Identification of spatial patterns in the distribution of meningitis in the State of Mato Grosso – Brazil, from 2007 to 2019

Identificação de padrões espaciais na distribuição da meningite no estado de Mato Grosso – Brasil, no período de 2007 a 2019

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Abstract

Objective: *to analyze the underreporting of meningitis records in the state of Mato Grosso, under conditions of vulnerability, based on spatial analysis.* **Methodology:** *Meningitis cases and estimated population were collected from DataSUS, organized by municipality of residence in the state of Mato Grosso and year of notification. Incidence rates were calculated by dividing the number of cases by the population, multiplying the result by 100,000. For spatial autocorrelation analysis, mean rates were used for the entire period, in addition to the variables percentage of poor, percentage of the population living in households with toilets and running water, and Municipal Human Development Index – Income (MHDI Income), obtained from the Atlas of Human Development in Brazil.* **Results:** *in general, inverse autocorrelation was observed for the percentage variable of the population living in households with toilets and running water, with municipalities in the center and southeast of the state under high-high autocorrelation and municipalities in the northwest and northeast under low -low. As for the MHDI Income, cities in the center presented high-high autocorrelation and cities in the south and northwest, low-low.* **Conclusion:** *the scenario suggests that there is underreporting of meningitis cases in Mato Grosso, as situations marked by less privileged socioeconomic conditions are risk factors for disease transmission. Improvement of health services is suggested, seeking equitable public policies that aim to reduce the existing inequalities in this country.*
Keywords: *Meningitis. Vulnerabilities. Spatial Analysis. Health Services.*

Resumo

Objetivo: analisar a subnotificação dos registros de meningite no estado de Mato Grosso, analisado sob condições de vulnerabilidade, a partir de análise espacial. **Metodologia:** casos de meningite e população estimada foram coletados no DataSUS, sendo organizados por município de residência no estado de Mato Grosso e ano de notificação. Taxas de incidência foram calculadas a partir da divisão do número de casos pela população, multiplicando o resultado por 100.000. Para análise de autocorrelação espacial, foram utilizadas taxas médias para todo o período, além das variáveis percentual de pobres, percentual da população que vive em domicílios com banheiro e água encanada e Índice de Desenvolvimento Humano Municipal – Renda (IDHM Renda), obtidas junto ao Atlas de Desenvolvimento Humano no Brasil. **Resultados:** de uma forma geral, observou-se autocorrelação inversa quanto à variável percentual da população que vive em domicílios com banheiro e água encanada, com municípios do centro e do sudeste do estado sob autocorrelação alto-alto e municípios do noroeste e do nordeste, sob baixo-baixo. Quanto ao IDHM Renda, municípios do centro apresentaram autocorrelação alto-alto e municípios do sul e noroeste, baixo-baixo. **Conclusão:** o cenário sugere que há subnotificação de casos de meningite em Mato Grosso, pois situações marcadas por condições socioeconômicas menos privilegiadas são fatores de risco para transmissão da doença. Sugere-se aprimoramento de serviços de saúde, buscando políticas públicas equânimes que visem reduzir as desigualdades existentes neste país.
Palavras-chave: Meningite. Vulnerabilidades. Análise Espacial. Serviços de Saúde.

INTRODUCTION

Disease linked to conditions of vulnerability, such as places of greater agglomeration and lack of hygienic education (CRUZ; BERNARDO; GUSMÃO, 2021), mortality from meningitis is reducible by immunoprevention, in addition to diagnostic and treatment actions (MALTA et al., 2007).

Despite good surveillance and control possibilities due to mandatory notification and hospitalization, the disease is underreported for several reasons related to the sensitivity and efficiency of the epidemiological surveillance system of the various health services (SANTOS; RUFFINO-NETTO,

2005). The assessment of this scenario of underreporting of meningitis records is not a recent issue (ARANTES; RUFFINO-NETTO, 1977), remaining a problem addressed in current scientific studies (LUZ et al., 2020).

The chance of an individual to use a certain type of health facility is associated with their income, establishing reproductions of inequalities in the health system, as the possibility of choosing the consumption of these services is limited by the aforementioned factors (TRAVASSOS et al., 2000). In this way, equitable public policies that aim to reduce inequalities in access to health services in the country are essential.

Given the above, this work aims to analyze the underreporting of meningitis records in the state of Mato Grosso related to conditions of vulnerability, using spatial analysis.

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METHODOLOGY

Cross-sectional study based on secondary data and with spatial analysis. Data referring to meningitis cases and estimated population were collected from the Informatics Department of the Unified Health System, from the Notifiable Diseases Information System (both linked to the Ministry of Health) (BRASIL. MINISTÉRIO DA SAÚDE, 2021a; 2021b). The cases refer to meningococcal infection (code A39.0 of the International Catalog of Diseases – ICD 10), viral meningitis (A87), bacterial meningitis not classified elsewhere (G00), meningitis in bacterial diseases classified elsewhere (G01), meningitis in other infectious and parasitic diseases classified elsewhere (G02) and meningitis due to other and unspecified causes (G03). The records were organized by municipality of residence in the state of Mato Grosso and by year of notification. Chi-square test (5% significance level) was calculated for demographic information (race/color and age groups) provided by case records.

Incidence rates per year were calculated by dividing the number of cases by the population, multiplying the result by 100,000. Subsequently, average rates were calculated for each study period (2007-2009, 2010-2012, 2013-2015, 2016-2019), dividing each result by three (number of years per study period). The sum of fees for the last period had its result divided by four.

The Atlas of Human Development in Brazil (ATLAS BRASIL, 2021), which uses data from the 2010 IBGE Demographic Census, was the source of the variables percentage of poor, percentage of the population living in households with toilets and running water, and the Municipal Human Development Index – Income (MHDI Income). The adoption of these variables as indicative of conditions of social vulnerability is justified.

Subsequently, spatial dependence (spatial autocorrelation) was analyzed from the Moran Index, which has values from -1 to +1 (BRASIL. MINISTÉRIO DA SAÚDE, 2007), with values below 0.3 referring to weak spatial autocorrelation and values above 0.7, strong spatial autocorrelation (VALE et al., 2019). The analysis was performed by calculating the Moran Global Index (I) for the average rate for the entire study period (sum of all incidence rates per year divided by thirteen) and for each explanatory variable. The following classification was adopted for the strata of Local Moran Index values: high-high (quadrant 1, highest priority), low-low (quadrant 2, lowest priority), high-low (quadrant 3, intermediate priority) and low-high (quadrant 4, intermediate priority) (the first two representing positive spatial association) (BRASIL. MINISTÉRIO DA SAÚDE, 2007). The Bayesian rate method was not chosen because it could distort the spatial associations already found, as they smooth rates from weighting in small areas, leading to biased spatial correlations.

The QGis Program (version 2.18.20) was used to generate thematic maps. Spatial autocorrelation analyzes were performed in the GeoDa Program, version 1.14.0.
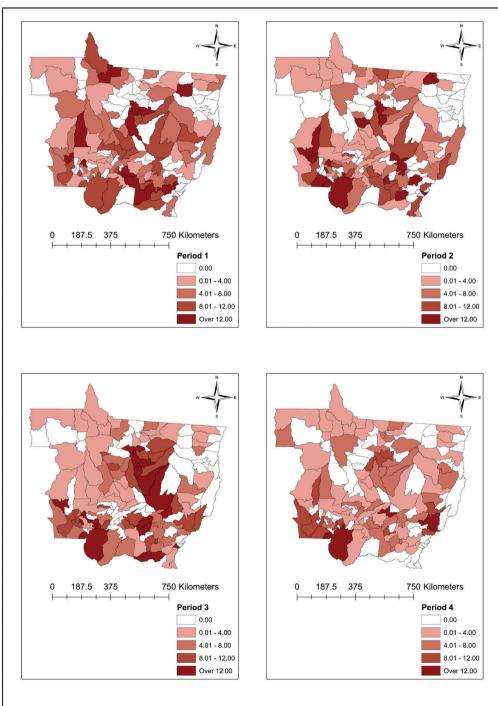
RESULTS

A total of 2,875 cases of meningitis were recorded during the study period. Regarding the percentage change in the period, the largest number of cases was observed in 2007 (13.50% of the total cases of the entire period), 2008 (255, 8.56%), 2013 (250, 8.39%), 2014 (225, 7.56%) and 2017 (206, 6.92%). In 2020 and 2021, 60 (2.01%) and 37 (1.24%) cases were observed, respectively. Of this total, 1,454 were observed for brown, 986 for white, 129 for black, 49 for indigenous and 31 for yellow. It is noteworthy that 226 cases had the race/color category ignored. The race/color category was significantly associated with cases of meningitis in the age groups analyzed (p-value < 0.01). As for the average incidences, high values were observed in the "ignored" category. Also noteworthy are the highest incidences in the age groups up to nine years of age, especially in children under one year of age (1.50 in yellow and 9.32 in indigenous people) (Table 1).
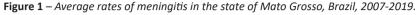
Table 1 – *Meningitis cases (and annual average incidences per 100,000 inhabitants) classified by race/color and age group in the state of Mato Grosso, Brazil, 2007-2019.*

Age group	Race/color Ignored	White	Black	Yellow	Brown	Indigenous	P-value
Less than 1	32 (5860.81)	173 (0.92)	6 (0.45)	4 (1.50)	206 (1.41)	24 (9.32)	
1 to 4	61 (2564.10)	192 (0.28)	14 (0.19)	5 (0.39)	193 (0.29)	7 (0.66)	
5 to 9	44 (1404.40)	145 (0.17)	16 (0.14)	5 (0.28)	199 (0.21)	8 (0.62)	
10 to 14	13 (312.50)	77 (0.08)	17 (0.11)	1 (0.05)	140 (0.13)	4 (0.32)	
15 to 19	13 (311.53)	53 (0.06)	7 (0.04)	5 (0.22)	85 (0.08)	1 (0.09)	
20 to 39	29 (56.92)	171 (0.04)	31 (0.04)	4 (0.04)	326 (0.09)	3 (0.09)	
40 to 59	25 (156.22)	129 (0.04)	28 (0.06)	5 (0.08)	227 (0.10)	2 (0.12)	
60 to 64	2 (121.14)	21 (0.05)	7 (0.10)	0 (0.00)	40 (0.13)	0 (0.00)	
65 to 69	2 (178.89)	6 (0.02)	3 (0.06)	2 (0.23)	14 (0.06)	0 (0.00)	
70 to 79	2 (199.80)	16 (0.03)	0 (0.00)	0 (0.00)	20 (0.07)	0 (0.00)	
Over 80	3 (378.31)	3 (0.01)	0 (0.00)	0 (0.00)	4 (0.03)	0 (0.00)	
							< 0.01

Source: own authorship.

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As for the average rates per period, higher values were observed in municipalities located in the central and southern portions of the state of Mato Grosso. There was a relative decrease in values from the first to the second period (with rates between 0.01 and 8.00 in most cities), followed by a new increase in the third period (with eighteen cities making up the last stratum, with values above 12.00). In the fourth period, only three municipalities had mean rates in the stratum of higher values (Figure 1).

Figure 1 – *Average rates of meningitis in the state of Mato Grosso, Brazil, 2007-2019.*

Source: own authorship.

Regarding the Moran Global Index, municipalities in the northwest, north and northeast portions of the state had low values for average rates for the entire period (low-low autocorrelation), standing out as low priority

municipalities. Municipalities in the southwest and south portions presented high values for these rates (high-high autocorrelation), configuring themselves as high priority municipalities. Regarding the explanatory variables, a high-high autocorrelation of the variable percentage of poor was observed in municipalities in the northwest and northeast portions (the latter also with municipalities under low-high autocorrelation). Municipalities in the center and

southeast showed low-low autocorrelation. In general, inverse autocorrelation was observed for the percentage variable of the population living in households with toilets and running water, with cities in the center and southeast under high-high autocorrelation and cities in the northwest and northeast under low-low. As for the MHDI Income, cities in the center presented high-high autocorrelation and cities in the south and northwest, low-low (Figure 2).
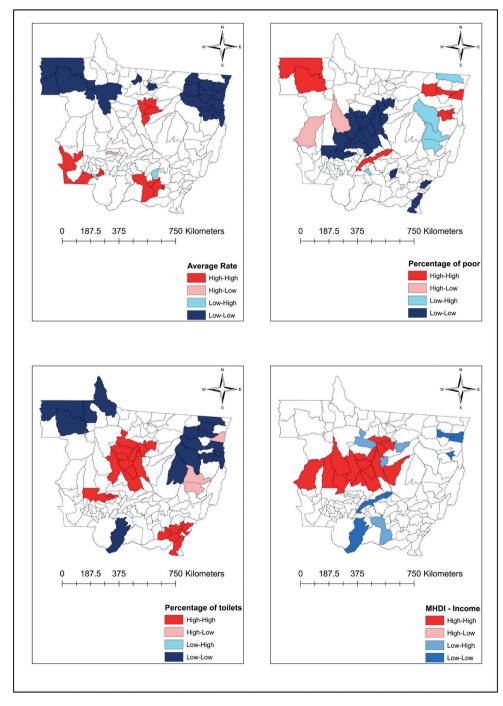
Figure 2 – *Moran Local indices of average rates of meningitis and explanatory variables in the state of Mato Grosso, Brazil, 2007-2019.*

Source: own authorship.

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DISCUSSION

Disease transmitted by direct person-to-person contact, from respiratory secretions of infected (asymptomatic or symptomatic) (BRASIL. MINISTÉRIO DA SAÚDE, 2019a), meningitis is linked to conditions of vulnerability, present in more crowded places and lack of hygienic education (CRUZ; BERNARDO; GUSMÃO, 2021). Mortality is classified as preventable from newborns to the 75-year-old population, being reducible by immunoprevention. In the population of children under 5 years of age, reductions in mortality are highlighted due to adequate diagnostic and treatment actions (MALTA et al., 2007).

Despite good surveillance and control possibilities due to mandatory notification and hospitalization of practically 100% of cases, meningococcal disease is underreported for several reasons related to the sensitivity and efficiency of the epidemiological surveillance system of the various health services (SANTOS; RUFFINO-NETTO 2005).

Our findings showed a reduction in mean meningitis rates per period, especially in the last analysis period (2016 to 2019), which has been reported in the literature (BRASIL. MINISTÉRIO DA SAÚDE, 2019b). However, observing the spatial autocorrelations, it can be seen that higher values of the average rates were located in municipalities with a lower percentage of poor people and better socio-environmental conditions (higher percentage of the population living in households with bathroom and running water and higher MHDI Income), when while lower rates were observed in municipalities with a higher percentage of poor people and worse socio-environmental conditions.

This scenario suggests the hypothesis of underreporting of records of meningitis cases in Mato Grosso, as situations of crowding at home and less privileged socioeconomic conditions are risk factors for disease transmission (BRASIL, MINISTÉRIO DA SAÚDE, 2019a). As noted in other grievances, underreporting can be explained by problems in the internal flow between the place where cases are handled and the place of consolidation of this information, sent to the SINAN database, in addition to possible failures in the receiving flow due to the occurrence of errors during case data transfer. Another possible explanation is the lack of filling in the investigation and notification forms at the health unit, leading to the absence of notification of some cases (FAÇANHA et al., 2006).

Underreporting of records can also occur due to the great physical distance between the city and hospital services used by its residents, which is recognized as a factor that hinders hospitalization in the country as a whole. This difficulty is aggravated by the fact that the cost of travel is higher in poorer municipalities, which must be taken into account by policies to improve the care model (OLIVEIRA; TRAVASSOS; CARVALHO, 2004). In this context, in Mato Grosso there are many municipalities with a large territorial extension, composed of a population in situations of social vulnerability, reinforcing the hypothesis of underreporting of records of meningitis cases.

As described, higher rates were observed in municipalities with better socioeconomic indicators. In general, they are municipalities that produce corn, soy, cattle and cotton, which constitute a strategic territory for the expansion of agricultural production (IBGE, 2015). Thus, it is believed that better socioeconomic levels end up generating greater access to health information, leading to greater demand for services of this order, facilitating the recording of notifications of cases of the disease in question.

In this context, studies have shown that individuals with better socioeconomic status are more likely to see a doctor (CAPILHEIRA; SANTOS, 2006; BOING et al., 2010), since the increased chances of seeking health services would be directly related to groups more privileged social groups, with greater education and with access to public services (water, sewage, electricity and garbage collection) (NERI; SOARES, 2002). Thus, poorer individuals may have less access to medical services, not knowing their true health status (NORONHA; ANDRADE, 2002). This situation can make the disease control scenario more difficult, as it would prioritize municipalities with higher rates of meningitis, which does not necessarily represent the real situation of disease transmission in the entire state of Mato Grosso.

These considerations corroborate the analysis of the social determination of health, analyzed in studies that show the issue not only from a biological aspect, but also from a social, economic and environmental point of view. Resulting from socially constructed behaviors and habits, differences in health are also consequences of factors that are not directly controlled by individuals or groups: they often have economic determinants, making poor health a consequence of a socially imposed condition (SOUZA; SILVA; SILVA, 2013).

Far beyond indicators and causalities, the social field must be understood through the complexities of everyday life, overcoming fragmented knowledge external to the individual (GARBOIS; SODRÉ; DALBELLO-ARAUJO, 2014): there is no division between the social and biological spheres (GARBOIS; SODRÉ; DALBELLO-ARAUJO, 2017), and health is conditioned by several interconnected factors. Therefore, it is essential to study the perception of health services, the representations about the health-disease process and its implications for the practice of services (ZIONI; WESTPHAL, 2007).

In addition, of the total of 2,875 cases, 1,334 were from the age groups of less than 1 year to 9 years old, which is in agreement with the literature, since about 30% of the reported cases occur in children under 5 years of age (BRASIL. MINISTÉRIO DA SAÚDE, 2019). However, it is noteworthy that 980 cases were observed in the age groups from 20 to 59 years, which may be indicative of increased transmission of the disease in the state, as changes in the affected age groups may represent outbreaks/epidemics of the disease (BRASIL. MINISTÉRIO DA SAÚDE, 2019), which may be hidden by underreporting of case records.

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Aiming to improve the disease diagnosis systems, it is suggested the expansion of active search services, which is essential for early diagnosis. As observed in a study on leprosy in a municipality of Maranhão, the active search (along with the participation of health professionals) was decisive for the identification of suspected cases, leading to an increase in case detection in areas where the family health program is more acted. Furthermore, it was observed that the expansion of coverage allowed different sectors of society to receive information about the disease and its determinants (SILVA et al., 2010).

Additionally, to control the transmission of meningitis, the importance of preventive measures should be highlighted, such as the intensification of chemoprophylaxis and the education sector as a disseminator of educational measures regarding health, bringing knowledge to society from day care centers and schools (SANTOS; RUFFINO-NETTO, 2005).

CONCLUSION

The present study highlighted meningitis as an unresolved public health problem, which may have a more serious scenario hidden from the possible underreporting of cases. The results presented may be useful for improving and expanding public policies aimed at search, diagnosis and notification services for meningitis cases in Mato Grosso.

Policies aimed at reducing vulnerabilities can prioritize the mitigation of the effects of material conditions, such as interventions for educating women to reduce their own vulnerability, as well as their children. Health services seek to reduce differentials of consequences caused by the disease, by improving the quality of these services, preventing further impoverishment caused by it (BUSS; PELLEGRINI FILHO, 2007).

As possible limitations, it is highlighted that ecological studies are built by aggregated level data, so that the aggregation by municipalities does not necessarily represent an individual level (ecological bias). In addition, in the same municipality, there may be differentiation regarding the quality of the surveillance system. Another possible limitation refers to the use of secondary data, which may have typing errors, biasing case records (including contributing to an increase in underreporting) (FAÇANHA et al., 2006).

It is suggested to expand the active search to expand the diagnosis of meningitis and its respective prophylaxis, thus contributing to reduce its transmission in the state. As identified, there are differences in the use and evaluation of health services (BOING et al., 2010) and based on the improvement of these services, equitable public policies are sought to reduce existing inequalities in this country.

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