

## EPIDEMIOLOGICAL PROFILE OF MALARIA IN THE STATE OF TOCANTINS, BRAZIL, FROM 2003 TO 2008\*

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### SUMMARY

This study describes the epidemiological profile of malaria in the State of Tocantins, in the period 2003-2008, investigates the association between the frequency of malaria and population growth, classifies the cases by 'autochthonous' and 'imported', reports the indices of the disease and analyses the distribution of the cases by *Plasmodium* species, age and gender. The retrospective study was based on secondary data, stored in SIVEP-malaria and analyzed using the software Epi-Info 3.5.1. and Bioestat 5.0. 19,004 samples were investigated for malaria, 19% of them were positive, 73.32% with *Plasmodium vivax*, 21.80% with *Plasmodium falciparum*, 4.79% with mixed infections and only 0.08% with *Plasmodium malariae*. Male individuals accounted for 76.95% and predominated in all years and age groups, especially in the 15 to 49 years old group. From the overall cases, 34.27% were autochthonous and 65.73% were imported ( $\chi^2 = 356.8, p = 0.0001$ ). The frequency of malaria decreased significantly during the entire series ( $r = 0.96, p = 0.002$ ) and the number of municipalities with autochthonous transmission also diminished. It was found that malaria is predominantly imported, related to land activities, which confirms the need for effective measures to maintain vigilance throughout the state and enhance educational activities in order to guide the population towards early treatment-seeking.

**KEYWORDS:** Tocantins Malaria; Epidemiology; *Plasmodium*; Transmission.

### INTRODUCTION

Human malaria is a fast-evolving parasitic disease that is still a serious problem to public health. In addition to the fact that 40% of the world population living in tropical and subtropical areas is at risk of contracting the disease, it is estimated that between 300 and 500 million new cases per year will appear, causing 1.5 to 2.7 million deaths annually, striking mostly children under five years old<sup>18,23</sup>.

The infection is caused by a unicellular protozoan of the genus *Plasmodium* and each species has different characteristics to the disease. In Brazil, the most frequent species that cause infection in humans are: *P. vivax*, which accounted for 83.7% of registered cases, *P. falciparum*, by 16.3% and *P. malariae* (rarely observed)<sup>26</sup>. However, studies conducted by ARRUDA *et al.*<sup>2</sup> revealed a discrepancy between the prevalence of antibodies against *P. malariae* and the malaria cases officially reported. According to the authors, the low incidence of reports on this species is due to the thick smear method, the official technique for the diagnosis of malaria in Brazil, which does not allow the evaluation of morphological difference of erythrocytes infected with *P. vivax* and *P. malariae*, and this can lead to a misidentification of the species, underestimating the true incidence of the latter.

The main form of malaria transmission is through the bite of an

infected female *Anopheles* mosquito. It usually occurs in populations living in poor housing and labor conditions, in a context of disordered land occupation, mineral exploration, agrarian colonization, settlement areas and intense migration from rural areas to the outskirts of the cities<sup>33</sup>. The quality and the extension of protection and healthcare measures towards the exposed populations has positively influenced the control of the disease<sup>20</sup>, but the difficulties faced to reduce economic and social risk factors in the Amazon region hamper the elimination of the disease<sup>26</sup>.

Regarding the prophylaxis, there is no available vaccine that protects against malaria. To be more protected, people need to be informed about the risks of contracting the disease, set appropriate security measures and still be aware that all prevention methods can fail. If this occurs, early diagnosis and appropriate treatment are today the main foundations for the control of the disease<sup>24</sup>.

In the American continent 36.5% of people live in areas propitious to the transmission of the disease<sup>17</sup>. In Latin America, countries that share the Amazon rainforest (Bolivia, Colombia, Ecuador, Peru, Venezuela, Brazil, French Guyana, Guyana and Suriname), suffered the greatest impact of the problem in 2004, with 91% of malaria cases and 79% of deaths attributed to malaria. Brazil counted 52.27% of the total cases, followed by Colombia and Peru<sup>27</sup>.

\*Part of the Master Thesis of E.V. Parise, presented at UFT, Palmas, TO, Brazil.

Financial support: Science and Technology Office (SECT) of Tocantins, Brazil.

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In the Brazilian area, 99.8% of malaria cases are found in the Amazon region which comprises the states of Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia, Roraima and Tocantins<sup>24</sup>. The region has geographical and ecological characteristics highly favorable for the interaction of the *Plasmodium* and *Anopheles* mosquitoes, which, linked to socio-cultural, economic and political factors depending on man, create different levels of endemic transmission<sup>20</sup>.

Tocantins is located in the southeast of Northern Brazil and borders in the South with the State of Goiás, in the North with Maranhão and Pará, in the East with Maranhão, Piauí and Bahia, and in the West with Mato Grosso and Pará<sup>15</sup>. In spite of being part of the Amazon Region, Tocantins is now considered a non-endemic area with malaria transmission risk<sup>23</sup> and presents favorable climate and environmental characteristics for the development of the vector.

In accordance with this situation, it is of fundamental importance to have an annual assessment of malaria indices in this tropical region, in order to know the epidemiology of the disease and collaborate with agencies responsible for its control. In this sense, the objective of this study was to make a survey of malaria cases reported in the state of Tocantins in the period 2003-2008 in order to quantify the risk of disease transmission, check the distribution of cases according to 'autochthonous' and 'imported' classification, describe the frequency and percentage of cases by *Plasmodium* species, as well as knowing the most prevalent age and gender in sufferers of the disease.

## MATERIALS AND METHODS

The study was conducted in the state of Tocantins, whose land area covers 277,620,914 km<sup>2</sup> with a population of 1,280,509 inhabitants and a density of 4.5 inhabitants per square kilometer<sup>15</sup>.

The research refers to a retrospective study of epidemiological profile, based on secondary data, in which a survey was conducted with the description of all malaria cases reported in the Tocantins State, in the period 2003-2008. The data were obtained from the Malaria Epidemiological Surveillance System-Malaria (SIVEP-Malaria) of the Health Surveillance Office at the Ministry of Health, available online. Census data and population estimations of each year were obtained from the site of the Universal Healthcare System Database (DATASUS), from the source of the Brazilian Institute of Geography and Statistics (IBGE)<sup>15</sup>.

The study was based on the frequency and incidence of the disease, from the number of positive cases reported in the State, through active and passive search; the cases were classified according to the origin (autochthonous and imported); posted in accordance with *Plasmodium* species (*P. falciparum*, *P. vivax* and *P. falciparum*+*P. vivax*) and the distribution of cases was done by age and gender.

The indicator used to calculate the risk of malaria transmission was the Annual Parasite Index (API), calculated from the number of positive slides of malaria in the year, divided by the population, multiplied by a thousand, according to ATANAKA-SANTOS *et al.*<sup>3</sup> and CORREA & ALVES<sup>11</sup>. However, the Interagency Information Network for Health (RIPSA)<sup>29</sup> emphasizes that this indicator has limitations, specifically with regards to the examined slides because they can show a new case, a recurrence or several slides of the same person. For this reason, the

suggestion of DIAS<sup>13</sup> was adopted and the number of new cases of the disease was used in the numerator instead of the overall number of positive slides, that is, only the samples collected by passive surveillance and active searching, avoiding duplicate cases.

From the results of the API, the state was classified into four levels: a) high risk (API greater than 49.9 cases per thousand inhabitants), b) medium risk (API between 10 and 49.9 cases per thousand inhabitants); c) low risk (API between 0.1 and 9.9 cases per thousand inhabitants) and d) no risk (zero API)<sup>23</sup>.

After the API, the Annual Blood Examination Rate (ABER), the Slide Positivity Rate (SPR), the Slide *P. falciparum* Rate (SPfR) and Slide *P. vivax* Rate (SPvR) were also analyzed, according to ATANAKA-SANTOS *et al.*<sup>3</sup> and SILVEIRA & REZENDE<sup>33</sup>.

The variation of the reduction in recorded malaria cases was expressed by the percentage of difference between the number of positive cases from one period to another, like the procedures used by ALVES *et al.*<sup>1</sup>.

The average API for the period 2003-2008, calculated for the age group, was based on the sum of annual APIs from each age group divided by six (number of years studied), similar to the procedure used by ATANAKA-SANTOS *et al.*<sup>4</sup> and CHAVES & RODRIGUES<sup>10</sup>.

The data were compiled in figures and tables for a better interpretation of the epidemiological scenario, and the statistical analysis was worked out using the software Epi Info version 3.5.1 and version 5.0 BioStat. The Spearman Correlation ( $r_s$ ) was used to correlate population growth and positive cases and the Pearson Correlation ( $r_p$ ) was used to relate smears and positive slides. To compare the positive cases by *Plasmodium* species a Kruskal-Wallis (H) test was made and the comparison between the genders was tested with the Mann-Whitney (U) test. Cases of autochthonous and imported malaria were compared by the Chi-square test, and all tests were performed considering a significance level of 5%.

In accordance with the ethical standards for research involving human subjects contained in the resolution no. 196/96 of the National Board of Health, the research project was submitted to the Ethics Committee of the Federal University of Tocantins and was approved in plenary on June 10<sup>th</sup> 2008 under number 024/2008.

## RESULTS

For the overall period of this study, 19,004 blood sample records were analyzed using the thick blood smear method, for the *Plasmodium* species, of which 3,610 (19%) were positive. The number of positive cases of malaria has been decreasing every year according to the number of samples examined, and the Pearson correlation test showed a statistically significant reduction ( $r_p = 0.96$ ,  $p = 0.002$ ). The frequency of positive cases showed no significant association with the demographic growth of the population ( $r_s = -0.37$ ,  $p = 0.46$ ) and the percentage of variation in case reduction fluctuated between years interspersed -15.65% to -47.14%, totaling, in the final series, a decrease of 86.37% (Table 1).

From the 3,610 cases reported during the study period, imported malaria was the most frequent, with 65.73% of cases ( $\chi^2 = 356.8$ ,  $p = 0.0001$ ). In 2003, from the 1,211 cases recorded, 691 were imported and 520 autochthonous, while in 2008, from 165 registered cases, 152

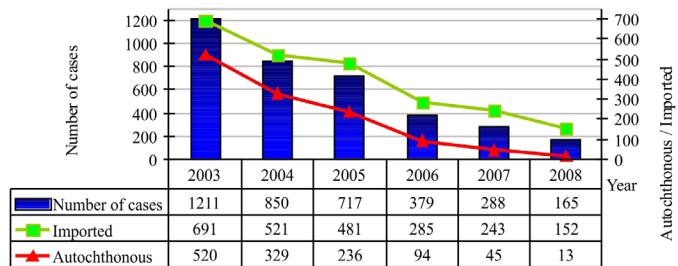
**Table 1**

Annual population, blood samples examined for malaria, number and percentage of positive samples and positive variation recorded in Tocantins, in the period 2003 to 2008

Year	Population	Blood samples			% variation
		Examined	Positive		
		No.	No.	%	
2003	1,230,181	4,743	1,211	25.53	-
2004	1,262,644	4,575	850	18.58	-29.81
2005	1,305,728	3,757	717	19.08	-15.65
2006	1,332,441	2,601	379	14.56	-47.14
2007	1,243,627	2,029	288	14.21	-24.01
2008	1,280,509	1,299	165	12.79	-42.71
Total		19,004	3,610	19.00	-86.37

( $r_p = 0.96$ ;  $p = 0.002$ ), ( $r_s = -0.37$ ;  $p = 0.46$ )

were imported and 13 autochthonous. There was a decrease of 78.00% of the imported cases and 97.50% of the autochthonous cases (Fig. 1). In the Chi-square test, a significant difference in the distribution of annual totals was detected between the two classifications ( $\chi^2 = 158$ ,  $p < 0.05$ ).

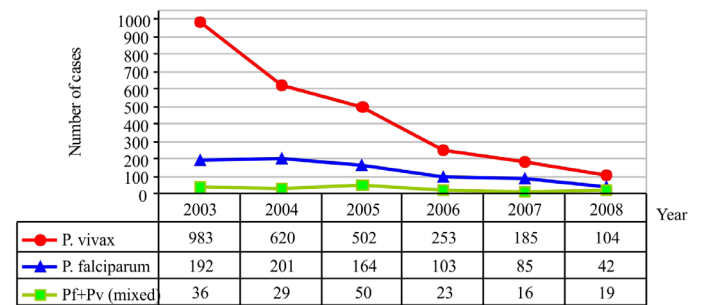


**Fig. 1** - Annual distribution of malaria cases recorded in Tocantins, in the period 2003 to 2008, according to the epidemiological classification. ( $\chi^2 = 158$ ;  $p < 0.05$ )

Due to this reduction in cases, the number of municipalities with transmission has also changed. In 2003 there were 42 cities (30.22%) with autochthonous transmission and in 2008 there were only nine (6.47%),

a decrease of 78.57%. With respect to imported cases, in 2003, 35 cities (25.18%) reported the presence of imported malaria from other states or from abroad, whereas in 2008 only 25 districts (17.98%) reported the presence of infected migrants. So, it's also a decrease of 28.57% of the counties with imported cases records.

Figure 2 illustrates the temporal distribution of cases, with decreasing tendencies in all three forms of malaria (*P. vivax*, *P. falciparum* and mixed). *P. vivax* represented the majority with 73.32%, and their frequency decreased continuously accumulating a decrease of 89.42%. *P. falciparum* accounted for 21.80% of the infections with 78.12% reduction, mixed infections accounted for 4.79% with 47.22% reduction. With the Kruskal-Wallis test, a significant difference in the distribution of cases was recorded for *Plasmodium* species ( $H = 12.87$ ,  $p = 0.016$ ). As for *P. malariae*, only three cases of imported origin were reported sporadically, representing 0.08% of the total.



**Fig. 2** - Annual distribution of malaria cases recorded in Tocantins, in the period 2003 to 2008, according to the species of *Plasmodium*. ( $H = 12.87$ ;  $p = 0.016$ )

Unlike what may be observed in the frequency of cases by species, the percentage of reduction did not follow the same pattern. The rate of positive smears for *P. falciparum* (SPfR) ranged from 15.85% in 2003 to 29.51% in 2007, representing an increase of 86.18%, but the last series took the opposite direction and diminished by 13.76%. The mixed malaria index showed a similar range from 2.97% in 2003 to 11.52% in 2008. In the meantime, the rate for *P. vivax* slides (SPvR) has decreased from 81.17% in 2003 to 63.03% in 2008, which represents a reduction of 22.35%. Thus, the ratio of *P. falciparum*/*P. vivax* which was 0.19 *P. falciparum* positive slides for each slide positive for *P. vivax*, in 2003, doubled to 0.44 *P. falciparum* slides for each slide for *P. vivax*, in 2007 (Table 2).

**Table 2**

Distribution of the indices related to the occurrence of malaria reported in Tocantins, in the period 2003 to 2008

Year	API (mil)	ABER(%)	SPR(%)	SPfR(%)	SPvR(%)	SR(Pf+Pv)	F/V
2003	0,98	0.38	25.53	15.85	81.17	2,97	0,19
2004	0,67	0.36	18.58	23.65	72.94	3,41	0,32
2005	0,55	0.29	19.08	22.87	70.01	6,97	0,32
2006	0,28	0.19	14.56	27.18	66.75	6,07	0,40
2007	0,23	0.16	14.21	29.51	64.24	5,56	0,44
2008	0,13	0.10	12.79	25.45	63.03	11,52	0,41

API - Annual Parasite Index; ABER - Annual Blood Examination Rate; SPR - Slide Positive Rate; SPfR - Slide *Plasmodium falciparum* Rate; SPvR - Slide *Plasmodium vivax* Rate, SR(Pf+Pv) - Rate of Slides by *Plasmodium falciparum* + *Plasmodium vivax*; F/V - Ratio between *Plasmodium falciparum*/*Plasmodium vivax*

Regarding the risk of illness, there was a sharp decline in the study period. In 2003, the Annual Parasite Index (API) recorded 0.98 cases per 1,000 inhabitants and rose to 0.13 cases per 1,000 inhabitants in 2008, which is a decrease of 86.73%. The Annual Blood Examination Rate (ABER) also showed a gradual decrease in the percentage, from 0.38% in 2003 to 0.10% in 2008 and a total reduction of 73.68% in the period.

Observing the change in the ABER and the API, it was verified that there was a continuous decline in the Slides Positive Rate (SPR) except for the year 2005, when there was an increase of 0.5% over 2004, yet at the end of the series the decrease reached 49.90%.

Regarding gender, malaria struck both sexes, with predominance in males (76.95%) over females (23.05%), showing a constant profile in the distribution over the years. In the *Mann-Whitney* test a significant difference with respect to gender ( $U = 4.0, p = 0.02$ ) was detected. This behavior related to males was observed in both classifications, autochthonous and imported, but in the latter, the percentage was evident, bringing together 80.65% of the cases. In 2005, when a rise in the SPR (Table 2) was found, a rise in the proportion of male imported cases was also noticed. The same increase in the proportion of this genre was repeated in 2008, when the variation of reduction of malaria became evident (Table 1), and over 90% of the cases were imported (Fig. 1).

Regarding the age, there was a predominance of males in all age groups (Fig. 3). The highest frequency was among the individuals in the economically active age group of 15 to 49 years old (73.41%), with an even more significant rate for the 20 to 49 years old group (62.13%). Analyzing the individuals in this latter age group, an expressive percentage of men over women is noticed, with 80.29% of cases. It was also observed that the highest peak in the frequency of cases occurred in the age group 20-29 years; however, the highest average of the API is in the 30 to 39 years old group (0.73/1,000 inhab.) followed by the 20 to 29 years old group (0.70/1,000 inhab.) and, subsequently, in individuals between 40 to 49 years old (0.59/1,000 inhab.).

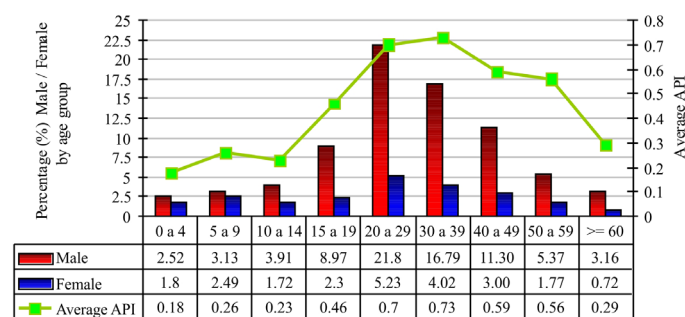


Fig. 3 - Percentage of malaria cases recorded in Tocantins, in the period 2003 to 2008, by gender and average Annual Parasite Index (API), by age group.

In this study, the low performance regarding the diagnosis and treatment was explained. The average of the six years showed that in 74.38% of the cases treatment was started within 48 hours of first symptoms. Moreover, after the suspicion of a case, the deadline for starting the treatment has been effective, on average 90.79% of the cases started treatment within 24 hours of collection of the blood sample. The rate of hospitalization increased from 21% in 2003 to 35.36% in 2006, showing a fall in 2007, with 22.22% and again increased in 2008, with

26.67%. The mortality coefficient, which was 8.3/10,000 inhabitants in 2003, rose to 35.3/10,000 in 2004, 27.9/10,000 in 2005 and disappeared in 2006. In absolute numbers these coefficients represent only one, three and two deaths respectively.

Regarding the origin of imported cases 89.97% come from states that are part of the Amazon, especially the state of Pará, which borders Tocantins and 8.72% are coming from two neighboring countries - Guiana and Suriname; left only 1.31% of the cases arising from other states of Brazil and six other countries (Table 3).

Table 3

Distribution of malaria cases recorded in Tocantins, in the period 2003 to 2008, according State or country of origin

State/Country of origin	Number of cases	%	% accumulated	
Amazon region	Amazonas	15	0.63	
	Amapá	19	0.80	
	Maranhão	26	1.10	
	Mato Grosso	14	0.59	
	Pará	2,030	85.55	
	Rondonia	27	1.14	
	Roraima	04	0.17	89.97
Other UF	Bahia	02	0.08	
	Espírito Santo	01	0.04	
	Goiás	01	0.04	
	Minas Gerais	02	0.08	
Paraíba	02	0.08		
Other countries	South Africa	02	0.08	
	Angola	04	0.17	
	USA	01	0.04	
	France	02	0.08	
	Guiana	09	0.38	
	Venezuela	05	0.21	1.31
	French Guiana	176	7.42	
	Suriname	31	1.31	8.72
	Total	2,373		

## DISCUSSION

The results showed that malaria occurred in all years and varied considerably, according to the reduction of tested samples<sup>9</sup>. As was observed previously in the Amazon region<sup>10,24</sup>, in this study there was a year in which the examined slides did not show any relation to the percentage of positive samples and this provoked the lowest index in the variation of reduction of cases of all series.

MARCHESINI *et al.*<sup>19</sup> claim that a growing region tends to have

more people being attracted to the area and therefore being exposed more intensively to the vector during the preparation of the land for housing and/or planting. In this study the frequency of positive cases showed no significant association with the demographic growth of the population coinciding with the findings of CHAVES & RODRIGUES<sup>10</sup>. MARQUES & GUTIERREZ<sup>20</sup> state that there are several factors from different origins that interact for malaria transmission, including biological, ecological, socio-cultural, political and economical factors. The decreasing number of cases in Tocantins is possibly related to the intensification of control measures, such as: increased action of municipalities in the implementation of control measures, increased investment by the three spheres of government, increasing number of laboratories, insertion of control actions against malaria in healthcare programs and strengthening of treatment units<sup>24</sup>.

In this study, in the same ratio as the reduction of the overall cases there was a reduction in the number of autochthonous and imported cases, and consequently, a decreased number of municipalities where transmission was observed. Most cases are imported, and this allowed the observation that in Tocantins malaria behaves differently from other states of the Amazon, where most of cases are autochthonous. BARATA<sup>5</sup>, in his studies, reported that the proportion of malaria cases related to the introduction of imported cases varies directly with the existing surveillance system. Thus, the delay in detection of imported cases may provide outbreaks settings with relatively large proportions for the region. In Tocantins, although the number of municipalities have significantly reduced transmission, it is important to remain vigilant, because the State is part of the Amazon and has favorable characteristics for the development of the vector. In addition, the State constantly receives active carriers of the parasite, which determines the vulnerability and receptivity to worse cases.

With respect to the species of *Plasmodium*, a reduction of infections was observed in the three forms of malaria together with a significant difference in the annual distribution of cases by species. Considering that 65.73% of the reported cases in Tocantins are imported, this difference follows the pattern recorded in the Brazilian Amazon and is possibly related to the source of infection frequented by patients. In Brazil, *P. falciparum* predominated with more than 50% of the cases from 1966 to 1973 and from 1984 to 1988, which is attributed to the accelerated migration, expansion of mining activities, deforestation and settlement projects<sup>12,20,33</sup>. *P. vivax* began to predominate after 1988, starting from 48.6%<sup>20</sup> to over 83.7% nowadays<sup>26</sup>.

In Tocantins, the reduction in the number of malaria cases, with predominance of infections caused by *P. vivax* has been occurring since 1993, just as infection by *P. falciparum* has been reducing. That year, the index of this species represented 46.3% and went down to 20.9% in 2002<sup>22</sup>. During the period of the study, the *P. vivax* decreased 22.35%, while the *P. falciparum* ranged upward<sup>24,32</sup> in every year except in 2008, totalizing an increase of 60.57%, possibly attributed to the existence of strains resistant to commonly used drugs<sup>36</sup>. The 13.76% decrease seen in 2008 is possibly related to the adoption of the new treatment plan of anti-malarial drugs adopted by the Ministry of Health<sup>24</sup>, for this species control.

Another probable cause of increase in the proportion of *P. falciparum* may be the migration flow and the proximity with settlement, as described

BARBIERI<sup>7</sup> and SILVEIRA & REZENDE<sup>33</sup>. One of the indicators is that 70.39% of the cases of *Plasmodium* refer to imported cases and the other is that, in years when the rates were higher (2006 and 2007) the preceding cases occurred in a larger number of families settled by projects of the Agrarian Reform (2005 and 2006)<sup>16</sup>.

The Ministry of Health emphasizes that the resistance to drugs, the delay in diagnosis and treatment and the weakness of the epidemiological surveillance, are factors that contribute in the frequency of malaria<sup>24</sup>. The treatment, considered as a key measure to block the disease, must involve the breaking of the *Plasmodium* life cycle by interfering in the life cycle of the *Anopheles* mosquito, or the cycle of human disease or both<sup>7</sup>. Therefore, in non-endemic areas, medical care, epidemiological surveillance, entomological and actions of health education are priority strategies to lessen the severity of cases and prevent spots with transmission from establishing<sup>1</sup>.

The increase in the percentage of *P. falciparum* infections observed in this study may be directly related to the delay in implementing the necessary actions to stop outbreaks of transmission<sup>35</sup>, since 74.38% of cases started treatment after 48 hours of onset of first symptoms.

The calculation of the Annual Parasite Index (API) indicates that Tocantins is part of the low risk classification, where the API varies between 0.1 and 9.9 cases per thousand inhabitants, different from the average found in the Amazon Region, classified as medium risk, and the states of Acre, Amazonas and Roraima, classified as high risk<sup>24</sup>.

The Annual Blood Examination Rate (ABER) did not reach the ideal 10% for a good detection of malaria<sup>11</sup> but it followed the change in the Annual Parasite Index (API)<sup>33</sup>, showing a declining trend throughout the series. In this case, it must be taken into consideration that the calculation of the ABER was obtained by computing the entire population of the State, directly and indirectly protected, and not only in one region under threat<sup>11</sup>.

The reduction in the ABER represented the demand of malaria cases in the State and, consequently, there was a reduction in the Slides Positive Rate (SPR), corresponding to the expected course, however, it is different from the results reported in the Brazilian Amazon<sup>33</sup> and in Colombia<sup>37</sup>. In this, VALERO-BERNAL<sup>37</sup> found that the reduction in the ABER resulted in a considerable increase in the SPR and the API, showing evident resurgence of the pathology with weak possibilities of control, possibly enhanced by a reduced accessibility and low coverage of the healthcare system.

This sharp decline in the ABER, API and SPR means a reduction in the transmission levels in Tocantins, which could be related to improvements in the structuring of healthcare services, implemented since 1999 with the beginning of the decentralization of control actions of vector diseases, from FUNASA to the states.

Regarding gender, malaria focused more frequently on males<sup>1,21,34,39</sup>, and aged 15 to 49 years old<sup>6,8,25,30,35</sup>, possibly attributed to the mobility, type of occupation and/or environment in which they reside. This increased participation of males and working age individuals expresses the relocation of labor in the search for employment in areas of greatest risk of transmission, where activities related to agriculture

usually prevail, like livestock, hunting/fishing, mining and agricultural exploitation<sup>4,7,14,24,28,31</sup>.

Considering that malaria occurs most often outside home, it is clear that individuals over 14 are much more exposed to environments propitious to infected vectors, as they start to enter the productive chain and respond to the social phenomenon of work conditions and begin a process of family independence. In this study, women and children under 10 represent the smaller proportion of cases, since they travel less, tend to stay longer inside home, and can use nets and other forms of prevention against exposure to the vector, keeping themselves more protected<sup>21,39</sup>.

According to what has already been noted, the speed in diagnosis and treatment is essential to interrupting the transmission chain and to prevent the development to more serious forms of the disease<sup>24</sup>. However, in the study period, the low diagnosis and treatment performance was clear. Only 22.12% were under treatment within 48 hours from the first symptoms. From an epidemiological point of view, it represents a longer period of circulating parasitemia in patients and therefore a greater possibility of *Anopheles* infection with increasing transmission levels<sup>38</sup>. This fact may have influenced the proportion of *P. falciparum* infections and also in the percentage of hospitalization, even though it became evident that most of these infections are of imported origin.

SILVEIRA & REZENDE<sup>33</sup> point out that the variation in admission rates for malaria treatment tends to reproduce closely the variation in the incidence of cases caused by *P. falciparum*. In Tocantins, for the period 2003 to 2008, the index of hospital admission did not follow the steady decrease presented by the SPR and the API, but the increases followed the SPFR, except in 2007. This may be related to the low number of cases, when the health professionals start to become unconcerned about the disease, not taking into account its explosive potential, and when they realize the patient has severe symptoms, making it necessary special care. When analyzing the mortality rate, it was found that this indicator is under control since, in absolute numbers, there have only been a few deaths and they have stopped occurring since 2006.

When analyzing the origin of cases, it was found that the majority came from the Amazon region and the neighboring countries, French Guiana and Suriname, which are endemic areas for malaria. These regions offer various activities related to land, mining, road construction and agricultural exploitation, these being attractive to the self-employed. By exposing themselves to the source of infection without the required protection, workers get infected and after some time, they return to their families, carrying the parasite of malaria in the bloodstream, resulting in imported cases in Tocantins.

When analyzing the delay in initial treatment for Tocantins, it is probably related to the effort of the infected individuals to keep on working away from their hometown as long as possible until the situation gets unbearable and they return home for treatment. Faced with this situation, there is a need to strengthen the basic healthcare services for treating patients suffering from malaria, especially concerning to diagnosis and treatment, as well as improving health education actions in order to guide the population to seek treatment as early as possible, because, although there was an annual reduction in the number of cases, the State is vulnerable and open to worse events, according to the constant population movements.

Regarding the deadline for starting treatment, the rates have proven to be inadequate, and the situation is different for disease control. Generally, it was clear that the persistent decline of autochthonous and imported cases signaled that the State is leaving the endemic area of the disease and is entering the area with residual transmission. Nevertheless, it is still important to maintain effective surveillance measures in the entire State in order to preserve the unaffected areas and to identify early cases that emerge, to avoid localized outbreaks.

## RESUMO

### Perfil epidemiológico da malária no Estado do Tocantins, Brasil, no período 2003 a 2008

Este estudo descreve o perfil epidemiológico da malária no Estado do Tocantins, no período 2003 a 2008, investiga a associação entre a frequência da malária e o crescimento populacional, classifica os casos por autóctone e importada, relaciona os índices da doença e analisa a distribuição dos casos por espécie de *Plasmodium*, faixa etária e gênero. O estudo retrospectivo baseou-se em dados secundários, armazenados no SIVEP-malária e analisados através dos Softwares Epi-Info 3.5.1. e Bioestat 5.0. Foram investigadas 19.004 amostras para malária, sendo 19% positivas; 73,32% por *Plasmodium vivax*, 21,80% por *Plasmodium falciparum*, 4,79% por infecções mistas e 0,08% por *Plasmodium malariae*. Os indivíduos masculinos representaram 76,95% e predominaram em todos os anos e faixas etárias, principalmente naqueles de 15 a 49 anos. Do total de casos, 34,27% tiveram origem autóctone e 65,73% importado ( $\chi^2 = 356,8$ ;  $p = 0,0001$ ). A frequência da malária reduziu de forma significativa durante toda série histórica ( $r_p = 0,96$ ;  $p = 0,002$ ) e, concomitantemente, reduziram os municípios com transmissão autóctone. Constatou-se que a malária é predominantemente importada, relacionada às atividades de campo, que confirma a necessidade de manter medidas efetivas de vigilância em todo Estado e aprimorar ações educativas no sentido de orientar a população na busca pelo atendimento precoce.

## ACKNOWLEDGEMENTS

We thank the Science and Technology Office of the State of Tocantins, the program of support for Higher Education Research, for the financial support given to the research and to the team of the State Malaria Center, for contributing with the information.

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Received: 23 October 2010

Accepted: 30 March 2011

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