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THE BELO MONTE HYDROELECTRIC PLANT AND THE EPIDEMIOLOGICAL PROFILE OF MALARIA IN THE POPULATION OF ALTAMIRA CITY– PARÁ –BRAZIL

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ABSTRACT

The Belo Monte Hydroelectric Power Plant is the most controversial construction in Brazil, due to the great environmental and social impact for the population living in its area of influence. Despite the requirements for the entrepreneur to execute the Basic Environmental Plan and the health determinants, which are aligned with local public policies, so far the impacts have not been adequately mitigated. This study analyzes the prevalence of malaria cases in the urban region of Altamira from 2010 to 2017, in order to understand the potential relationships between these occurrences and the Belo Monte Hydroelectric Plant. To verify if the number of malaria cases is under statistical control, we used the time series control chart. Malaria had a considerable reduction in the number of notifications, which occurred after the execution of the Malaria Control Action Program by the entrepreneur, so monitoring was considered successful until the end of 2017. However, with environmental pressures and difficulties in difficult access areas, in 2018 new cases appeared in the urban area of Altamira.

INTRODUCTION

The magnitude of the impacts resulting from the implementation of large projects, such as hydroelectric plants, arouses the interest in studies due to the possibility of spreading infectious diseases and the increase of the local synanthropic fauna. From this, occurs the formation of breeding sites and also the increase of the population of insects that transmit the diseases, a fact that has already occurred in the lake of the Itaipu plant, with the increase mainly of

mosquitoes transmitting malaria (FERREIRA, 1996). Of course, the health situation in the Amazon has been aggravated by the environmental changes brought by the large projects, and even though it is known that health will be adversely affected, in general, deep studies are not carried out to provide anticipatory measures in order to minimize the harmful effects to the local population (COUTO, 2016). It is already widely documented that the ecosystem is very important for the maintenance of human health. That means that human well-being is a product of ecosystem well-being, so if there is an imbalance in the environment the chances of life-sustaining declines (FINKELMAN *et al*., 1984) and diseases can spread. For Couto (1999), the Amazon presents natural characteristics

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appropriate for the emergence, spread and aggravation of diseases associated with the construction of hydroelectric dams. These diseases are transmitted by vectors and related to migration and ecological modifications and, in addition, health tends not to be considered as a priority in the implementation of hydroelectric projects in the Amazon. Also, Finkelman (1984) states that "the health impacts generated by the construction of hydroelectric dams are conditioned by the state of health that the population enjoys at the beginning of the work" (p. 177). Since the socio-sanitary framework of the region's inhabitants is among the worst in the country, if there is not a adequate planning the implementation of these projects may represent an additional epidemiological burden for local populations. Through the migratory scenario that commonly occurs in the areas of large projects, making it possible to increase cases of epidemic diseases, it is fundamental to implement action plans to control infectious diseases, especially those transmitted by mosquito vectors. These diseases are considered fundamental in the ecosystem and population relationship within the context of hydroelectric plant deployment (COUTO, 2016). This was the motivation to verify the behavior of some infectious diseases with vectorial transmission in the Belo Monte Hydroelectric Plant (BMHP). In this article we will discuss the epidemiological profile of malaria in the urban area of Santarém, the main city affected by the construction of the BMHP, from 2010 to 2017. 2010 is the first year of analysis before the beginning of the operation, and 2017 is the last, which for the most recent of official epidemiological data is available.

MATERIAL AND METHODS

The research site was Altamira, the main city in the area of influence of the BMHP, located in the Pará State. Before the beginning of the hydroelectric operation, the demographic census of the Brazilian Institute of Geography and Statistics (BIGS) of 2010 recorded that the total population of the city was of 79.193 inhabitants (IBGE, 2014). In that same year a demographic explosion began to occur in the city of Altamira, as a result of the construction of BMHP. In 2012, the BIGS estimated that the population would be 148,224 people, and in July 2017, the estimate was 111,435 (IBGE, 2017). This decrease occurred due to the end of the construction phase of the work, which caused many workers to be fired. This research has a qualitative-quantitative character, since it is a retrospective epidemiological study, developed and based on data from the Health Department in Altamira city. Epidemiological data on malaria were collected from January 2010 to June 2017, in the Information System of Diseases and Notifications (ISDN) and Altamira Epidemiological Surveillance Information System (AESIS).

To reach the qualitative approach, we used the exploratory research method, with informal interviews made in January 2015 and 2016. The interviewees were selected according to the interest of the research, that is, health professionals, health advisors of the city, a nurse, the former coordinator of the Malaria Control Plan (MCAP) and the nurse and current coordinator of endemics of the city, who were free to expose the past and present situation related to health in Altamira and the intervention of Belo Monte at that population's life. One of the interviewees belonged to the company Norte Energia, and acted as coordinator of the MCAP. The others are health professionals from the city. The interviews were marked in advance by telephone contact and were conducted at the

interviewees' workplace. After the presentation of the research, all the participants authorized the interview and gave their oral consent, according to the resolution of the National Commission of Health Research (NHC) 466 and 510 of the National Commission of Ethics in Research (NCER). The reports were recorded and transcribed to select the relevant excerpts for this study. Thus, the excerpts of the interviews will be fully cited, in which the profession practiced by the interviewers will be used: nurse, nursing technique, and so on, to identify them. With regard to quantitative methodology, the Time Series Analysis is a statistical technique that studies any set of observations ordered in time. Its main objective is to describe, explain and predict the behavior of the series, to verify if there is a trend, seasonal variation, to predict future values based on past values and to measure, from the values of a time series, the process quality (BUSSAB and MORETTIN 2013). Statistical Quality Control (SQC) is a technique that assists in the monitoring and evaluation of data, facilitating the reduction of the variability of a quality characteristic, seeking to find improvements in performance and productivity (RAMOS *et al.*, 2013). The main objective of this technique is to quickly detect the cause of variations in the characteristic of the variable and to use a corrective action before the units of nonconformity occur, where the most important is the elimination of variability without loss of the quality of the analysis (RAMOS *et al.*, 2013). The control chart is used to analyze trends and patterns that take place over time. Its main purpose is to monitor a process, verifying if it is under statistical control, indicating its range (HENNING 2014). The union of the statistical techniques Statistical Quality Control and Time Series Analysis resulted in the development of the control chart for time series (LIMA 2008).

RESULTS

Initially a model was adjusted only for the period from January 2010 to June 2017, as a modeling procedure for the series under study, from the Simple Exponential Smoothing methodology (this methodology is not among those described above). From this adjusted model, forecasts were obtained for the entire period analyzed.

The Malaria Situation in Altamira

Figure 1 shows the time-series control graph for the number of malaria cases recorded in the urban area of Altamira, from January 2010 to June 2017.
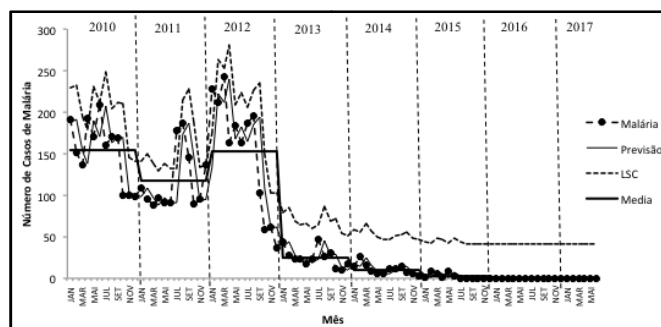
Source: Authors, 2017

Figure 1. Time series control chart for the number of malaria cases, of Altamira city, from January 2010 to June 2017

From the graph, it can be seen that registered cases of malaria in urban areas are decreasing. In the chart, it can be seen that

the number of malaria cases in Altamira city, in the period 2011 to 2012, was outside the expected limits (forecast), since there were two points above the upper control limit for the months of July/2011 and January/2012. That means that, in these two points, the notifications were higher than expected. This increase is related to the lack of implementation of public policies in the region, which is endemic for malaria. After implementation of the Malaria Control Program (MCAP), which corresponds to Program 8.3 and operates within the five cities in the area of direct influence of Belo Monte plus Pacajá, the prevalence of the disease drops significantly until reaching a negligible level in the year of 2017.

DISCUSSION

The MCAP was successful because of the great financial investment made, with all the conditions for execution of the action plan and monitoring during the period of identification and treatment of the patients. With this, one can understand the significant change in the epidemiological profile of malaria. This may raise the question of whether BMHP could also interfere with the epidemiological profile of infectious diseases. In malaria, as shown, it influenced greatly, with a significant and positive decrease for the population that was penalized by this disease. But talking about malaria eradication in the region is hasty. We can only say that the disease is under control in some municipalities, and if there is no plan to continue monitoring, there is a possibility that the number of cases will grow again, once the barriers are permeable and the continuous flow of people can change the situation. In an interview, the councilor of health of the municipality of Altamira and member of the Management Committee of the Sustainable Regional Development Plan (MCSRDP) of the Xingu, pointed out that:

> Geographically, Altamira is the hub of all the surrounding cities. They all drain here, to Altamira. So it was a natural spontaneous demand of patients from the region. But we were building a Unified Health System for us, with our epidemiological profile, with our cultural profile giving, importance to our specificities, of 'caboco' riverside.

Program 8.3 was successful in the control and monitoring of malaria, as a result of the investment and actions in the affected sites, as mentioned by the nurse, coordinator of the MCAP, who already acted as coordinator of endemics of the municipality, in an interview with the health secretariat in 2016:

> So the malaria plan worked very well because there was a structuration of the municipalities with laboratories, with vehicles, cars, work equipment, supplies for the municipalities ... We never missed blades, stylus, glove ... Material for work of field. And still fuel. Cities often did not even have the fuel to act. Given this structure for the city, and the inputs, it was necessary to train people. And that's where the State comes in. The role of the State was such as giving technical support, training and supervision... Within the MCAP, the State assumed the same functions, which were already advocated by the Ministry. Then they were trained in each city. And, there was a term, there was an agreement, that hired human resources to work on Malaria.

Malaria had a considerable reduction in the number of notifications after the implementation of the MCAP by the entrepreneur, and monitoring was considered successful until 2015. However, other endemic diseases in the region that did not have a specific attention program had different results. Dengue is related to seasonality and environmental changes. For this disease, the notifications and confirmations of the cases, at the end of 2015, show that it is still out of epidemiological control. As far as leishmaniasis is concerned, it was verified that it is under statistical control in the municipality, with no points above or below expectations (PIRES, 2018).

For the municipal health advisor interviewed, the results were positive:

> It is undeniable that the project, in its conditions, provided resources that were fundamental in several sectors, such as in the Malaria Program, the MCAP, Plan of Action for Malaria Control, which was a plan that worked. That the Federal Government and the Ministry of Health should mirror, because the MCAP proved that with investment, planning and responsibility, we can eradicate malaria in the Legal Amazon and in the rest of the country, because we are practically zeroed in Malaria.

Malaria Program 8.3 was successful with patient follow-up and treatment, thus closing the disease cycle, preventing new mosquitoes from becoming infected and proliferating in the environment. In addition to these other measures were taken, as reported by the Coordinator of the MCAP:

> ... another thing that happened was also the acquisition of mosquito net impregnated with insecticide. It was acquired, it seems to me, 45 thousand, or it reaches the range of almost 50 thousand mosquito nets impregnated with insecticide. It seems that the first shipment came from Germany, they are imported. And they were distributed in the highest risk areas where they had Malaria. Then, in the year 2011, 2012, 2013, there were distributed almost 40 thousand mosquito nets. In 2014, 2015, we practically resettled in areas that were lacking, in areas where the population had reached new people, or that the mosquito net had spoiled and such, then we were resetting. So this mosquito net was a great ally in this process, allied to other things. And in addition, the use of rapid diagnostic test. Although malaria microscopy is a gold standard, the gold standard for diagnosing malaria, in remote areas, mining areas, villages, in remote settlements, we use a lot of rapid tests that have greatly improved the accessibility of everything, and have been used successfully, including indigenous areas.

However, we know that the ease of flow of people moving to several nearby municipalities may break the protective barrier of the MCAP and may change the epidemiological profile of malaria again. The presence of Anopheles is common to the entire Xingu region, and with the possible entry of an infected person, malaria infection and proliferation can occur again, which worries local authorities.

> One of the concerns is with the municipality of Pacajá, which accounted for 437 cases from January 1, 2017 to August 24, 2017, according to the epidemiological

summary of the Information Service for Malaria Epidemiological Surveillance (SIVEP, 2017).

With this amount of cases, there may be a proliferation of infected mosquitoes and the displacement of sick or asymptomatic persons by the region between cities around the site, which may cause an increase in other cities. In this way, continuous actions are necessary to interrupt the chain of transmission of the disease and possible proliferation. After the end of the analytical period, in May 2018, four cases of malaria in the urban area of Altamira have already been reported by the endemic coordinator.

In response, the Health Secretariat recruited health agents to carry out the epidemiological blockade and the distribution of mosquito nets with repellent. As demonstrated, the municipality was without any case since July 2015. The knowledge of the fauna of mosquitoes of the genus Anopheles of the municipality of Altamira, allows to predict the interferences of the installation of the Project of Hydroelectric Utilization of Belo Monte in the transmission of malaria in the region, making possible the establishment of preventive measures for new malaria outbreaks in the region (ABREU, 2015, p. 22).

Malaria is endemic in the Amazon region and with the implementation of a monitoring and control plan, the notifications for two years (2016 and 2017) ceased in the city of Altamira. The difficult access to the localities around the Altamira headquarters for monitoring has always appeared as a threat of resurgence of new cases, as well as the intense dynamics in the flow of people that transit through the Xingu and Altamira area. As an aggravating factor of the complex social and epidemiological panorama of the region, Altamira is considered the county seat that meets the demands of local health and other neighboring cities and localities. The nurse coordinator of endemics, says that due to the massive migration to the host city, congestion problems occurred in all health sectors, amplifying the waiting in the attendances and the lack of hospital medical assistance. This left the local population in a situation of greater vulnerability, and the reality of the Amazon region, by itself, is recognized as lacking in resources to receive large projects (MIRANDA NETO, 2015). In this scenario, of a region without basic sanitation, and deficient to receive a great migratory flow, that began the installation of BMHP. There were no anticipatory measures to prepare the cities that remain in the area of direct impact, with health infrastructure, education, security or so. In this context, several social movements in the city of Altamira have organized to demand compliance with health programs and non-violation of Human Rights. Rapid population growth has overwhelmed Altamira's health system, which was previously considered deficient to meet the demands of local and neighboring municipalities (COUTO, 2016).

From the point of view of endemic diseases in the region, the limited available historical series indicates that markers are under control in the case of malaria. However, since most health determinants have not been fulfilled, more studies are needed to assess the extent to which these indicators are effectively reliable and will be maintained after the completion of the work.

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