

Epidemiological profile of patients with malaria admitted to the Erasmo Meoz University Hospital in the municipality of Cúcuta, during the period 2014-2021

Perfil epidemiológico de pacientes con malaria que ingresan al Hospital Universitario Erasmo Meoz del municipio de Cúcuta, durante el periodo 2014-2021

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Resumen

Esta investigación describe el perfil epidemiológico de pacientes con paludismo que ingresan a la ESE HUEM del Municipio de San José de Cúcuta, durante el periodo 2014-2021. Se desarrolla un estudio epidemiológico observacional transversal, que busca determinar la prevalencia de pacientes con malaria que ingresan a este centro hospitalario durante el periodo de estudio; se tienen en cuenta variables asociadas a sexo, edad, manifestaciones clínicas, tipo de parásito etc. El análisis de los resultados permite determinar que pacientes de nacionalidad colombiana, se constituyen como el grupo con mayor porcentaje de atención (67,74%), seguidos de pacientes provenientes de la hermana república de Venezuela (32,26%). La fiebre, es la manifestación clínica con el más alto diagnóstico en pacientes que ingresan por esta patología (91,36%). Plasmodium vivax se describe como el parásito diagnosticado con mayor frecuencia en este centro hospitalario. El sexo masculino se presenta con una alta prevalencia de hospitalización (64,4%). Al analizar el rango de edad con mayor riesgo de infección por malaria, los pacientes entre los 15 a 59 años se registran como la población que es hospitalizada con mayor frecuencia (78,8%).

Palabras clave: Malaria, Manifestaciones Clínicas, Perfil Epidemiológico.

Abstract

The objective of this research is to describe the epidemiological profile of patients with malaria who enter the ESE HUEM of the Municipality of San José de Cúcuta, during the period 2014-2021. A cross-sectional observational epidemiological study is developed, which seeks to determine the prevalence of patients with malaria admitted to this hospital during the study period; Variables associated with sex, age, clinical manifestations, type of parasite, etc. are taken into account. The analysis of the results allows us to determine that patients of Colombian nationality constitute the group with the highest percentage of care (67.74%), followed by patients originating from the sister republic of Venezuela (32.26%). Fever is the clinical manifestation with the highest diagnosis in patients admitted for this pathology (91.36%). Plasmodium vivax is described as the most frequently diagnosed parasite in this hospital center. The male sex has a high prevalence of hospitalization (64.4%). When analyzing the age range with the highest risk of malaria infection, patients between 15 and 59 years old are recorded as the population that is hospitalized most frequently (78.8%).

Keywords: Malaria, Clinical Manifestations, Epidemiological Profile.

1. Introduction

Malaria is an infectious disease produced by parasites of the genus Plasmodium and is transmitted to humans by the bite of female mosquitoes of the genus Anopheles [1]. This

disease is considered one of the main public health problems due to its prevalence and contribution to morbidity and mortality; a year more than 500 million people becomes seriously ill and more than 1 million die [2]. The epidemiology of malaria is considered "highly complex"

because it depends on etiological factors, topography, climatic variations and the ecological diversity of the vector [3]. This disease exhibits a broad spectrum of clinical manifestations, which include asymptomatic infection, uncomplicated and complicated malaria and depends on multiple environmental factors, the host and the parasite [4]. The incubation period varies from 9 to 40 days, being the shortest for *Plasmodium falciparum* and the longest for *Plasmodium malariae*, during which the patient remains asymptomatic [5]. Within the symptomatology associated with malaria, most patients have fever (92%), chills (79%), headache (70%) and diaphoresis (64%) [6]. Among the most frequent symptoms there are nausea, dizziness, vomiting, myalgia, diarrhea, discomfort, abdominal, mild pain and dry cough. At the level of physical signs there is a fever, jaundice, paleness, tachycardia, hepatomegaly, splenomegaly, hypotension and orthostatic [7,8]. Classic paroxysm consists of fever with chills, accompanied by abdominal pain, nausea, vomiting, diarrhea, back pain, myalgia, paleness and jaundice [9].

Plasmodium falciparum is the most prone species to generate severe or complicated malaria [10,11], causing the greatest moral load at the global level because more than 95 % of the cases that are notified is by this species, especially in sub-Saharan Africa [3]; followed by *Plasmodium vivax*, which is much more common in the Americas and the Western Pacific [2]. With respect to *Plasmodium malariae* in the last year there has been no cases in Colombia. *Plasmodium ovale* is less frequent, relatively unusual out of Africa and includes less than 1% of isolates [12].

In Latin America, malaria has a high prevalence. In 2017-2018, approximately 500,000 cases of malaria were reported in Venezuela, making it the country with the highest number of infected patients, followed by Brazil (174,522 cases), Peru (4,727 cases) and Ecuador with 1,279 cases [13,14]. In 2019, the World Health Organization (WHO) reported more than 976,000 cases in the Americas, of which 83% correspond to Venezuela, Colombia and Brazil and of these 74.1% are attributed to *P. vivax* and *P. falciparum* [14]. By 2021, more than 247 million cases were reported worldwide and it is estimated that it caused the death of 619,000 people [13].

Regarding the behavior of this disease in Colombia in the last 5 years, the number of reported cases has remained stable. The National Institute of Health (INS) recorded more than 61,339 cases in the country in 2018 (*P. vivax* 50%, *P. falciparum* 48%). As of this year, although the number of patients increased considerably, it was gradually decreasing over the last four years, occurring in 2019, 78,513 cases (*P. vivax* 48.6%, *P. falciparum* 50.3%), in 2020, 76,928 cases were described (*P. vivax* 49.8%, *P. falciparum* 49.4%), in 2021, 72,022 cases were registered (*P. vivax* 49.6%, *P. falciparum* 49.6%) and in 2022, 71,573

cases were reported (*P. vivax* 60.7%, *P. falciparum* 38.3%) [15].

At the level of the Norte de Santander department, a similar behavior to that presented at the national level is recorded, but the number of cases has increased in some years. According to records from this Institute, in 2018 the lowest number of cases for the department was recorded in the last five years, for a total of 1,303 cases. From 2019, the total number of cases increased considerably, with a total of 4,055 cases being recorded for this period. In 2020, 4,122 cases were described, for 2021, 4,998 cases were recorded, and in 2022 there was again a decrease in the number of records of patients with malaria at the departmental level, with only 1,962 cases being recorded [15].

In countries such as Colombia, malaria is still endemic and is caused by three different species [*P. falciparum*, *P. vivax* and *P. malariae*], which represents a significant social, economic and health burden for the nation [16,17]. However, within the behavior of malaria morbidity in the last seventeen years in this country, a large number of specific cases of each parasite by region has been maintained, which does not occur in the region of Norte de Santander, since varieties of cases produced by different genera of the parasite such as *P. falciparum* or mixed cases can be reported, which lead to having a wide range of pharmacological management to treat each of these varieties of the pathology and alternatives for those that are resistant to conventional treatment [18].

According to WHO estimates, the increase in malaria cases in Venezuela in 2017 and 2018 affected some neighboring countries such as Colombia, which recorded an increase in the number of malaria cases due to the increase in immigrants from this country [1]. Departments such as Norte de Santander, Arauca, Cesar and Guajira recorded a constant increase in the number of cases, a situation that is complicated by the high resistance that some of these patients present to conventional treatment [17]. The INS confirms that 95.2% of the reported cases of malaria from abroad are of Venezuelan origin, while only 4.8% come from other countries [15].

Given the behavior of Malaria at the national level and especially in the border departments with the Republic of Venezuela, as well as the increase in the number of cases registered at the Departmental level associated with the migration problem and the care of patients from Venezuela, the present investigation is developed that seeks to determine the epidemiological profile of patients infected by parasites of the genus *Plasmodium* sp., in the Erasmo Meoz University Hospital of the Municipality of San José de Cúcuta in the period between 2014 and 2021.

2. Methodology

In order to achieve the proposed objectives, the work methodology was divided into two phases that sought to determine the prevalence of patients with malaria who were treated at the Erasmo Meoz University Hospital in the study period between 2014 and 2021, a period of greatest impact on the care of patients from Venezuela, and also to describe the symptoms most frequently presented in patients treated at this hospital. **Study area:** This study is carried out at the Erasmo Meoz University Hospital in the municipality of Cúcuta, capital of the Norte de Santander department in eastern Colombia. **Study design:** A cross-sectional, descriptive, observational epidemiological study is carried out that seeks to describe the prevalence of patients with malaria who are admitted to the different services of the Erasmo Meoz University Hospital. The frequency of the disease is determined according to variables such as sex, age, ethnic groups, origin, nationality, type of parasite and clinical manifestations. The study period covers the years 2014 to 2021, a period of greatest migratory activity from Venezuela to Colombia, as well as the beginning of the electronic registration of the medical history in the hospital center. **Inclusion Criteria:** Within the inclusion criteria, patients of any sex, age, and origin who were admitted to this hospital center through the different services (outpatient clinic, emergency room, and hospitalization), whose malaria diagnosis was confirmed by images or by laboratory, and who present a complete electronic medical history, are taken into account. **Data Collection:** A technical sheet is made that allows the collection of information from the electronic medical records that meet the inclusion criteria, taking into account the specific objectives and variables established in this research. **Statistical Analysis:** All analyses were performed using the Epi Info™ 7 Statistical Package software. The analysis included descriptive statistics.

3. Results

Table 1. Distribution of results according to variables related to nationality, sex and age range.

Variable	Results				
Nationality	Colombian: 357			Venezuelan: 170	
%	67,74%			32,26%	
Sex	Male: 318			Female: 170	
%	65.16%			34.83%	
Age range	0-5 years: 35	6-14 years: 60	15-30 years: 209	31-59 years: 206	60-81 years: 17
%	6,6%	11,40%	39,70%	39,10%	3,20%

Regarding the *Plasmodium* species identified in the total number of patients admitted to this hospital with symptoms associated with malaria, the analysis of the results allows us to describe three species of this genus that were observed in the diagnostic laboratories of the Erasmo Meoz University Hospital. Of the total of 527 clinical histories analyzed, 91.3% (481 patients) were diagnosed with parasites of the *Plasmodium vivax* species. To a lesser extent, but no less

The analysis of the results allows us to determine that of a total of 669 clinical histories that were selected as possible cases of malaria during the study period, those clinical histories of patients that did not meet the inclusion criteria established for this research were discarded. The confirmation of the parasite was carried out by direct observation methods (thick blood smear test or peripheral blood smear). Of the total clinical histories analyzed, 142 that did not meet any inclusion criteria were discarded. The analysis of the information is carried out on 527 clinical histories of patients who were admitted to the emergency services, hospitalization or outpatient clinic at the Erasmo Meoz University Hospital in the Municipality of Cúcuta and who meet the inclusion criteria. Of the total clinical histories selected, 67.7% (357 patients) correspond to patients of Colombian nationality and 32.3% (170 patients) are listed as people of Venezuelan nationality (see Table 1).

Similarly, when reviewing the sex type, 64.4% (338 patients) belong to the male gender and 35.9% (189 patients) are part of the female gender (see Table 1). In relation to the age of the patients who entered this hospital center with symptoms associated with malaria infection, they were grouped into 5 groups taking into account the risk of greater exposure to the transmitting mosquito due to their occupation, presenting a higher prevalence in patients between the ages of 15 and 30 years in 39.7% (209 patients) of the total samples analyzed. Secondly and in a similar percentage, patients with malaria were recorded in an age range between 31 and 59 years in 39.1% of the cases studied (206 patients). To a lesser extent, patients between 6 and 14 years were found in a prevalence of 11.4% (60 patients), between 0 and 5 years 6.6% (35 patients) were identified and between 60 and 80 years 3.2% (17 patients) were identified during this study period (see Tab. 1).

important due to the pathogenicity of this species, 8.2% (43 patients) were identified with the *Plasmodium falciparum* species and one (1) patient with *Plasmodium malariae* (0.2%). Likewise, five patients (0.9%) were identified with mixed malaria (*P. vivax/P. falciparum*) (see Table 2).

Regarding the clinical presentation of hospitalized patients, the analysis of the results allows to determine that

fever in 91.36% of the cases analyzed (446 patients) is described as the clinical presentation with the highest prevalence. To a lesser extent, headache is present in 57.17% of the cases (279 patients), abdominal pain in

28.48% (142 patients) and vomiting in 28.4% (139 patients) (see Table 2).

Table 2. Distribution of results according to variables associated with symptoms and parasite species.

Variable	Results			
Symptomatology	Fever: 446	Emesis: 139	Abdominal pain: 142	Headache: 279
%	91.36%	28.4%	28.48%	57.17%
Plasmodium species	<i>P. vivax</i> : 442	<i>P. falciparum</i> : 40	Mixed Infection: 5	<i>P. malariae</i> : 1
%	91%	8.1%	0.9%	0.2%

4. Discussion

The analysis of the results allows us to determine a considerable increase in the care of patients with pathologies associated with this type of disease. Among these, malaria constitutes a public health problem of high impact in the department of Norte de Santander due to the clinical symptoms it presents and the increase in recent years of patients from the Republic of Venezuela. Although the percentage of patients with malaria of Venezuelan origin (32.26%) is not present in the same proportion as patients of Colombian nationality (67.74%), the number of patients of foreign nationality who enter this hospital center with symptoms associated with this infection is high. The impact on public health generated by the care of these patients has been a constant in recent years in the different public IPS that are present at a national level, especially those found in the border region.

Regarding the increase in malaria cases, the INS describes that Colombia has witnessed an increase in the number of malaria cases from Venezuela in border areas of our country, with the departments of Guainía, Norte de Santander and Vichada receiving the majority of cases [16]. Up to epidemiological week 17 of 2018, 520 cases of malaria from abroad had been reported, of which 496 cases correspond to uncomplicated malaria and 24 cases to complicated malaria; 399 cases have been registered with *P. vivax* infection, 93 cases with *P. falciparum* infection and 28 cases with mixed infection (*P. falciparum* and *P. vivax*) [17]. 95.2% of these cases come from Venezuela, and most were reported by the department of Guainía (43.2%), followed by the department of Norte de Santander (14.6%) [16]. Similarly, Rodríguez et al. [19] describe the presence of malaria cases from Venezuela in 0.02% of the cases registered at the national level. Studies carried out by Shannon et al. [20] describe the health effects caused by the migration of patients from Venezuela, especially related to the care of patients who enter different hospitals for the treatment of diseases [21].

The increase in the prevalence of malaria cases reported in the municipality of Cúcuta and the department may be related

to the increase in malaria in Venezuela and the care of patients from this country at the Erasmo Meoz University Hospital. The increase in malaria cases is a probable reflection of the regional increase in cases, with a particularly strong resurgence in Venezuela. From 2013 to 2014, the incidence of malaria in Venezuela increased by 69 percent. In 2017, a total of 406,000 cases were reported, a five-fold increase compared to the figures for 2013 [22]. Gutiérrez et al. [21] describes an increase in malaria cases throughout the Americas, associated in turn with the increase in these diseases, especially in Venezuela. In the last week of December 2019, a total of 78,513 cases of malaria were reported in Colombia, 98.29% of them uncomplicated and 1.71% complicated cases, three percent of these cases were imported from other countries. Venezuela was the main source of imported malaria cases (95.7%), 1.53% of the cases originating in Peru, 0.79% in Brazil and the rest from other countries, especially diagnosed at the borders [21]. Vector-borne diseases present a major health problem in Venezuela, especially at the level of malaria that is endemic in several regions of this Latin American country [23].

On the other hand, when analyzing the type of sex of patients with malaria admitted to this hospital during the study period, the results reflect a higher prevalence in male patients [65%]. Similar results were found in other regions of the country. Studies carried out in Colombia by Laborde et al. [23] describe a higher percentage of infected male patients, reaching a prevalence of 69.6%. Other research carried out in Colombian territory also identifies a higher prevalence of malaria in male patients. Works carried out by Cardona et al. [24] and Hernández et al. [25] describe a higher prevalence of the disease in male patients above 57% of the total cases presented. At an international level, studies carried out by Sana et al. [26] present results similar to those published in Colombia. Works developed by these researchers in India reflect a marked tendency in the number of cases presented in the male gender, since more than 61% of the cases registered in these studies are men. However, most of these studies are uncertain regarding the cause of male dominance in malaria infection, some attributing it to the greater

exposure of men to the outdoors/mosquito bites or to men's occupations, who mainly perform mining and agricultural tasks, including illegal mining and illicit crops [27,28]. It is necessary to clarify that, in the work carried out by Restrepo [29] in the department of Choco on knowledge, practices and attitudes about malaria, a higher rate of infection was presented in female persons in 66.8% of the cases studied.

On the other hand, when analyzing the data obtained in the present investigation and relating them to the age ranges of the patients who were treated in this hospital center, the analysis of the results allows to determine that patients between 15 and 59 years of age, present the highest prevalence of hospitalization in this hospital center. These results, which are related at a national level with research carried out in the department of Nariño by Galindo et al. [30], describe that the most frequent ages of infection are found in individuals between 15 and 64 years, with emphasis between 15 and 19 years. A lower prevalence is present in older ages (between 60 and 81 years), as well as the results obtained in the present investigation [31]. At an international level, the results related to the age range that present the infection differ a little with the results presented in this investigation. Studies carried out by Wångdahl et al. [32], in Sub-Saharan Africa, describe that the age range between 18 and 39 years is presented as the population with the highest risk of acquiring the disease [50.7%]. To a lesser extent, the range between 40 and 59 years [13.8%], 12 to 17 years [13.6%], 0 to 5 years [7.1%], 6 to 11 years [10.4%] and over 60 years [3.4%] is presented. Other research carried out by Trojánec et al. [33] recorded the age group between 0 and 15 years [30%] as the group with the highest frequency of Plasmodium infection [*P. vivax* and *P. falciparum*].

When analyzing the species of *Plasmodium sp.* that were identified and diagnosed in patients at the Erasmo Meoz Hospital during the study period, the highest percentage was found to be parasites of the *Plasmodium vivax* species, in 91.3% of the population studied. To a lesser extent, patients were described with the *Plasmodium falciparum* species in 8.2% of the total samples analyzed. These results are similar to those published by Rodríguez et al. [34], in a study developed in the department of Risaralda, Colombia. The results of this research determine that the *Plasmodium vivax* species is presented as the parasite with the highest presence in the samples of patients analyzed in this region of the country, reaching 93.4% of the total cases studied, followed by *Plasmodium falciparum* with 3.7% and mixed malaria [*P. vivax/P. falciparum*] in 2.9% of the total patients studied. Other research carried out at a national level also describe a greater presence of the *Plasmodium vivax* species in patients treated in different hospitals, with prevalences between 57% and 75%, followed by *Plasmodium falciparum*, which occurs with a much lower frequency, between 20% and 40%, mixed infections by *P. vivax/falciparum* with a much lower presence between 1% and 4% of the cases studied and infections by *Plasmodium malariae* with 1% of the reported

cases [25,35]. When relating the prevalence of this infection among foreign patients treated in hospitals in Colombia, Rodríguez et al. [23] describe that 67.8% of the cases were attributed to *Plasmodium vivax*, 28.8% to *Plasmodium falciparum* and 3.3% to mixed infections. Venezuelans represent 28.3% of all confirmed cases and 55.6% of all malaria-related deaths. Similarly, when analyzing the prevalence of malaria parasite infection in patients treated internationally, a higher prevalence of *P. vivax* is described. Work carried out by Khan et al. [36], on the prevalence of malaria in the Pakistani population, determined the presence of *P. vivax* in 92.8% of the population studied and *P. falciparum* in 7.2% of the samples analyzed. However, and unlike the results presented in Pakistan, Trojánec et al. [33], presents a higher presence of *P. falciparum* in patients studied in sub-Saharan Africa, where a higher prevalence of this parasite is described, higher than 73.4% of the cases analyzed. To a lesser extent, *P. vivax* was diagnosed in 17.2%, *P. ovale* in 3.9% and *P. malariae* in 2.5% of the total number of patients treated. Similarly, patients with mixed malaria infection are described, with *P. falciparum* and *P. ovale* in 2.0%, *P. falciparum* and *P. vivax* in 0.5% and *P. ovale* and *P. malariae* in 0.5%.

When analyzing the clinical manifestations presented by patients upon admission to the Erasmo Meoz University Hospital in the municipality of Cúcuta, fever was described as the most common symptom in 91.36% of the cases analyzed, followed to a lesser extent by headache (57.17%), abdominal pain (28.48%) and vomiting (28.48%). These results are similar to those published in the Department of Córdoba, Colombia, by Knudson et al. [31], who describe fever (99.1%) as the most frequent symptom in the patients studied. Similarly, Gutiérrez et al. (21), describes fever, headache, chills and myalgia as frequent symptoms in this type of patients. At an international level, research conducted by Wangdahl et al. (32), on the prevalence of malaria in sub-Saharan African migrants, relate fever (89%) as one of the symptoms most frequently reported by these patients, followed by headache, stomach ache, cough and body pain in lesser proportion. Similarly, Trojánec et al. [33], determine the clinical characteristics of imported malaria where Headache (61.6%) is the most common clinical manifestation in these patients, followed by muscle pain (38.4%), joint pain (36.4%), tachycardia (35.9%), prostration (30.8%), vomiting (30.3%), diarrhea (30.8%), dehydration (30.3%), abdominal pain (16.2%), jaundice (16.2%), hepatomegaly (18.2%) and splenomegaly (10.5%) [33]. Although studies show a significant mortality rate due to malaria at national and international levels, such as those published by Iza et al. [37], which relate a high mortality rate in patients with malaria in Chocó and Antioquia or the one described by Laborde et al. [23], which describe a mortality rate of up to 17% of the total number of patients who were treated for malaria in hospitals, in the studies carried out in the present investigation, no case of death due to this disease or its complications was recorded.

5. Conclusions

Although the majority of patients treated at the Erasmo Meoz Hospital are of Colombian origin, a high percentage of patients admitted to this hospital come from the Republic of Venezuela, who travel from this country seeking medical care in the city of Cúcuta, Colombia. Regarding the type of sex of the patients treated at this hospital, the male sex is present with a higher prevalence of hospitalization, perhaps associated with the fact that the great majority of these people are working in rural areas in jobs with greater exposure to the presence of the mosquito (*Anopheles*) such as mining, sawmills, scrapers, livestock, agriculture, etc. When analyzing the age range with the highest risk of hospitalization for malaria, patients who are of working age (between 15 and 59 years) are presented as the population with the highest risk of infection. The results of the present investigation reflect that these patients represent almost 80% of the total population hospitalized at Erasmo Meoz for this infection.

When determining the species of the *Plasmodium* parasite with the highest diagnosis in this hospital, the *Plasmodium vivax* species is recorded as the parasite with the highest presence in patients who enter this hospital center. These results are similar to those reported at the national level related to the prevalence of this species in the country. When performing an analysis of the clinical manifestations that are recorded when the patient enters any of the services of the University Hospital (outpatient clinic, emergency room or hospitalization), fever is recorded as the symptomatology with the highest presence in these patients.

References

- [1] Organización panamericana de la salud. Malaria. [Internet].2023. Disponible En: <https://www.paho.org/es/temas/malaria>
- [2] Jadan K.P., Alban C.J., Salazar A. Caracterización del paludismo como enfermedad endémica en Ecuador. *AMC*. 23(4) (2019) 540-558.
- [3] Aqeel S, Naheda A, Raza A, Khan W. A., Micro-Epidemiological Report On The Unstable Transmission Of Malaria In Aligarh, India. *Parasite Epidemiol Control Rev*. 127;11 (2020) E00161.
- [4] Chaparro P.E., Lopez M., Rengifo L.M., Padilla J., Herrera S., Arévalo M. Clinical and epidemiological aspects of complicated malaria in Colombia, 2007– 2013. *Malar J*. 15, (2016) 269.
- [5] Arévalo M., Lopez M., Medina, L. Medina L., Moreno A., Gutierrez J.B., Herrera, S. Clinical profile of *Plasmodium falciparum* and *Plasmodium vivax* infections in low and unstable malaria transmission settings of Colombia. *Malar J*. 14, (2015)154.
- [6] Trampuz A., Jereb M., Muslovic I, Prabhu R.M. Clinical review: Severe malaria. *Rev. Critical Care.*; 7(1): (2013) 315-323.
- [7] D'Acromont V, Landry P, Mueller I, Pecoud A., Genton B. Clinical and laboratory predictors of imported malaria in an outpatient setting: an aid to medical decision making in returning travelers with fever. *Rev. Am J Trop Med Hyg*. 66[1]: (2012) 481-496.
- [8] Mungwahali K.Y., Menéndez R.L., Pomier S.O. Caracterización clínica del paludismo importado. *Rev Cubana Med Trop [Internet]*. 2020
- [9] Garcia L. Malaria. *Clinics In Laboratory Medicine*. 2010;30[1]:93-129. <https://doi.org/10.1016/j.cll.2009.10.001>
- [10] Vásquez Ana María, Tobón Alberto. Mecanismos de patogenia en la malaria por *Plasmodium falciparum*. *Biomédica [Internet]*. 2012 Mar [cited 2023 Oct 08] ; 32[Suppl 1]: 106-120.
- [11] Maitland K, Marsh K. Pathophysiology Of Severe Malaria In Children. *Acta Tropica*. 2004;90[2]:131- 140.
- [12] White N.J., *Plasmodium knowlesi*: The Fifth Human Malaria Parasite, *Clinical Infectious Diseases*, Volume 46, Issue 2, 15 January 2008, Pages 172–173
- [13] León Al. Gobernabilidad migratoria, ¿reforzando el modelo de securitización en Suramérica? El éxodo venezolano y sus retos para el Estado colombiano. *Estudios Políticos [Universidad de Antioquia]*, 2020; 57, pp. 210-228.
- [14] Tovar C, Velasco MC, Avilés PA, Ricardo DM, Alvis EM, Ramirez J, Yasnot MF. Liver And Kidney Dysfunction, Hypoglycemia, And Thrombocytopenia In *Plasmodium Vivax* Malaria Patients At A Colombian Northwest Region. *Parasite Epidemiol Control*. 2021; 25;13:E00203.
- [15] Instituto Nacional de Salud. Dirección de Vigilancia y Análisis del Riesgo en Salud Pública. Dirección de Vigilancia y Análisis del Riesgo en Salud Publica. Publicación en línea: ISSN 2357-6189.
- [16] Hernández Rodríguez R, Gerena Vallejo A, Orozco Díaz C, Rivas S, Vargas Vasquez YH. La “Malaria” como problema de salud pública en Buenaventura, Cali, Barranquilla y Dabeiba para los años 2012-2013.
- [17] Instituto Nacional de Salud. Dirección de Vigilancia y Análisis del Riesgo en Salud Pública. Dirección de Vigilancia y Análisis del Riesgo en Salud Publica. Malaria. Publicación en línea: ISSN 2357-6189.
- [18] Gualteros D.A., Cortes C., Ramírez M., Collazos N., Martínez A.F., Cardona J.A., Rodriguez A.J. Estimating the burden of disease and the economic costs attributable to Malaria in the Coffee-Triangle region of Colombia 2007-2013. *Rev. International Journal of Infectious Diseases*. 73[2]: (2018) 94.
- [19] Rodríguez A.J., Herrera A.C., Botero S., Cabrera J., Herrera P.A., Puentes S. Clinico-epidemiological aspects of uncomplicated *Plasmodium vivax* malaria in an endemic department of Colombia, 2008–2012. Posters / *International Journal of Antimicrobial Agents* 42S2(2013) S41–S159 <https://doi.org/10.1186/s12936-016-1323-5>
- [20] Shannon D., Page K.R., Hoz F., Spiegel P., Beyrer C. Venezuelan Migration and the Border Health Crisis in Colombia and Brazil. *Journal on Migration and Human Security Rev*. Vol. 7[3] (2019) 79-91
- [21] Gutiérrez E., Villamizar R., Holguin Y., Molina K., Puerta V. Malaria en Bogotá, Colombia [2007-2017] – An analysis of notified domestic and international cases. *Travel Medicine and Infectious Disease Rev*. 33 [2020]. <https://doi.org/10.1016/j.tmaid.2020.101560>
- [22] Laborde C., Correa E., Cuadras L., Aramendiz K., Pareja P., Maestre R. Epidemiological characterization of patients with malaria notified by a health insurer in Colombia, 2016-2017. *Cubana Med Trop Rev*. 72[1]: (2020) e436.
- [23] Doocy S, Page K.R., De la Hoz F., Spiegel P., Beyrer C. Venezuelan Migration and the Border Health Crisis in Colombia and Brazil. *Rev. Journal on Migration and Human Security*. 7[3] (2019).
- [24] Cardona J.A., Salas W., Carmona J.A. Systematic review of qualitative studies about malaria in Colombia. *Heliyon Rev*.(5), (2020) e03964.
- [25] Hernández R.A., Jiménez W.G., Galindo J.I. Comportamiento epidemiológico de la malaria en la costa pacífica del departamento de Nariño, Colombia, 2003-2017. *Cienc. Salud*. Rev. 18 [3]: (2020) 1-15.
- [26] Sana A., Naheda A., Raza A., Khan W. A micro- epidemiological report on the unstable transmission of malaria in Aligarh, India. *Parasite Epidemiology and Control Rev*. 27:11 (2020) e00161
- [27] Fletcher I.K., Grillet M.E., Moreno J.E., Drakeley C., Hernández J., Jones K., Lowe R. Synergies between environmental

- degradation and climate variation on malaria re-emergence in southern Venezuela: a spatiotemporal modelling study. *Lancet Planet Health Rev.* 6: (2022) e739–48.
- [28] Carmona J., Olivera M.J., Yasnot M.F. A Retrospective Review on Severe Malaria in Colombia, 2007–2020. *Heliyon* 6 (2020) e03964.
- [29] Restrepo., A. Conocimientos, prácticas y actitudes sobre la malaria en el municipio de Lloró, Chocó, Colombia. *Archivos de Medicina Rev.* 19 [2]: (2019) 291-302.
- [30] Galindo J.I., Hernández R.A., Jiménez W.G. Comportamiento epidemiológico de la malaria en la costa pacífica del departamento de Nariño, Colombia, 2003-2017. *Cienc. Salud Rev.* Vol. 18 [3]: (2020) 1-15
- [31] Knudson A. Perfil clínico y parasitológico de la malaria por *Plasmodium falciparum* y *Plasmodium vivax* no complicada en Córdoba, Colombia. *Fac. Med. Rev.* 63(4) (2015)
- [32] Wängdahl A., Tafesse R., Eliasson I., Broumou I., Farooq F., Lind F., Vashchuk G., Hildell A., Franson S., Hallberg E., Grip I., Nordling I., Gervin A., Kaitoly S., Tekleab B., Wyss K., R., A., Hertting O., Färnerta A. Malaria parasite prevalence in Sub-Saharan African migrants screened in Sweden: a cross-sectional study. *The Lancet Regional Health – Europe Rev.* 2023.
- [33] Trojáněk M., Grebenyuk V., Richterová L., Zicklerová I., Nohýnková E., Mandáková Z., Kantor J., Roháčová H., Stejskal F. Epidemiology and clinical features of imported malaria: a 14-year retrospective single-centre descriptive study in Prague, Czech Republic. *Malaria Journal Rev.* 21 (2022) 257.
- [34] Rodríguez A.J., Jiménez C.E., Herrera A.C., Medina A., Martínez J.W. Patrones de comportamiento de la malaria en el departamento de Risaralda, Colombia, 2007-2009. *Médica de Risaralda Rev.* 18 [1]. (2012).
- [35] Chaparro P.E., Lopez M., Rengifo L.M., Padilla J., Herrera S., Arévalo M. Clinical and epidemiological aspects of complicated malaria in Colombia, 2007– 2013. *Malar J Rev.* 15 (2016) 269.
- [36] Khan Y.M., Nadir S., Parveen S., Khan R.A. Prevalence of human malaria parasite and its effects on patient blood chemistry in Pakistani population. *Journal of pharmacy research Rev.* 6(5) (2013) 522–524.
- [37] Iza S.N., Iza J.A., Padilla J.C., Olivera M.J. Malaria mortality in Colombia from 2009 to 2018: a descriptive study. *Journal of the Brazilian Society of Tropical Medicine Rev.* Vol.:54: (2021) [e0441-2020].