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Full Length Research Paper

Malaria in the Amazon River Basin of Ecuador

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Malaria is a disease caused by protozoa of the genus Plasmodium, transmitted by Anopheles mosquitoes. It is the protozoal disease with greatest impact on the world. It affects more than 100 countries and Ecuador is one of the 21 endemic countries in the Americas, mainly in the Amazon. The aim of the study was to identify clinical and epidemiological factors of risk associated with the diagnosis of febrile patients treated at the Health Center Type A-Tiputini. The investigation corresponds to a descriptive study, field and cross-sectional, conducted during the Epidemiological weeks 1-31 on the banks of the Napo River, Canton Aguarico, Orellana Province in Ecuador during year 2015. Several risk factors related to area of study, such as geo-political distribution, and environmental variables, clinical characteristics of present illness and a history of malaria of patients. The diagnosis is made by examining thick film. A total amount of 123 cases of malaria were counted; (n = 117/123) were symptomatic patients came mainly from Aguarico canon and (n = 6/123) asymptomatic natives of the town of San Vicente. Imported cases (8) came from Peru and (1) of Argentina. It was found as important environmental risk factors for malaria: climate (tropical), increased rainfall (> 6000mm) and average relative humidity (> 80%). Cases increased in March at the expense of *P. vivax*. Most affected age groups were 5-9 years, 21.13% (15/123) for the male gender. Patients corresponded mostly of students and farmers. Failures in the supply of electricity were observed (provided by the hour), specifically at dawn and dusk, enabling the contact-man interaction. Of all cases 32.52% had a history of malaria; 67.48% showed no background. The most common symptoms that most patients developed included fever (81.3) profuse sweating (48.7) headache (44.7) asthenia (16.2) and chills (8.1). All patients were diagnosed with uncomplicated malaria. Cases with uncomplicated malaria were treated with chloroquine and primaquine. The current study allowed to redefine *P. vivax* endemic areas in the Ecuadorian Amazon, specifically in the communities of Canton Aguarico, factors that interfere with its spread and prevalence.

Keywords: Characteristics, clinical and epidemiological, malaria, anopheles.

INTRODUCTION

Malaria is an endemic parasitic disease caused by a plasmodium, transmitted through the bite of the female Anopheles mosquito, which harbors the infectious form of the parasite (Chaparro et al., 2013) *P.falciparum, P. vivax* *P. ovale* and *P. malariae* (Vargas, 2003) to which has been added a new species called *P. knowlesi* common in primates: four classic species of protozoa of the genus Plasmodium are recognized who now it has been attributed to human disease cases (Van Hellemond et al., 2009; Martinez- Salazar et al., 2012). Globally, the highest prevalence are caused by *P. vivax* and *P. falciparum*; causing severe infections and death by the species *P. falciparum* (Chaparro et al., 2013; PAHO, 2013).

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According to data from the World Health Organization (WHO) in 2015, there were 198 million cases of malaria, with 584,000 deaths. Approximately half of the world's population is at risk of malaria, with most cases and deaths recorded in sub-Saharan Africa. Also, there are other areas affected worldwide such as Asia, Middle East, parts of Europe and Latin America (WHO, 2015).

According to WHO and Pan American Health Organization (PAHO, 2013) in the region of the Americas malaria morbidity has been reduced by 60%. This decrease was slightly higher at the expense of P. falciparum and mixed infections (62%) than in *P. vivax* infections (60%).

Ecuador, is one of the 21 malaria endemic countries in America with downward trend (PAHO, 2013). In relation to the total cases reported in the country, provinces of Guayas, Esmeraldas, Orellana and Los Rios consolidate 78.31% of cases. The provinces of Morona Santiago, Pastaza, Sucumbíos, Cotopaxi and Manabi, reach 16,30% and the provinces of Bolivar, Cañar, Napo, El Oro, Pichincha, Santo Domingo and Santa Elena recorded 5.39%. These percentages showed a sharp downward trend in the incidence of malaria, according to data obtained by the National Service for Malaria Eradication (NMES), since the year 2003, 51,345 cases were achieved compared with 2012, whose number dropped to 558; those reports have earned the country an international recognition of malaria leading country in the Americas during 2009 and 2012 (Montalvan, 2013).

However, despite the national and international efforts to eradicate malaria in the country agencies, it has not been able to control the epidemic, declared endemic in west Ecuador, Pacific, center, in the valleys and east, in the Amazon river basin, implementing an epidemiological scenario of malaria as a geographically defined area predominantly to *P. vivax* to become one of the major public health problems (San Sebastian et al., 2000).

According to the standard operational manual (NMES-RAVREDA) for managing the microscopic diagnosis of plasmodium (Montalvan, 2013) 7, it indicates that the main vectors responsible for the transmission of malaria in regions of Ecuador are: Anopheles *albimanus*, An *puntimacula*, and *An nuñez pseudopuntipennis-tovari* (Montalvan, 2013; Diaz Cortes et al., 2010).

In terms of previous studies, Colan et al., (1993) indicate when referring to a similar study in the Peruvian Amazon, the epidemiological behavior of the centers are not well understood and do not follow similar patterns due to related factors with the vector, spread from Ecuador border, migration and drug trafficking between countries affect each specific geographical area. Also, San Sebastián et al., (2000) during a period of four years in the Ecuadorian Amazon recorded a total of 773 cases of malaria. The predominant parasite in the area was *P. vivax* (92% cases). Similarly, Martinez et al. (2015) in the publication called "The grouping of the symptoms of non-severe malaria in Amazonian semi-immune patients" indicates that the most common symptoms experienced by patients were headache (86, 5%), fever (78.4%) and chills (75.4%), arthralgia (63.7%), myalgia (64.3%) and weakness (62.6%), diarrhea, vomiting, pallor represented the three symptoms that occurred less frequently.

The main goal of this study was to indicate casuistry malaria on the banks of the Napo River in Canton Aguarico, Orellana Province and identify the clinical and epidemiological characteristics associated with microscopic diagnosis made in febrile patients.

MATERIALS AND METHODS

The investigation corresponds to a descriptive, field and cross-section study. Made during Epidemiological Weeks 1-31 (corresponding to January 3, 2015 to August 31) on the banks of the Napo River, Canton Aguarico, Orellana Province, Ecuador of that year. Risk factors that may be related to the study area were inquired, such as geo-political distribution, environmental variables, population and clinical characteristics of present illness and a history of malaria.

The analysis of cases was performed at the Health Center Type A Tiputini 22D03-Aguarico, for having a laboratory for the diagnosis of vector-borne diseases. It was taken as the basis of this health center because of its greater coverage in the diagnosis of malaria endemic areas of ethnic communities: Kichwa, Pandochikta, Puerto Miranda, Boca Tiputini, San Carlos, Yana Yaku, Patas Hurcu, Llanchama, Vicente Salazar, Puerto Quinche, Huiririma Center, San Vicente and Ocaya Center.

Study area

Canton Aguarico is located in the province of Orellana, at the geographic coordinates latitude S 0 ° 55'16 "and longitude 075 ° 23'57 O" whose cantonal head is Tiputini. (GADMCA, 2013). Limits the north, with the Cuyabeno Canton in the province of Sucumbios, on the south by the Canton Arajuno in the province of Pastaza and the international border with Peru; to the east, with Peru and west, with Canton Francisco de Orellana. It has an area of 11,480 km2. Covering politically six parishes: Tiputini, Captain Carlos Augusto Rivadeneyra, Cononaco, Nuevo Rocafuerte, Santa Maria de Huiririma and Yasuni (GADMCA, 2013; GADMCA, 2015). The climate is part of the very humid tropical region of the Ecuadorian Amazon, between altitudes of 65 to 600 meters. The annual average temperature ranges between 23.0 ° C and 25.5 ° C with a relative humidity level of 80%, with average annual rainfall greater than 3000 mm, reaching a register up to 6315 mm. In this area rains always exceeds temperature, so there is no dry season (GADMCA, 2013).

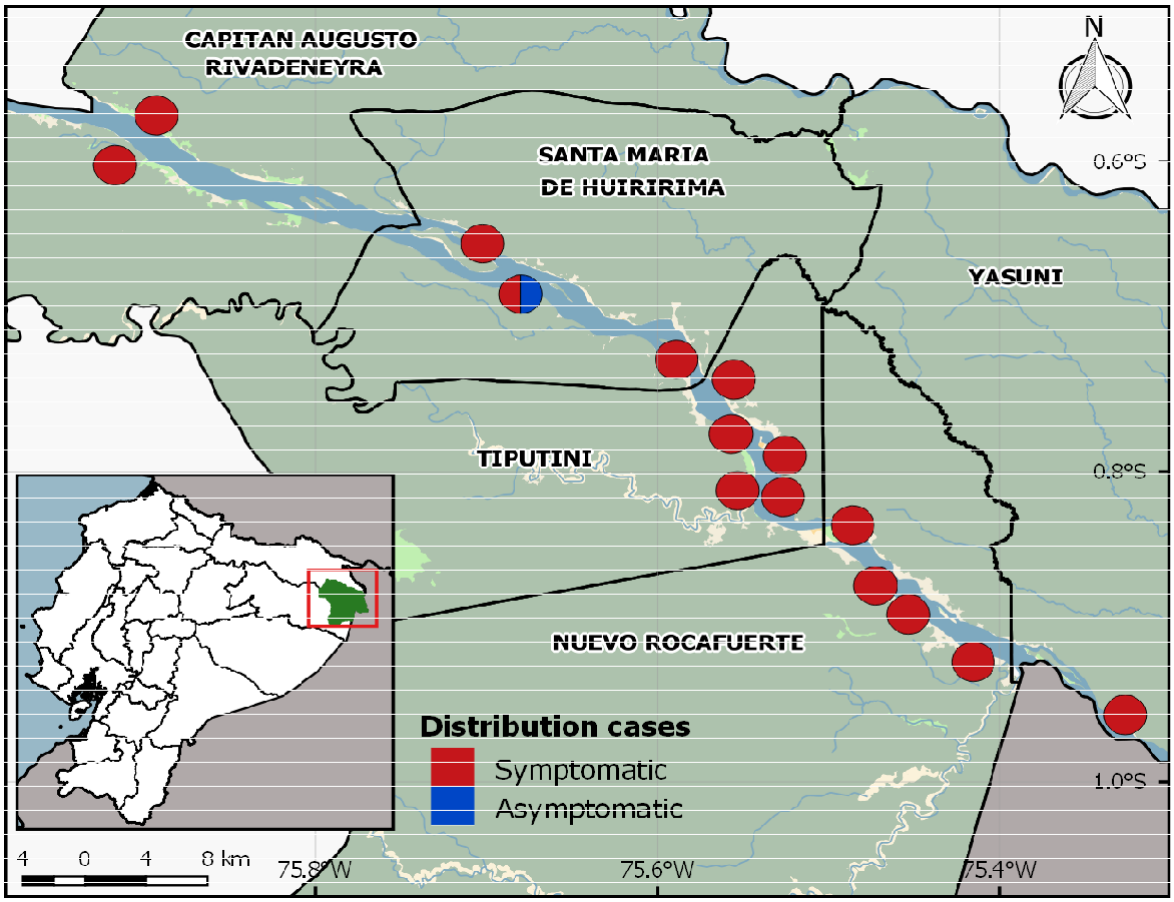

Figure 1. Geographical location of Canton Aguarico in Orellana Province, Amazonía Ecuatoriana. Source: GADMCA, 2015

The estimated population is 4,847 inhabitants, with 2,195 women and 4,847 men (INEC, 2010). The most important economic activities are agriculture, forestry and fishing (49.8%) followed by activities inherent to the public administration and defense (23.5%) and construction (6.5%) (INEC, 2010). There are two prevalent ethnic groups, Kichwa or Runa Napo that are located on the banks of the Napo and the Waorani ethnic group located in the Ecuadorian Amazon rainforest (San Sebastian et al., 2000; GADMCA, 2015). Accessibility is only by river. Ranging from Coca (Francisco de Orellana) to Health Center Type A Tiputini. It includes ten hours in canoe and five hours in shift and slide. Approximately 350 km, by the only way, the Napo River (GADMCA, 2013).

Clinical and Epidemiological characterization of Malaria

During the months of January to July 2015, samples were taken to patients who spontaneously demanded the services of the health center, with a history of fever. Patients were interviewed and examined. Examination included clinical features of present illness (hyperthermia, diaphoresis, chills and headache) and a history of malaria. Cases were diagnosed as uncomplicated malaria by plasmodiun and differential diagnosis (with obvious focus of respiratory infection, urinary tract infection, among others); it also included the review of the notification forms and case closure with appropriate monitoring controls of antimalarial treatment.

Microscopic Diagnosis

Diagnostic methodology consisted of taking a blood sample pad of the finger, preferably the middle finger or ring for being the less used in daily activities (Gutierrez et al., 2003). Two preparations of thick film sheet carrying objects were made. A sample was sent to the Laboratory of Health Center Tiputini type A for the respective quality control performed in the Health District 22D01 Joya de los Sacha in the province of Orellana.

Samples were stained with Giemsa (MERCK) ® and examined with immersion objective (100X). 300 fields were observed before reporting a sample as negative. The cross method or semi-quantitative was used in positive samples (Montalvan, 2013). The parasitemia was estimated and reported as asexual blood stages and

Table 1. Malaria. Distribution of symptomatic and asymptomatic cases on the banks of the Napo River . Canton Aguarico. Orellana Province. EW 1-31. 2015

Parish	Locality	Symptomatic Cases	Fr (%)	Asymptomatic Cases	Fr (%)
Santa María de Huiririma	Puerto Quinche	29	24,79	0	0,00
Capitán Agusto Rivadeneyra	Chiru Isla	16	13,68	0	0,00
Tiputini	Tiputini	14	11,97	0	0,00
Tiputini	Vicente Salazar	11	9,40	0	0,00
Capitán Agusto Rivadeneyra	Pandochicta	9	7,69	0	0,00
Santa María de Huiririma	Centro Ocaya	8	6,84	0	0,00
Yasuni	Martinica	6	5,13	0	0,00
Nuevo Rocafuerte	Nuevo Rocafuerte	3	2,56	0	0,00
Tiputini	San Carlos	3	2,56	0	0,00
Nuevo Rocafuerte	Alta Florencia	2	1,71	0	0,00
Nuevo Rocafuerte	Bello Horizonte	2	1,71	0	0,00
Santa María de Huiririma	San Vicente	2	1,71	6	100,00
Capitán Agusto Rivadeneyra	Limón Yacu	1	0,85	0	0,00
Nuevo Rocafuerte	Santa Rosa	1	0,85	0	0,00
Tiputini	Boca Tiputine	1	0,85	0	0,00
Other Countries					
Perú	Angotero, Cabo Pantoja, Torres Causano, Santa María.	8	6,84	0	0,00
Argentina	San Carlos de Boriloche	1	0,85	0	0,00
Total		**117**	**100**	**6**	**100**

Source: Laboratory MSP Tiputini Type “A.” National Service for Malaria eradication (SNEM).

sexual blood stages (gametocytes) by leukocytes. This result was made by observing 100 revised microscope fields by immersion in a thick blood smear corresponding to approximately 0.2 mL of blood (Montalvan, 2013).

Statistical analysis

All data obtained was examined and analyzed using statistical software EpiInfo 6.04b of Center for Disease Control (CDC, 1997) and represented in tables for a better comprehension.

RESULTS

There were counted a total of (n = 123) cases. Symptomatic cases came mainly from localities in Puerto Quinche (n = 29) 24.79%. In the second order, Chiru Isla (n = 16) 13.68% and third order, Tiputini (n = 14) 11.97%. In relation to the asymptomatic cases (n = 6) 100% of the cases belonged to a single town, San Vicente. It is noteworthy that were treated (n = 9) 7.69% imported cases from Angotero, Cabo Pantoja, Causano Torres and Santa Maria of the neighboring country, Peru and a case concerning San Carlos de Boriloche, Argentina. (Table 1)

The study area is located at the geographic coordinates latitude S 0 ° 55'16 "and length 75 ° 23'57 O". It has a variable rainfall during the months of the study tended to increase. Temperature ranged from 23.0 - 25.5 ° with increase in the average relative humidity. Most positive cases of malaria were for students and farmers. A high level of poverty was evident. Most common symptoms that developed patients were fever, profuse sweating, headache, fatigue, nausea and chills. Of 123 cases, 32.5% (n = 40) had a history of malaria while 67.4% (n = 83) showed no background. All patients were diagnosed as uncomplicated malaria (Table 2).

Prevailed for males, the group of 5-9 years (n = 15) 21.13%, followed by the group of 10-14 years (n = 11) 15.49% and 15-19 and 30-34 years (n = 9) 12.68%. In relation for the female gender, age range of 10-14 years highlighted (n = 18) 34.62% continuing the 5-9 group (n = 10) 19.23% and 30-34 (n = 7) 13.46% (Table 3).

During January-June (2014) 1800 sheets were inspected by thick film, with (n = 8) positive. Of them (n = 6) corresponded to *P. vivax* and (n = 2) to *P. falciparum*. While for year (2015) 5808 negative films were examined in the months of study, resulting (n = 123) for *P. vivax* positive sheets. The months of highest incidence were february, march and june. No cases of *P. falciparum* occurred in the period of the investigation. (Table 4)

Tabla 2. Malaria. Clinical risk factors, epidemiology and diagnosis. Aguarico Canton, Orellana Province. Ecuador. EW 1-31. 2015.

Epidemilogical history	Fa	Fr (%)
Geographical coordinates	S 0°55'16" O 75°23'57"	
Temperature	23,0-25,5°C	
Pluviosity	2000-3000 cc	
Relative humidity	80%	
Climate	Tropical Humid	
Ocupation	Students / Agriculture	
Ethnics	Kichwas/Huaoranis	
Poverty	High Level	
Treatment access	123 patients	100.0
Clinical history		
Fever	95	81.3
Shivers	10	8.1
Profuse sweating	60	48.7
Headache	55	44.7
Asthenia	20	16.2
Nausea	2	1.6
Vomit	0	0.0
Diarrhea	0	0.0
Malaria history		
Yes	40	32.5
No	83	67.4
Diagnosis		
Non complicated malaria	123	100.0
Complicated malaria	0	0.0

Source: MSP Laboratory Tiputini Type "A.". National Service for Malaria eradication (SNEM).

Table 3. Population distribution by age group and sex. Canton Aguarico. Orellana Province. Ecuador. EW 1-31. 2015.

Age Group	Masculine	Fr (%)	Femenine	Fr (%)
< OF 1 year	2	2.82	0	0.00
1—4	5	7.04	4	7.69
5—9	15	21.13	10	19.23
10—14	11	15.49	18	34.62
15—19	9	12.68	5	9.62
20—24	6	8.45	4	7.69
25—29	1	1.41	1	1.92
30—34	9	12.68	7	13.46
35—39	2	2.82	1	1.92
40—44	1	1.41	2	3.85
45—49	4	5.63	0	0.00
50—54	2	2.82	0	0.00
55—59	2	2.82	0	0.00
60 and more	2	2.82	0	0.00
TOTAL	**71**	**100.00**	**52**	**100.00**

Fuente: MSP Laboratory Tiputini Type "A National Service for Malaria eradication (SNEM).

Table 4. Malaria Comparison of analyzed slides. Aguarico Canton. Orellana Province. Ecuador. Years 2014-2015.

Month	Negative Slides				*P. falciparum*				*P.vivax*			
	2014	Fr (%)	2015	Fr (%)	2014	Fr (%)	2015	Fr (%)	2014	Fr (%)	2015	Fr (%)
January	161	8.94	394	6.78	0	0	0	0	1	17	6	5
February	465	25.83	758	13.05	1	50	0	0	3	50	36	29
March	387	21.50	3739	64.38	0	0	0	0	1	17	45	37
April	255	14.17	350	6.03	1	50	0	0	0	0	13	11
May	335	18.61	374	6.44	0	0	0	0	1	17	4	3
June	197	10.94	193	3.32	0	0	0	0	0	0	19	15
TOTAL	**1800**	**100.00**	**5808**	**100.00**	**2**	**100**	**0**	**0**	**6**	**100**	**123**	**100**

Source: MSP Laboratory Tiputini Type "A National Service for Malaria eradication (SNEM).

DISCUSSION

Results for this study show that despite significant efforts by health teams to ensure the prevention, diagnosis and treatment for malaria is not enough.

Malaria remains one of the most serious problems of public health, especially in the border region of the Amazon. Among the possible causes of the resurgence of malaria in such areas, highlighted in order of importance: 1) reduction of prevention activities by the control program of malaria, 2) increased oil and tourism activity, 3) population migration to endemic areas, 4) increased cases imported under the influence of borders with neighboring countries (Peru) 5) vector resistance to insecticides and malarial drug (Blair et al., 2003; Rubio-Palis, 2003; Salomon et al., 2005).

Facts offices of National System for Malaria Eradication (NMES, 2014) and provided by the Ministry of Public Health of Ecuador (MSP), have allowed to report casuistry and define current malaria endemic areas in Aguarico canton, located in the Ecuadorian Amazon.

For the cumulative prevalence of malaria during 31 weeks of epidemiological study, it was observed that all (123) of the reported cases (117) were symptomatic and came mainly from Aguarico canton. In this study they correspond to the areas referred as endemic distributed in the communities of Puerto Quinche, Chiru Isla, Tiputini, Vicente Salazar, Pandochicta, Central Ocaya, Martinique, Nuevo Rocafuerte, San Carlos, Alta Florence, Bello Horizonte, San Vicente, Lemon Yacu, Santa Rosa, and Boca Tiputini. Significantly, in the town San Vicente (n = 6/6) 100% of asymptomatic adults were detected, picked at random during community visits. Asymptomatic malaria is common in Africa, but unusual in low transmission areas in Latin America (Osorio et al., 2004).

Study results presented suggest that asymptomatic malaria is uncommon in Canton Aguarico having an average incidence of malaria 6 cases / 4847 inhabitants. These findings are similar to those reported by (Osorio et al., 2004), who found low prevalence of asymptomatic malaria in an area of the Colombian Pacific (Quibdo, Choco). The absence of symptoms at the time of diagnosis could be explained by the acquisition of some degree of immunity because people would be exposed to various infections per year and would eventually have acquired immunity (Njama-Meya et al., 2004). Molineros et al. (2014), demonstrated that populations exposed, had developed immunity to infection and become carriers of symptomatic parasites without febrile illness. They report that in endemic areas the population carries gametocytes so that young children have higher levels, which decreases progressively with age. It is the fact that the African black population has developed high immunity against some types of malaria.

Factors such as early detection of infection before the individual develops symptoms, such as self-medication using traditional medicine and the culture of the area whose inhabitants go to the Yachag (expert in indigenous medicine) to remediate their diseases, reports a great influence. These components could explain most asymptomatic cases. In this study, only one patient reported to had multiple episodes of malaria, remained asymptomatic and never received antimalarial treatment. This finding suggests that asymptomatic malaria may be present in the canton.

Regarding to the presence of imported cases from neighboring countries, mostly came from the upper Napo river, border area of Peru, belonging to the Angoteros hamlets (1), Cabo Pantoja (1), District Torres Causana (3), Quebrada de Santa María (3). These outbreaks are endemic in Peru. Indeed, in a study by (Colan et al., 1993) indicates that since 1978, the top of the Napo River remains endemic, particularly corresponding to the Quebrada de Santa Maria area. The reasons for the appearance of these foci are explained by the constant migration of Peruvians seeking work in the oil areas of Aguarico canton. In relation to the case from San Carlos Bariloche (Argentina) corresponds to a patient who began his journey as traveling from Peru, being retained in Iquitos several days, where he probably became infected, whose final destination was the Yasuni National Park in Ecuador, located in the Orellana province between the Napo river and Curaray river in the Amazon Basin, two hours from the place of study. The patient,

after presenting symptoms of fever was diagnosed positive to *P. vivax*, by thick film in the health center Tiputini.

Regarding the epidemiological history, area shows the characteristics of tropical climate that constitute risk factors for malaria and disease outbreaks (Osborn et al., 2004) conditions coupled with the failure to prevent the population help reproduction Anopheles mosquito (Onori and Grab, 1980; Rubio-Palis et al, 2013).

Regarding the population, it is considered economically active. In recent years the source of temporary labor is the insertion in the oil companies. However, despite not suffer from shortages of basic services, these remain limited. Electrical power is provided by hours. In this regard, cuts start at 18:00 until 24:00 every day. Water consumption is by pipeline and have excreta disposal in housing; health services are poorly distributed, because the way to the health center in a community of the canton, route is between one to two hours by motorized canoe. At present the Ministry of Public Health of Ecuador (MSPE) in 22D03 Aguarico District, has four operating units in the public network, Hospital Franklin Tello in Rocafuerte, Health Centre Type A Tiputini, Health Centre Type A Captain Augusto Rivadeneyra and health Centre Type A Dikaro.

The most common symptoms that developed patients included fever, profuse sweating, headache, asthenia and chills. These symptoms are consistent with the study called cluster of symptoms of uncomplicated malaria in semi-immune patients in Mancio Lima, a city located in the Amazon region of Brazil (Martins et al., 2015). Malarial paroxysm was not found in patients, that is usually accompanied by headache, nausea, myalgia, arthralgia and fatigue. Fever and its elements are the central component of malarial case. (Malagon et al., 2004; Rodriguez et al., 2010), consistent with the clinical characterization of the symptoms found in our study. However, Asayag et al. (2008) indicated in article Sensitivity and Specificity of fever as a clinical predictor of malaria in Loreto, Peru, that it is possible to detect cases of malaria without evidence of fever, due to the development of partial immunity without preventing infection but can affect people with asymptomatic parasitaemia. That situation was detected in some cases in the present study (28/123) . Also, Alves et al. (2002) emphasize that groups living in the Amazon Brasileria (Portuchuelo and Ji-Paraná) for long periods of time (mean of 25.5 and 18) respectively, develop asymptomatic malaria. Similarly, Tada et al. (2007) and Katsuragawa et al. (2010) point to the Amazon region of Brazil that individuals carriers of asymptomatic malaria are a source of malaria infection.

Of all 123 cases, 32.5% had a history of malaria while 67.4% showed no background even though the study area is considered endemic area. This result coincides with the work called Non-Self 12 cases in Chile presented by (Peréz et al., 2006). The authors indicate that (2/12) cases reported in their study had a history of residence in malarious endemic areas of Ecuador.

Cases with uncomplicated malaria were treated with chloroquine and primaquine according to the guidelines for monitoring and control of malaria (MSP, 2015; SNEM, 2015; Castro et al., 2014) 29 patients during this study not relapsed so it could indicate that there is no resistance to antimalarial drugs. However, it became clear that the drug to treat patients with malaria is not available routinely in the aforementioned study area. In this regard, when not treated promptly, spread of the disease to other localities is promoted.

Risk population infected corresponded to the 5-9 age group, 21.13% (15/123) for the male gender. As for the female gender, highlighted the 10-14 age group, 34.62% (18/123) demonstrating that the area affected by malaria during the period of the study population corresponded to children and young in canton. This observation is consistent with research in Iquitos, Peru (Loo, 1996; Chaporro et al., 2010) who indicate a predominance of people affected by malaria between the ages of 0-20 years included.

This result could be explained because young people who were infected with malaria during the study period mainly relate to students who rise early at 04:00 am to take the canoe or Tamberi (word Kichua) on the banks of the Napo river to reach the nearest schools and farmers engaged in hunting, fishing and farming. This observation coincides with entomological studies in the vector who note the vector feeds, especially *An pseudopuntipennis* in the period between. 18: 00- 24: 00 and 04: 00-06: 00 hours *An*. *oswaldoi* 5:00 . -06: 00 and *An-tovari nuñez* 24: 00-04: 00 hours latter being predominant species in the Amazon region (Vargas, 2003; Jimenez et al, 2012).

In this regard, climatic conditions have a profound effect on the life cycle of the mosquito and the development of malaria parasites. Factors such as temperature and humidity below 16 ° C cease development of malaria parasites in the mosquito. Plasmodium development in the mosquito occurs in the temperature range between 20 and 30 ° C and relative humidity above 60% as obtained in the present study (Millers et al., 2014). The high temperature prolongs the life of the mosquito to transmit the disease to several people. This disease is sensitive to global climate change, perceived as vector-borne disease. However, there is no time related to vector activity in the area to enable comparisons about studies.

It is important to mention the importance of using the test selected in this research. Although, there have been developed new diagnostic methods, the thick film is still used as a gold benchmark for diagnostic confirmation of malaria laboratory (Garcia et al, 2015; Cabezas et al., 2004; Arróspide et al., 2006; Gutierrez and Arróspide, 2013) relate the practical use, the use of thick film; this technique easy to perform and inexpensive, used in this research presents a sensitivity of 98%.

When the monthly frequency of cases in the previous homologue year was compared, it was found that the highest number of malaria cases of *P. vivax* was february, registering (50%) of them. Similarly, (2) cases of *P. falciparum* and (6) cases of *P. vivax* were diagnosed. However, by 2015, it reached its highest peak in March (37%), none *P. falciparum* cases were recorded, but an increase of positive cases of *P. vivax* (123). This increase in positive cases in the aforementioned months is related to the rainy season in the Ecuadorian Amazon. This variable, determines the presence of stagnant wells, puddles, ponds, swamps, pools, ideal for displaying the existence and proliferation of habitat waters for malaria-causing mosquito. Similar to the study done by Sanabria et al. (2004), 32 who indicate that climatic factors such as temperature, rainfall and humidity allow the existence and development of sufficient density susceptible to infection by plasmodium mosquitoes.

Also, although it was not an objective of the exhibited study to identify Anopheles species present in the Amazon region *An. Nuñez ovari* and *An. Trinkae* are the most prevalent (Montalvan, 2013; San Sebastian et al., 2000). These vectors breed occurs during the months of February to June in the puddles that are being dry when the rains stop being heavy and shaded freshwaters. Species, usually susceptible to pyrethroid insecticides and organophosphorus in use in the country (Cortez Diaz et al., 2008).

In relation to vector control methods, it was proceeded to make spraying of 478 houses, protecting 1877 inhabitants of the parishes belonging to the canton, as a preventive measure to avoid the progressive increase in cases. Based on the foregoing, it is clear that campaigns of spray in the houses of the periphery of canton are not the best way of prevention. In this regard, the best strategy is education and timely treatment of infected patients. Likewise, in order to protect the inhabitants of the community, the Ministry of Public Health of Ecuador (MSP) proceeded to deliver 707 tents to the residents of the towns of Chiru Isla, Puerto Quinche, Sinchichicta, Vicente Salazar. However, these localities presented the biggest amount of positive cases.

The existence of inadequate basic sanitation, idiosyncrasies of the population of the study communities, culture, health care, based on traditional medicine, access to health services, constant migration and exchange of the Ecuadorian and Peruvian border town, inadequate epidemiological surveillance, delay in carrying out the epidemiological fence and active case searching, allow the increase in cases, coupled with environmental factors present.

Similarly, it is important to consider the constant interaction to allow continuous communication of each case, with the services of Health of Peru and Ecuador in the border areas, as they represent favorable factors to the presence of prevalent tropical diseases and transmitted by vectors in Canton Aguarico, which led to the presence of a malaria epidemic this year.

CONCLUSIONS

There were counted (123) cases of malaria; (117/123) were symptomatic patients came mainly from Aguarico canton and (n = 6/123) asymptomatic natives of the town San Vicente. Imported cases (8) came from Peru and (1) of Argentina.

It was found as important environmental risk factors for malaria, climate (tropical), increased rainfall (> 6000mm) and average relative humidity (> 80%). Cases increased in March at the expense of *P. vivax*.

The most affected age groups were 5-9 years, 21.13% (15/123) for the male gender. As for the female gender, highlighted the 10-14 age group, 34.62% (18/123).

Patients corresponded mostly students and farmers. Failure was observed in the supply of electricity (provided by the hour), specifically at dawn and dusk, enabling the contact-man interaction.

Of all cases 32.52% had a history of malaria; 67.48% showed no background. The most common symptoms that developed patients included fever (81.3) profuse sweating (48.7) headache (44.7) asthenia (16.2) and chills (8.1). All patients were diagnosed with uncomplicated malaria. Cases with uncomplicated malaria were treated with chloroquine and primaquine.

The current study allowed to redefine endemic areas of *P. vivax* in the Ecuadorian Amazon, specifically in the communities of Canton Aguarico, factors that interfere with its spread and prevalence. It is necessary to investigate the specific vectors in each endemic area, type of resistance, key factors in future studies to define effective control strategies.

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