

Temporal trends in tetanus incidence and lethality in Brazil: analysis of the national database from 2009 to 2018

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SUMMARY

OBJECTIVE: This study aimed to analyze the epidemiological and hospital characteristics of cases and deaths due to accidental tetanus in Brazil.

METHODS: A time-series study with secondary data extracted from the Department of Informatics of the Brazilian Unified Health System. The time series were evaluated by linear regression parameters, considering a significance level of 1%.

RESULTS: A total of 2,772 cases were reported between 2009–2018. Predominant cases were men and aged between 40–59 years old, with incomplete 1st–4th grade. The lethality rate was found to be predominant in women, whites, illiterates, and those who aged above 80 years. The overall lethality was 32.5%. The incidence rate reduced from 1.6 in 2009 to 0.95 per million inhabitants in 2018, but lethality increased from 30.77–40.70%. The highest rate of incidence and lethality occurred in the elderly people and in the northern region.

CONCLUSION: The high cost and lethality of tetanus configure it as a public health problem. The demonstration of the epidemiology of patients who most evolve to death can help to contribute to a reduction in lethality, which shows an increase in the analysis period. Finally, special attention should be given to the elderly people and those living in the northern region.

KEYWORDS: Tetanus. Incidence. Epidemiology. Brazil.

INTRODUCTION

Tetanus is an infectious and noncontagious disease caused by the anaerobic gram-positive bacteria. *Clostridium tetani* can enter the body through a continuity solution caused by injury in the skin or mucosa¹. Inside the host, the bacterium finds favorable conditions to multiply, take on a filamentous form, and produce neurotoxins². Tetanospasmin neurotoxin can act on the nerve terminals, resulting in the failure to inhibit motor reflexes, and generalized contractions of the agonist and antagonist muscles, causing tetanic spasms^{3,4}.

Treatment includes debridement of focus, antibiotic therapy, immunization, neuromuscular blockers, and early tracheostomy⁵.

The high lethality rate and complications of this disease occur mainly due to the dysfunction of the respiratory muscles⁶. All these factors make the treatment of tetanus more complex and expensive for the health system⁷.

Despite its acute and severe behavior, tetanus is an immune preventable disease. According to the Basic Vaccination Calendar adopted by the Ministry of Health of Brazil, tetanus immunization, the pentavalent vaccine, should be administered at 2, 4, and 6 months, with boosters at 12–15 months and 4 years as diphtheria-tetanus-pertussis (DTP) vaccine, and between 10–19 years old as diphtheria and tetanus (DT) vaccine, and needs reinforcement every 5 or 10 years if at risk or during

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Conflicts of interest: the authors declare there is no conflicts of interest. Funding: This work was financially supported by the Research Support Foundation of Maranhão State (FAPEMA) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) [Finance Code 001].

Received on September 16, 2021. Accepted on September 17, 2021.

pregnancy⁸. In addition to scheduled vaccination, an emergency prophylactic dose after exposure to risky situations can reduce by approximately four times the patient's chance of progressing to death^{9,10}.

In 2020, global tetanus incidence data estimated the occurrence of 11,763 new cases, with the European continent having the lowest incidence and the African continent having the highest incidence, followed by South-East Asia¹¹. In Brazil, between 1982 and 2006, tetanus cases reduced by more than 80%, from 1.8–0.22 cases per 100,000 inhabitants. However, the lethality rate did not reduce¹². This situation is especially worrisome since tetanus is an immune-preventable disease. For this reason, more efficient health measures are desirable, with an approach at the collective level and with interventions at wide population coverage.

Therefore, considering the high lethality of tetanus, the high cost of treating this condition in addition to the scarcity of recent studies that address the epidemiological, hospital, and mortality characteristics of tetanus in Brazil, the objective of the present study was to investigate the epidemiological profile of cases reported and deaths from tetanus, by Brazilian macro-regions from 2009–2018.

METHODS

A time-series study was conducted with secondary data extracted from the Department of Information of the Brazilian Unified Health System (DATASUS). The variables collected included information on the epidemiological profile and hospital data on cases and deaths from tetanus reported in Brazil from 2009–2018. Analyses were carried out at the national geographical levels, the Brazilian macro-regions (North, Northeast, Midwest, Southeast, and South), and the Federative Unit of Brazil.

Secondary data were extracted from the Information System for Notifiable Diseases (SINAN) and the Hospital Information System of the Unified Health System (SIH/SUS). In addition, population data were obtained through census data and estimates collected on the platform of the Brazilian Institute of Geography and Statistics (IBGE).

The following variables were collected: educational status, sex, race, age group, type of disease, the evolution of the disease, number of hospitalizations, average hospitalization value, the average length of stay, and deaths during hospitalization. Notified cases of neonatal tetanus were excluded. The average amount spent on hospitalization was obtained by the total value of hospitalizations divided by the number of hospitalizations. The average length of stay was obtained by the sum of all days spent divided by the number of hospitalizations.

The lethality rate was calculated using the ratio between the number of cases with evolution to death and the total number of

reported cases of tetanus in the same region and year. The tetanus incidence rate was calculated by macro-region and age group.

Statistical analysis used GraphPad Prism version 9.1 (GraphPad Software Inc., San Diego, CA, USA). Descriptive statistics included measures of absolute and relative frequency. Time series were evaluated using parameters estimated through linear regression. The level of significance adopted was 1%.

RESULTS

In Brazil, 2,772 cases of tetanus were reported from 2009–2018 and were distributed as follows: 918 in the Northeast (NE), 625 in the Southeast (SE), 545 in the South (S), 361 in the North (N), and 323 in the Midwest (CO). The three states with the highest numbers of tetanus cases were Minas Gerais, Rio Grande do Sul, and São Paulo.

The reported cases of tetanus in Brazil reduced during 10 years of analysis (325 cases in 2009, declining to 199 cases in 2018). An important finding in the analysis of the time series was the significant reduction in cases in the NE over time ($\sim 50\%$; $\beta = -6.9$; $p = 0.003$). The other regions showed stable behavior in the period (Figure 1A).

The overall incidence in Brazil decreased from 1.7 per million inhabitants in 2009 to 0.95 per million inhabitants in 2018. The greatest reduction was in the Midwest region, from 3.3 per million inhabitants in 2009 to 0.75 per million inhabitants in 2018 (Figure 1B). In all these years, the Southeast region had the lowest incidence, and the Northeast ($p = 0.001$) showed a significant decrease.

In the analysis of the time series, there was an increase in lethality by tetanus in Brazil, being 30.77% in 2009 and 40.70% in 2018, with emphasis on the increase of the lethality observed in the Northeast region, with 25.41% lethality in 2009 and 47.54% in 2018 ($p = 0.007$). The highest lethality rate was in the North region at 48.6% in 2016 and the lowest in the Midwest at 4.5% in 2017 (Figure 1C). When the incidence rate was analyzed by age group, the highest rate occurred in those who aged ≥ 60 years (Figure 1D).

The highest proportion of cases occurred in individuals with low schooling. The male gender predominated in the approximate proportion of six men for each woman (6:1). The most frequent age group was 40–59 years (Table 1).

Due to the high lethality of tetanus, this study further analyzed the epidemiological profile associated with death. The lethality rate was higher among illiterates, whites, females, and those who aged above 65 years (Table 1).

There were 1,993 admissions to the hospital due to tetanus. The average value of each hospitalization was R\$ 5,522.61, with an average stay of 17 days and a lethality rate of 19.5% during hospitalization. Table 2 shows distribution according to region.

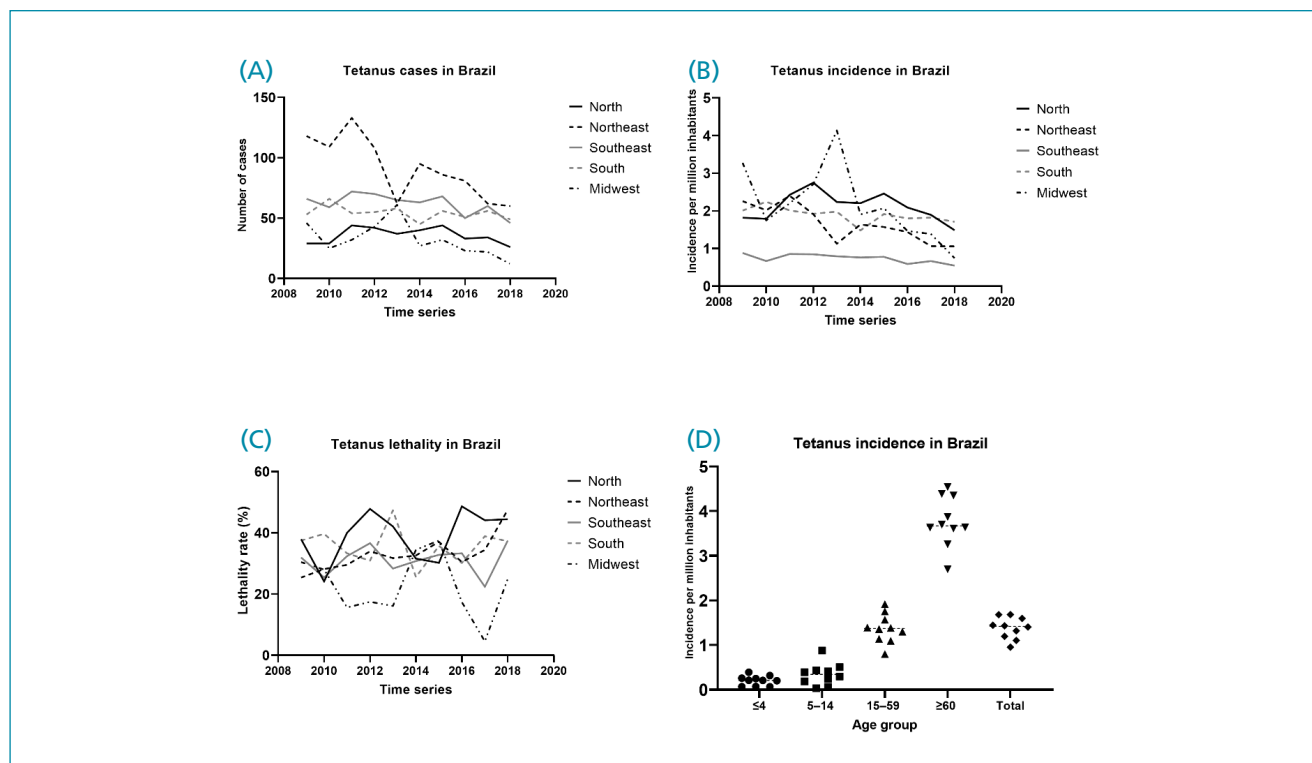


Figure 1. (A) Time series of tetanus cases; (B) tetanus incidence rate per million inhabitants; (C) tetanus lethality rate in Brazil according to macro-region; (D) and tetanus incidence rate in Brazil according to age group.

DISCUSSION

The main findings of the present study show that reported cases of tetanus in Brazil from 2009–2018 predominated in individuals from the 1st–4th grade of elementary school and in males in the approximate proportion of 6:1 when compared with females. The age group most affected was 40–59 years. Our findings are in agreement with other studies carried out in Brazil with other time frames¹³.

The higher prevalence in men can be explained by their greater exposure to work activities, in addition to the routine vaccination of pregnant women in prenatal care¹⁴. The predominance in adults and the elderly people emphasizes that strategies are also needed to update the vaccination calendar of this group, as well as that of the population with low education, and not only in maternal and child vaccinations¹⁵.

The incidence rate for Brazil in 2009 when compared with that of the USA (0.1 per million inhabitants in 2008) was approximately 10 times higher¹⁶. Some explanations for this finding are that less than 50% of people with acute injuries seek health care in Brazil and some patients fail to receive post-exposure tetanus prophylaxis due to the harmless appearance of some injuries¹⁷. According to the European Center for Disease Prevention and Control, the incidence rate in Europe in 2017 (0.2 per million inhabitants) was also lower than in Brazil¹⁸.

Despite the still high rate, our study, as well as other studies, showed a reduction from 1.7 per million inhabitants to 0.95 per million inhabitants, from 2009–2018, the largest reduction in the Midwest region. This reduction may be due to greater access to health services, better vaccination coverage, and greater educational and socioeconomic development^{14,15}.

The highest rate of tetanus incidence in individuals aged ≥ 60 years is in line with national and international literature¹⁵. This greater risk is due to inadequate vaccination, as the vaccine is sufficiently immunogenic in the elderly people¹⁶. Furthermore, over the years, psychomotor capacity and perception of space have decreased, resulting in the elderly people more susceptible to accidents¹³.

Great emphasis has been placed on maternal and child vaccination. However, when establishing strategies that focused on certain groups, managers take the risk of neglecting others. Therefore, vaccination campaigns regardless of sex and age, training of health professionals, and observation in each contact as a timely way of immunization are necessary¹⁹. In addition to vaccination strategies, it is essential to pay attention not only to the risk of tetanus in acute injuries but also to how protocols are formulated for managing chronic injuries that are common in the elderly people¹⁷.

Table 1. Descriptive analysis of tetanus cases and lethality rate reported in Brazil (2009–2018).

	Categories	Cases		Lethality rate
		n	%	%
Educational level (in years)	Illiterate	141	5.09	42.55
	<Grade 4 (elementary school)	418	15.08	33.73
	Grade 4 (elementary school)	160	5.77	31.25
	5–8 (elementary school)	289	10.43	23.53
	Complete elementary school	169	6.10	33.73
	Incomplete high school	83	2.99	25.30
	Complete high school	135	4.87	25.93
	Incomplete graduate level	12	0.43	8.33
	Complete graduate level	26	0.94	30.77
	Not applicable	42	1.52	–
	No data	1,297	46.79	–
Color/race	White	878	31.67	34.97
	Black	225	8.12	32.00
	Yellow	28	1.01	14.29
	Brown	1,417	51.12	31.97
	Indigenous	8	0.29	25.00
	No data	216	7.79	–
Sex	Male	2,360	85.14	31.02
	Female	412	14.86	41.02
Age group (years)	<1	18	0.65	27.78
	01–04	13	0.47	30.77
	05–09	38	1.37	18.42
	10–14	77	2.78	24.68
	15–19	99	3.57	11.11
	20–39	576	20.78	22.92
	40–59	1,106	39.90	31.74
	60–64	255	9.20	34.51
	65–69	220	7.94	45.00
	70–79	277	9.99	47.29
	80 or above	93	3.35	58.06
	1st trimester	1	0.04	0.00
	2nd trimester	2	0.07	100.00
	Without gestational age data	1	0.04	100.00
	No	263	9.49	39.92
	Not applicable	2,486	89.68	31.62
	No data	19	0.69	–
Autochthone	Yes	2,261	81.57	33.83
	No	219	7.90	31.96
	No data	292	10.53	–
Case follow-up	Recovery	1,470	53.03	–
	Death by tetanus	901	32.50	–
	Death by another cause	61	2.20	–
	No data	340	12.27	–

Table 2. Tetanus data from Brazilian Unified Health System (2009–2018).

Macro-region	Hospital admission	Average cost (in R\$)	Average stay (in days)
North	313	3,468.32	12.7
Northeast	637	4,688.28	18.1
Southeast	444	7,348.89	19
South	398	6,572.74	16.9
Midwest	141	5,137.1	14.9
Total	1,933	5,522.61	17

The lethality of tetanus in Brazil was 32.5%, similar to Nigeria but much higher than that in developed countries, such as the USA (13.2%)¹⁶ and Japan (6.8%)²⁰. The outcome of tetanus cases is primarily related to the quality of care, early diagnosis, and treatment^{21,22}. A systematic review of 27 studies involving 3,043 patients showed that the mortality rate in African patients was 43%. This high lethality was because mechanical ventilation is not accessible in many medical facilities²³.

In the present study, the lethality rate was higher in illiterates, whites, females, and those who aged above 65 years old. Evidence has demonstrated a greater chance of progressing to death in female patients (3.46 times more than in men) and in those who aged above 60 years¹⁹.

The average value of each hospitalization was R\$ 5,522.61 (Brazilian real BRL), sufficient to purchase about 12,500 vaccines, considering that the value of one dose of the DT vaccine (adult double) was approximately R\$ 0.41²⁴. This reinforces the cost-benefit of vaccination policies, regardless of age and gender.

Studies have shown the high cost of treatment and support for tetanus. Some developed countries such as the United Kingdom have used the Tetanus Quick Stick (TQS) test,

a rapid test to assess serological status in individuals with suspected lesions, to avoid unnecessary expenses with prophylaxis, since less than 50% of patients remember about their vaccination²⁵. However, it is necessary to assess the cost-benefit in Brazil.

The wide variation between mortality during hospitalization, length of stay, and costs in Brazilian regions suggest intense variability within the same country in the management of patients with tetanus. Health professionals' knowledge of post-injury prophylaxis and tetanus management is essential. Thus, it is necessary to train and update professionals who work in a hospital environment²⁴. These findings could help researchers, health workers, and health system administrators in planning more effective intervention strategies to reduce tetanus incidence across diverse Brazilian regions. In addition, the findings indicate that new policies must be planned considering specific strategies for the most vulnerable population groups.

CONCLUSION

The study findings showed that the tetanus incidence rate in Brazil is declining. However, special attention should be paid to the elderly people, who have the highest incidence rate and the highest lethality. Greater attention is also needed in the northern region, due to the higher lethality of tetanus as well as the predominance of the highest incidence rate in Brazil, in most years.

AUTHORS' CONTRIBUTIONS

LCC: Conceptualization, Data curation, Formal Analysis, Writing – original draft. **CPCM:** Conceptualization, Investigation, Writing – review & editing. **VPR:** Project administration, Data curation, Formal analysis, Validation, Writing – review & editing.

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