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BRIEF COMMUNICATION

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Epidemiological profile of imported malaria cases in Colombia

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Abstract

Despite the significant progress made in reducing morbidity and mortality in recent years, malaria remains a critical global health challenge. In Colombia, we are working towards eliminating malaria to achieve zero indigenous cases of human malaria. In this effort, it is also essential to understand the epidemiological profile of imported cases. This study aimed to determine the epidemiological situation of imported malaria cases in Colombia from 2007 to 2020. An observational, descriptive, and retrospective study used secondary sources for data analysis. A total of 7,583 imported malaria cases (0.8% of total burden) were recorded. 85% (6,507/7,583) were caused by *Plasmodium vivax*, and 89% (6,772/7,583) were imported from Venezuela. Imported malaria trend varied, contributing minimally to the national burden. Venezuela was identified as the main source of imported cases. These findings will contribute to improving disease surveillance and preventing the reintroduction of malaria in areas undergoing elimination.

Key word: malaria, cases, imported, Colombia, *Plasmodium vivax*.

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Introduction

According to the World Health Organization (WHO), it is estimated that, in the year 2022, there were approximately 249 million cases of malaria worldwide, resulting in 608,000 deaths. Approximately 95% of all malaria cases were recorded in Africa. According to this information, the situation on this continent remains precarious because the disease burden is unacceptably high, and the convergence of threats poses an additional challenge to disease control and elimination efforts (1).

A malaria endemicity of 1.5 million to 0.6 million was observed between 2000 and 2021. However, most of the burden was concentrated in Brazil, Venezuela, and Colombia. On the other hand, countries such as Argentina, Paraguay and El Salvador have been certified as malaria-free. In other nonendemic countries, between 2013 and 2017, 11,466 imported cases of malaria from endemic countries were recorded in the United States (76%) and Canada (19%). The largest number of diagnosed infections was caused by *Plasmodium falciparum* in men aged 26 to 50 years who had been to Africa (2). In the last decade in Colombia, there has been a 40% reduction in endemic malaria compared to the previous decade (3).

Due to the social and economic burden that malaria imposes on society and the health system in tropical countries, malaria has historically been considered a priority public health problem (4). In 2019, considered an epidemic year in Colombia, total costs attributable to malaria were estimated at US$2.1 million. The average costs for uncomplicated malaria care varied by parasite species: US$17.3 for *Plasmodium vivax* infections, US$17.5 for *P. falciparum*, and US$22.5 for mixed infections. On the other hand, the average cost of complicated malaria care was US$ 593.75 (5).

The antimalarial initiatives designed and implemented at different times have had as their objective the prevention, control, and eradication of the transmission of the disease and have yielded variable results (4).

Currently, following the "Global Technical Strategy against Malaria 2016-2030", the objective of eliminating the transmission of this parasitosis has been resumed. Most

endemic countries in the region have implemented this initiative (6). The WHO recommends that countries approaching elimination or directing their efforts to prevent the re-establishment of malaria transmission stratify their receptive geographic units according to the risk of malaria transmission, intensify active surveillance and control detected cases in a timely manner (7). However, although indigenous transmission contributes to almost the entire cumulative case burden, imported malaria from neighboring endemic countries could play a determining role in the reintroduction of transmission and hinder the timely achievement of elimination goals (8). To guarantee the maintenance of these potential achievements and prevent the re-establishment of the disease, active epidemiological surveillance of this event would allow for updated and timely information for making relevant decisions (7).

In this sense, despite the commitment assumed by the country to eliminate malaria by 2035, the collection, systematization, and critical analysis of baseline information on imported malaria is incomplete and underutilized. Additionally, few studies have focused on understanding the sociodemographic and epidemiological characteristics of the population carrying parasitic strains from other endemic countries.

This aspect has had little relevance in the adaptation of the elimination initiative at the national, cross-border and regional levels. This study aimed to determine the epidemiological behavior of malaria imported from endemic countries in the region and other continents into Colombia between 2007 and 2020.

Material and Methods

An observational, descriptive, and retrospective study was carried out to determine the epidemiological situation of malaria cases imported from abroad into Colombia from 2007-2020. We follow the recommendations of the Strengthening the Reporting of Observational studies in Epidemiology-STROBE

The data were obtained from the Integrated Information System of the Ministry of Health of Colombia available at https://www.sispro.gov.co/Pages/Home.aspx . The definition of an imported malaria case established by the World Health Organization was adopted, which specifies that it is a confirmed case of malaria where the infection was acquired outside the country. All cases recorded during the study period that met this definition were included. Person, place, and time variables were used. All data were stored in Excel (Microsoft, Redmond, USA) and analyzed using R software version 2.15 (R Development Core Team, R Foundation for Statistical Computing, Vienna, Austria). Absolute frequency indicators were established as total cases and by parasite species, and relative frequencies were established as proportions. Measures of central tendency were calculated, such as the average number of cases per year and per decade, the mean, median, and measures of dispersion, such as maximum, minimum, and standard deviation values. An epidemiological map was constructed using ArcGIS version 10.5 (ESRI, Redlands, CA).

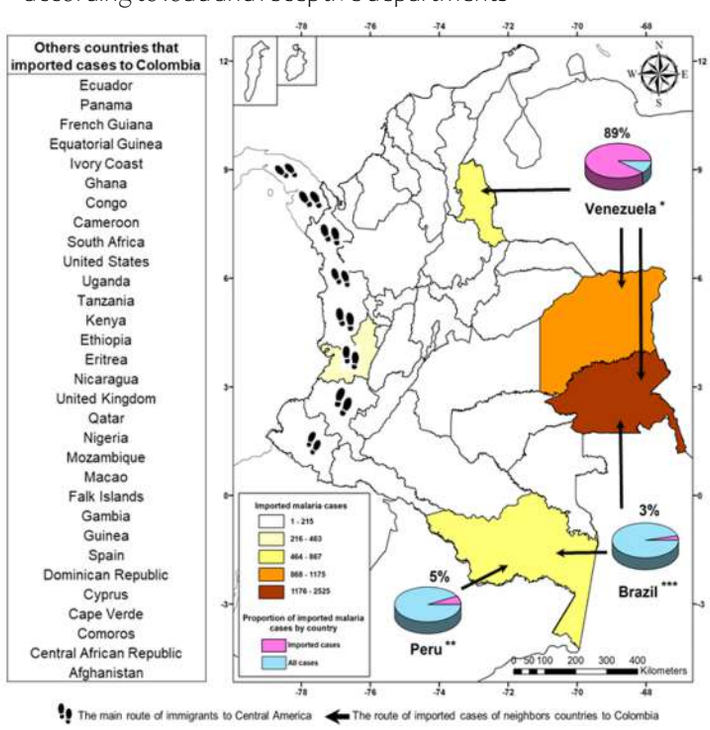
The present study complied with the ethical requirements established in Resolution 8430 of 1993 of the Ministry of Health of Colombia, Article 11, which establishes that studies such as the present are risk-free and do not require approval from an Ethics Committee. The confidentiality and anonymity of the data were guaranteed.

Results

From 2007-2020, 7,583 imported cases of malaria were recorded from different endemic countries and other continents, with an average of 542 cases per year. The proportion of imported malaria cases during this time was 0.8% (median: 0.4% [2.9%-0.1%]). The years that reported the highest proportion of cases were 2017 (2.3%), 2018 (2.9%) and 2019 (2.8%). Eighty-five percent (6,507/7,583) of the cases were diagnosed with *P. vivax*.

A total of 34 countries from four continents contributed to this case study. There were seventeen countries in Africa (38 cases), eleven from America (7,452 cases), three from Asia (3 cases) and three from Europe (3 cases). In the Americas, Venezuela contributed 89% (6,772/7,583) of cases, followed by Peru with 5% (373/7,583) (**Figure 1, Table 1**).

Figure 1: Distribution of malaria cases imported from abroad according to load and receptive departments



The main Colombian departments that received cases were Guainía with 33.3% (2,525 cases), Vichada with 15.5% (1,175 cases), Norte de Santander with 9.4% (712 cases), Amazonas with 6.1% (464 cases), and Valle del Cauca with 2.8% (216 cases). However, cases were registered in all departments of the country (**Figure 1**).

Table 1: Malaria cases imported into Colombia per year by parasite species, age group and country of origin, 2007-2020

Year	Imported cases		*Plasmodium* ***vivax*** [a]		Age group 15-44 [b]		Country							
							Venezuela [c]		Peru		Brazil		Others	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2007	37	0.03	30	81.1	24	64.9	21	56.8	6	16.2	4	10.8	6	16.2
2008	60	0.1	52	86.7	34	56.7	44	73.3	1	1.7	9	15	6	10
2009	109	0.14	102	93.6	72	66.1	51	46.8	38	34.9	13	11.9	7	6.4
2010	66	0.06	56	84.8	58	87.9	40	60.6	1	1.5	16	24.2	9	13.6
2011	84	0.13	56	66.7	54	64.3	26	31	3	3.6	6	7.1	49	58.3
2012	98	0.16	85	86.7	63	64.3	61	62.2	6	6.1	20	20.4	11	11.2
2013	152	0.25	134	88.2	83	54.6	62	40.8	58	38.2	29	19.1	3	2
2014	276	0.68	253	91.7	176	63.8	177	64.1	70	25.4	21	7.6	8	2.9
2015	518	0.99	411	79.3	333	64.3	407	78.6	61	11.8	37	7.1	13	2.5
2016	591	0.71	494	83.6	393	66.5	510	86.3	41	6.9	22	3.7	18	3
2017	1239	2.25	1045	84.3	798	64.4	1176	94.9	25	2	25	2	13	1
2018	1776	3.13	1516	85.4	1223	68.9	1709	96.2	19	1.1	26	1.5	22	1.2
2019	2159	2.75	1916	88.7	1523	70.5	2099	97.2	34	1.6	14	0.6	12	0.6
2020	418	0.51	357	85.4	292	69.9	389	93.1	10	2.4	4	1	15	3.6
Total	**7583**	**1**	**6507**	**86**	**5126**	**68**	**6772**	**89**	**373**	**5**	**246**	**3**	**192**	**3**
Media	**541.6**	**0.8**	**464.8**	**84.7**	**366.1**	**66.2**	**483.7**	**70.1**	**26.6**	**10.9**	**17.6**	**9.4**	**13.7**	**9.5**
SD ±	**689.1**	**1.1**	**600.4**	**6.4**	**478.8**	**7.6**	**682.6**	**21.8**	**24**	**12.9**	**9.9**	**7.8**	**11.4**	**14.9**
Median	**214**	**0.4**	**193.5**	**85.4**	**129.5**	**64.6**	**119.5**	**68.7**	**22**	**4.8**	**18**	**7.4**	**11.5**	**3.3**
Max	**2159**	**3**	**1916**	**94**	**1523**	**88**	**2099**	**97**	**70**	**38**	**37**	**24**	**49**	**58**
Min	**37**	**0**	**30**	**67**	**24**	**55**	**21**	**31**	**1**	**1**	**4**	**1**	**3**	**1**

a. Parasite species in > 86% of cases; b. Age group with > 68% of cases; c. Country with >89% of cases
Source: Table prepared by the authors to show the main results of this study.

The 15-44 age group contributed 68% (5,126/7,583) of the cases registered during the period. A total of 90.2% (5,856/6,495) of *P. vivax* cases and 87.8% (916/1,043) of *P. falciparum* cases came from endemic areas with active transmission in Venezuela (**Table 1**).

Discussion

This study showed that malaria imported from abroad into Colombia has shown a variable trend and intensity. Initially, a low and stable incidence was recorded until the middle of the period, but since the middle of the second half of 2010, there has been a progressive increase. However, in 2020, there was an abrupt interruption due to the Coronavirus disease emergency. Despite this, imported malaria represented less than 1% of the total malaria burden in Colombia.

Economically active population groups from endemic areas of Venezuela have been the main contributors to imported cases and infections, mostly caused by the *P. vivax* parasite. In addition to the departments bordering Venezuela, a wide dispersion of imported cases has been observed in the rest of the Colombian territory. This situation reflects the complex social and economic reality that the country has faced in recent years, as well as the resulting migratory flow (9).

The migrant population seeks job opportunities and a better quality of life in Colombia. The high demand for labor in illegal mining activities and illicit crops in the country has facilitated the linkage of these groups with these economies, which increases their vulnerability and the resurgence and appearance of epidemic outbreaks in areas of low transmission (10,11).

Additionally, a transitory and illegal migratory route of populations from different continents and countries in the region is evident, which is carried out through national border municipalities that are part of the Colombian-Panamanian border. From there, people begin their journey through Central America with the aim of reaching Mexico and the United States. This diversity of populations from endemic countries could introduce carriers with parasite strains different from those prevalent in the receiving areas and to which people are susceptible, which could contribute to the reestablishment and resurgence of epidemic transmission, affecting the elimination goals proposed in the countries (12,13). This was evident in Colombia from 2016-2018, with the appearance of epidemic outbreaks of malaria in receptive areas of low transmission in border municipalities of the eastern and southern departments of the national territory (14).

In Colombia, the implementation of the malaria elimination strategy is underway, but its progress in the target areas is unknown. However, the results of this study revealed and should alert the country's institutional managers about

the importance of detecting, identifying, and understanding the migratory routes of human populations with potential carriers of parasites of different origin. Furthermore, it is crucial to detect *P. falciparum* strains with deletions of the pfhrp2 gene in a timely manner and the presence of resistance markers to antimalarial drugs. It is essential to understand the implications of this in plans for malaria elimination in Colombia and Central American countries.

During the development of this study, some limitations were found related to the registration and reliability classification of cases that were entered into the surveillance system, as well as their timely verification and follow-up. These limitations may have affected the quality and accuracy of the data collected, which in turn may have impacted the interpretation of results and decision-making based on the information obtained.

It is recommended that the Ministry of Health and Social Protection and the National Institute of Health of Colombia improve and strengthen the timeliness and reliability of comprehensive surveillance by implementing more specific methods for classifying imported or indigenous infections. This would be achieved through timely and accurate diagnoses, which would allow the necessary control measures to be intensified. Furthermore, it is important to specify microtargeting and understand transmission dynamics to define timely preventive and control measures. These actions will contribute to better management of malaria in Colombia and to the protection of the population's health.

Conclusion

The epidemiological pattern of imported malaria shows a minimal impact on national morbidity, with Venezuela being the primary source of imported cases. It is crucial to take this into account to prevent the potential reintroduction of transmission in areas where malaria has been eliminated and to develop policies that strengthen timely diagnosis and appropriate treatment for this population.

Author Contribution Statement

Julio Cesar Padilla Rodríguez: Conceptualization, Methodology, Software , Writing- Original draft preparation. **Mario J. Olivera**: Conceptualization, Methodology, Software , Writing- Original draft preparation. **Luis Acuña Cantillo**: Conceptualization, Methodology, Visualization, Investigation , Software , Writing- Original draft preparation.

Ethics statement

The authors declare that the present study was conducted under the strictest ethical conditions.

Financial support

None.

Conflict of interest

The authors declare no conflicts of interest.

Availability of data

The datasets generated and /or analyzed during current study available from the corresponding author on reasonable request.

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