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Original research

# Prevalence of trachoma in indigenous and non-indigenous areas, Northeastern Brazil, 2019–2021

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**ABSTRACT**

**Objective.** To estimate the prevalence of trachoma in indigenous and non-indigenous populations in selected areas of the state of Maranhão, in northeastern Brazil.

**Methods.** This was a population-based survey with probabilistic sampling. For the diagnosis of trachoma, external ocular examination was performed using head magnifying loupes, at 2.5X magnification. The prevalence of trachomatous inflammation – follicular (TF) in children aged 1–9 years and the prevalence of trachomatous trichiasis (TT) in the population aged ≥15 years were estimated. Relative frequencies of sociodemographic and environmental characteristics were obtained.

**Results.** The study included 7 971 individuals, 3 429 from non-indigenous populations and 4 542 from indigenous populations. The prevalence of TF in non-indigenous and indigenous populations was 0.1% and 2.9%, respectively, and the prevalence of TT among indigenous populations was 0.1%.

**Conclusions.** The prevalence of TF and TT in the two evaluation units in the state of Maranhão were within the limits recommended for the elimination of trachoma as a public health problem. However, the prevalence of TF was higher in the indigenous evaluation unit, indicating a greater vulnerability of this population to the disease. The prevalence of TF of below 5.0% implies a reduction in transmission, which may have resulted from improved socioeconomic conditions and/or the implementation of the World Health Organization SAFE strategy.

**Keywords** Trachoma; neglected diseases; prevalence; health surveys; Brazil.

Trachoma is a neglected tropical disease (NTD) and one of the main causes of preventable blindness in the world (1). Its etiological agent is the bacterium *Chlamydia trachomatis*, which is associated with low socioeconomic conditions, low human development rates, and poor basic sanitation. The main form of transmission is direct contact through hands contaminated with conjunctival secretions of an individual with trachoma, and indirect transmission through flies or fomites also occurs (2).

The World Health Organization (WHO) recommends the SAFE strategy: Surgery to correct trachomatous trichiasis, Antibiotic treatment to cure infection, Facial cleanliness, and Environmental improvement to advance the elimination of trachoma as a public health problem (3). Trachoma is recognized as a public health problem in at least 44 countries, and by 2023, 15 countries had confirmed the elimination of trachoma. In Latin America, the elimination of trachoma was confirmed in

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Mexico in 2017, but it persists in parts of Brazil, Colombia, Guatemala, and Peru (4, 5).

The indicators of elimination of trachoma as a public health problem are as follows: prevalence of trachomatous inflammation – follicular (TF) in children aged 1–9 years of <5% in endemic districts; prevalence of trachomatous trichiasis (TT) unknown by the health system of <2 per 1 000 population aged 15 years or older in endemic districts; and a health system capable of managing incident cases of TT (6). The goal of eliminating trachoma is aligned with the Sustainable Development Goal of accelerating the elimination of NTDs by the year 2030 (7).

In Brazil, trachoma was considered one of the biggest public health problems until the mid-twentieth century, but the prevalence subsequently decreased considerably. However, according to the last national trachoma survey of schoolchildren (period 2002–2008), the mean prevalence of TF was 5.0%, and in some states the prevalence was above the national average. Different clinical forms of trachoma in indigenous communities have been reported since the 1990s, with the prevalence of TF ranging from 12.5% to 47.4% (8, 9).

Based on this evidence, and with the aim of eliminating trachoma as a public health problem, efforts were made in vulnerable areas, such as team training, treatment of cases and household contacts, monitoring of the epidemiological situation, as well as implementation of the SAFE strategy.

To assess the epidemiological situation of trachoma in Brazil and whether the global goals of elimination of trachoma had been achieved, the Ministry of Health conducted a prevalence survey between 2018 and 2023 in non-indigenous and indigenous populations, considering in the latter the cultural and social differences and their greater vulnerability. As part of the national survey, this study sought to estimate the prevalence of trachoma and identify sociodemographic and environmental risk factors for trachoma in indigenous and non-indigenous populations in selected areas of the state of Maranhão.

## MATERIALS AND METHODS

### Study design

This study was a population-based survey with three-stage probabilistic sampling. The methods used in the survey followed the recommendations of the Global Trachoma Mapping Project (GTMP) (10) and were described in detail in a previous publication (11).

For the selection of the survey evaluation units (EU), 10 EUs in non-indigenous areas and 5 EUs in indigenous areas in Brazil were selected according to specific criteria (11), including 2 EUs in the state of Maranhão, which is considered one of the primary foci of the disease in Brazil, and is analyzed in this study.

### Context

The national survey was conducted in the non-indigenous EU in 2018 and 2019, and in the indigenous EU in 2021. This study considers the two EUs surveyed in the state of Maranhão, located in the Northeast region of Brazil. The microregions of Chapadinha and Codó, belonging to the mesoregion of Leste Maranhense, were selected as the non-indigenous EU. The selected municipalities were: Chapadinha, Coroatá, Mata Roma, São Benedito do Rio Preto, and Timbiras. The indigenous EU comprised all the subdistricts (*polo base* in Portuguese) and 18 villages belonging to the Special Indigenous Sanitary District of Maranhão (Dsei-MA), distributed in 10 municipalities: Bom Jardim, Centro do Guilherme, Maranhãozinho, Grajaú, Arame, Fernando Falcão, Jenipapo dos Vieiras, Barra do Corda, Amarante, and Montes Altos (Figure 1).

### Participants and sample size

For the selection of EUs (defined as aggregate areas in strata with populations ranging from 100 000 to 250 000 inhabitants) in non-indigenous areas in the country, homogeneous mesoregions were considered according to the territorial division of the Brazilian Institute of Geography and Statistics (12), with at least one municipality at epidemiological risk of trachoma. The following indicators of poverty and sanitation were considered: average monthly income of people aged 10 years or older (with and without income) below one-fourth of the minimum wage and <30% households with water supply from the general network. For mesoregions that contained a rural population of more than 250 000 inhabitants, homogeneous microregions were combined to make up the EU. Thirty clusters were randomly selected from each EU, and 30 households were visited in each cluster. A total of 900 households were surveyed in each EU (11).

For the selection of EUs in indigenous areas, the Special Indigenous Health Districts (Dsei) were considered. The Dsei service network uses the subdistricts, which can be located either in a nearby municipality or in a village, as a primary care clinic (13). As a criterion for inclusion of the Dsei, the size of the population, geographic location, and proximity to non-indigenous EUs were considered, to allow for comparison between the indigenous and non-indigenous EUs.

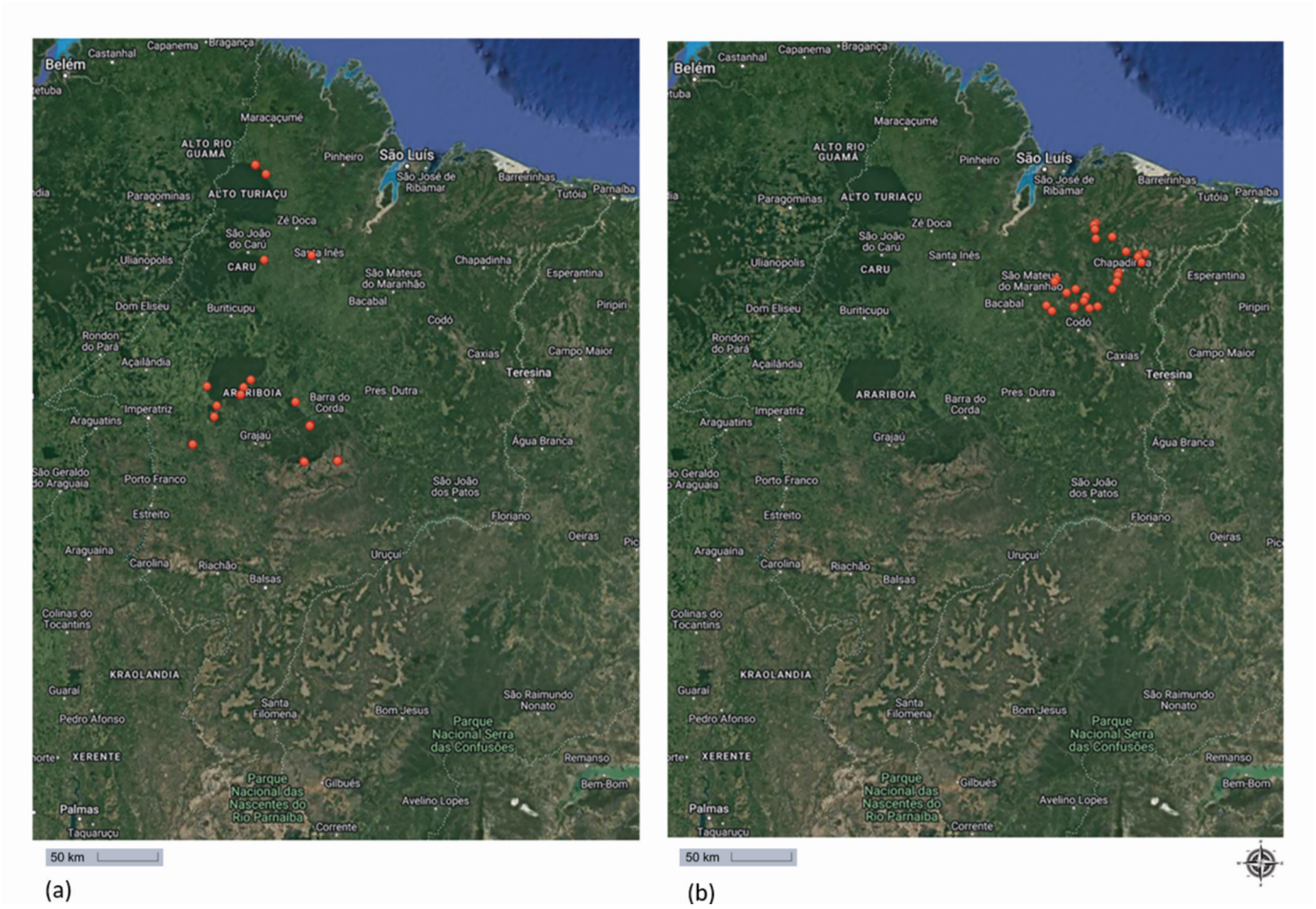
### Data collection and instruments

For data collection, we used the questionnaire recommended by Tropical Data (TD), which is an organization responsible for supporting national programs that adopt the GTMP methodology (14), adapted to the Brazilian context. The questionnaire was divided into three parts: the first part focused on information about the EU; the second part focused on the household, where a person over 18 years of age answered questions related to basic sanitation and hygiene; and the third part focused on the individual residents of the household, including their sociodemographic characteristics and eye examination results. In each household, all residents aged 1 year or older were examined for the presence of trachoma. If any resident was absent at the time of the first visit, at least one more visit was made.

The field team received training in advance according to the TD manuals and consisted of an examiner, a recorder, a community health/indigenous health agent who accompanied the team in the territory and acted as a translator when necessary, and a driver. A pilot study was conducted in an area close to the EU to standardize the field procedures. Data were collected using mobile phones with Android operating system and stored securely until further use; the data were downloaded and sent to a TD server when the field team arrived at a location where they could connect to the Internet.

For the classification of trachoma, external ocular examination was performed using head magnifying loupes, at 2.5X

**FIGURE 1. Maranhão evaluation units, (a) indigenous, (b) non-indigenous**




***Source:*** Tropical Data. Available from: https://www.tropicaldata.org/brazil.

magnification, with a flashlight and finger stickers used as a guide to ensure that the identified follicles were at least 0.5 mm in diameter. All cases of trachoma were defined according to the WHO classification (15). The cases and their household contacts were treated at the time of the survey (16).

## Variables and statistical methods

The absolute frequency and relative frequency proportions of the demographic and clinical examination-related variables were calculated, in addition to those that characterized the structure of the sample households. Additionally, chi-square tests of independence were performed to evaluate the difference between proportions in the samples from the two EUs at the 95% level.

The prevalence of TF in children aged 1–9 years was adjusted only by age, and the prevalence of TT in the population aged ≥15 years was adjusted for sex and 5-year age group, using the population distribution data for the EUs from the latest available Brazilian Demographic Census from 2010 (17). EU-level adjusted prevalence estimates were calculated using the TD algorithms programmed using R statistical software, available from https://github.com/itidat/tropical-data-analysis-public, which are based on the GTMP. The adjusted prevalence of TF was stratified according to sex, age group, and characteristics related to the water supply and sanitary facilities of the household. The 95% confidence intervals (CI) for prevalence were estimated using bootstrapping. The 2.5th and 97.5th percentiles of the mean values found in 10 000 resamples of the original set of clusters were considered as the lower and upper limits of the interval, respectively. The 95% CI was not reported if the sample size was small ($n < 30$) or if the variance between clusters was zero. Stratified estimates and respective CIs were calculated in SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA), according to the TD algorithms to maintain comparability.

## Ethical aspects

The study was approved by the Research Ethics Committee of the Oswaldo Cruz Foundation (Statement No. 2 742.820 and 3 963.166) and the National Council for Research Ethics (Statement No. 4 274.934). The procedures followed were in accordance with the ethical standards of the responsible committees on human experimentation and in accordance with the principles of 1964 Declaration of Helsinki and later amendments.

## RESULTS

### Participant characteristics

Fieldwork was carried out in the Leste Maranhense EU from 21 August to 3 September 2019 and in the Dsei-MA EU from 15 November to 5 December 2021. This study included data from 7 971 individuals: 3 429 from the Leste Maranhense EU and 4 542 from the Dsei-MA EU.

Table 1 presents the characterization of the survey sample in the two EUs. In both EUs, the majority of registered participants were male (Leste Maranhense EU 52.6%; Dsei-MA EU 50.5%), and the most representative age group was 15–29 years (Leste Maranhense EU 25.1%; Dsei-MA EU 30.7%). Among children aged 5–14, 821 (99.5%) attended school at Leste Maranhense EU, while 1 245 (97.0%) attended school at Dsei-MA (Table 1).

Regarding ethnicity/skin-color data, which were collected only in the Leste Maranhense EU, of the 2 342 individuals aged 15 years or older, 293 (12.5%) declared themselves White, 214 (9.1%) Black, 1 834 (78.3%) Brown, and 1 (0.1%) Indigenous (Table 1).

The average number of people per household was 5.1 in the Dsei-MA EU, and 3.8 in the Leste Maranhense EU (Table 1).

A total of 3 094 people aged 1 year or older were examined in the Leste Maranhense EU, and 4 161 people were examined in the Dsei-MA EU, with the 15–29 years age group constituting the highest proportion of those examined (Leste Maranhense EU 23.1 %; Dsei-MA EU 29.8%) (Table 1).

Losses, represented by individuals absent on the day of the examination, refusals, and prolonged absences amounted to 335 persons (9.8%) at Leste Maranhense EU and 381 persons (8.4%) at Dsei-MA EU (Table 1).

**TABLE 1. Sample distribution according to sociodemographic and total variables examined in the Leste Maranhense and Dsei-MA evaluation units**

| | | Evaluation unit | | | |
|---|---|---|---|---|---|
| | | Leste Maranhense | | Dsei-MA | |
| | | *n* | % | *n* | % |
| Total | | 3 429 | 100.0 | 4 542 | 100.0 |
| Sex | Male | 1 803 | 52.6 | 2 292 | 50.5 |
| | Female | 1 626 | 47.4 | 2 250 | 49.5 |
| Age group | 1–4 years | 262 | 7.6 | 622 | 13.7 |
| | 5–9 years | 366 | 10.7 | 693 | 15.3 |
| | 10–14 years | 459 | 13.4 | 590 | 13.0 |
| | 15–29 years | 862 | 25.1 | 1 395 | 30.7 |
| | 30–49 years | 779 | 22.8 | 860 | 18.9 |
| | 50+ years | 701 | 20.4 | 382 | 8.4 |
| Is the child in school (5–14 years)? | No | 4 | 0.5 | 38 | 3.0 |
| | Yes | 821 | 99.5 | 1 245 | 97.0 |
| Ethnicity/color (15 years or older)[a] | White | 293 | 12.5 | NA | NA |
| | Black | 214 | 9.1 | NA | NA |
| | Brown | 1 834 | 78.3 | NA | NA |
| | Indigenous | 1 | 0.1 | NA | NA |
| Average number of people per household | | 3.8 | | 5.1 | |
| Total number of examinees | | 3 094 | 100.0 | 4 161 | 100.0 |
| Examined (by age group) | 1–4 years | 257 | 8.3 | 599 | 14.4 |
| | 5–9 years | 363 | 11.8 | 676 | 16.2 |
| | 10–14 years | 439 | 14.2 | 539 | 13.0 |
| | 15–29 years | 716 | 23.1 | 1 242 | 29.8 |
| | 30–49 years | 677 | 21.9 | 755 | 18.2 |
| | 50+ years | 642 | 20.7 | 350 | 8.4 |

***Notes:*** NA, not applicable.
[a] In Dsei-MA evaluation unit, the ethnicity/color of the individuals was not asked.
***Source:*** Prepared by the authors based on the data from the prevalence survey to validate the elimination of trachoma as a public health problem in Brazil, 2019–2021.

### Household environmental indicators and access to health services by EU

Table 2 shows that in the two EUs, the main source of water for drinking (Leste Maranhense EU 62.0%; Dsei-MA EU 68.3%) and washing the face (Leste Maranhense EU 74.1%; Dsei-MA EU 64.4%) was a protected well. Regarding access to water for drinking (Leste Maranhense EU 50.4%; Dsei-MA EU 71.2%) and washing the face (Leste Maranhense EU 58.2%; Dsei-MA EU 67.2%), it was most often located in the backyard of the household.

Regarding where people defecated, most households in both EUs had no sanitation structure (Leste Maranhense EU 52.1%; Dsei-MA EU 65.2%) and people defecated and urinated in random locations, with no specific place to direct the waste (Leste Maranhense EU 52.8%; Dsei-MA EU 64.7%) (Table 2).

Further, 74.4% of households surveyed in the Leste Maranhense EU and 88.6% in the Dsei-MA EU received monthly visits from community health or indigenous health agents. In Dsei-MA EU, 50.7% of households received a monthly visit from an indigenous sanitation agent (Table 2).

### Prevalence of trachomatous inflammation – follicular

A total of 620 children aged 1–9 years in the Leste Maranhense EU and 1 275 children in the Dsei-MA EU were examined, and 46 cases of TF were found in the indigenous EU and only 1 case was found in the non-indigenous EU. The adjusted prevalence was 0.1% (95% CI [0.0, 0.4]) and 2.9% (95% CI [1.4, 5.0]) in the Leste Maranhense EU and Dsei-MA EU, respectively (Table 3). The prevalence rate ratio indicates that the probability of an indigenous child having TF was 29 times higher than that of a non-indigenous child.

Of the 46 participants with TF in the Dsei-MA EU, 22 were male and 24 were female, with a mean age of 4.7 years. In the Leste Maranhense EU, the only participant with TF was a 7-year-old boy. The adjusted prevalence of TF was highest among children in the Dsei-MA EU, living in households where the main source of water for drinking and for washing the face was an unprotected spring, and the amount of time required to collect water for drinking and washing the face was generally between 30 minutes and 1 hour. Regarding the type of sanitary installation, the highest adjusted prevalence of TF was found among participants who lived in places without access to a toilet (3.2%), or who used a latrine without slabs/holes (3.3%).

### Prevalence of trachomatous trichiasis

A total of 2 035 people aged 15 years or older were examined for TT in Leste Maranhense EU and 2 347 were examined in the Dsei-MA EU. No cases were found in Leste Maranhense EU, and seven cases were found in the Dsei-MA EU, resulting in an adjusted prevalence of 0.1% (95% CI [0.0, 0.2]). All seven cases

**TABLE 2. Distribution of the sample households according to variables related to access to water and sanitary facilities and access to health services in the Leste Maranhense EU and Dsei-MA evaluation units**

| | | Evaluation unit | | | | *p*-value |
|---|---|---|---|---|---|---|
| | | Leste Maranhense | | Dsei-MA | | |
| | | *n* | % | *n* | % | |
| Total | | 900 | 100.0 | 900 | 100.0 | NA |
| Main source of drinking water | Piped water | 9 | 1.0 | 122 | 13.6 | < 0.001 |
| | Surface water | 6 | 0.7 | 115 | 12.8 | |
| | Unprotected spring | 51 | 5.7 | 22 | 2.4 | |
| | Protected spring | 37 | 4.1 | 0 | 0.0 | |
| | Unprotected well | 215 | 23.9 | 8 | 0.9 | |
| | Protected well | 558 | 62.0 | 615 | 68.3 | |
| | Other source | 24 | 2.7 | 18 | 2.0 | |
| Time to get water to drink | Water source at home | 454 | 50.4 | 641 | 71.2 | < 0.001 |
| | Less than 30 minutes | 418 | 46.4 | 184 | 20.4 | |
| | Between 30 minutes and 1 hour | 27 | 3.0 | 69 | 7.7 | |
| | More than 1 hour | 1 | 0.1 | 6 | 0.7 | |
| Main source of water to wash face | Piped water | 9 | 1.0 | 121 | 13.4 | < 0.001 |
| | Surface waters | 16 | 1.8 | 167 | 18.6 | |
| | Unprotected spring | 10 | 1.1 | 10 | 1.1 | |
| | Protected spring | 1 | 0.1 | 1 | 0.1 | |
| | Unprotected well | 186 | 20.7 | 6 | 0.7 | |
| | Protected well | 667 | 74.1 | 580 | 64.4 | |
| | Other source | 11 | 1.2 | 15 | 1.7 | |
| Time to get water to wash face | All face-washing done at the water source, outside the home | 2 | 0.2 | 169 | 18.8 | < 0.001 |
| | Water source at home | 524 | 58.2 | 605 | 67.2 | |
| | Less than 30 minutes | 371 | 41.2 | 112 | 12.4 | |
| | Between 30 minutes and 1 hour | 3 | 0.3 | 14 | 1.6 | |
| Place where they usually defecate | Collective latrine shared by more than household | 407 | 45.2 | 101 | 11.2 | < 0.001 |
| | Individual sanitary module or private latrine at home | 24 | 2.7 | 212 | 23.6 | |
| | No structure, outside the domicile | 469 | 52.1 | 587 | 65.2 | |
| Type of sanitary installation | Discharge for piped sewage/ septic tank | 164 | 18.2 | 32 | 3.6 | < 0.001 |
| | Discharge to dry pit/black pit/ open drains/ unknown location | 95 | 10.6 | 98 | 10.9 | |
| | Latrine with slab | 63 | 7.0 | 7 | 0.8 | |
| | Latrine without slab/hole | 103 | 11.4 | 181 | 20.1 | |
| | No structure, outside the domicile | 475 | 52.8 | 582 | 64.7 | |
| ACS or AIS visit frequency in the last 12 months | Monthly | 670 | 74.4 | 797 | 88.6 | < 0.001 |
| | Every 2 months | 114 | 12.7 | 56 | 6.2 | |
| | 2–4 times | 70 | 7.8 | 13 | 1.4 | |
| | Once | 25 | 2.8 | 3 | 0.3 | |
| | Never received | 21 | 2.3 | 31 | 3.4 | |
| AISAN visit frequency in the last 12 months[a] | Monthly | NA | NA | 456 | 50.7 | NA |
| | Every 2 months | NA | NA | 34 | 3.8 | |
| | 2–4 times | NA | NA | 90 | 10.0 | |
| | Once | NA | NA | 168 | 18.7 | |
| | Never received | NA | NA | 152 | 16.9 | |

***Notes:***
ACS, community health agent; AIS, indigenous health agent; AISAN, indigenous sanitation agent; NA, not applicable.
[a] In Leste Maranhense evaluation unit, the AISAN visit frequency was not asked.
***Source:*** Prepared by the authors based on the data from the prevalence survey to validate the elimination of trachoma as a public health problem in Brazil, 2019–2021.

identified in the Dsei-MA EU were in adults aged 50 years and older, of whom five were men and two were women.

The highest prevalence of TT was found in households that collected water from surface water bodies (1.3%) and households that took more than 1 hour to fetch water and return (6.3%). Regarding the source of water used to wash the face, the highest prevalence of TT was in households that used water from unprotected springs (2.2%) and households that used water from sources outside the home (1.1%). Regarding sanitation, the prevalence of TT was highest in households that had an individual private latrine at home (0.3%) and those that had latrines without slabs/holes (2.3%).

## DISCUSSION

Our study revealed a prevalence of TF and TT in the two EUs in the state of Maranhão that was within the limits recommended for the elimination of the disease as a public health problem; however, the prevalence of TF was higher in the indigenous EU, indicating a greater vulnerability of this population to the disease. According to an earlier survey of schoolchildren, the prevalence in the state of Maranhão was 4.1% (18). The indigenous area in the state of Maranhão was considered as silent for the disease, as no activity related to trachoma had been developed there until 2020.

There was no difference in the prevalence of TF in the Dsei-MA EU between males and females, which is consistent

**TABLE 3. Adjusted prevalence of trachomatous inflammation – follicular in children aged 1–9 years according to demographic variables related to access to water and sanitary facilities in the Leste Maranhense and Dsei-MA evaluation units**

| | | Evaluation unit | | | |
|---|---|---|---|---|---|
| | | Leste Maranhense | | Dsei-MA | |
| | | *n* | Prevalence[a] % (95% CI) | *n* | Prevalence[a] % (95% CI) |
| Total | | 620 | 0.1 (0.0, 0.4) | 1 275 | 2.9 (1.4, 5.0) |
| Sex | Male | 327 | 0.2 (0.0, 0.7) | 663 | 3.1 (0.9, 5.9) |
| | Female | 293 | 0.0 (NA) | 612 | 3.5 (1.5, 5.8) |
| Age group | 1 to 4 years | 257 | 0.0 (NA) | 599 | 1.3 (0.3, 2.7) |
| | 5 to 9 years | 363 | 0.1 (0.0, 0.4) | 676 | 1.6 (0.7, 2.9) |
| Main source of drinking water | Piped water | 9 | 0.0 (NA) | 147 | 0.0 (NA) |
| | Surface waters | 6 | 0.0 (NA) | 175 | 9.5 (4.7, 14.4) |
| | Unprotected spring | 31 | 0.0 (NA) | 34 | 13.4 (0.0, 27.8) |
| | Protected spring | 39 | 0.0 (NA) | 0 | 0.0 (NA) |
| | Unprotected well | 144 | 0.0 (NA) | 11 | 0.0 (NA) |
| | Protected well | 369 | 0.2 (0.0, 0.5) | 875 | 2.8 (1.2, 4.6) |
| | Other source | 22 | 0.0 (NA) | 33 | 0.5 (0.0, 1.4) |
| Time to get water to drink | Water source at home | 323 | 0.0 (NA) | 904 | 1.7 (0.6, 3.0) |
| | Less than 30 minutes | 279 | 0.2 (0.0, 0.5) | 260 | 4.5 (1.0, 9.5) |
| | Between 30 minutes and 1 hour | 18 | 0.0 (NA) | 104 | 8.5 (4.0, 13.2) |
| | More than 1 hour | 0 | 0.0 (NA) | 7 | 0.0 (NA) |
| Main source of water to wash your face | Piped water | 9 | 0.0 (NA) | 146 | 0.0 (NA) |
| | Surface waters | 10 | 0.0 (NA) | 267 | 7.8 (3.8, 12.7) |
| | Unprotected spring | 10 | 0.0 (NA) | 20 | 29.5[b] |
| | Unprotected well | 114 | 0.0 (NA) | 9 | 0.0 (NA) |
| | Protected well | 465 | 0.1 (0.0, 0.4) | 803 | 1.9 (0.6, 3.6) |
| | Other source | 12 | 0.0 (NA) | 30 | 1.9[c] |
| Time to get water to wash your face | All face washes are done at the water source, outside the home | 1 | 0.0 (NA) | 272 | 8.8 (4.2, 14.3) |
| | Water source at home | 383 | 0.0 (NA) | 834 | 1.0 (0.2, 2.1) |
| | Less than 30 minutes | 236 | 0.2 (0.0, 0.6) | 141 | 0.8 (0.0, 1.6) |
| | Between 30 minutes and 1 hour | 0 | 0.0 (NA) | 28 | 10.0[b] |
| Place where they usually defecate | Collective latrine shared by more than one household | 245 | 0.0 (NA) | 121 | 2.1 (0.0, 5.3) |
| | Individual home sanitary module or private latrine at home | 19 | 0.0 (NA) | 285 | 2.3 (0.3, 5.1) |
| | No structure, outside the domicile | 356 | 0.2 (0.0, 0.5) | 869 | 3.2 (1.4, 5.2) |
| Type of sanitary installation | Discharge into dry fossa/black fossa/open drains/ unknown sites | 52 | 0.0 (NA) | 117 | 0.3 (0.0, 0.9) |
| | Discharge for piped sewage/ septic tank | 81 | 0.0 (NA) | 40 | 0.6 (0.0, 2.1) |
| | Latrine with slab | 39 | 0.0 (NA) | 6 | 0.0 (NA) |
| | Latrine without slab/ hole | 88 | 0.0 (NA) | 250 | 3.3 (0.0, 7.9) |
| | No structure, outside the domicile | 360 | 0.2 (0.0, 0.5) | 862 | 3.2 (1.4, 5.3) |

***Notes:*** NA, not applicable.
[a] Adjusted for simple age.
[b] The 95% CI is not presented because the sample size is smaller than 30.
[c] The 95% CI is not presented because there is no variability between the clusters.
***Source:*** Prepared by the authors based on the data from the prevalence survey to validate the elimination of trachoma as a public health problem in Brazil, 2019–2021.

with the results of studies involving Brazilian schoolchildren (19, 20) and of studies in other countries that used the same methodology as this survey (21, 22). There was also no significant difference according to age, although the prevalence was higher among children aged 5–9 years, consistent with other studies (19, 23). Although some studies suggest an association between trachoma and low school attendance (3, 24), the level of school attendance among children aged 5–14 years in this study was high in the indigenous and non-indigenous EUs.

The prevalence of TF of below 5.0% implies that a reduction in transmission may have occurred because of improved socioeconomic conditions and/or the implementation of the SAFE strategy (25).

Among the factors that may explain the difference between the prevalence in the two EUs are the living conditions and behaviors that may be risk factors for communicable diseases, including trachoma (26). The highest prevalence of TF was found in households without latrines, where residents defecated and urinated in the open, and waste was not discharged to specific locations. Exposed human feces provide a breeding

ground for synanthropic flies, which are believed to be important mechanical vectors of *C. trachomatis* (27).

Households in the indigenous EU had a higher level of crowding, where in general all residents slept in one room. According to Assaad et al. (28) and Jones (26), the greater the number of individuals sleeping in the same room, the greater the possibility of trachoma transmission. Contrary to expectations, some important environmental indicators (access and use of water) were better in the indigenous population, in which the prevalence of TF was higher. These results need further research, as cultural characteristics could be responsible.

The prevalence of TT at 0.1% in the indigenous population demonstrates high transmission of trachoma in the past. The sequelae of the disease, including TT, usually affect those aged 15 years or older in communities where the disease has been present for many generations and access to basic sanitation is precarious. According to the model of Gambhir et al. (29), more than 150 episodes of *C. trachomatis* infection are needed for a person to develop TT. Reducing the intensity of ocular transmission of *C. trachomatis* reduces the incidence of sequelae and hence the incidence of blindness in the population.

It is noteworthy that we identified the presence of TT previously unknown to the health system. Although this study found that 88.6% of the households in the Dsei-MA EU received a monthly visit from an indigenous health agent, the system was not able to identify all cases and refer them to the ophthalmology clinic. Epidemiological studies conducted with different indigenous peoples of the country concluded that, among other factors, poor access to health services, both to primary care in villages and to specialized services, causes ethnic minorities to be subject to a high risk of diseases and/or their complications (30, 31).

This study has important strengths. Households were selected using probabilistic sampling, which allows the adequate statistical inference of the estimates obtained here (10, 11). The large sample size also ensured good statistical power, even in a low prevalence situation. Likewise, all methods of clinical examination and data collection were based on standardized procedures and instruments, with prior training, to minimize the possibility of information bias. To our knowledge, this is the first study to assess the trachoma situation in indigenous areas of the state of Maranhão, obtaining estimates needed for planning and implementing public policies to control the disease in a neglected population.

This study also has some limitations. First, some factors that may be associated with transmission, such as the presence of flies around children's eyes, were not recorded. Second, the method used to estimate the confidence intervals, which was based on the algorithms applied by TD, was not adequate to generate estimates in the case of categories with a small number of samples, or in EUs in which the events were concentrated in only one cluster. In these instances, it was decided not to present the confidence interval of the estimate. Furthermore, although the approach used does not allow prevalence to be estimated by cluster, empirical observation revealed that the prevalence of trachoma in the Dsei-MA EU was not homogeneous.

## Implications for practice and research

Trachoma surveillance and control activities, health education practices, case management, and effective monitoring with quality information need to be expanded in indigenous areas of the state of Maranhão, particularly among ethnic groups with a higher prevalence of trachoma.

Even in communities with low circulation of *C. trachomatis*, residual cases and sources of infection may persist in the most vulnerable segments of the population, which have different cultural habits (32). The existence of trachoma in the population is an indicator of precarious living and health conditions, and in order to change the epidemiological profile of the disease, access to basic sanitation, education, and primary ocular health care (23) is essential, alongside the adoption of necessary measures for disease intervention and control. An effective information system (33) needs to be maintained, incorporating technologies such as geostatistical analyses and integrated serosurveillance to support post-elimination surveillance (34), so that the disease does not again become a public health problem in Brazil.

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## Prevalencia del tracoma en zonas de población indígena y no indígena del nordeste de Brasil, 2019-2021

**RESUMEN**

**Objetivo.** Estimar la prevalencia del tracoma en poblaciones indígenas y no indígenas en determinadas zonas del estado de Maranhão, en el nordeste de Brasil.

**Métodos.** Se trató de una encuesta de ámbito poblacional con muestreo probabilístico. Para el diagnóstico del tracoma, se realizó un examen ocular externo con una lupa frontal de 2,5X aumentos. Se estimó la prevalencia de la inflamación tracomatosa folicular (TF) en la población infantil de 1 a 9 años y la prevalencia de la triquiasis tracomatosa (TT) en la población de 15 años o más. Se obtuvieron las frecuencias relativas de las características sociodemográficas y ambientales.

**Resultados.** En el estudio participaron 7 971 personas, 3 429 de poblaciones no indígenas y 4 542 de poblaciones indígenas. La prevalencia de la TF en las poblaciones no indígenas e indígenas fue de 0,1% y 2,9%, respectivamente, en tanto que la de la TT en las poblaciones indígenas fue de 0,1%.

**Conclusiones.** La prevalencia de la TF y la TT en las dos unidades de evaluación del estado de Maranhão estuvo dentro de los límites recomendados para la eliminación del tracoma como problema de salud pública. Sin embargo, la prevalencia de la TF fue mayor en la unidad de evaluación indígena, lo que indica una mayor vulnerabilidad de esta población a la enfermedad. La prevalencia de la TF inferior al 5,0% implica una reducción de la transmisión, que puede haber sido consecuencia tanto de la mejora de las condiciones socioeconómicas como de la aplicación de la estrategia SAFE de la Organización Mundial de la Salud.

**Palabras clave** Tracoma; prevalencia; enfermedades desatendidas; encuestas epidemiológicas; Brasil.

## Prevalência de tracoma em áreas indígenas e não indígenas, Nordeste do Brasil, 2019-2021

**RESUMO**

**Objetivo.** Estimar a prevalência do tracoma em populações indígenas e não indígenas em áreas selecionadas do estado do Maranhão, na região Nordeste do Brasil.

**Métodos.** Inquérito de base populacional com amostragem probabilística. Para o diagnóstico de tracoma, foi realizado exame ocular externo com o auxílio de lupas binoculares com ampliação de 2,5×. Foram estimadas a prevalência de inflamação tracomatosa folicular (TF) em crianças de 1 a 9 anos de idade e a prevalência de triquíase tracomatosa (TT) na população com idade ≥15 anos. Foram obtidas as frequências relativas das características sociodemográficas e ambientais.

**Resultados.** O estudo incluiu 7 971 indivíduos (3 429 de populações não indígenas e 4 542 de populações indígenas). A prevalência de TF nas populações não indígenas e indígenas foi de 0,1% e 2,9%, respectivamente, e a prevalência de TT entre as populações indígenas foi de 0,1%.

**Conclusões.** A prevalência de TF e TT nas duas unidades de avaliação no estado do Maranhão ficou dentro dos limites recomendados para a eliminação do tracoma como problema de saúde pública. No entanto, a prevalência de TF foi maior na unidade de avaliação indígena, indicando uma maior vulnerabilidade dessa população à doença. A prevalência de TF abaixo de 5,0% implica uma redução na transmissão, que pode ter sido resultado de melhores condições socioeconômicas e da implementação da estratégia SAFE da Organização Mundial da Saúde.

**Palavras-chave** Tracoma; prevalência; doenças negligenciadas; inquéritos epidemiológicos; Brasil.