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The epidemiological profile of malaria in the municipality of Sinop, Mato Grosso State, from 2001 to 2015

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Abstract. Human malaria is a parasitic disease that affects about 500 million people in the world, causing nearly one million deaths each year. The main objective of this study was to reveal the epidemiological profile of malaria in municipality of Sinop based in fourteen years of analysis (2001 - 2015). The retrospective study was based on secondary data stored Malaria Epidemiological Surveillance System-Malaria (SIVEP-Malaria) of the Health Surveillance Office at the Ministry of Health, available online. Based on epidemiological analysis the results showed that the frequency of malaria decreased as from 2003 to 2012, where there was an expressive increase in malaria cases. Malaria was predominantly autochthonous in Sinop and *P. vivax* was predominant specie in all years under study. The study revealed areas with the highest incidence of malaria and the influence of factors related to maintenance and disease transmission. Based on epidemiological profile of malaria in Sinop, disease is not only a public health problem but political, environmental and socioeconomic. It is necessary maintain epidemiological surveillance through of rapid diagnosis and effective treatment of patients.

Keywords: Malaria; Epidemiology; Sinop.

Introduction

Malaria is an important parasitic disease that affects about 500 million people worldwide causing about one million deaths each year (Parise et al., 2011). The disease is caused by a protozoan of the genus *Plasmodium*. Actually, five species are responsible for disease in humans: *Plasmodium vivax*, *P. falciparum*, *P. malariae*, *P. ovale* e o *P. knowlesi*. The latter has been recently discovered, accounting for over 50% of clinical cases of malaria in Asia (White, 2008; Cox-Singh et al., 2008; Ong, 2009).

Actually, malaria is a major public health problem in Brazil. The most cases of malaria are concentrated in the Amazon region, which is composed by States of Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia, Roraima e Tocantins (Oliveira-Ferreira et al., 2010). In the last 14 years (2000-2013), the Ministry of Health recorded an average of 392.6 thousand cases of malaria per year in Brazil (de Pina-Costa et al., 2014). In Amazon Region, three *Plasmodium* species are responsible for human malaria:

Plasmodium falciparum, *P. vivax* and *P. malariae*; however *P. malariae* does not have the same epidemiological importance than *P. falciparum* and *P. vivax* (Oliveira-Ferreira et al., 2010; Fugikaha et al. 2007). *P. vivax* is the specie with highest number of cases registered in the country (Battle et al., 2012).

The Mato Grosso State is situated in the Brazilian Amazon region which is considered an endemic area for malaria transmission (Maciel & Oliveira, 2014). The occurrence of malaria cases in Mato Grosso is related to several factors, specially the activities for the extraction of natural resources such as mining activities and wood extraction. In the period from 2000 to 2011, there was a reduction of 86.1% in the number of malaria cases in Mato Grosso and the State was considered as low risk region for malaria in the Amazon (Ministério da Saúde, 2013). The Sinop city, located at 551 km from Cuiaba, Mato Grosso State, presented a rapid and constant development in the recent past through a strong economy based on wood extraction and mining. Sinop reports throughout its

history imported and autochthonous cases of malaria in the population because the great ecological and environmental conditions. Another factor to the implementation of malaria in Sinop is the intense migratory flow of people from other states where malaria is endemic. These population profiles are attracted due to the demand for jobs and the great growth of the city in recent years.

There are a few epidemiological studies of microgeographic scale in malaria regions of Brazil. In this sense, the objective of this study was collected detailed data related to malaria cases reported in Sinop from 2001-2015. In addition, quantify the values of malaria incidence, check the distribution of cases according to autochthonous and imported cases, describe the frequency and percentage of cases by *Plasmodium* species and identify areas of risk of acquiring malaria in the municipality.

METHODS

Study design

This work was a descriptive study with quantitative approach. According Lakatos & Marconi (2007), this is an empirical research which the objective is analysis of facts or phenomenon,

program evaluation or establishing relationships between variables.

Study area

The study was conducted in Sinop, located 500 Km from Cuiaba, Mato Grosso State, an endemic area of malaria in Brazil (Figure 1). The health services for malaria in Sinop include only one public health post for diagnosis, administered by the municipality, which provides a parasitological diagnosis and free treatment for the residents of the area.

Data Collection

The data collection system was based on the information contained in the epidemiological summary records of SIVEP – malaria database. The research was based on the description of all malaria cases recorded by the SIVEP – malaria between the years 2001-2015. The reporting forms were examined and interpreted during the study period for the analysis of variables such as: frequency and incidence of the disease based on the number of positive cases (autochthonous and imported) per year, *Plasmodium* species (*P. falciparum* and *P. vivax*) and local of infection. In addition, it was evaluated the number of Cure Verification Slides (CVS) and the Percentage of Positive Slides (PPS) of each year



Figure 1. Map of Mato Grosso State indicating the location of the municipality of Sinop. Font: Wikipedia. Site: <https://pt.wikipedia.org/wiki/Sinop>

Data analysis

The percentage of positive slides (PPS) of each year was calculated according with number of

positives slides to malaria each year. The *P. falciparum* and *P. vivax* infection rate was calculated in each year of study. To evaluate the

risk of malaria transmission in Sinop was used the Annual Parasite Incidence (API). This classification is based on number of confirmed cases during 1 year/population under surveillance x 1000 inhabitants, whose results to classify the malaria endemic areas at high, medium or low risk of malaria transmission.

In this work, was evaluated if malaria cases were acquired in Sinop or outside the city. To this end, were considered autochthonous cases those who contracted the infection in localities within Sinop transmitted by mosquitoes and imported malaria, a case of malaria that is brought into an area by someone who has become infected somewhere else. The person could be either a tourist or immigrant.

The data were tabulated and organized in Microsoft Office Excel 2012 program and later transformed into graphs and tables which allowed visualization of the most important epidemiological phenomena for analysis and discussion.

Results and discussion

During the study period, there was malaria records in almost every year in Sinop, totaling 18,186 tests performed with 2,425 positive results (1.34%) (Table 1). The largest number of malaria cases occurred in 2003 with 3,270 samples

examined, of which 27% (900 slides) were positive. After 2003, although the population present upward trend, the number of positive samples decreased significantly in 2009 with only 4% of positive samples (Table 1). However, in 2010 and 2012 occurred an unexpected increase of cases reaching in these years 10.5 and 11.9% of positive samples (131 and 190 cases), respectively. From 2013 to 2015, occurs a visible fluctuation in the number of cases, ranging from 6 to 10% (Table 1).

A suitable method to evaluate the percentage of malaria infection in a particular region was through the observation of PPS (Percentage of Positive Slides). Although there have been cases of malaria in Sinop in 2001, these data should not have notified or were not passed to the Ministry of Health (Graphic 1). Besides that, in 2002 was conducted only one test for malaria which resulted in 100% positivity. In 2003, were recorded 27.5% of PPS in Sinop and these values has reduced significantly up to 2009 (4%). In 2010, the PPS value increased to 10% and presented a small variation up to 2015 (Graphic 1). Despite the large number of malaria cases in 2012 (190), the PPS values fluctuated considerably to 2010 and 2015 (3.8 – 11.9). These data indicate that there was expressive variation in the number of PPS investigated during 2010 - 2015.

Table 1. Annual distribution of malaria cases in Sinop, Mato Grosso State, 2001 to 2015.

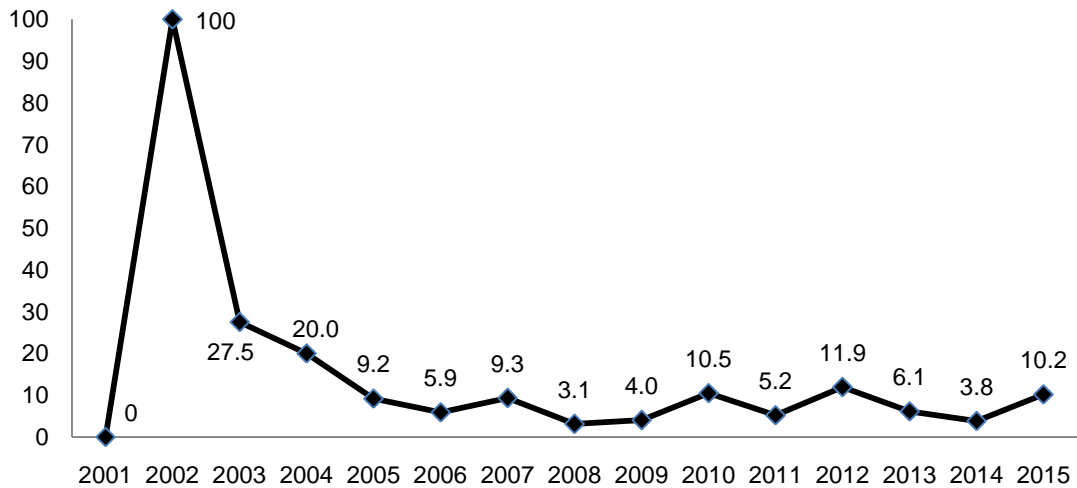
Year	Diagnosis*	Positives	Percentage (%)
2001	0	0	0
2002	1	1	100.0
2003	3,270	900	27.5
2004	2,939	588	20.0
2005	2,25	206	9.2
2006	1,836	109	5.9
2007	1,382	128	9.3
2008	926	29	3.1
2009	554	22	4.0
2010	1,278	131	10.3
2011	912	47	5.2
2012	1,6	190	11.9
2013	818	50	6.1
2014	292	11	3.8
2015	128	13	10.2
Total	18,186	2,425	

* Numbers of exams and tests used to diagnose malaria in each year.

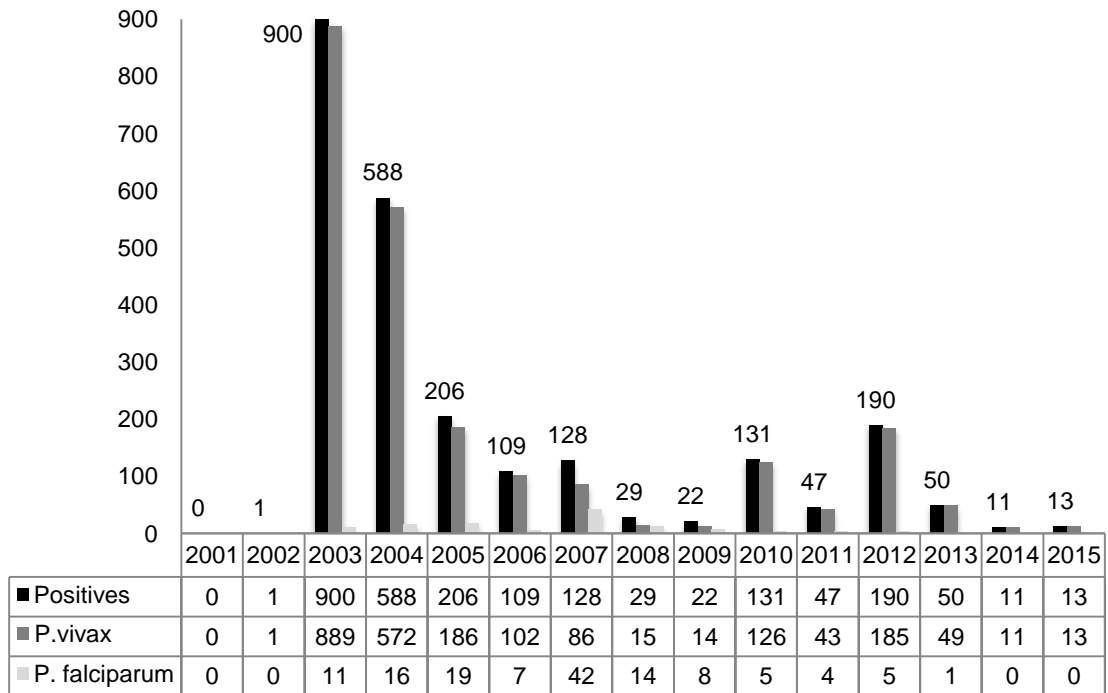
Font: SIVEP Malaria

Based on all positive cases of malaria diagnosed during the study, it was verified a significant difference in the distribution of cases in relation to *Plasmodium* species. *P. vivax* was the specie most prevalent in the study. However, in 2008 there was a difference in the epidemiological profile when it was possible verify a comparison between the number of cases of *P. vivax* and *P.*

falciparum (50%) (Graphic 2). However, in the other years of study there was no variation about the proportion of *P. vivax* and *P. falciparum*. During of study was possible observe that *P. vivax* infection reduced continuously in Sinop, however was especially a significant increase of *P. vivax* cases in 2010 and 2012 (Graphic 2).



Graphic 1. Percentage of Positive Slides (PPS) investigated in Sinop, Mato Grosso State, 2001 to 2015.



Graphic 2. Number of malaria cases by *Plasmodium* species in Sinop, Mato Grosso State, 2001 to 2015.

Sinop is a city characterized by a rapid population flow seeking employment and better life quality. The population is ever increasing and the number of autochthonous malaria cases prevailed under the imported cases, showing that malaria in Sinop is a problem that persists with large numbers of infections (Table 2). In 2009, there was a difference in these data, where there was a predominance of imported cases. However, in 2010 and 2012 there was a significant increase of autochthonous cases (Table 2). Considering the values during 2001 - 2015 in both classifications (autochthonous and imported), even so total of autochthonous cases (1,982 – 81.7%) was superior

to imported cases (384 – 15.8%). Thereby, the most malaria cases diagnosed were contracted in Sinop.

According to the Brazilian Ministry of Health, the Cure Verification Slides (CVS) is malaria diagnostic test realized during and after recent treatment in patients with malaria. The objectives of CVS is verify if treatment was effective and evaluate a CVS like a indicator of deficiencies of health services in surveillance of infection sources. Besides that, CVS is useful to distinguish a new infection (new cases) from recrudescence or relapse. During the study, a total of 818 Cure Verification Slides (CVS) were realized and were found 468 (57.2%) patients cured during or after treatment (Table 3). This index shows that little less

than half of patients had to be treated again (42.8%). Thereby, it is important stress that in all treated malaria cases should be performed a CVS to confirm the cure of the patient. Throughout the entire study, only in 2009 and 2015 there was a

100% cure through CVS (Table 3). This constant of patients without cure can be explained by the occurrence of failure of health facilities, lack of adherence to treatment and the parasite resistance to main antimalarials.

Table 2. Distribution of malaria cases in Sinop, Mato Grosso State, 2001 to 2015, according with local of acquisition of malaria cases

Year	Population	Positive	Autochthonous	Imported
2001	0	0	0	0
2002	82,992	1	1	0
2003	86,775	900	785	115
2004	90,551	588	530	58
2005	90,551	206	176	30
2006	99,121	109	68	41
2007	108,209	128	83	45
2008	110,513	29	18	11
2009	114,053	22	7	15
2010	113,099	131	97	34
2011	116,013	47	23	24
2012	118,833	190	163	5
2013	123,634	50	30	4
2014	126,817	11	0	2
2015	126,817	13	1	0
Total		2,425	1,982	384

Table 3: Cure Verification Slides (CVS) investigated in Sinop, Mato Grosso State, 2001 to 2015.

Tests performed (CVS)		Positive samples	
Year	N.º	Nº	%
2001	0	0	0
2002	0	0	0
2003	16	4	25.0
2004	165	110	66,6
2005	142	82	57.7
2006	51	45	88.2
2007	135	60	44.4
2008	15	13	86.6
2009	7	7	100.0
2010	81	49	60.4
2011	55	30	54.5
2012	125	55	44.0
2013	23	12	52.1
2014	2	0	0
2015	1	1	100.0
Total	818	468	57.2

Font: SIVEP – Malaria

When were analyzed the distribution data of malaria cases in Sinop, stratifying the malaria

incidence by regions or neighborhoods, was found that Gleba Mercedes, Jardim das Primavera, Boa

esperança, Jardim das Violetas and Vitória Régia were the higher malaria transmission regions during study period (Graphic 3). In 2003, almost all areas showed malaria cases and from this year there was a significant decrease in the numbers of confirmed cases in some regions considered high risk to malaria infection (Data not shown).

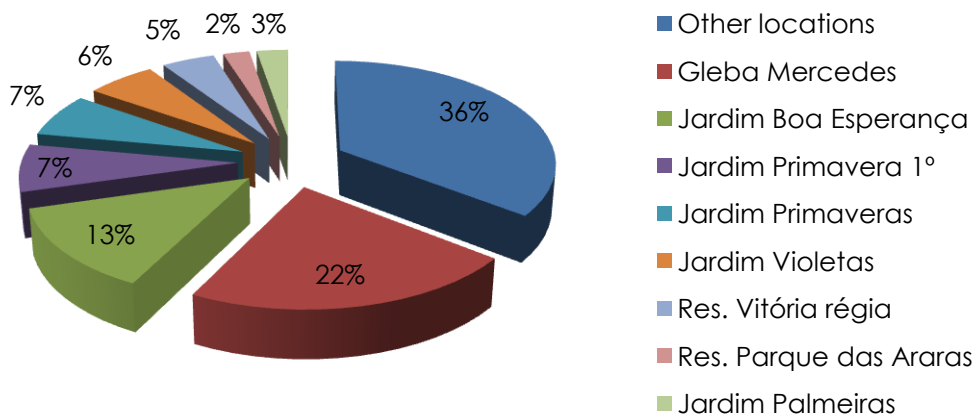
Malaria in Sinop, like other cities in Amazon Region, is a health problem since the 1940s. In this study, malaria was prevalent almost years of follow-up. However, in 2001 there was any malaria case registered in SIVEP database and in 2002 there was only one record of the disease. This fact could be clearly explained by the negligence of malaria cases in Sinop. The Brazilian government has adopted policies of decentralization of health sectors and established stricter rules for earmarking budget funds for health at three levels of government since 2000. These public policies have caused considerable problems in the transfer of financial resources of the Union for funds from States and Municipalities (Machado et al., 2014; Rodrigues & David, 2011). The Health Secretariat of Sinop may have lost or were not passed data regarding the number of autochthonous and imported malaria cases that had been diagnosed.

The Mato Grosso State possesses natural and epidemiological characteristics for malaria transmission like tropical forest and mining areas (Ferreira et al., 2012; Maciel et al., 2013). In Sinop, in addition to these epidemiological characteristics, the malaria cases observed in this study were influenced by the intense process of urbanization. This event could also be observed in other areas of the Brazilian Amazon, especially in areas without infrastructure, such as industrial zone of Manaus, Belem, Sao Luis and Maraba (Opas, 2010).

The number of malaria cases in Sinop demonstrated a downward trend through all following years researched. This decrease in the number of cases can be interpreted by factors such

as real notification of disease and intensification of epidemiological surveillance (Brasil, 2010). Nonetheless, in 2010 and 2012 there was a significant increase in the number of malaria cases in Sinop. According Tauil (2011), in 2010 the increase in the number of malaria cases occurred at national level, which was reported 333,424 malaria cases, of these, 332,310 (99.7%) were contracted in the Amazon Region.

Regarding the *Plasmodium* species that cause malaria in Brazil, *P. vivax* was the predominant specie during the entire study. *P. vivax* is responsible for more than 80% of malaria cases in Brazil, while *P. falciparum* represents around 15% of infections (Oliveira-Ferreira et al., 2010; WHO, 2013). The malaria cases in Sinop seem to relate to intense migration process and agglomerations on the outskirts of the city. In 2003, Sinop registered the greater index of *P. vivax* infection in all study period, which were recorded 900 malaria cases. This phenomenon also occurred in some localities of the Amazon and the incidence rose again from 2003 to 2005 (Oliveira-Ferreira et al., 2010). The analysis this increase malaria cases may be related with climatic changes and intense migratory movements to region. The disorderly occupation of the area to agrarian reform projects and the consequent deforestation for logging, cattle ranching and agriculture created an excellent environment in periurban area to transmission of malaria. In 2008, there was a significant reduction in malaria cases reported in Sinop and in all Amazon Region. These results were obtained from efforts to understand the dynamics of malaria transmission, mobilizing the multi-sector forces of Ministry of Health, mainly the health managers in states and municipalities in the Amazon region, to coordinate population movements and to prioritize surveillance, prevention and control of malaria on their agendas (Oliveira-Ferreira et al., 2010).



Graphic 3. Malaria cases distribution by neighborhood in Sinop, Mato Grosso State, 2001 to 2015.

The results suggested that the numbers of autochthonous malaria cases registered in Sinop, 2001-2015, are related to environment and climate conditions which encourages a proliferation of mosquitoes and hamper the implementation of control programs in the region (França, 2008). The expressive number of autochthonous malaria cases registered in Sinop can be related to other factors such as extensive endemic area, varied living conditions and housing, high temperatures during the year and the presence of rivers and streams founds in the region (Rodrigues & David, 2011; Lacerda, 2007). According Oliveira-Ferreira et al, (2010), the weakness of epidemiological surveillance and delay in diagnosis and treatment were factors that may have contributed to the increase in the number of malaria cases in this municipality because patients undiagnosed and untreated are able to maintain the etiologic agent in circulation and increase the risk of new cases.

In relation to the distribution of malaria cases by neighborhoods in Sinop, the higher occurrence of disease was in regions primarily dominated by remained area of tropical dense forest. The areas of higher risk of malaria infection are the neighborhood Boa Esperança, Violetas, Primavera, Vitória Régia and Gleba Mercedes. These neighborhoods are outlined by extensive forests areas, woodlands, savanna and near to ponds and lakes. In addition, another fact that may explain the higher prevalence of malaria in certain districts is a transient mobility of some individuals from urban to rural areas, which increase the prevalence of the disease in these localities (Barbieri & Sawyer, 2007). During the study, the decrease in transmission rate in some districts may be related to the epidemiological surveillance action developed to malaria control. In Sinop, a frequent training are offered to Community Health Agents (CHA), endemic agents, doctors, nurses, biologists and laboratory technicians, as well as investments in equipment and adherence to treatment in infections with *P. vivax* and *P. falciparum*.

Conclusions

The main conclusions were:

- The municipal health services and surveillance process have been effective on the implementation of malaria control actions in Sinop;
- The methodology applied in the study, through of quantitative analysis, allowed to characterize the epidemiological profile of malaria in Sinop;
- Epidemiological studies are important to planning and to manage the health services of malaria surveillance.

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