, with a growth in the incidence rate of CS of 40.7% in the region. North, followed by 33.3% in the Central-West, 14.8% in the Northeast, 14.0% in the Southeast and 13.3% in the South (Figure 1).

Figure 1 – Temporal evolution of congenital syphilis incidence rates in Brazil and Brazilian macro-regions, 2001-2022.

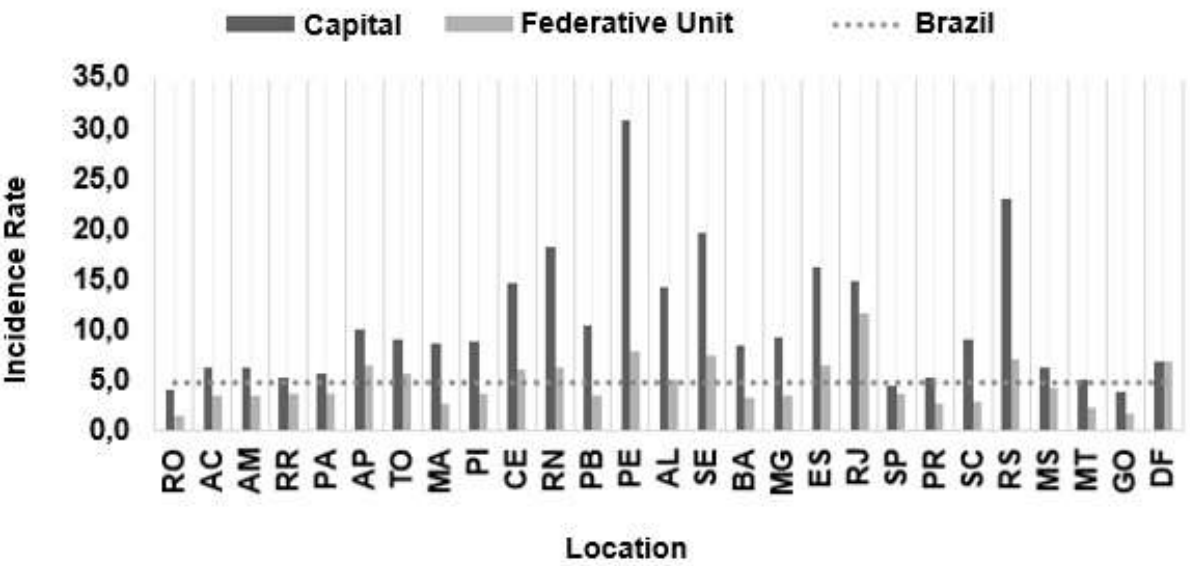


Source: Prepared by the authors based on data available from DATASUS, 2024.

CS in the FU and capitals showed highly variable patterns, highlighting noticeable differences in the standardized average rate values across different locations. The state of Rio de Janeiro exhibited an alarming average incidence (11.7 cases per 1,000 LB), a value 2.4 times higher than the national average. However, only 11 of the 27 states reported rates above the national average, namely: Rio de Janeiro, Pernambuco, Sergipe, Rio Grande do Sul, Federal District, Amapá, Espírito Santo, Rio Grande do Norte, Ceará, Tocantins, and Alagoas (Figure 2).

Regarding the capitals, 24 metropolitan areas exhibited a standardized average incidence rate of CS higher than the Brazilian average. Recife and Porto Alegre recorded 31.1 and 22.6 cases per 1,000 LB, respectively, values significantly higher than the national average (Figure 2). In contrast, Rondônia, Goiânia, and São Paulo were the three capitals that, together with their respective states, showed an average incidence lower than that of the Brazilian territory, with 3.9, 3.9, and 4.3 cases per 1,000 LB, respectively (Figure 2).

Figure 2 – Standardized average incidence rate of congenital syphilis by Federative Units and Capitals, 2001-2022.



Source: Prepared by the authors based on data available from DATASUS, 2024.

The temporal analysis of CS in Brazil, conducted using the Joinpoint method, revealed changes in trends throughout the investigated period, with at least one interval showing an increasing trend in all six studied locations. On the other hand, five of the six evaluated locations showed stationary trends in recent years, except for the Northeast, which exhibited an increasing trend of 4.6% per year (95% CI: 1.9 – 7.3; p=0.003) in the 2015–2022 period (Table 2).

Furthermore, Table 2 shows that the most pronounced growth occurred in the South region from 2007 to 2016, with an annual increase of 28.5% (95% CI: 27.2 – 29.8; p<0.001) in incidence. In Brazil overall, the highest APC occurred from 2009 to 2017, with an annual increase of 18.8% (95% CI: 16.3 – 21.3; p<0.001). The highest significant AAPC occurred in the Northeast, which presented an average annual increase of 11.6% (95% CI: 4.4 – 19.3; p<0.01). In contrast, from 2017 to 2022, Brazil and the North and Southeast regions exhibited a stationary trend.

Table 2 – Annual percentage change and average annual percentage change of congenital syphilis in Brazil, 2001-2022. Brazil, 2024.

Location	**Period**	**APC (95% CI)***	**AAPC (95% CI)†**	**p-vale**	**Trend**
Brazil	2001-2009	6.32‡ (3.4 – 9.3)	10.2‡ (7.5 – 13.0)	**<0.001**	**Increasing**
	2009-2017	18.79‡ (16.3 – 21.3)		**<0.001**	**Increasing**
	2017-2020	-2.21 (-15.3 – 12.8)		0.737	Stationary
	2020-2022	12.94 (-2.1 – 30.2)		0.087	Stationary

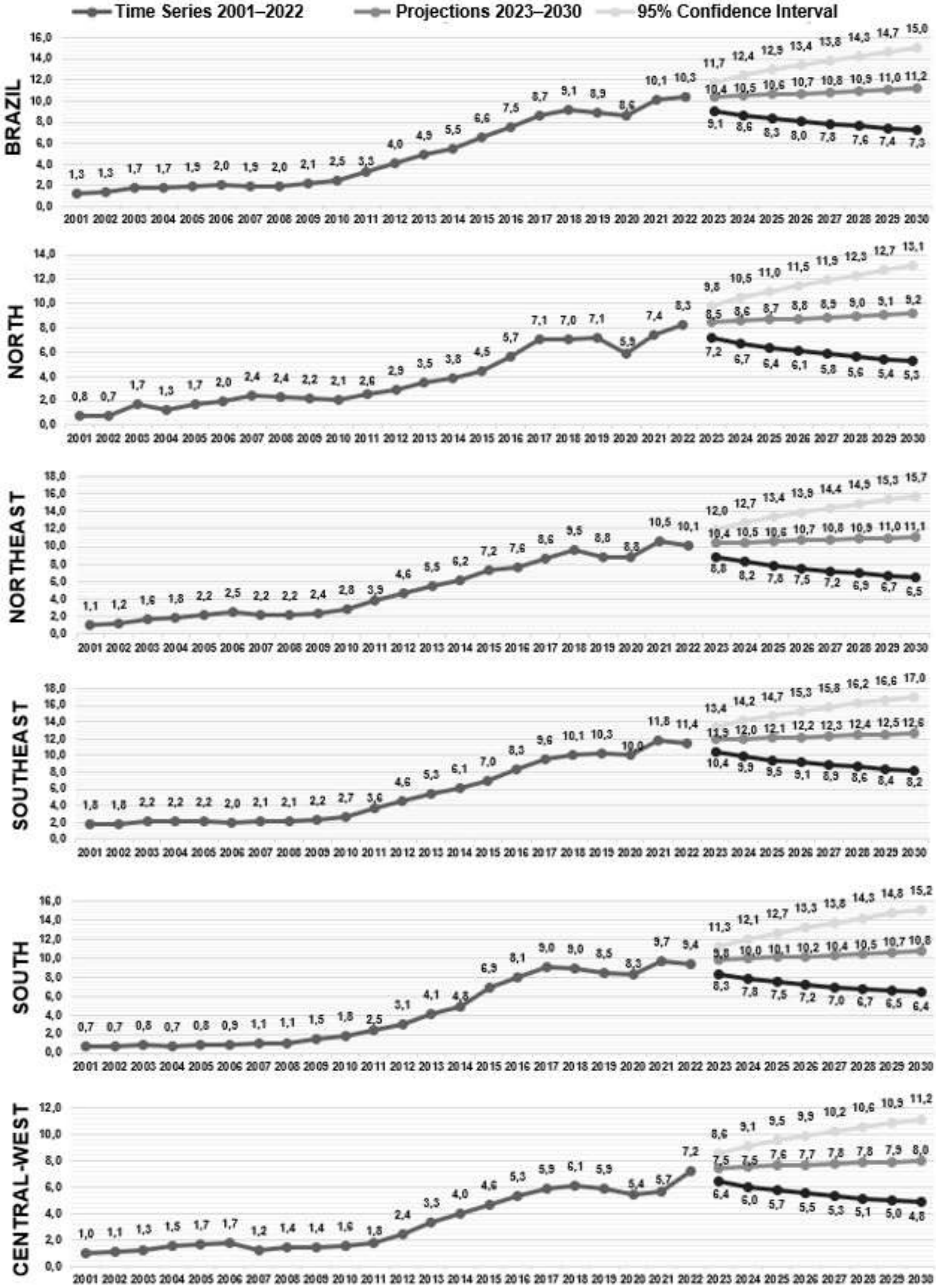
North	2001-2007	18.96‡ (9.7 – 28.9)		**0.001**	**Increasing**
	2007-2010	-4.98 (-44.2 – 61.8)		0.836	Stationary
	2010-2017	18.05‡ (12.9 – 23.4)	10.9‡ (3.2 – 19.3)	**<0.001**	**Increasing**
	2017-2022	2.60 (-1.9 – 7.3)		0.233	Stationary
Northeast	2001-2005	23.35‡ (5.6 – 44.0)		**0.012**	**Increasing**
	2005-2008	-3.18 (-39.1 – 54.0)		0.881	Stationary
	2008-2015	19.65‡ (14.0 – 25.6)	11.6‡ (4.4 – 19.3)	**<0.001**	**Increasing**
	2015-2022	4.57‡ (1.9 – 7.3)		**0.003**	**Increasing**
Southeast	2001-2009	1.40 (-1.0 – 3.9)		0.221	Stationary
	2009-2012	27.52‡ (1.9 – 59.5)		**0.037**	**Increasing**
	2012-2017	16.05‡ (11.4 – 20.9)		**<0.001**	**Increasing**
	2017-2020	1.35 (-10.6 – 14.9)	9.1‡ (5.4 – 13.0)	0.812	Stationary
	2020-2022	11.23 (-1.7 – 25.9)		0.083	Stationary
South	2001-2007	4.10‡ (1.0 – 7.3)		**0.014**	**Increasing**
	2007-2016	28.53‡ (27.2 – 29.8)		**<0.001**	**Increasing**
	2016-2020	-0.04 (-3.1 – 3.1)	13.5 (12.1 – 15.0)	0.976	Stationary
	2020-2022	8.88 (-0.8 – 19.6)		0.071	Stationary
Central-West	2001-2005	14.74 (-2.2 – 34.6)		0.085	Stationary
	2005-2009	-6.20 (-25.8 – 18.6)		0.561	Stationary
	2009-2016	22.91‡ (16.2 – 29.9)	9.4‡ (3.9 – 15.2)	**<0.001**	**Increasing**
	2016-2022	2.49 (-1.1 – 6.2)		0.157	Stationary

Source: Prepared by the authors from data available in DATASUS, 2024.
* APC: Annual Percentage Change; p≤0.05; 95% CI: 95% Confidence Interval
†AAPC: Average Annual Percentage Change; p≤0.05; 95% CI: 95% Confidence Interval.
‡ Statistically significant values; p≤0.05;

Figure 3 presents the predicted incidence rates and their respective 95% CI of CS in Brazil and Brazilian macro-regions for the period from 2023 to 2030. The dark gray central line corresponds to the cases reported in the 22 years analyzed, showing growth in CS incidence rates and a sudden decrease in the period affected by the COVID-19 pandemic. Meanwhile, the line corresponding to the predicted cases (medium gray line) indicates that, from 2023 to 2030, the trend will be an increase in notifications both nationwide and across all regions. It should be noted that the gray lines represent the maximum and minimum detection rates within the 95% CI.

All analyzed locations are projected to show an increase in the coming years. The Southeast region of the country will continue to have the highest rates, with an estimated 12.1 cases per 1,000 LB in 2025 and 12.6 cases per 1,000 LB in 2030, corresponding to an average annual increase of 0.9%. However, by 2030, the total estimated growth of CS incidence rates in Brazil and its macro-regions will be as follows: South (11.2%), Southeast (10.5%), North (9.2%), Brazil (8.3%), Central-West (8.0%), and Northeast (6.8%) (Figure 3).

Figure 3 – Projections of congenital syphilis incidence rates in Brazil and its macro-regions for the period 2023-2030.



Source: Prepared by the authors based on data available from DATASUS, 2024.

DISCUSSION

The findings of this research corroborate the idea that sociodemographic characteristics play a fundamental role in the dynamics of CS transmission in Brazil, as pointed out in other studies[13,14]. Since it is a multifactorial disease, the social context should not be neglected in the approach to syphilis, as individuals in more vulnerable situations face difficulties accessing health services, which undermines adherence to Primary Health Care (PHC), prenatal care, and access to information on prevention[14,15]. Therefore, CS prophylaxis should focus on at-risk population groups through maternal and child health promotion policies.

The results of this investigation are similar to those of studies carried out in Brazil[7] and Canada[16], which showed that a significant portion of children were diagnosed with CS in the first days of life. This indicator reflects a relatively positive reality in the country, since early diagnosis allows treatment to be administered at the appropriate time. On the other hand, the birth of neonates infected with syphilis also reflects a failure in care at all stages prior to delivery, considering that CS is regarded as a sentinel event for assessing the quality of prenatal care[17].

The low educational level prevalent among the mothers of reported children highlights the context of social vulnerabilities frequently observed in the maternal profile of syphilis cases. Research indicates that education level directly influences the incidence of CS, such that the lower the educational level, the higher the likelihood of infection and adverse disease-related outcomes[18,19]. n this context, proper understanding of the disease and its treatment is essential for combating and preventing syphilis during pregnancy, contributing not only to therapeutic adherence, but also to the elimination of vertical transmission.

The present study showed that most mothers of newborns with CS had access to prenatal care and were diagnosed during consultations. These data demonstrate the complexity of addressing vertical transmission of syphilis in the country, since, despite prenatal care and timely detection of the infection, adverse outcomes persisted[19]. Furthermore, among women who received treatment, more than half underwent inadequate therapeutic regimens, and a high proportion of sexual partners were not treated. In this regard, the difficulty of engaging the partners of infected pregnant women is highlighted, as well as the need to develop specific care strategies aimed at this population [20].

In the analysis, a predominance of CS notifications was observed in the Southeast region of the country. However, it is also possible to note that, in this location, there is greater effectiveness of plans and strategies developed for diagnosis, implementation of rapid tests in PHC, performance of serological tests at the time of birth and educational actions to raise awareness about the use of condoms(21). Furthermore, a strong centralization of CS records was identified in the capitals of the federative units, possibly resulting from the structuring of local networks within the Unified Health System (*Sistema Único de Saúde* - SUS). In territories with lower technological capacity, there is a concentration of resources in the metropolitan regions of the states(22).

Similarly, municipalities located in rural areas have less availability of resources and a greater probability of underreporting, which hinders the monitoring of CS indicators(23). In a study conducted in Brazilian cities with international borders, it was observed that 16.0% did not have access to PHC and 28.8% did not administer penicillin for the treatment of syphilis(24). Municipalities with low population density, located far from urban centers, create gaps in healthcare provision, making it difficult to identify cases, provide treatment, and control the infection. Therefore, public policies aimed at expanding access to health services should prioritize less advantaged regions(23,24).

CS is characterized as one of the main indicators of the quality of maternal and child healthcare in Brazil and worldwide(17,25). However, the increase in incidence rates found in this study may also be related to the expansion of testing availability in PHC, due to the mandatory implementation of rapid tests and serological screening in the first and third trimesters of pregnancy. This measure enabled the identification of asymptomatic individuals and, consequently, an increase in the number of notifications(3). Another fundamental aspect was the implementation of the Alyne Network as a new strategy for reducing maternal and infant mortality in the country, including access to screening and treatment of syphilis, HIV and other sexually transmitted infections in the SUS(6).

Joinpoint regression analysis indicated a predominantly increasing trend both in Brazil and in its macro-regions. Part of this increase may be explained by the global penicillin shortage in 2014, considering that no other medication is recommended for the treatment of syphilis during pregnancy (26). Therefore, it is essential to ensure the administration and availability of this substance in the SUS and in public maternity hospitals as a strategy to combat CS(17). On the other hand, it is noteworthy that CS trends are not uniform across Brazilian macro-regions, highlighting regional disparities in the structuring and availability of public health services aimed at disease screening(23,24).

It is important to highlight that the decrease in CS rates from 2019 onwards, as well as the sudden increase in 2021, were also observed in other studies(4,15). In this context, it is believed that the decline is directly related to the COVID-19 pandemic, which, due to social distancing measures, resulted in a reduction in testing and diagnosis of the disease[15]. Due to the major mobilization of health sectors to contain the spread of SARS-CoV-2, the consolidation of cases of various infectious diseases was impaired, leading to a false reduction in incidence rates during this period[4].

Based on the results of this investigation, it is observed that the increasing trend of CS notifications is a behavior that will continue in the coming years. This scenario is an expected consequence due to the population's negative attitudes towards risky sexual habits[4], combined with poor governmental management in addressing the problem[1]. From another perspective, the WHO has indicated that this issue is directly related to the lack of research and guidelines to guide healthcare professionals in developing countries, highlighting the need for supportive measures so that evidence-based interventions can be developed[25].

Due to the high incidence of CS, in 2010, countries in the Americas established a target of 0.5 cases per 1,000 LB by 2015, later revised to reach this value by 2030[1]. However, in 2015, Brazil had a rate of 6.6 cases per 1,000 LB[4], and it is estimated that this figure may reach 11.2 cases per 1,000 LB by 2030, leading to the belief that, at present, the elimination of vertical transmission of CS will not become a reality in the country. On the other hand, countries such as Cuba, Thailand, Anguilla, and Bermuda have received certification of CS elimination within their territories by ensuring prenatal care, early syphilis testing, and adequate treatment for pregnant women and their sexual partners[27].

To improve this national scenario, in 2021, the Guide for Certification of the Elimination of Vertical Transmission of HIV and/or Syphilis was developed, offering municipalities the opportunity to be certified through seals of good practices aimed at eradicating CS[3]. Still, even with indicators and impact targets restructured for the Brazilian reality, the results of this study demonstrate the difficulties in achieving the requirements of this certification. Therefore, it is necessary not only to reward, but also to subsidize the implementation of preventive and control measures, through financing and training of healthcare professionals, in addition to improving the infrastructure of the SUS, to ensure effectiveness in reducing CS rates[4].

In this research, it was identified that CS will continue to show increasing trends and high incidence rates in the coming years, going in the opposite direction to the targets set by governmental entities[1,3]. However, these projections should not be interpreted as deterministic forecasts, but rather as estimates conditioned on the continuation of the current observed trends. In this regard, structural changes in public policies may significantly alter this trajectory in the following years[28]. Thus, the need becomes evident to implement measures that integrate CS screening with health education actions, appropriate treatment for pregnant women and their partners, as well as quality follow-up for NB from the very first moments of life [28,29].

The ARIMA model demonstrated good accuracy in projections for syphilis and other sexually transmitted infections (STIs), such as Acquired Immunodeficiency Syndrome (AIDS), gonorrhea, and hepatitis, in countries such as China[28], Japan[29] and South Korea[30]. As in this study, these studies also predicted an increase in syphilis notifications in the coming years and highlighted the importance of providing epidemiological data for the development of effective countermeasures. Thus, knowledge of CS rate projections allows competent authorities to prepare in advance and optimize the mobilization of resources for disease control[28].

Among the limitations of this study, the underreporting of CS cases stands out, partially explained by the mild or asymptomatic clinical manifestations of the disease. This characteristic contributes to late diagnosis, maintenance of the transmission chain, and difficulty in monitoring the infection. In addition, heterogeneity in the quality of notifications was observed among regions, with worse indicators in the North, a phenomenon that may reflect failures in the local surveillance system and barriers to accessing health services. Even in this context, it is noteworthy that the rates found were alarming, indicating that the national scenario may be even more critical than the data presented suggest, thus requiring urgent attention from health authorities.

Another point to highlight is the low completeness of some sociodemographic variables. Maternal education had 28.9% of records classified as ignored or not completed. A similar situation was observed in the variables partner treatment (26.6%), race/color (22.4%), time of diagnosis (14.9%) and maternal treatment regimen (11.4%). This low quality of notifications partially compromises the reliability of the findings and may result in an underestimation of reality. Despite these methodological limitations, the findings of this study remain robust and relevant, offering a comprehensive view of the evolution of CS in Brazil and enabling the identification of regional disparities in the disease.

Moreover, as this is a study based on aggregated data, it was not possible to analyze individual risk factors or assess local characteristics in greater depth. It is worth noting that obstacles commonly faced by most prediction studies were also observed in this investigation, such as the difficulty in analyzing dynamic health situations and contextual characteristics. These factors may underestimate or overestimate projections of incidence rates in the coming years. However, all presented values are statistically significant and fall within an acceptable margin of error, as established by the 95% confidence interval (95% CI) and the MAE and MAPE accuracy values below 10%.

CONCLUSION

In light of the above, it was evidenced that CS occurred mainly among female newborns, of brown race/color, and up to 6 days old, with a recent diagnosis and residing in the Southeast region of the country. Regarding maternal characteristics, they had 4 to 7 years of schooling, underwent prenatal care, their diagnosis was given during the consultations, and they did not undergo any type of treatment.

The temporal analysis demonstrated changes in trends throughout the period investigated. The AAPC results showed that Brazil and four of its five regions presented an increasing trend during the years studied. Projections of expected cases suggest that, from 2023 to 2030, notifications will continue to rise in the country and in all its regions, with the Southeast remaining the region with the highest CS rates in Brazil.

Therefore, the results of this study provide relevant evidence on past temporal trends and future projections of CS in Brazil. This research aims to contribute to the advancement of scientific knowledge and to support the formulation of more effective strategies to address this condition, serving as a tool to support the planning and implementation of preventive actions. Thus, to achieve these objectives, it is necessary to implement public policies aimed at eliminating the vertical transmission of syphilis, with a focus on case screening, early diagnosis, and timely treatment. In this context, it is essential to expand prenatal care coverage, as well as to ensure governmental support measures, such as financial subsidies and continuing education programs for healthcare professionals involved in maternal and child health.

REFERENCES

1. Organização Mundial da Saúde (OMS). Global Health Sector Strategies on, Respectively, HIV, Viral Hepatitis and Sexually Transmitted Infections for the Period 2022-2030 [Internet]. Geneva: WHO; 2022 [cited 2024 Feb 20]. Available from: https://www.who.int/publications/i/item/9789240053779
2. Tripathy DM, Gupta S, Vasudevan B. Resurgence of syphilis, the great imitator. Med J Armed Forces India [Internet]. 2022[cited 2024 Feb 20];78(2):131-5. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9023770/
3. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde e Ambiente. Departamento de Vigilância, Prevenção e Controle das Infecções Sexualmente Transmissíveis, do HIV/Aids e das Hepatites Virais. Guia para Certificação da Eliminação da Transmissão Vertical de HIV, Sífilis, Hepatite B e Doença de Chagas [Internet]. Brasília: Ministério da Saúde; 2023 [cited 2024 Apr 29]. Available from: https://www.gov.br/aids/pt-br/central-de-conteudo/publicacoes/2023/guia_versao-preliminar.pdf
4. Ministério da Saúde (BR). Secretaria de Vigilância em Saúde e Ambiente. Departamento de Doenças de Condições Crônicas e Infecções Sexualmente Transmissíveis. Sífilis 2024: Boletim Epidemiológico [Internet]. Brasília: Ministério da Saúde; 2024 [cited 2025 Ago 18]. Available from: https://www.gov.br/aids/pt-br/central-de-conteudo/boletins-epidemiologicos/2024/boletim_sifilis_2024_e.pdf
5. Silveira MF, Leon RGP, Becerra F, Serruya SJ. Evolution towards the elimination of congenital syphilis in Latin America and the Caribbean: a multicountry analysis. Rev Panam Salud Publica. 2019;43:e31. https://doi.org/10.26633/RPSP.2019.31
6. Ministério da Saúde (BR). Portaria GM/MS n.º 5.350, de 12 de setembro de 2024. Diário Oficial da União [Internet]. 2024 [cited 2025 Aug 11]. Seção 1: p. 90-94 Available from: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2024/prt5350_13_09_2024.html
7. Araujo GAS, Maranhão TA, Sousa GJB, Silva TL, Silva IG, Vasconcelos MN. Distribuição espaço-temporal e fatores relacionados à sífilis congênita no nordeste brasileiro. Enferm Glob. 2023;22(1):337-383. https://doi.org/10.6018/eglobal.524931
8. Costa IB, Pimenta IDSF, Aiquoc KM, Oliveira AGRC. Congenital syphilis, syphilis in pregnancy and prenatal care in Brazil: an ecological study. PLoS One. 2024;19(6):e0306120. https://doi.org/10.1371/journal.pone.0306120
9. Instituto Brasileiro de Geografia e Estatística (IBGE). Cidades e Estados [Internet]. Rio de Janeiro: IBGE; 2025 [cited 2025 Abr 25]. Available from: https://www.ibge.gov.br/cidades-e-estados.html
10. Kim HJ, Chen HS, Byrne J, Wheeler B, Feuer EJ. Twenty years since Joinpoint 1.0: two major enhancements, their justification, and impact. Stat Med. 2022;41(16):3102–30. https://doi.org/10.1002/sim.9407
11. Popescu TD. Time Series Analysis with Application in Public Health and Biomedical Data. WSEAS Trans Signal Process. 2023;19:139-46. https://doi.org/10.37394/232014.2023.19.15
12. Alabdulrazzaq H, Alenezi MN, Rawajfih Y, Alghannam BA, Al-Hassan AA, Al-Anzi FS. On the accuracy of ARIMA based prediction of COVID-19 spread. Results Phys. 2021;27:104509. https://doi.org/10.1016/j.rinp.2021.104509

13. Ferreira FKS, Rolim ACA, Bonfada D. Perfil dos casos de sífilis congênita no Rio Grande do Norte: estudo de série temporal. Rev Ciên Plural. 2021;7(2):33-46. https://doi.org/10.21680/2446-7286.2021v7n2ID23765
14. Maciel ELN, Zandonade E, Gottems L, Penna GO. Syphilis as a marker of ethno racial inequalities in Brazil. Lancet Glob Health. 2023;11(11):e1670-e1671. https://doi.org/10.1016/S2214-109X(23)00424-2
15. Lima HD, Jesus ML, Paula JF, Jango LH, Pereira JTO. O impacto da pandemia da Covid-19 na incidência de sífilis adquirida no Brasil, em Minas Gerais e em Belo Horizonte. Rev Eletr Acervo Saúde. 2022;15(8):e10874. https://doi.org/10.25248/reas.e10874.2022
16. Public Health Agency of Canada, Canada Communicable Disease Report. Infectious syphilis and congenital syphilis in Canada, 2023 [Internet]. Health Economics in Public Health; 2025 [cited 2025 Aug 18]. Available from: https://www.canada.ca/en/public-health/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2025-51/issue-2-3-february-march-2025/infectious-congenital-syphilis-2023.html
17. Fernandes JFV, Pires RCR, Cantanhede AM, Cordeiro EEDS. Sífilis em gestantes residentes em São Luís, Maranhão: perfil e evolução de 2006 a 2018. RECIIS. 2021;15(2):362-78. https://doi.org/10.29397/reciis.v15i2.2182
18. Paixao ES, Ferreira AJF, Pescarini JM, Wong KLM, Goes E, Fiaccone R, et al. Maternal and congenital syphilis attributable to ethnoracial inequalities: a national record-linkage longitudinal study of 15 million births in Brazil. Lancet Glob Health. 2023;11(12):e1889-e1898. https://doi.org/10.1016/S2214-109X(23)00405-9
19. Neta ME, Oliveira e Silva CS, Silva Jr RF, Eleutério TP, Holzmann APF, Ruas EFG, et al. Prevalência e fatores associados à sífilis em gestantes atendidas na atenção primária à saúde de um município do sudeste do Brasil. Rev Bras Saúde Matern Infant. 2024;24:e20230188. https://doi.org/10.1590/1806-9304202400000188
20. Fernandes LPMR, Souza CL, Oliveira MV. Oportunidades perdidas no tratamento de parcerias sexuais de gestantes com sífilis: uma revisão sistemática. Rev Bras Saúde Mater Infant. 2021;21(2):361-8. https://doi.org/10.1590/1806-93042021000200002
21. Padovani C, Oliveira RR, Pelloso SM. Syphilis in during pregnancy: association of maternal and perinatal characteristics in a region of southern Brazil. Rev Latino-Am Enfermagem. 2018;26:e3019. https://doi.org/10.1590/1518-8345.2305.3019
22. Ferreira HRP, Ferreira JCSC, Pereira MKA, Alencar SRS, Ferreira LFO. Análise dos casos de sífilis gestacional e congênita no estado do Piauí entre os anos de 2008 a 2018. Rev Bras Cienc Saúde. 2022;26(2):131-142. https://doi.org/10.22478/ufpb.2317-6032.2022v26n2.59499
23. Lucena HNS, Aquino BCOS, Nascimento RCA, Queiroz AAR, Barreto VP, Medeiros ER, et al. Distribuição espacial e temporal da sífilis congênita na população potiguar. Enferm Foco (Brasília). 2023;14:e-202319. doi: https://doi.org/10.21675/2357-707X.2023.v14.e-202319
24. Lannoy LH, Santos PC, Coelho R, Dias-Santos AS, Valentim R, Pereira GM, Miranda AE. Gestational and congenital syphilis across the international border in Brazil. PLoS One. 2022;17(10):e0275253. https://doi.org/10.1371/journal.pone.0275253
25. Organização Mundial da Saúde (OMS). Governance for the Validation of Elimination of Mother-To-Child Transmission of HIV, Syphilis and Hepatitis B Virus [Internet].

Geneva: WHO; 2022 [cited 2024 May 26]. Available from: https://www.who.int/publications/i/item/9789240056961

26. Organização Mundial da Saúde (OMS). Implementing the global health sector strategies on HIV, viral hepatitis and sexually transmitted infections, 2022–2030: report on progress and gaps 2024 [Internet]. Genebra: OMS; 2024 [cited 2025 Aug 18]. Available from: https://www.who.int/publications/i/item/9789240094925
27. Jo W, Kim SM, Kim SY, Kim HG, Park HS, Park SY, et al. Congenital syphilis: a practical review for clinicians. Clin Microbiol Rev. 2023;36(3):e00126-22. https://doi.org/10.1128/cmr.00126-22
28. Zhu Z, Zhu X, Zhan Y, Gu L, Chen L, Li X. Development and comparison of predictive models for sexually transmitted diseases—AIDS, gonorrhea, and syphilis in China, 2011–2021. Front Public Health. 2022;10:966813. https://doi.org/10.3389/fpubh.2022.966813
29. Kasamatsu A, Otsuka M, Takahashi T, Arima Y, Arashiro T, Ito H, et al. Epidemiology of syphilis among female sex workers and pregnant women during a period of increasing syphilis among women in Japan, 2019–2021. Sex Transm Infect. 2024;100(1):55-6. https://doi.org/10.1136/sextrans-2023-055934
30. Song YJ, Choi H. Seasonality of syphilis in males through the 2011 to 2019 mandatory surveillance period: a cross-sectional study in South Korea. Medicine (Baltimore). 2023;102(50):e36723. https://doi.org/10.1097/MD.0000000000036723

Data and material availability
The supplementary data used for the development of this article are available in the RGE repository on SciELO Data.
https://doi.org/10.48331/SCIELODATA.VKBSUS

Authorship contribution
Conceptualization: Thalis Kennedy Azevedo de Araujo, Thatiana Araujo Maranhão.

Data curation: Thatiana Araujo Maranhão, George Jó Bezerra Sousa.

Formal analysis: George Jó Bezerra Sousa, Luís Felipe Oliveira Ferreira, José Cláudio Garcia Lira Neto, Maria Lúcia Duarte Pereira.

Investigation: Maria Madalena Cardoso da Frota, Maria Izabel Félix Rocha, Maria Lúcia Duarte Pereira.

Methodology: Thalis Kennedy Azevedo de Araujo, Thatiana Araujo Maranhão.

Project administration: Thalis Kennedy Azevedo de Araujo, Maria Madalena Cardoso da Frota.

Supervision: Maria Madalena Cardoso da Frota, Thatiana Araujo Maranhão, George Jó Bezerra Sousa.

Visualization: Luís Felipe Oliveira Ferreira, José Cláudio Garcia Lira Neto, Maria Lúcia Duarte Pereira, Maria Izabel Félix Rocha.

Writing-original draft: Thalis Kennedy Azevedo de Araujo, Maria Madalena Cardoso da Frota.

Writing-review & editing: Thatiana Araujo Maranhão, Luís Felipe Oliveira Ferreira, José Cláudio Garcia Lira Neto, Maria Lúcia Duarte Pereira.

The authors declare that there is no conflict of interest.

Corresponding author

Maria Madalena Cardoso da Frota
frotamadalena2001@gmail.com

Received: 05.29.2025
Approved: 09.12.2025

Associate editor:
Ricardo de Mattos Russo Rafael

Editor-in-chief:
João Lucas Campos de Oliveira