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# Impact of COVID-19 pandemic on notifiable diseases in Northern Brazil

## *Impacto da COVID-19 em doenças de notificação compulsória no Norte do Brasil*

## *Impacto de la COVID-19 en las enfermedades de notificación compulsoria del Norte de Brasil*

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**ABSTRACT**

**Objective:** To assess the impact of the COVID-19 pandemic on notifiable diseases in Northern Brazil. **Methods:** A descriptive retrospective study was conducted using data from the Notifiable Disease Information System (Sistema de Informação de Agravos de Notificação – Sinan) and SUS Hospital Information System (Sistema de Informações Hospitalares do SUS – SIH/SUS) on bacterial and viral meningitis, dengue, dengue hemorrhagic fever, arboviruses, syphilis, tuberculosis, leprosy, and viral hepatitis. Descriptive statistics was used to assess the variation in absolute numbers of notifications and hospitalizations from 2015 to 2020 and their average variations. **Results:** Notifications and hospitalizations for meningitis, non-dengue arboviruses, leprosy, leptospirosis, and viral hepatitis exhibited a general decrease of 50 to 80% compared to previous years. There was regional variation in dengue and dengue hemorrhagic fever, with independent increases and decreases. Acquired, gestational and congenital syphilis presented a 60% decrease in notifications and hospitalizations, except for congenital syphilis, which remained stable. Tuberculosis notifications and hospitalizations remained stable in the entire region. **Conclusion:** There was an overall decrease of more than a half of notifications and hospitalizations, representing a variable impact depending on the state and the endemic process of each subregion.

**Descriptors:** Disease Notification; COVID-19; Health Information Systems; Descriptive Epidemiology.

***RESUMO***

***Objetivo**: Avaliar o impacto da pandemia COVID-19 em doenças de notificação compulsória no Norte do Brasil. **Métodos**: Estudo descritivo e retrospectivo realizado com dados das bases Sinan (Sistema de Informação de Agravos de Notificação) e SIH/SUS (Sistema de Informações Hospitalares do SUS) sobre meningite bacteriana e viral, dengue, febre hemorrágica da dengue, arboviroses, sífilis, tuberculose, hanseníase e hepatites virais. Utilizou-se estatística descritiva para avaliação da variação nos números absolutos das notificações e internações do período de 2015 a 2020 e suas variações médias. **Resultados**: As notificações e internações de meningite, arboviroses não-dengue, hanseníase, leptospirose e hepatites virais, em geral, demonstraram redução de 50 até 80% em relação a períodos anteriores. Houve variabilidade regional com dengue e febre hemorrágica da dengue, com aumentos e reduções independentes. As sífilis adquirida, gestacional e congênita demonstraram queda de até 60% nas notificações e nas internações, exceto sífilis congênita, que se manteve em estabilidade. As notificações e as internações de tuberculose se mantiveram estáveis em toda a região. **Conclusão:** Houve redução geral de mais da metade das notificações e das internações hospitalares, apresentando um impacto variável, dependendo do Estado e do processo de endemia de cada sub-região.*

***Descritores:** Notificação de Doenças; COVID-19; Sistemas de Informação em Saúde; Epidemiologia Descritiva.*



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***RESUMEN***

***Objetivo**: Evaluar el impacto de la pandemia de la COVID-19 en las enfermedades de notificación compulsoria del Norte de Brasil. **Métodos**: Estudio descriptivo y retrospectivo realizado con datos de las bases SINAN (Sistema de Información de Agravios de Notificación) y SIH/SUS (Sistema de Informaciones Hospitalarias del SUS) sobre la meningitis bacteriana y viral, el dengue, la fiebre hemorrágica del dengue, las arbovirosis, la sífilis, la tuberculosis, la lepra y las hepatitis virales. Se utilizó de la estadística descriptiva para la evaluación de la variación de los números absolutos de las notificaciones y los ingresos del periodo entre 2015 y 2020 y sus variaciones medias. **Resultados**: Las notificaciones y los ingresos de meningitis, arbovirosis no-dengue, la lepra, la leptospirosis y las hepatitis virales, en general, han demostrado una disminución del 50 hasta el 80% respecto los periodos anteriores. Hubo variabilidad por región respecto el dengue y fiebre hemorrágica del dengue con subidas y bajadas independientes. Las sífilis adquirida, gestacional y congénita han demostrado caída hasta el 60% de las notificaciones e ingresos excepto la sífilis congénita que se mantuvo estable. Las notificaciones y los ingresos por tuberculosis se mantuvieron estables en toda la región. **Conclusión:** Hubo una disminución general de más de la mitad de las notificaciones y los ingresos hospitalarios, presentando un impacto variable, a depender del Estado y del proceso de endemia de cada sub-región.*

***Descriptores:** Notificación de Enfermedades; COVID-19; Sistemas de Información en Salud; Epidemiología Descriptiva.*

## INTRODUCTION

Notifiable diseases and conditions are fundamental components of public health measures around the world. Since 1951, when the International Sanitary Regulations were formulated by the World Health Organization (WHO), there has been an effort to establish a list of diseases that should be notified due to their relevance to the health of the world population[1].

In Brazil, in 1961, the compulsory notification of 45 diseases and conditions was introduced as a measure that only gained strength in 1969 with the smallpox eradication campaigns[2]. Since then, measures related to notifiable diseases and conditions have improved accompanied by technological innovations, consolidating themselves with the creation of the Unified Health System (*Sistema Único de Saúde – SUS*) and its Organic Law 8080, which established Epidemiological Surveillance in the country[3]. In this context, the SUS Hospital Information System (*Sistema de Informação Hospitalar do SUS – SIH/SUS*) was established in 1991, followed by the Notifiable Diseases Information System (*Sistema de Informação de Agravos Notificáveis – Sinan*) in 1993, with the aim of computerizing such notifications, thus improving processing and health planning for specific epidemiological realities[4]. The systems are constantly updated with epidemiological information about various diseases such as meningitis, arboviruses, syphilis, tuberculosis, leprosy, leptospirosis and viral hepatitis, with the inclusion of COVID-19 in 2020[5].

At the beginning of 2020, Brazil recorded the first cases of COVID-19, a pandemic caused by the Sars-Cov-2 coronavirus, which had a huge impact on access to health services and caused changes in people's behaviors, namely adherence to social isolation, the wearing of face masks and use of hand sanitizer in addition to more intense restrictive measures in the states with the temporary closure of establishments and the ban on public events to contain contagion and overcrowding in public health services[6,7].

Thus, as reported by studies from other countries, it is assumed that these measures influenced the usual behavior of infectious diseases in the country in addition to the occurrence of a possible intensification in the underreporting of diseases and conditions due to the difficult access to health services[8,9]. Therefore, the present study seeks to assess the impact of the COVID-19 pandemic on notifiable diseases in Northern Brazil.

## METHODS

A retrospective descriptive study was carried out with data on notifications from the TabNet database of Sinan and the number of hospitalizations reported to SIH/SUS referring to the North of Brazil, comprising the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins. The data collected correspond to the annual cases reported in each state – therefore, municipalities are not discriminated.

Collected data on the total annual cases and the number of hospitalizations for each disease covered the years 2015 through 2020 and were defined based on the International Classification of Diseases (ICD-10) and the nomenclature contained in the SIH/SUS: bacterial meningitis (ICD10: G00; SIH/SUS: bacterial meningitis); viral meningitis (ICD-10: A87, SIH/SUS: viral meningitis); dengue (ICD-10: A90; SIH/SUS: dengue [classic dengue]); dengue hemorrhagic fever (ICD-10: A91; SIH/SUS: hemorrhagic fever due to dengue virus); arboviruses (chikungunya,

zika and others) (ICD-10: A92; SIH-SUS: other remainder arbovirus fevers, hemorrhagic fever, viruses); congenital syphilis (ICD-10: A50; SIH/SUS: congenital syphilis); acquired syphilis (ICD-10: A51); gestational syphilis (ICD-10: O98.1); tuberculosis (ICD-10: A15 and A16; SIH/SUS: pulmonary tuberculosis); leprosy (ICD-10: A30; SIH/SUS: leprosy [leprosy]); leptospirosis (ICD-10: A27; SIH/SUS: unspecified leptospirosis); acute hepatitis B (ICD-10: B16; SIH/SUS: acute hepatitis B); viral hepatitis (ICD-10: B17; SIH/SUS: other viral hepatitis).

There was inclusion of data from Sinan on diseases already reported in 2020 and entered on the platform, namely dengue, meningitis (not broken down by etiology), syphilis (acquired, in pregnancy and congenital), tuberculosis and leprosy. For the other diseases, on which data had not been entered, the analysis was based on the notifications of hospital admissions obtained from the SIH/SUS, which, despite not properly representing all notifications (as it excludes non-hospital cases), are indirect indications of the incidence and the capacity of hospital services due to the COVID-19 pandemic.

It was decided to exclude data from the SIH/SUS on acquired syphilis because the nomenclature of the database does not agree with the notification criteria. The same was done with gestational syphilis, as the nomenclature of the database aggregates several obstetric infectious diseases into one parameter and it is not possible to distinguish them from the others included.

For data collection, the TabNet Win32 3.0 database was used to obtain data from SIH/SUS and Sinan on dengue, meningitis, tuberculosis and leprosy. In the case of syphilis indicators, the website http://indicadoressifilis.aids.gov.br/ was consulted based on the referral from the DATASUS webpage. Data analysis was performed using descriptive statistics and the impact was evaluated by comparing the absolute numbers of notifications from 2019 and 2020 in addition to the average of notifications for the period 2015-2019.

Data were organized into graphs and tables using Google Docs and Google Sheets. Statistical analysis was performed using SPSS (Statistical Package for the Social Sciences) 25.

The research did not need approval from the Research Ethics Committee (REC) because it used data in the public domain and did not identify any of the participants. However, the authors guarantee compliance with resolution 466/12 of the National Health Council (*Conselho Nacional de Saúde – CNS*) on scientific research.

## RESULTS

The findings are presented according to the notifiable diseases. Tables I and II below show the data.

### Meningitis

The notifications of meningitis were the most affected in the entire North region. There was a drop of 73% in 2020 when compared to the previous year. When comparing the averages of the last five years, the states whose notifications in 2020 were most different from the average of notifications from 2015-2019 were Amapá (-83%), Acre (-77%) and Pará (-70%) (Table I), with Pará being the state with the highest absolute reduction, with 145 reported cases, and having an average of 482.80 from 2015-2019.

As for hospitalizations, meningitis cases are etiologically divided into viral and bacterial according to ICD-10. There was a decrease in all states compared to 2019, with the exception of Amazonas (+82% in bacterial meningitis) and Rondônia (+89% in bacterial meningitis) (Table II). Amazonas is the only state that showed an increase in hospitalizations compared to the 2015-19 average. It should be noted that Rondônia had not reported cases to Sinan, despite having reported hospitalizations to SIH/SUS.

### Dengue and dengue hemorrhagic fever

Dengue notifications on Sinan did not maintain a common pattern, showing a sharp growth compared to the average of the last five years in Rondônia (+296% compared to 2019 and +42% compared to the average) and in Amazonas (+43% compared to the average). Additionally, there was a sharp decrease in Amapá (-97% compared to the average and -80% compared to 2019) and Tocantins (-70% compared to the average). (Table I).

Within the scope of hospitalizations registered as dengue fever or dengue hemorrhagic fever, what stands out most is the sharp increase in hospitalizations for dengue hemorrhagic fever in Amazonas compared to the average for 2015-19 (+202%) and in Rondônia (+ 50%), which is in line with the data reported to Sinan. In Amapá, there was a sharp decrease in hospitalizations for dengue (-90%) and no hospitalizations for hemorrhagic fever. Pará also showed a decrease in hospitalizations for dengue (-68%) (Table II).

### Arboviruses

Chikungunya and Zika fevers are reported to SIH/SUS as a single entity, corresponding to ICD-10 A92, despite the recent update on Zika virus as U06. There was, in general, a decrease in hospitalizations for arboviruses compared to the average of the last five years, especially in Acre (-60%), Tocantins (-54%) and Rondônia (-51%) (Table II).

### Syphilis

### Acquired syphilis

There was a significant drop in notifications of acquired syphilis in all states, with the largest drops recorded in Acre (-68%), Pará (-63%) and Amapá (-58%) in relation to the average of notifications in 2015-19 (Table I).

### Gestational syphilis

There was also a drop in notifications of gestational syphilis in all states. Compared to the average of the last five years, the biggest drops were registered in Amapá (-59%) and Acre (-53%). However, it should be noted that the decrease was, in general, lower than that of acquired syphilis. (Table I).

### Congenital syphilis

As observed for the conditions mentioned previously, congenital syphilis showed a drop in the number of notifications compared to the average for 2015-19, with emphasis in Amazonas (-70%) and Rondônia (-65%) (Table I). Hospitalizations remained stable on average, with the highest growth in Amapá (+212% compared to the average and +63% compared to 2019) and the biggest decrease in Rondônia (-61% compared to the average and -3% compared to 2019) (Table II).

### Tuberculosis

Notifications of tuberculosis to Sinan showed stability in 2020 in practically all states, with the largest decrease occurring in Rondônia (-20% compared to 2019 and -17% compared to the average) and the largest increase in Roraima (with +32% compared to the average and -9% compared to 2019) (Table I). Hospitalizations for pulmonary tuberculosis also showed stability, with a marked decrease in Amapá (only one hospitalization reported in an average of 10.8) and a sharp increase in Roraima (+104% compared to the average, but only +15% compared to 2019 ) (Table II).

### Leprosy

Notifications of leprosy showed a drop in all states in the North region in 2020. The biggest drops in relation to the average occurred in Roraima (-63%) and Amazonas (-49%) (Table I). Hospitalizations also showed a significant drop, especially in Roraima (-77%), Amazonas (-74%) and Amapá (-67%) (Table II).

### Leptospirosis

Hospitalizations for leptospirosis also showed a drop in 2020. The biggest drops were found in Amapá (-79%) and Amazonas (-71%) (Table II). It should be noted that there were not enough records for analysis in the states of Tocantins and Roraima.

### Acute hepatitis B and other viral hepatitis

There was, in general, a decrease in hospitalizations for hepatitis. The exception was in Pará, with an increase of approximately 50% both in relation to 2019 and the average for 2015-2019. As for hepatitis B, the biggest drops occurred in the state of Tocantins (-72%) and Amapá (-61%). As for the other types of hepatitis, which were grouped, the biggest drops occurred in Tocantins (-76%) and Pará (-70%) (Table II).

Table I - Number of Sinan notifications in the years 2019 and 2020, mean of notifications from 2015 to 2019, standard deviation of the mean, 2019 and 2020 percentage comparison, 2020 percentage comparison and the mean of the period from 2015 to 2019 by state in the North region.

| | 2020 | 2019 | Mean 2015-2019 | Standard deviation | 2019 x 2020 | Mean 2015-2019 x 2020 |
|---|---|---|---|---|---|---|
| **Acre** | | | | | | |
| Dengue | - | - | - | - | -% | -% |
| Meningitis | 5 | 26 | 22.00 | 7.07 | -81% | -77% |
| Leprosy | 86 | 133 | 146.00 | 11.73 | -35% | -41% |
| Tuberculosis | 555 | 587 | 465.60 | 81.32 | -5% | 19% |
| Acq syphilis | 86 | 302 | 266.60 | 142.37 | -72% | -68% |
| Gest syphilis | 211 | 552 | 446.40 | 126.15 | -62% | -53% |
| Cong syphilis | 26 | 77 | 77.40 | 11.15 | -66% | -66% |
| **Amapá** | | | | | | |
| Dengue | 39 | 193 | 1,417.40 | 1,115.79 | -80% | -97% |
| Meningitis | 2 | 12 | 11.60 | 3.61 | -83% | -83% |
| Leprosy | 93 | 148 | 133.40 | 13.91 | -37% | -30% |
| Tuberculosis | 555 | 587 | 465.60 | 81.32 | -5% | 19% |
| Acq syphilis | 118 | 480 | 284.20 | 147.05 | -75% | -58% |
| Gest syphilis | 92 | 339 | 225.60 | 72.35 | -73% | -59% |
| Cong syphilis | 59 | 125 | 81.20 | 27.63 | -53% | -27% |
| **Amazonas** | | | | | | |
| Dengue | 6,229 | 4,016 | 4,362.40 | 1,730.92 | 55% | 43% |
| Meningitis | 64 | 158 | 176.20 | 19.96 | -59% | -64% |
| Leprosy | 287 | 520 | 564.40 | 43.07 | -45% | -49% |
| Tuberculosis | 3,493 | 3,944 | 3,621.40 | 244.66 | -11% | -4% |
| Acq syphilis | 1,297 | 4,441 | 2,263.20 | 1,401.15 | -71% | -43% |
| Gest syphilis | 720 | 1,682 | 1,433.60 | 260.13 | -57% | -50% |
| Cong syphilis | 187 | 702 | 618.00 | 186.50 | -73% | -70% |
| **Pará** | | | | | | |
| Dengue | 3,782 | 5,484 | 7,208.00 | 2,426.63 | -31% | -48% |
| Meningitis | 147 | 445 | 482.80 | 27.22 | -67% | -70% |
| Leprosy | 2,123 | 3,601 | 3,522.40 | 215.00 | -41% | -40% |
| Tuberculosis | 4,545 | 5,537 | 4,601.80 | 539.88 | -18% | -1% |
| Acq syphilis | 635 | 2,577 | 1,699.60 | 852.23 | -75% | -63% |
| Gest syphilis | 862 | 2,218 | 1,759.80 | 334.82 | -61% | -51% |
| Cong syphilis | 385 | 944 | 791.40 | 90.59 | -59% | -51% |
| **Rondônia** | | | | | | |
| Dengue | 3,955 | 998 | 2,779.80 | 2,656.94 | 296% | 42% |
| Meningitis | | 39 | 61.20 | 12.92 | -100% | -100% |
| Leprosy | 447 | 629 | 678.80 | 97.16 | -29% | -34% |
| Tuberculosis | 592 | 736 | 716.80 | 53.21 | -20% | -17% |
| Acq syphilis | 462 | 845 | 735.40 | 255.93 | -45% | -37% |
| Gest syphilis | 195 | 383 | 286.00 | 71.22 | -49% | -32% |
| Cong syphilis | 34 | 77 | 98.20 | 15.51 | -56% | -65% |
| **Roraima** | | | | | | |
| Dengue | 572 | 1,605 | 665.80 | 589.67 | -64% | -14% |
| Meningitis | 14 | 23 | 19.60 | 5.89 | -39% | -29% |
| Leprosy | 51 | 121 | 136.40 | 33.49 | -58% | -63% |
| Tuberculosis | 296 | 324 | 224.60 | 61.77 | -9% | 32% |
| Acq syphilis | 219 | 648 | 366.60 | 231.50 | -66% | -40% |
| Gest syphilis | 133 | 281 | 159.20 | 71.44 | -53% | -16% |
| Cong syphilis | 22 | 67 | 37.20 | 21.16 | -67% | -41% |
| **Tocantins** | | | | | | |
| Dengue | 2,246 | 13,727 | 7,474.60 | 3,667.09 | -84% | -70% |
| Meningitis | 20 | 55 | 58.60 | 8.59 | -64% | -66% |
| Leprosy | 1,113 | 2,034 | 1,735.20 | 376.62 | -45% | -36% |
| Tuberculosis | 208 | 252 | 213.00 | 28.13 | -17% | -2% |
| Acq syphilis | 468 | 1,328 | 976.00 | 381.04 | -65% | -52% |
| Gest syphilis | 294 | 571 | 415.80 | 168.26 | -49% | -29% |
| Cong syphilis | 106 | 238 | 256.80 | 23.46 | -55% | -59% |

Acq.: acquired; gest.: gestational; cong.: congenital

Table II - Number of hospital admissions reported to SIH/SUS in the years 2019 and 2020, mean of annual admissions from 2015 to 2019, standard deviation of the mean, 2019 and 2020 percentage comparison, 2020 percentage comparison and the mean of the period from 2015 to 2019 by state in the North region.

| | 2020 | 2019 | Mean 2015-2019 | Standard deviation | 2020 x 2019 | Mean 2015-2019 |
|---|---|---|---|---|---|---|
| **Acre** | | | | | | |
| Pulmonary tuberculosis | 39 | 37 | 36.6 | 2.51 | 5% | 7% |
| Leprosy | 23 | 48 | 44.2 | 5.85 | -52% | -48% |
| Congenital syphilis | 132 | 97 | 96.2 | 32.78 | 36% | 37% |
| Dengue | 265 | 358 | 247.8 | 183.49 | -26% | 7% |
| Dengue hemorrhagic fever | 79 | 294 | 60.8 | 130.37 | -73% | 30% |
| Arboviruses | 8 | 58 | 19.8 | 21.95 | -86% | -60% |
| Viral meningitis | 10 | 16 | 9.6 | 3.91 | -38% | 4% |
| Bacterial meningitis bacteriana | 11 | 14 | 7.8 | 5.26 | -21% | 41% |
| Leptospirosis | 24 | 30 | 30.4 | 11.68 | -20% | -21% |
| Acute hepatitis B | 9 | 15 | 18.4 | 7.09 | -40% | -51% |
| Other viral hepatitis | 86 | 161 | 188.4 | 43.55 | -47% | -54% |
| **Amapá** | | | | | | |
| Pulmonary tuberculosis | 1 | 21 | 10.8 | 6.42 | -95% | -91% |
| Leprosy | 1 | 2 | 3 | 1.00 | -50% | -67% |
| Congenital syphilis | 119 | 73 | 38.2 | 22.16 | 63% | 212% |
| Dengue | 7 | 18 | 67 | 71.31 | -61% | -90% |
| Dengue hemorrhagic fever | 0 | 1 | 8.8 | 6.72 | -100% | -100% |
| Arboviruses | 6 | 1 | 9.4 | 11.28 | 500% | -36% |
| Viral meningitis | 1 | 6 | 5 | 2.65 | -83% | -80% |
| Bacterial meningitis bacteriana | 8 | 13 | 9.4 | 3.05 | -38% | -15% |
| Leptospirosis | 6 | 28 | 29 | 2.92 | -79% | -79% |
| Acute hepatitis B | 3 | 4 | 7.6 | 4.62 | -25% | -61% |
| Other viral hepatitis | 9 | 9 | 19.8 | 10.80 | 0% | -55% |
| **Amazonas** | | | | | | |
| Pulmonary tuberculosis | 72 | 125 | 124.6 | 14.98 | -42% | -42% |
| Leprosy | 7 | 16 | 26.6 | 10.81 | -56% | -74% |
| Congenital syphilis | 215 | 131 | 204 | 86.32 | 64% | 5% |
| Dengue | 292 | 107 | 168.8 | 104.96 | 173% | 73% |
| Dengue hemorrhagic fever | 26 | 18 | 8.6 | 5.64 | 44% | 202% |
| Arboviruses | 16 | 11 | 26.8 | 28.50 | 45% | -40% |
| Viral meningitis | 12 | 15 | 22.4 | 5.90 | -20% | -46% |
| Bacterial meningitis bacteriana | 39 | 26 | 21.4 | 13.13 | 50% | 82% |
| Leptospirosis | 11 | 37 | 38.2 | 8.35 | -70% | -71% |
| Acute hepatitis B | 19 | 28 | 21.8 | 5.93 | -32% | -13% |
| Other viral hepatitis | 131 | 184 | 193.6 | 66.38 | -29% | -32% |
| **Pará** | | | | | | |
| Pulmonary tuberculosis | 226 | 295 | 309.4 | 26.10 | -23% | -27% |
| Leprosy | 50 | 73 | 81.2 | 15.82 | -32% | -38% |
| Congenital syphilis | 919 | 1,096 | 944.2 | 157.42 | -16% | -3% |
| Dengue | 593 | 1,053 | 1874 | 922.61 | -44% | -68% |
| Dengue hemorrhagic fever | 51 | 39 | 41 | 18.55 | 31% | 24% |
| Arboviruses | 246 | 561 | 474 | 260.65 | -56% | -48% |
| Viral meningitis | 49 | 97 | 71.8 | 16.12 | -49% | -32% |
| Bacterial meningitis bacteriana | 127 | 212 | 164.8 | 36.68 | -40% | -23% |
| Leptospirosis | 65 | 141 | 108.4 | 26.09 | -54% | -40% |
| Acute hepatitis B | 15 | 10 | 10.2 | 3.70 | 50% | 47% |
| Other viral hepatitis | 154 | 314 | 515.4 | 216.50 | -51% | -70% |
| **Rondônia** | | | | | | |
| Pulmonary tuberculosis | 46 | 40 | 42.6 | 10.38 | 15% | 8% |
| Leprosy | 48 | 94 | 66.2 | 24.42 | -49% | -27% |
| Congenital syphilis | 154 | 150 | 95.6 | 38.27 | 3% | 61% |

Table II - Number of hospital admissions reported to SIH/SUS in the years 2019 and 2020, mean of annual admissions from 2015 to 2019, standard deviation of the mean, 2019 and 2020 percentage comparison, 2020 percentage comparison and the mean of the period from 2015 to 2019 by state in the North region. (Continuation)

| | 2020 | 2019 | Mean 2015-2019 | Standard deviation | 2020 x 2019 | Mean 2015-2019 |
|---|---|---|---|---|---|---|
| Dengue | 527 | 393 | 833 | 539.65 | 34% | -37% |
| Dengue hemorrhagic fever | 12 | 10 | 8 | 1.87 | 20% | 50% |
| Arboviruses | 12 | 20 | 24.4 | 8.99 | -40% | -51% |
| Viral meningitis | 3 | 10 | 10.8 | 3.96 | -70% | -72% |
| Bacterial meningitis bacteriana | 17 | 9 | 21.6 | 7.60 | 89% | -21% |
| Leptospirosis | 12 | 26 | 25 | 5.66 | -54% | -52% |
| Acute hepatitis B | 9 | 19 | 16.6 | 6.66 | -53% | -46% |
| Other viral hepatitis | 60 | 135 | 141 | 10.84 | -56% | -57% |
| **Roraima** | | | | | | |
| Pulmonary tuberculosis | 134 | 117 | 65.8 | 30.9144 | 15% | 104% |
| Leprosy | 2 | 11 | 8.6 | 2.88097 | -82% | -77% |
| Congenital syphilis | 199 | 153 | 78.6 | 53.44436 | 30% | 153% |
| Dengue | 60 | 109 | 74 | 39.60429 | -45% | -19% |
| Dengue hemorrhagic fever | 9 | 11 | 6.8 | 3.70135 | -18% | 32% |
| Arboviruses | 6 | 12 | - | - | -50% | - |
| Viral meningitis | 3 | 1 | - | - | 200% | - |
| Bacterial meningitis bacteriana | 10 | 8 | 12 | 5.52268 | 25% | -17% |
| Leptospirosis | 1 | 1 | - | - | 0% | - |
| Acute hepatitis B | 3 | 2 | - | - | 50% | - |
| Other viral hepatitis | 8 | 11 | 11 | 2.73861 | -27% | -27% |
| **Tocantins** | | | | | | |
| Pulmonary tuberculosis | 37 | 44 | 31.4 | 9.71 | -16% | 18% |
| Leprosy | 60 | 149 | 90.6 | 35.80 | -60% | -34% |
| Congenital syphilis | 213 | 256 | 192.4 | 52.64 | -17% | 11% |
| Dengue | 110 | 595 | 386.4 | 170.79 | -82% | -72% |
| Dengue hemorrhagic fever | 2 | 30 | 9.4 | 11.67 | -93% | -79% |
| Arboviruses | 13 | 19 | 28.25 | 24.62 | -32% | -54% |
| Viral meningitis | 3 | 9 | 13.2 | 4.92 | -67% | -77% |
| Bacterial meningitis bacteriana | 22 | 32 | 26 | 10.00 | -31% | -15% |
| Leptospirosis | 2 | 2 | - | - | -% | - |
| Acute hepatitis B | 4 | 4 | 14.2 | 18.95 | 0% | -72% |
| Other viral hepatitis | 10 | 26 | 41.2 | 26.81 | -62% | -76% |

## DISCUSSION

The literature review for the present study found no other similar study in Brazil, with this being the first study to assess data on the compulsory notification of diseases in Brazil during the COVID-19 pandemic, whose analysis can be fundamental for public health and health promotion in the country. In the present study, a general downward trend in notifiable diseases was noticed, both in relation to the 2019 notifications and the average of the previous five years. Thus, this drop can be attributed to two main factors: the COVID-19 pandemic and the underreporting of diseases that occurred in the North region.

COVID-19 may have affected notifications in two ways: the decrease in the occurrence of infectious diseases - transmitted by direct human contact - due to the restriction measures and people's difficult access to health services[7,10].

Restriction measures adopted at the state level to contain the spread of the pandemic, such as social distancing, curfews, and more intense measures such as lockdown, have an effect on the decrease in (notification?) infectious diseases, as seen in other countries such as Australia and South Korea[10-12]. In the present study, the disease that most represents this factor is meningitis, as its incubation and evolution time is more acute, with large decreases that could not be explained by other factors alone. In addition, the decrease in demand for health services is a contributing

factor for not reporting all cases. And, despite the maintenance of essential services, such as dialysis and antiretroviral treatment, Brazil, as well as the world, faced, due to the pandemic, a decrease in the demand for health services, thus impacting on notifications[13,14], with leprosy being a disease that represents this reality. Thus, although the most severe forms require hospital follow-up, detection and notification are usually carried out in primary care services[15].

It is important to emphasize that endemic arboviruses such as dengue, chikungunya and zika showed a variable pattern of notification in the present study, with an increase in states such as Rondônia and Amazonas and a decrease in Amapá and Tocantins. As the transmission is predominantly associated with the *Aedis aegypti* mosquito, human behavior and social distancing would not be determining factors in its transmission and consequent notification, and this notification varies according to subregional trends in addition to the decrease in demand for health services in less severe cases[16].

Syphilis cases draw attention due to their diverse clinical spectrum; cases were found in adults, pregnant women and newborns. As with leprosy, most cases of acquired and gestational syphilis are diagnosed in primary care services. Therefore, due to the extended clinical picture of the disease, with the presence of little symptomatic and practically non-transmissible latent phases, the decrease in notifications would hardly be attributed to the lower incidence caused by the pandemic, which is an effect that – if it occurs – will be detected later[16]. The decrease in notifications are probably associated with the decrease in the demand for health services, as previously discussed. However, a different reality is observed in the context of hospitalizations for congenital syphilis: a general trend towards stability. This reality can be explained by the lower burden, in 2020, on the child population and the pediatric hospital service in relation to the adult and older populations[17,18]. Thus, it is clear that although the number of cases reported to Sinan have decreased, hospitalizations remain constant, which is indicative of such reality.

As for tuberculosis, unlike the reality of countries such as South Korea and other predictions, the northern region of Brazil did not show a great decrease in notifications, unlike leprosy, for example[11]. The Stop TB Partnership, an international group based by the United Nations (UN) for the fight against tuberculosis, made predictions about tuberculosis in countries with high rates of the disease considering possible impacts of COVID-19 on its management and estimated that three months of lockdown could lead to a delay of five to eight years in the global fight against tuberculosis[19]. Therefore, the stability of cases recorded should be a reason for alert because if there is a trend towards an increase in notifications, stability could be a demonstration of a setback in measures to fight tuberculosis.

The analysis of hospitalizations for leptospirosis and viral hepatitis – predominantly hospital diseases – in the current study revealed that the drop in hospitalizations for other diseases, regardless of etiology, due to hospital overcrowding represents the level most affected by the pandemic[12,14].

Another factor that should be considered in relation to this trend is the underreporting of cases in the databases. This is a reality consisting of failure in one of the three phases of care: access to the health service, diagnosis of the disease or notification in the information system[9]. The North region is one of the most affected by underreporting, with tuberculosis being the main target of studies[8,20]. In addition, other conditions such as violence against children and adolescents showed a large drop in these numbers in 2020, another factor attesting to the impact of the pandemic[9].

Thus, the underreporting in the North region of Brazil is added to that caused by the pandemic, thus making intervention in this situation a priority, especially in times of public health crisis where data integrity is fundamental for planning[9]. In this context, it is essential to use data from information systems for their purpose: to support decision-making at municipal, state and federal levels[4]. Thus, epidemiological studies such as this one – and events, units and sentinel regions – should be used to guide the care and active search by epidemiological surveillance services aiming at data correction and operational adjustments for its proper control[2,3,20].

It is important to emphasize the statistical limitations of the present study. To properly analyze trends and their inversions, it would be necessary to individually assess each disease with statistical methods that evaluate time series in a more accurate dimension of the magnitude of the impact of the pandemic on each disease[21]. However, as a preliminary analysis, the use of descriptive statistics already flags important and relevant points and assists in public health measures, which are very necessary in the current reality.

There is a worldwide need to assess the impact of the aforementioned pandemic on health services. However, to date, there are still few studies evaluating this impact. Thus, new studies that seek to assess each disease individually are necessary to direct public health measures as needed, as provided for by the principle of equity of SUS. Thus, despite the limitations, recognizing this reality is of fundamental importance for health planning in subsequent years so that, in addition to the morbidity and mortality of COVID-19, the effects of other diseases can be minimized. Assessing the impact of each disease individually would be necessary to better formulate public health policies.

## CONCLUSION

With regard to the impact of the COVID-19 pandemic on disease notifications in the Northern region of Brazil, there was a general trend of decrease in notifications and hospital admissions, with a decrease of more than half of the previous averages reported, with a variable impact depending on the state and the endemic process of each subregion.

## CONFLICTS OF INTEREST

The authors have no conflicts of interest.

## CONTRIBUTIONS

All authors contributed equally to the conception and design of the study; the acquisition, analysis and interpretation of data; and the writing and/or revision of the manuscript. All authors have approved the final version of the manuscript to be published and are responsible for all aspects of it, including ensuring its accuracy and integrity.

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