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Infectious meningitis: epidemiological aspects of the disease in the state of Mato Grosso do Sul

Meningites infecciosas: aspectos epidemiológicos da doença no estado de Mato Grosso do Sul

Letícia Martins Bertati[I]

Jakeline Miranda Fonseca[II]

Ana Paula Rezende de Oliveira Goldfinger[II]

Larissa Domingues Castilho de Arruda[II]

Danielle Ahad das Neves[II]

Danila Fernanda Rodrigues Frias[I,II,*]

[I] Universidade Brasil, Fernandópolis, SP, Brasil

[II] Secretaria de Estado de Saúde de Mato Grosso do Sul, Campo Grande, MS, Brasil

* **E-mail:** danila.frias@ub.edu.br

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ABSTRACT

Introduction: Meningitis is a global medical emergency that requires immediate diagnosis and treatment due to its high mortality and morbidity rates. **Objective:** To depict the epidemiology of infectious meningitis in the state of Mato Grosso do Sul from 2010 to 2022. **Method:** For this research, a cross-sectional, descriptive, retrospective, and quantitative study was conducted using the state of Mato Grosso do Sul as the unit of analysis. The sample was delimited to the period from 2010 to 2022, and the information was coded and collected from the Notifiable Diseases Information System (SINAN), considering the year and month of notification, notification municipality, age, sex, race/color, education, etiology, serogroup, confirmation criteria, and case evolution. **Results:** During the analyzed period, 2,826 cases of meningitis were reported, with 71.3% confirmed. The most affected individuals were males of mixed race/color and children aged 0 to 9 years. The prevalence in the state was 7.7 cases per 10,000 inhabitants. The majority of meningitis cases (39.7%) were classified as unspecified meningitis and 23.1% as aseptic meningitis. The lethality rate during the study period was 11.3%, with a concentration of deaths at the extremes of age. **Conclusions:** Although meningitis is a well-known disease, its lethality rate remains high. It is suggested to intensify control and prevention actions in municipalities, combined with demonstrating the importance of notifying the disease to epidemiological surveillance, which will help in organizing more targeted and specific action strategies to combat cases.

KEYWORDS: *Haemophilus influenza*; Epidemiological Monitoring; *Neisseria meningitidis*; Public Health

RESUMO

Introdução: As meningites são um problema global e de emergência médica, que requer diagnóstico e tratamento imediato, devido a sua elevada taxa de mortalidade e morbidade. **Objetivo:** Retratar a epidemiologia das meningites infecciosas no estado de Mato Grosso do Sul, de 2010 a 2022. **Método:** Estudo transversal, descritivo, retrospectivo e quantitativo que utilizou como unidades de análise o estado de Mato Grosso do Sul. A amostra foi delimitada ao período de 2010 a 2022, as informações foram codificadas e coletadas do Sistema de Informação de Agravos de Notificação (Sinan), sendo considerados: ano e mês da notificação, município de notificação, idade, sexo, raça/cor, escolaridade, etiologia, sorogrupo, critério de confirmação e evolução do caso. **Resultados:** No período analisado foram notificados 2.826 casos de meningite com 71,3% de confirmação. Destacou-se como mais acometidos os indivíduos do sexo masculino, de raça/cor parda, e as crianças de zero a nove anos de idade. A prevalência no estado foi de 7,7 casos por 10.000 habitantes. A maioria dos casos de meningite (39,7%) foi classificada como meningite não especificada e 23,1%, como meningite asséptica. A taxa de letalidade no período foi de 11,3%, com concentração dos óbitos nos extremos de idade. **Conclusões:** Embora a meningite seja uma doença conhecida há muito tempo,

sua taxa de letalidade continua elevada. Sugere-se a intensificação das ações de controle e a prevenção junto aos municípios aliada à demonstração da importância da notificação do agravo junto à vigilância epidemiológica, o que auxiliará a organização de estratégias de ação mais pontuais e direcionadas ao combate dos casos.

PALAVRAS-CHAVE: *Haemophilus influenza*; Monitoramento Epidemiológico; *Neisseria meningitidis*; Saúde Pública

INTRODUCTION

Infectious meningitis is an inflammatory process involving the meninges, brain, and spinal cord, caused by various infectious agents (bacteria, viruses, fungi, and parasites)[1]. The disease ranges from self-limiting viral meningitis with a good prognosis to bacterial cases that are fatal within a few hours[2].

The clinical picture of infectious meningitis changes with age, duration of illness, socioeconomic conditions, the presence of comorbidities, immunodepression, and etiology, and can present with a classic triad: fever, headache, and neck stiffness. In addition, the affected individual may also present with altered level of consciousness, mental confusion, vomiting, and cranial nerve paralysis[3].

This pathology can cause numerous immediate or long-term complications, due to the sequelae generated, associated with focal neurological deficits, hearing loss, cognitive impairment, and epilepsy, with irreversible damage, leading to the patient's death[3].

Infectious meningitis is a global problem and medical emergency that requires immediate diagnosis and treatment due to its high mortality and morbidity rates. Meningitis caused by bacteria and viruses is the most important from a public health point of view, due to its greater occurrence[4].

Regarding the pathogens of bacterial meningitis, and despite advances in medication and vaccination, *Streptococcus pneumoniae*, *Haemophilus influenza*, and *Neisseria meningitidis* are the most common[5]. Other agents occasionally involved are: *Listeria monocytogenes*, the *Enterobacteriaceae* family, *Streptococcus agalactiae*, and *Staphylococcus aureus*[6].

The main etiological agents of viral meningitis are enteroviruses, arboviruses, measles virus, mumps virus, lymphocytic choriomeningitis virus, HIV-1, adenoviruses, and herpes viruses[7].

Parasitic or eosinophilic meningitis can be caused by protozoa (*Toxoplasma gondii*, *Trypanosoma* cruzi, *Plasmodium* sp, free-living amoebas, and *Entamoeba histolytica*) and helminths (*Taenia solium*, *Echnococcus granulosus*, *Schistosoma mansoni*, *Gnathostoma* sp, *Toxocara canis*, and *Angiostrongylus cantonensis*).[8]

The etiologic agents of fungal meningitis are *Cryptococcus neoformans* and *Cryptococcus gatti*. However, other agents such as yeasts of the genus Candida and fungi such as *Histoplasma* spp., *Coccidioides spp.*, *Aspergillus spp.*, and the order Mucorales can also cause this disease[8].

The most common types of meningitis are viral, followed by bacterial. The prognosis for viral meningitis is more favorable, as it can be cured in between 7 and 10 days and patients recover without sequelae. Unlike bacterial meningitis, which is more serious and can lead to death within hours, the incidence of which is higher in children than in adults[9,10].

Due to increased knowledge of the disease by health professionals and researchers, who have developed effective vaccines and antibiotics, the mortality rate from infectious meningitis has decreased[11]. In addition, in Brazil, the disease became compulsorily notifiable, with information entered into the Notifiable Diseases Information System (SINAN), which promoted the possibility of epidemiological analysis and improved surveillance of the disease.

In this context, the aim of this study was to portray the epidemiology of infectious meningitis in the state of Mato Grosso do Sul, from 2010 to 2022, with a view to promoting effective actions focused on controlling and preventing the disease.

METHOD

This is a retrospective, cross-sectional, qualitative, and quantitative epidemiological study using secondary data from 2010 to 2022, provided by the Technical Management of Acute and Exanthematous Diseases of the Mato Grosso do Sul State Health Department.

To analyze the data, the information was collected from SINAN, without identifying the subjects, considering the following indicators: year and month of notification, municipality of notification, municipality and area of residence, age, gender, race, schooling, etiology, serogroup, confirmation criteria, and case evolution.

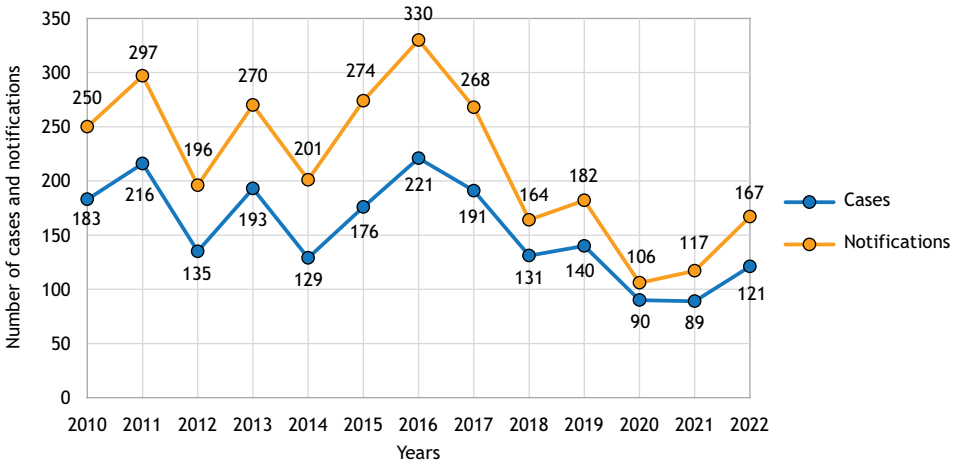
Data on the state's population was obtained from the database of the Brazilian Institute of Geography and Statistics[12].

The following formula was used to calculate the incidence of aggravation:

$$\text{Incidence Coeff.} = \frac{(\text{number of new cases reported})}{(\text{population in the period})} \times 100{,}000$$

The following formula was used to calculate prevalence:

$$\text{Prevalence Coeff.} = \frac{(\text{number of notified cases})}{(\text{average population for the period})} \times 100{,}000$$



Source: SINAN, 2023

Figure 1. Annual distribution of notifications and meningitis confirmed cases in Mato Grosso do Sul, 2010 to 2022.

The information obtained was tabulated in R software version 4.2.2 and subjected to descriptive statistical analysis. The images were also processed and produced using R software version 4.2.2. The results were expressed in the form of tables, graphs and maps.

Because it used public data, the research was exempt from evaluation by the Research Ethics Committee, in accordance with Resolution No. 510 of April 7, 2016, of the National Health Council (CNS).

RESULTS AND DISCUSSION

During the study period, 2,826 cases of meningitis were reported in the state of Mato Grosso do Sul, of which 2,015 cases (71.3%) were confirmed.

The annual distribution of notifications and confirmed cases is shown in Figure 1.

2016 stood out as the year with the most notifications and confirmed cases. From 2018 onwards, the number of notifications and confirmed cases appear very close to each other, which indicates an improvement in the indication of clinical suspicion by health professionals.

The COVID-19 pandemic possibly contributed to the increase in underreporting of mild cases of meningitis, which justifies the drop in the number of notifications and cases in 2020 and 2021. Thus, the statement that the drop occurred only due to preventive actions should not be made, as it creates a gap related to the real reason for the decrease in cases[13].

The profile of confirmed cases is shown in Table 1.

Regarding age group, children aged between zero and nine were the most affected, which is shown by several studies[1,14,1516]. Others differed from this study, as they found that the most affected age group was 20 to 39 years old[13,17,18]. This divergence can be explained by the fragmentation of the age groups, which in this study was from zero to nine years.

The occurrence in children can be explained by the immaturity of their immune system during development, which makes them more susceptible to diseases[19].

Regarding the sex of the person affected, males stood out, as in other studies[13,17,18,20,21]. Reliable confirmation as to why males stand out has not yet been reported in the literature but it is suggested that these individuals are more prone due to their tendency to neglect their health, seeking medical help later, as well as not carrying out preventive measures, such as vaccination[21,22].

The brown race/color stood out in this study, differing from the data presented in the studies by Dazzi et al.[23]; Silva, Mezarobba[24]; Matos et al.[25] and Silva et al.[16], in which the white race/color stood out. The mixture of ethnicities in the Brazilian population may justify this divergence, since miscegenation makes it difficult to determine the race of the population, because it is self-declared.

As for schooling, this indicator could not be analyzed due to the large amount of ignored data. The importance of filling in the notification forms in full is reinforced, so that epidemiological studies can be carried out with reliable data, and so that managers can collaborate in developing proposals aimed at controlling and preventing the disease.

The prevalence of the disease in the state of Mato Grosso do Sul during the study period is shown in Figure 2.

The municipalities with the highest meningitis prevalence rates from 2010 to 2022 in the state of Mato Grosso do Sul were Campo Grande, Dourados, and Ivinhema.

The state of Mato Grosso do Sul had a prevalence of meningitis in the period of 7.7 cases per 10,000 inhabitants. The prevalence rate of this disease may be related to various factors, including: the socio-economic conditions of those affected, the precariousness of housing and the environment, the lack of access to health care and preventive educational policies, and crowding in

peripheral neighborhoods[13,26]. The arrival of immigrants and refugees in the state may also have contributed to the prevalence rates of the disease.

As for the incidence of the disease over the last four years, the data is shown in Figure 3.

Table 1. Profile of individuals confirmed with meningitis in Mato Grosso do Sul, from 2010 to 2022.

Variable	n	%
Race		
Yellow	10	0.50
Black	43	2.10
Indigenous	85	4.20
White	656	32.60
Brown	919	45.60
Blank	9	0.45
Ignored	293	14.50
Age group		
0-9 years	776	38.50
10-19 years	212	10.50
20-29 years	229	11.40
30-39 years	233	11.60
40-49 years	217	10.80
50-59 years	156	7.70
Over 60 years old	181	9.00
Ignored	10	0.50
Sex		
Female	856	42.50
Male	1,157	57.40
Ignored	2	0.10
Education		
Illiterate	7	0.30
Basic education	115	5.70
Elementary school	218	10.80
High school	182	9.00
Higher education	49	2.40
Blank	59	2.90
Ignored	682	33.80
Not applicable	703	34.90
Area of residence		
Peri-urban	11	0.50
Rural	156	7.70
Urban	1,802	89.40
Ignored	7	0.30
Blank	39	1.90

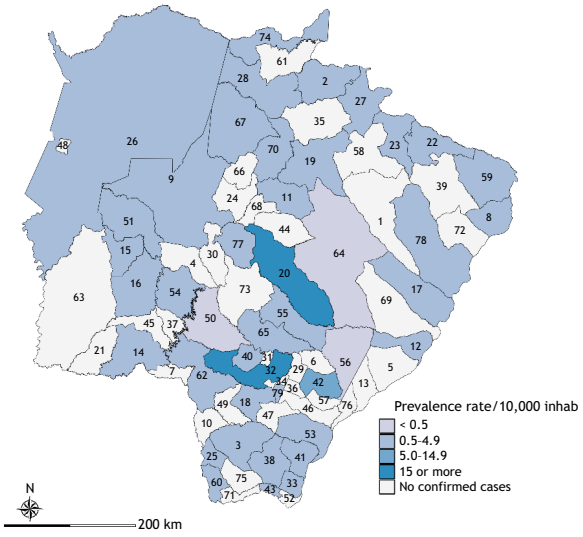
Source: SINAN, 2023.

There was a variation in the municipalities with the highest incidence rates of the disease from 2019 to 2022 in the state. Only Três Lagoas recorded cases in three years, as did Campo Grande and Costa Rica in two.

The main signs/symptoms presented by confirmed cases of meningitis are described in Table 2.

The main signs/symptoms were: headache, vomiting, and rigidity. It is worth noting that 23.3% had seizures. The disease has non-specific symptoms and varies according to the patient's age and the duration of the illness, including: fever, diarrhea, vomiting, myalgia, lethargy, tachycardia, hypotension, skin manifestations, stiff neck, Kernig's sign, Brudzinski's sign, among others[1,3]. It should be noted that some of the signs/symptoms may not have been reported, as most of the cases occurred in children, and they are often unable to say precisely what they are feeling, only showing some alteration through crying and signs of discomfort.

The data on the type of meningitis is shown in Figure 4.



Source: Prepared by the authors, 2023.
1- Água Clara; 2- Alcinópolis; 3- Amambai; 4- Anastácio; 5- Anaurilândia; 6- Angélica; 7- Antônio João; 8- Aparecida do Taboado; 9- Aquidauana; 10- Aral Moreira; 11- Bandeirantes; 12- Bataguassu; 13- Batayporã; 14- Bela Vista; 15- Bodoquena, 16- Bonito; 17- Brasilândia; 18- Caarapó; 19- Camapuã; 20- Campo Grande; 21- Caracol; 22- Cassilândia; 23- Chapadão do Sul; 24- Corguinho; 25-Coronel Sapucaia; 26- Corumbá; 27- Costa Rica; 28- Coxim; 29- Deodápolis; 30- Dois Irmãos do Buriti; 31- Douradina; 32- Dourados; 33- Eldorado; 34- Fátima do Sul; 35- Figueirão; 36- Glória de Dourados; 37- Guia Lopes da Laguna; 38- Iguatemi; 39- Inocência; 40- Itaporã; 41- Itaquiraí; 42- Ivinhema; 43- Japorã, 44- Jaraguari; 45- Jardim; 46- Jateí; 47- Juti; 48- Ladário; 49- Laguna Carapã; 50- Maracaju; 51- Miranda; 52- Mundo Novo; 53- Naviraí; 54- Nioaque, 55- Nova Alvorada do Sul; 56- Nova Andradina; 57- Novo Horizonte do Sul; 58- Paraíso das Águas; 59- Paranaíba; 60- Paranhos; 61- Pedro Gomes; 62- Ponta Porã; 63- Porto Murtinho; 64- Ribas do Rio Pardo; 65- Rio Brilhante; 66- Rio Negro; 67- Rio Verde de Mato Grosso; 68- Rochedo; 69- Santa Rita do Pardo; 70- São Gabriel do Oeste; 71- Sete Quedas; 72- Selvíria; 73- Sidrolândia; 74- Sonora; 75- Tacuru; 76- Taquarussu; 77- Terenos; 78- Três Lagoas; 79- Vicentina.

Figure 2. Spatial distribution of meningitis cases according to prevalence in Mato Grosso do Sul, from 2010 to 2022.

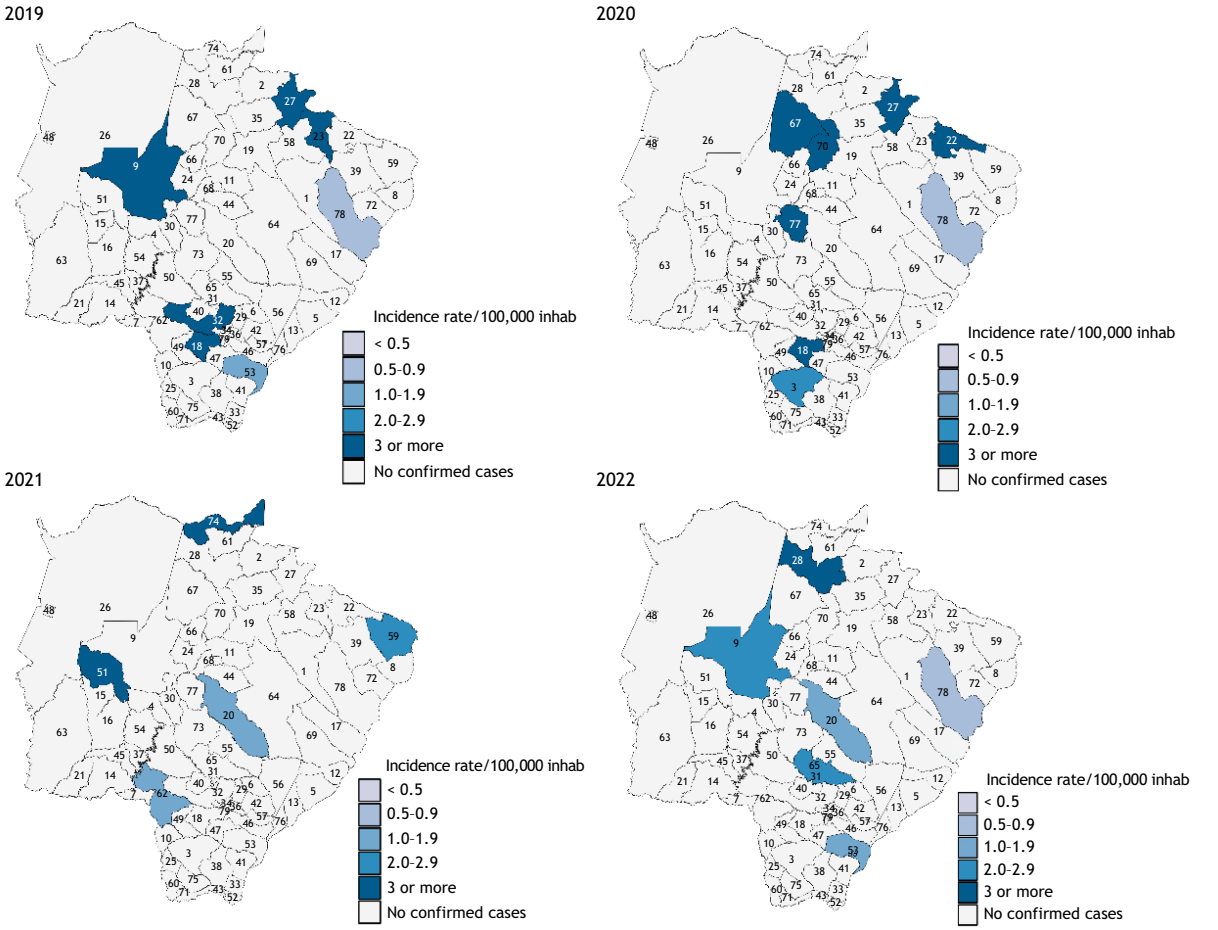


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Figure 3 Spatial distribution of meningitis cases according to incidence over the last four years (2019-2022) in Mato Grosso do Sul.

Most meningitis cases (39.7%) were classified as unspecified meningitis and 23.1% as aseptic meningitis. The literature highlights aseptic (viral) meningitis as being responsible for most cases, as cited by: Fonseca et al.[17] in a study carried out in the state of Tocantins; Aguiar et al.[18], in a study using national data from 2020 and 2021; and Paim, Gregio, and Garcia[20], in the state of Santa Catarina. Andrade Junior[13] detected a higher occurrence of bacterial meningitis in the state of Alagoas, all of which differ from this study.

It is worth noting that the occurrence of unspecified meningitis is related to failure to identify the agent, which may be related to failure at the point of care, identification of the pathogen, laboratory techniques, lack of sensitivity of cultures in detecting non-bacterial agents, and sample collection and handling[18,27].

Viral meningitis was the second most diagnosed in the state. The disease is easily transmitted via the oral-fecal and respiratory routes[24]. In addition, the patient's clinical condition is usually benign, with a rapid cure, which causes cases to be underreported[28].

When analyzing the type of meningitis and relating it to the age of the affected individual, the data is described in Table 3.

In the zero to 29 age group, meningitis without a specific cause stood out, while in the over 30 age group, bacterial meningitis. Viral meningitis was the second leading cause of meningitis in children aged zero to nine.

The incidence varied according to the age group of those affected. Viral meningitis affects more children because their immune system still has low levels of memory cells, which makes them more susceptible[24,29,30].

Bacterial meningitis in this study tended to affect older age groups, which can be explained by the use of the pentavalent

Table 2. Main signs/symptoms presented by individuals diagnosed with meningitis in Mato Grosso do Sul, from 2010 to 2022.

Variable	n	%
Seizure		
No	1,335	66.3
Yes	470	23.3
Ignored	123	6.1
Blank	87	4.3
Headache		
No	539	26.7
Yes	1,265	62.8
Ignored	161	8.0
Blank	50	2.5
Rigidity		
No	1,054	52.3
Yes	730	36.2
Ignored	152	7.5
Blank	79	3.9
Vomit		
No	778	38.6
Yes	1,095	54.3
Ignored	87	4.3
Blank	55	2.7

Source: SINAN, 2023.

vaccine and the meningococcal vaccine, which prevent the main bacterial etiological agents of meningitis. These vaccines are used in childhood; in adulthood, the protection induced by the vaccine is decreasing, which is why the number of cases is increasing[31,32].

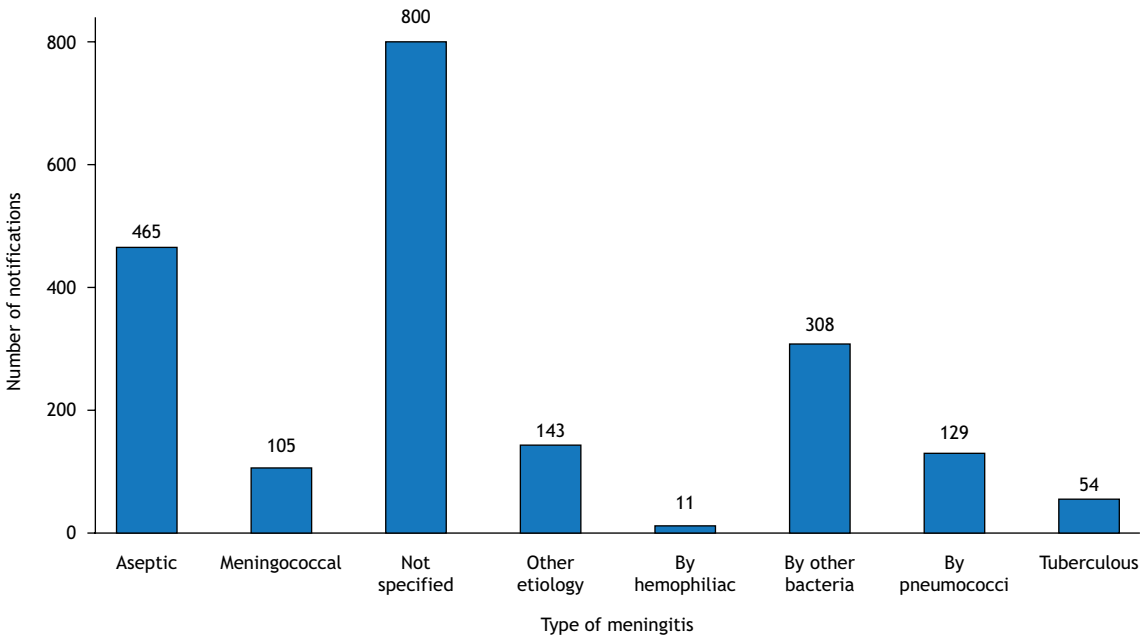
Cerebrospinal fluid (CSF) is collected for diagnostic purposes. The appearance of the CSF collected from the patients is shown in Figure 5.

Hospitalization occurred in 97.4% of cases and, of those hospitalized, the majority had clear CSF (47.0%), followed by cloudy CSF (33.7%). Examination of the cerebrospinal fluid is essential for detecting the causative agent and also acts as an indication of the disease.

Among the diagnostic techniques used, CSF chemocytology stood out (52.7%). This test is used to measure glucose and proteins and to count and differentiate cells in the CSF. It is important and is used to determine clinical suspicion, as it provides information on the intensity of the infectious process[33,34,35].

Vieira et al.[36] stated that the chemocytology test is very important for identifying microorganisms but other tests should be associated with the diagnosis due to the method's low specificity.

In 228 cases, the outcome was death, i.e. meningitis in Mato Grosso do Sul in the period had a case-fatality rate of 11.3%. Andrade Junior et al. reported a fatality rate of 15.08% in Alagoas, and Fonseca et al. reported a fatality rate of 20.5% in the state of Tocantins. Both states had a higher fatality rate than Mato Grosso do Sul. In Brazil, the fatality rate was 9.71% in 2020 and 11.07% in 2021[18], similar to this study.



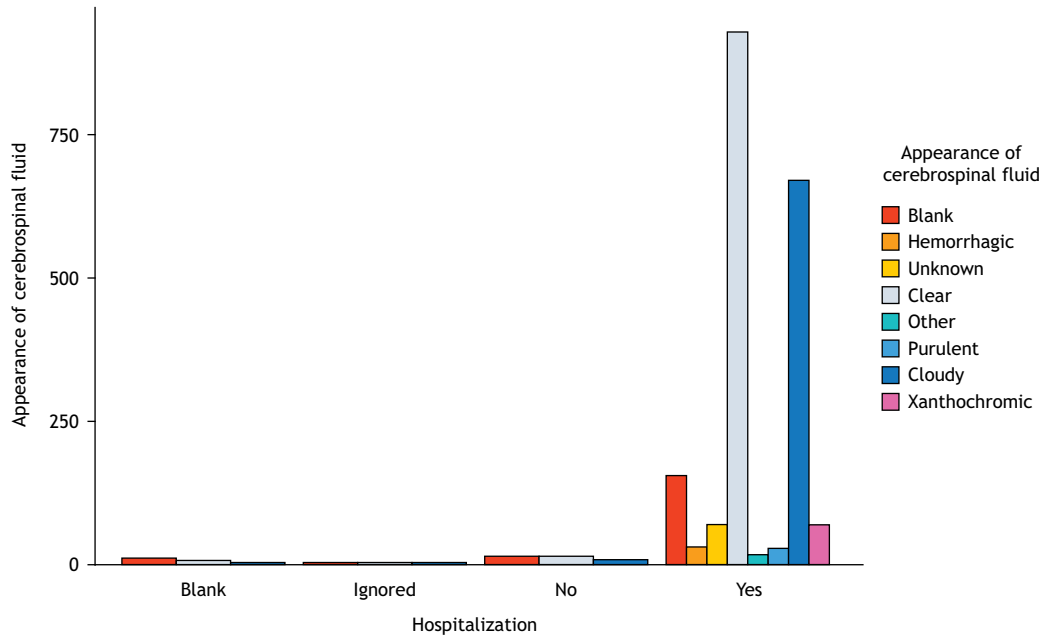
Source: SINAN, 2023.

Figure 4 - Type of meningitis presented by confirmed individuals in Mato Grosso do Sul, from 2010 to 2022.

Table 3. Type of meningitis presented by confirmed individuals according to age group in Mato Grosso do Sul, from 2010 to 2022.

Age	Viral meningitis (%)	Bacterial meningitis (%)	Meningitis without specific cause (%)
0-9	28.5	21.1	**49.4***
10-19	25.5	31.2	**39.6***
20-29	22.3	34.0	**38.0***
30-39	21.4	**30.9***	29.1
40-49	15.5	**37.8***	31.3
50-59	17.3	**34.0***	31.4
Over 60 years old	15.0	**49.7***	29.3

*Higher percentage of cases
Source: SINAN, 2023.



Source: SINAN, 2023.

Figure 5 - Appearance of cerebrospinal fluid from confirmed cases of meningitis in Mato Grosso do Sul, from 2010 to 2022.

A low lethality rate may be indicative of early treatment, which reduces symptoms and improves the prognosis of the disease[35].

It is worth noting that 18 cases of meningitis that occurred during the study period had meningococcemia, and there was an even greater worsening of the case, as 39.0% of them died. Meningococcemia occurred in 80.0% of the cases related to meningococcal meningitis.

When analyzing deaths related to the type of meningitis, the information is described in Figure 6.

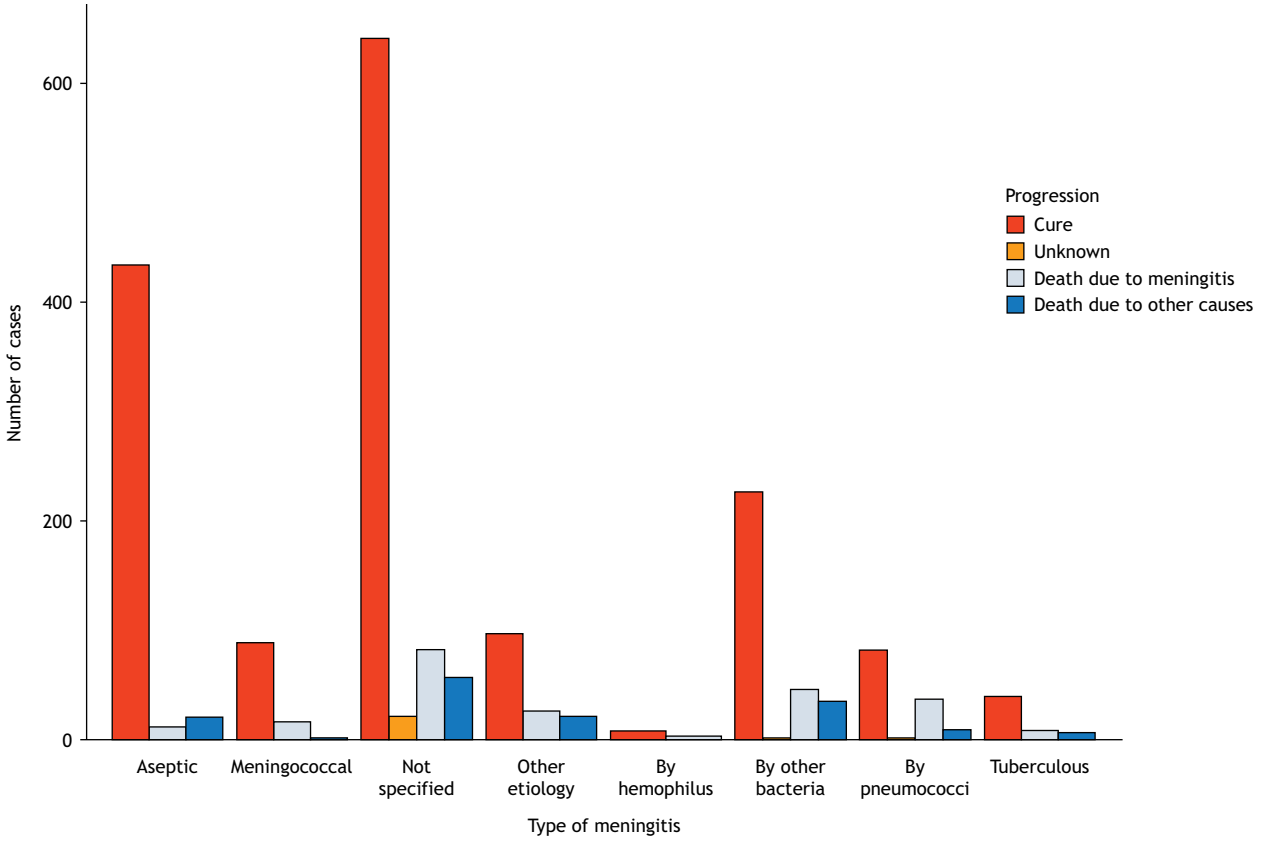
Meningitis caused by an unspecified agent accounted for most deaths (36.0%) but meningitis caused by other bacteria occurred less frequently than aseptic meningitis, but the number of deaths was higher, accounting for 20.2% of the deaths recorded. Aseptic meningitis had the second highest occurrence but fewer deaths when compared to others, such as meningococcal, pneumococcal, and other etiologies.

Bacterial meningitis is more serious and has higher morbidity and mortality rates[37]. If left untreated, it has a fatality rate of around 50.0%, and even with early diagnosis and correctly instituted treatment, this rate is between 8.0% and 15.0%, and these deaths usually occur between 24 and 48 hours after the onset of symptoms. It is worth noting that 10.0% to 20.0% of those affected by bacterial meningitis have permanent sequelae, including brain damage, hearing damage, and learning disorders[38].

As for the age group that died from meningitis, the data is shown in Figure 7.

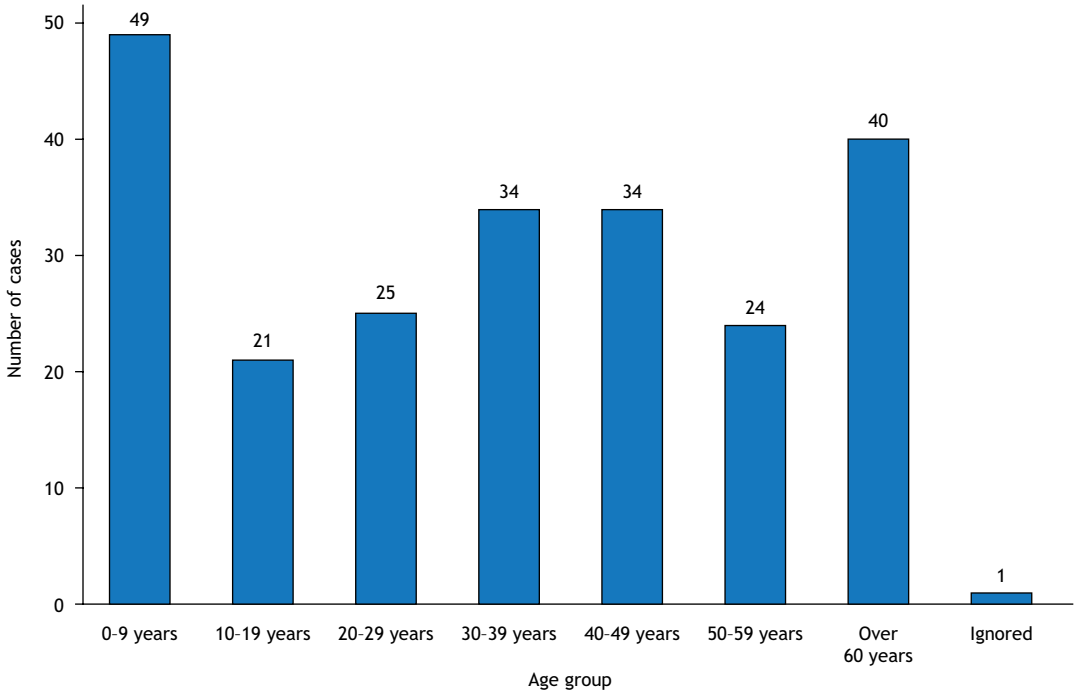
Deaths were more concentrated at the extremes of age, i.e. in the zero to nine and over 60 age groups, as in the studies by Magalhães and Santos[39], and Cruz et al.[21].

The association with the fact that mortality occurs more at the extremes of age may be related to the biological immunity of the



Source: SINAN, 2023.

Figure 6. Deaths from meningitis according to type in Mato Grosso do Sul, from 2010 to 2022.



Source: SINAN, 2023.

Figure 7. Deaths from meningitis according to age group in Mato Grosso do Sul, 2010 to 2022.

affected person, which makes them more susceptible to infections, the lack of vaccination and the presence of comorbidities (chronic diseases and immunodepression)[21,40].

CONCLUSIONS

It was found that the majority of those affected by meningitis in Mato Grosso do Sul are male, between the ages of zero and nine, of brown race/color, and living in urban areas.

Meningitis due to unspecified causes was the most common and the fatality rate for the period was 11.3%.

Although meningitis has been known about for a long time, its fatality rate remains high. Actions related to vaccination have been intensified, which has been showing an effect and lowering the number of cases, but even so, it remains an endemic disease in Brazil.

In order to reduce the number of cases, we suggest intensifying control and prevention actions in the state's municipalities, together with demonstrating the importance of reporting the disease to epidemiological surveillance and correctly capturing the information, which will help to organize more targeted action strategies to combat cases, as well as formulating public policies and consolidating existing ones.

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Authors' Contribution

Bertati LM, Frias DFR - Conception, planning (study design), acquisition, analysis, data interpretation, and writing of the work. Fonseca JM - Conception, planning (study design), and writing of the work. Goldfinger APRO, Arruda LDC, Neves DA – Writing of the work. All the authors approved the final version of the work.

Conflict of Interest

The authors inform that there is no potential conflict of interest with peers and institutions, political or financial, in this study.

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