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ORIGINAL ARTICLE

Meningococcal disease in children: an overview of hospitalizations and morbimortality in the State of Bahia and macro-regions from 2011 to 2020

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Keywords:
Meningococcal Infections, Epidemiology, Indicators of Morbidity and Mortality, Child.

Abstract

Objective: To describe the epidemiological profile of hospitalizations of children due to meningococcal disease in Bahia and its macro-regions, estimating morbidity and mortality due to the disease. **Methods:** This is an ecological, time-series study carried out through the Hospital Information System (SIH/DATASUS), from 2011 to 2020. The variables of interest were gender, age group, ethnicity, character and care regime, and outcome, grouped by year and macro-region in Bahia. **Results:** There were 431 hospitalizations of children between 0 and 14 years of age due to meningococcal infection, with a predominance of the age group of 0 to 4 years, male, mixed-race, attended on an emergency basis and in a public service regime. Of the hospitalized patients, 91.4% (n=394) were discharged and 8.6% (n=37) died. There was higher mortality and lethality among patients aged between 0 to 4 years. Among Bahia's macro-regions, the East and Central-North had the highest and lowest number of cases of the disease, respectively, while the East and the Far South had the highest mortalities and fatalities. **Conclusion:** The epidemiological profile of meningococcal disease in Bahia follows the global and national trend, with a predominance among boys, brown, aged between 0 to 4 years, whose prevalence, mortality and lethality stand out among the age groups studied. Taking into account the endemic status of meningococcal disease in the state, these results can support and direct specific strategies to combat meningococcus, reinforcing the need for constant preventive actions and epidemiological surveillance, with the establishment of health promotion strategies and better applicability of resources. for the eradication of the disease.

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INTRODUCTION

Neisseria meningitidis causes acute infection and may develop into invasive meningococcal disease[1]. Meningococcal disease has three main clinical forms – meningococcal meningitis, meningococcemia or a combination of the two[1], all of which also referred to as meningococcal infection[2]. Among the clinical forms, meningococcal meningitis stands out for its rapid evolution and high morbidity and mortality rates[3,4]. Meningococcemia, on the other hand, is a more acute form of disease with typical cutaneous symptoms[1]. Patients suspected with the disease must undergo prompt diagnostic investigation so that treatment is initiated without delay and poorer outcomes are prevented.

Epidemic outbreaks of bacterial meningitis affect more than 400 million individuals living in the so-called "African meningitis belt," which encompasses 26 countries[5]. Meningococcal disease is endemic in Brazil, with sporadic outbreaks. Since the 1990s, the most frequent circulating serogroups have been C and B[1]. The disease affects individuals of all age groups, but about 30% of the reported cases occur in children under five years of age, with the highest incidence rates found in infants in the first year of life[1]. Mortality rate reaches 10% in developed countries and 50% in developing countries.

An increase in the prevalence of bacterial meningitis has been observed in the Brazilian State of Bahia[7]. In recent years, meningococcal disease has shown a higher incidence with an increase in the prevalence of serogroup C meningococcus and a decrease in mortality indicators[7]. Despite the decrease in mortality seen in Bahia, meningococcal disease is still relevant in the current local health scenario, mainly because of the considerable morbidity observed in children.

In 2010, Brazil saw a significant increase in the circulation of serogroup C Neisseria meningitidis, along with a higher incidence of disease in children, which led to the introduction of the meningococcal conjugate type C vaccine (MenC)[8] in the national immunization schedule for children under one year of age[1]. As of 2016, the MenC vaccine became available for children under five years of age, which supported a decrease in the prevalence of the disease in the nation[1].

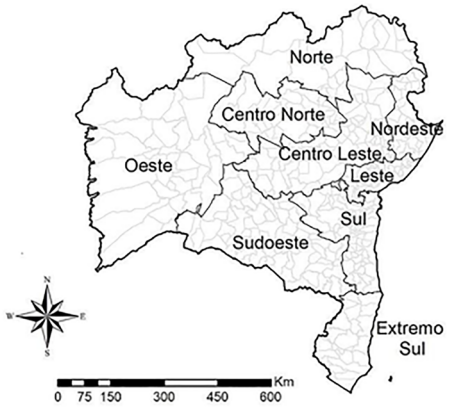
Bahia saw an increase in cases from 2008 to 2009[9], which prompted the Bahia State Department of Health (SESAB) to start a statewide vaccination campaign against meningococcal disease in 2010, with the MenC vaccine offered in the basic immunization schedule for children under two years of age[9]. Despite these actions, between 2011 and 2015, Salvador, the state capital of Bahia, remained the municipality most affected by meningococcal infection[9]. However, in recent years, there has been a decrease in cases and deaths, a fact possibly associated with the greater effectiveness of the MenC vaccine[7].

It is essential to know the epidemiological profile of a disease in order to guide preventive and curative efforts and reduce incidence, prevalence, morbidity, and mortality rates. In this context, the present study describes the epidemiological profile and estimates the morbidity and mortality of children hospitalized for meningococcal disease from 2011 to 2020 in the Brazilian State of Bahia and its macro-regions.

METHOD

This is ecological, retrospective, time-series study included data from the Hospital Information System of the Information Technology Department of Unified Health System (SIH/DATASUS) of the Ministry of Health.

The study included patients from Bahia, a state with an area of approximately 564,700 km² and a population of more than 14 million people according to the latest census survey[10]. Bahia is the fourth most populous state in Brazil and the most populous in the Northeast region. Salvador is the state capital. In terms of age distribution, the state has 1,059,885 inhabitants aged 0-4 years; 1,190,648 aged 5-9 years; and 1,339,561 aged 10-14 years[10]. The SESAB[11] divided the state into the North, Northeast, North-Central, East, Central-East, West, Southwest, South, and Extreme South macro-regions for purposes of health care (Figure 1).



Macro-region	Population in 2020 (inhabitants)	Area in 2019 (sq. km)	Regional Health Center location
Central-East (Centro Leste)	2.227.863	69.846,34	Feira de Santana
North-Central (Centro Norte)	807.806	47.713,57	Jacobina
Extreme South (Extremo Sul)	840.442	30.637,59	Teixeira de Freitas
East (Leste)	4.782.233	15.693,98	Salvador
Northeast (Nordeste)	865.943	20.602,47	Alagoinhas
North (Norte)	1.088.184	95.313,49	Juazeiro
West (Oeste)	958.933	158.081,27	Barreiras
Southwest (Sudoeste)	1.757.135	86.548,97	Vitória da Conquista
South (Sul)	1.601.095	40.322,75	Ilhéus

Figure 1. Health macro-regions of the State of Bahia. Source: Adapted from Bahia State Government[10] and Souza, *et al.*[12].

The study population included children aged 0-14 years hospitalized for meningococcal infection, diagnosis code A39 in the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)[2], in the years of 2011 to 2020. Since this is an epidemiological profile study, exclusion criteria were not defined.

Patients were analyzed for age (0-4 years, 5-9 years or 10-14 years), gender (male or female), ethnicity (white, brown, black, yellow, indigenous, not informed), year of hospitalization (2011 to 2020), type of care (elective or emergency), care system (i.e., type of association the hospital had with the Brazilian Unified Healthcare System in the categories public, private or not informed), and outcome (discharge or death).

Since the variables of interest were of the categorical type, they were represented as absolute numbers (n) and proportions (%). Overall prevalence was calculated as the division of reported cases of hospitalization for the disease over the population of children in Bahia aged 0-14 years per 100,000 population. Mortality was calculated as the division of the number of deaths from the disease over the population of children in Bahia aged 0-14 years per 100,000 population. Lethality was calculated as the division of the number of deaths from the disease over the total number children hospitalized per 100 hospitalizations, i.e., a percentage. Data were analyzed on Microsoft Excel® 2013.

Since this study was based on secondary data, none of the participants were identified, and the data were collected from a public database with free access, the Research Ethics Committee was not convened to approve it. Nonetheless, the study complied with the ethics criteria set out in Resolution 466/12 of the National Health Council.

RESULTS

From 2011 to 2020, 431 individuals aged 0-14 years were hospitalized for meningococcal infection in the State of Bahia. Higher prevalence was observed among children aged 0-4 years (Table 1).

Table 1. Distribution of hospitalizations for meningococcal infection considering age group and year of hospitalization; Bahia, 2011 to 2020.

A decrease was observed in the time period from 2011 to 2016 in the number of children hospitalized for meningococcal infection with the highest number of hospitalizations in the last decade occurring in 2011, with 25.8% of the total cases. Since 2017, the number of hospitalizations oscillated, with 2020 showing the lowest number of cases in the last ten years, or 2.8% of the total.

The distribution of hospitalizations based on gender (Table 2) revealed that meningococcal infection was more prevalent in males in all age groups and in all the years evaluated, with 24.5% more cases than females. Regarding ethnicity, we found a higher prevalence of patients self-declared as brown (33.9% of the individuals who declared ethnicity).

Table 1. Distribution of hospitalizations for meningococcal infection considering age group and year of hospitalization; Bahia, 2011 to 2020.

YEAR	AGE GROUP			
	n (%)	5-9 anos	10-14 anos	Total/Ano
	0-4 years	5-9 years	10-14 years	Total/ Year
2011	44 (10.2)	35 (8.1)	32 (7.4)	111 (25.8)
2012	22 (5.1)	21 (4.9)	16 (3.7)	59 (13.7)
2013	16 (3.7)	22 (5.1)	19 (4.4)	57 (13.2)
2014	16 (3.7)	7 (1.6)	17 (3.9)	40 (9.3)
2015	16 (3.7)	6 (1.4)	8 (1.9)	30 (7.0)
2016	22 (5.1)	3 (0.7)	5 (1.2)	30 (7.0)
2017	26 (6.0)	9 (2.1)	10 (2.3)	45 (10.4)
2018	15 (3.5)	1 (0.2)	1 (0.2)	17 (3.9)
2019	20 (4.6)	7 (1.6)	3 (0.7)	30 (7.0)
2020	4 (0.9)	4 (0.9)	4 (0.9)	12 (2.8)
Total/Age Group	201 (46.6)	115 (26.7)	115 (26.7)	431 (100.0)

Source: SIH/DATASUS, 2021.

However, the majority of the patient records (61.7%) had missing information. The analysis of ethnicity and age revealed a predominance of self-declared brown patients in the three age groups analyzed. Regarding type of care, most patients (98.4%) were admitted through emergency units. This pattern was sustained in all age groups. In the last decade, most hospitalizations were paid for by the Brazilian Unified Healthcare System (57.5% of the records in SIH/DATASUS). However, a significant portion of the medical records did not contain information on this variable (33.4%). Patients in the three age groups of interest had their hospitalization paid for predominantly by the Brazilian Unified Healthcare System.

In terms of outcome, 8.6% of patients died and 91.4% were discharged after hospitalization. A greater number of deaths was observed in the group aged 0-4 years (48.7%). The year with most deaths was 2011 (43.2%). The number of deaths remained stable from 2016 onwards, with two cases a year until 2019. No deaths of children hospitalized for meningococcal infection were recorded in 2020.

Regarding morbidity and mortality, the prevalence of meningococcal disease in children aged 0-14 years in Bahia was 12 cases per 100,000 population. Looking at individual age groups, we found a prevalence of 5.60 cases per 100,000 children aged 0-4 years and a prevalence of 3.2 cases per 100,000 children in the other age groups (5-9 years and 10-14 years). In terms of mortality, we found a rate of 1.0 death per 100,000 children aged 0-14 years. Regarding prevalence in the different age groups, the highest mortality was observed among children aged 0-4 years, followed by children aged 10-14 years and 5-9 years, respectively. Lethality was 8.6%

Table 2. Distribution of hospitalizations for meningococcal disease according to age groups; Bahia, 2011 to 2020.

VARIABLES	AGE GROUP			
	0-4 years	5-9 years	10-14 years	**Total**
Sex				
Female	89 (20.6)	49 (11.4)	54 (12.5)	192 (44.5)
Male	112 (26.0)	66 (15.3)	61 (14.2)	239 (55.5)
Ethnicity				
White	6 (1.4)	3 (0.7)	3 (0.7)	12 (2.8)
Black	1 (0.2)	0 (0.0)	3 (0.7)	4 (0.9)
Brown	88 (20.4)	32 (7.4)	26 (6.0)	146 (33.9)
Yellow	2 (0.5)	0 (0.0)	1 (0.2)	3 (0.7)
Indigenous	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Not reported	104 (24.1)	80 (18.6)	82 (19.0)	266 (61.7)
Type of care				
Emergency	198 (45.9)	112 (26.0)	114 (26.5)	424 (98.4)
Elective	3 (0.7)	3 (0.7)	1 (0.2)	7 (1.6)
Care system				
Public	91 (21.1)	78 (18.1)	79 (18.3)	248 (57.5)
Private	14 (3.2)	13 (3.0)	12 (2.8)	39 (9.0)
Not reported	96 (22.3)	24 (5.6)	24 (5.6)	144 (33.4)
Outcome				
Discharge	183 (42.5)	109 (25.3)	102 (23.7)	394 (91.4)
Death	18 (4.2)	6 (1.4)	13 (3.0)	37 (8.6)
Deaths	18 (48.7)	6 (16.2)	13 (35.1)	37 (100.0)
Prevalence (105)	5.6	3.2	3.2	12.0
Mortality (105)	0.5	0.2	0.4	1.0
Lethality (%)	4.2	1.4	3.0	8.6
TOTAL/AGE GROUP	201 (46.6%)	115 (26.7%)	115 (26.7%)	431 (100.0)

Source: SIH/DATASUS, 2021.

among children aged 0-14 years. Analysis of the data for each age group found lower lethality in patients aged 5-9 years and higher lethality in patients aged 0-4 years.

East (a region that includes Salvador and the surrounding townships) was the health macro-region of Bahia (Table 3) with the majority of the hospitalizations for meningococcal infection in the last decade (27.6%). North-Central (a region that includes Jacobina and adjacent townships) was the macro-region with the lowest number of hospitalizations (2.3%). The pattern of each age group in the different macro-regions of Bahia was similar to that of the State of Bahia as a whole, with higher prevalence in children aged 0-4 years, except in the

Table 3. Distribution of hospitalizations for meningococcal infection according to age group; health macro-regions of Bahia, 2011 to 2020.

MACRO-REGION	AGE GROUPS			
	0-4 years	**5-9 years**	**10-14 years**	**Total/ Macro-region**
Center-East	26 (6.0)	14 (3.2)	13 (3.0)	53 (12.3)
North-Central	4 (0.9)	2 (0.5)	4 (0.9)	10 (2.3)
Extreme South	17 (3.9)	10 (2.3)	8 (1.9)	35 (8.1)
East	60 (13.9)	28 (6.5)	31 (7.2)	119 (27.6)
Northeast	6 (1.4)	7 (1.6)	7 (1.6)	20 (4.6)
North	27 (6.3)	12 (2.8)	13 (3.0)	52 (12.1)
West	14 (3.2)	17 (3.9)	11 (2.6)	42 (9.7)
Southwest	29 (6.7)	11 (2.6)	16 (3.7)	56 (13.0)
South	18 (4.2)	14 (3.2)	12 (2.8)	44 (10.2)
Total/Age Group	201 (46.6)	115 (26.7)	115 (26.7)	431 (100.0)

Source: SIH/DATASUS, 2021.

Northeast, where equal prevalence was seen among individuals aged 5-9 and 10-14 years, and in the West, where higher prevalence was seen in children aged 5-9 years.

Table 3. Distribution of hospitalizations for meningococcal infection according to age group; health macro-regions of Bahia, 2011 to 2020.

The East and Extreme South macro-regions had the highest mortality rates, with 0.3 and 0.2 deaths per 100,000 children aged 0-14 years, respectively. These same regions had the highest lethality rates, with 2.1% and 1.9%, respectively (Table 4).

DISCUSSION

A total of 431 children and adolescents aged 0-14 years were hospitalized in public and private services for meningococcal infection in Bahia from 2011 to 2020. The number of cases has decreased over the years, but prevalence remains higher among infants aged 0-4 years.

Our findings corroborated the statistics published by the Ministry of Health, according to which approximately 30% of the individuals with disease are children under five years of age, with higher prevalence among infants aged up to 12 months[1]. Increased susceptibility has been described in children from the age of three months, since they present lower levels of antibodies, which were acquired passively during pregnancy[13]. However, from the age of 12 months, acquired immunity develops and antibody levels increase, which possibly causes a decrease in the prevalence of disease[13].

Table 4. Analysis of prevalence, mortality, and lethality by meningococcal infection; health macro-regions of Bahia, 2011 to 2020.

MACRO-REGION	MORBIMORTALITY		
	Prevalence (10^5)	Mortalidade (10^5)	Letalidade (%)
Central-East	1.5	0.1	1.2
North-Central	0.3	0.03	0.2
Extreme South	1.0	0.2	1.9
East	3.3	0.3	2.1
Northeast	0.6	0.03	0.2
North	1.5	0.1	0.9
West	1.2	0.1	0.7
Southwest	1.6	0.1	0.5
South	1.2	0.1	0.9
Total/Age Group	12.0	1.0	8.6

Source: SIH/DATASUS, 2021.

An analysis of the distribution of cases indicated that 2011 was the year with the highest number of hospitalizations. The following years saw a decrease in the number of cases, particularly in the first age group. In recent years, the number of hospitalizations has decreased to about 50% of the levels seen in 2012. The decrease in the number of hospitalizations of children aged 0-4 years is possibly associated with the inclusion of the MenC vaccine in the national immunization schedule in 2010, offered to children aged up to five years. In the long term, the MenC vaccine may cause a gradual decrease in the number of cases of meningococcal infection in other age groups.

A decline in the number of cases of meningococcal infection has been observed in the UK, Spain, Ireland, the Netherlands, Belgium, and other European countries since the introduction of MenC vaccine, suggesting the long-term effectiveness of immunization[13]. A pioneering study analyzed the introduction of the MenC vaccine in the UK and found an 81% decrease in the incidence of meningococcal infection[13]. The present study found a considerable increase in the number of cases from 2018 to 2019, possibly due to the lower coverage of vaccination in 2018 for children aged under one year in Bahia, with 76.5% of the individuals in this age group getting the vaccine versus the 95% recommended by SESAB[7]. Furthermore, a recent study looked into vaccination against meningitis in Brazil and found a 19.8% reduction in vaccination coverage from 2011 to 2020, with a gradual decrease over the years in all Brazilian regions[13]. Despite the decrease, all but the North region had vaccination coverage within the levels recommended by the Ministry of Health[14].

Although individuals aged five and older were offered the vaccine, no increase in the prevalence of disease was observed in this age group, possibly due to the effectiveness of immunization in younger age groups. Thus, unlike European and North American countries, Brazil sees no peaks in incidence among adolescents during endemic periods.

Regarding the drop in the number of cases seen in 2020, it is worth noting that this was an atypical year for infectious diseases and pediatric care due to the COVID-19 pandemic[16]. It is possible that social isolation, the closing of public spaces, and the intensification of hygiene and protection measures imposed by the pandemic may have decreased the spread of diseases with fecal-oral or airborne transmission[16,17].

A study performed in pediatric emergency departments in France compared the number of cases of some infectious diseases between the years 2017 and 2020 and found a 68% reduction in emergency department visits and a 44.7% decrease in hospitalizations[15]. This finding is in line with the considerable decrease in hospitalizations described in our study.

An analysis of the epidemiological profile of patients seen in the last decade in Bahia showed that meningococcal infection was more prevalent in brown boys aged 0-4 years. Although the majority of the patients included in our study did not declare ethnicity, those who did matched the predominance of brown-skinned people seen in the state of Bahia, as described by the Brazilian census survey[10] and other studies carried out in the Northeast of the country. In Piauí, higher prevalence of bacterial meningitis was observed among brown boys aged less than four years. A study on bacterial meningitis conducted in Salvador, Bahia, in 2011 and 2015, found similar results, with higher prevalence in males and browns, although the most affected age group was 20-39 years old[9]. Individuals from this age group were not included in our study.

Given the pathophysiology of meningococcal infection and the quick progression of the disease, most of the children included in our study sought care at emergency units. The majority of the children were seen in public healthcare facilities, since most of the population in Bahia cannot afford care at a private institution and thus relies on the Brazilian Unified Healthcare System. This was described by Silva et al.[19], as the authors demonstrated that the use of public healthcare was inversely proportional to the portion of the population with private health insurance. Nevertheless, individuals with private health insurance also seek care at public services and account for 20% of all patients treated at public healthcare institutions[19].

In terms of outcomes, most patients were discharged, which supports the idea that good progression is correlated with early introduction of treatment. It is important to note that the database used in our study did not contain information about sequelae. A study conducted in Jundiaí, in the state of São Paulo, found that the most frequent sequelae were speech, hearing, behavioral, cognitive, motor, and visual impairment, with 62.5% of the included individuals with some form of impairment[20]. However, the presence of sequelae was not considered in our study.

The highest mortality rate occurred in 2011, with numbers decreasing gradually to a plateau from 2016 to 2019. A drop in the number of deaths starting in 2012 was also described in two other studies carried out in Salvador, Bahia[3,9]. Again, it is possible that increased vaccination coverage might have caused a decrease in the prevalence and morbimortality of meningococcal infection in children and adolescents in the last decade.

Lethality in Bahia was in line with national results, which range from 2% to 20%[2,21], a proportion close to the 10% seen in developed countries[6]. Studies suggest that early diagnosis, immediate administration of antibiotics, not delaying lumbar puncture, aggressive control of septic shock, and availability of intensive care units may contribute to better outcomes and lower mortality and lethality[21].

The East health macro-region, which comprehends the Regional Health Center (NRS) with the largest population in the state, had the highest prevalence, mortality, and lethality rates. It should be mentioned that meningococcal infection has risk factors that affect both incidence and prevalence, such as poor hygiene conditions, crowding, socioeconomic conditions, age, and immunosuppressant therapy, among others[22]. In addition to these factors, which vary in each macro-region, individuals living in the East macro-region have better access to healthcare services than the populations living in other regions. Health status, infrastructure, availability of healthcare workers and drugs in each macro-region may also explain the distribution of hospitalizations throughout the state.

A limitation of this study is that no data from the time period in which the endpoints discharge and death were measured were found, either in the description of the variable or in the technical notes available in the database (SIH/DATASUS). Another potential limitation is the possibility of bias or ecological fallacy inherent to the chosen study design. Since the database used in the study does not provide information about the disease or individual exposure, but only about the study population as a whole, we cannot state that the patterns observed in the aggregate population are necessarily reproduced at an individual level. Despite these potential limitations, our study provided important information about morbidity and mortality from meningococcal infection in Bahia.

To sum up with, the epidemiological profile of children with meningococcal infection in the state of Bahia follows global and national patterns, with brown boys aged 0-4 years standing out as the preferentially affected population. Morbidity and mortality concentrated around this age group, reinforcing the need to strengthen preventive immunization, especially in the pediatric population. The data discussed in this study may be used as input in the development of specific strategies aimed at preventing and controlling the disease via epidemiological surveillance and health promotion strategies, so that resources are effectively deployed to combat meningococcal infection and ultimately eradicate the disease in Bahia.

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