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Artículo Original

Scientific Research on Malaria: A Bibliometric Analysis in Latin America, 2011-2020

Investigación científica sobre malaria: un análisis bibliométrico en América Latina, 2011-2020

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RESUMEN

Introducción: La malaria es una enfermedad protozoaria que continúa siendo un grave problema de salud pública en América Latina. El objetivo fue describir la producción científica de malaria en América Latina en el período 2011-2020. **Materiales y métodos**: Estudio bibliométrico. Se realizó una búsqueda sistemática en Scopus, se incluyeron artículos en formato IMRD realizados en humanos con malaria como variable principal, durante el período 2011-2020. **Resultados**: Se encontraron 1731 artículos sobre malaria en Scopus, de los cuales se incluyeron 590 (34,08%) según los criterios de selección. La publicación científica aumentó de 2011 a 2020 en un 147,22%. Se encontró que 415 (70,33%) estudios se publicaron en revistas del primer trimestre y 141 (23,9%) se publicaron en Malaria Journal. Asimismo, 506 (85,76%) estudios fueron redactados en inglés y la entidad de financiación más influyente fue el Conselho Nacional de Desenvolvimento Científico e Tecnológico 117 (11,44%). En 271 (45,93%) estudios, el autor correspondiente tenía afiliación brasileña, y en 53 (8,98%) artículos predominó la Fundação Oswaldo Cruz. En cuanto al diseño, 274 (46,44%) estudios fueron descriptivos, 260 (44,07%) epidemiológicos y 286 (48,47%) se realizaron en personas de la comunidad. Se ha incrementado la producción científica latinoamericana sobre malaria; hay un predominio en las revistas del primer trimestre, siendo Malaria Journal la más importante. La mayoría de los estudios son descriptivos relacionados con la epidemiología. Se requieren esfuerzos para incrementar la producción científica en el resto de países latinoamericanos con alta prevalencia de malaria.

Palabras clave: Bibliométrico, malaria, América latina, artículo de revista, (fuente de origen)

ABSTRACT

Introduction: *Malaria is a protozoan disease that continues to be a serious public health problem in Latin America. The goal was to describe the scientific production of malaria in Latin America during the period 2011-2020.* ***Materials and methods****: Bibliometric study. A systematic search was carried out in Scopus, articles in IMRD format carried out in humans with malaria as the main variable were included, during the period 2011-2020.* ***Results:*** *1731 malaria articles were found in Scopus, of which 590 (34.08%) were included according to the selection criteria. Scientific publication increased from 2011 to 2020 by 147.22%. It was found that 415 (70.33%) studies were published in Q1 journals and 141 (23.9%) published in Malaria Journal. Likewise, 506 (85.76%) studies were written in English language and the most influential funding entity was the Conselho Nacional de Desenvolvimento Científico e Tecnológico 117 (11.44%). In 271 (45.93%) studies, the corresponding author had Brazilian affiliation, and in 53 (8.98%) articles the Fundação Oswaldo Cruz predominated. Regarding the design, 274 (46.44%) studies were descriptive, 260 (44.07%) were epidemiological and 286 (48.47%) were carried out with people from the community. Latin American scientific production on malaria has increased; there is predominance in Q1 journals, with Malaria Journal being the most important. Most of the studies are descriptive related to epidemiology. Efforts are required to increase scientific production in the rest of the Latin American countries with a high prevalence of malaria.*

Keywords: Bibliometrics; Malaria; Latin America; Journal Article (Source: Mesh)

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Introduction

Malaria continues to be a challenging public health problem in the world, not only in endemic countries, but also beginning to represent a medical dilemma in distant countries due to imported cases (Autino *et al.*, 2012). Despite progress to eradicate malaria, in recent years control of the disease has stopped, as reported by the World Health Organization (WHO, 2021). Likewise, the understanding of the disease is limited by the scattered knowledge about the biology of Plasmodium and by the complex relationships between human populations and the multiple species of mosquitoes and parasites (Canavati *et al.*, 2017).

Malaria is one of the main parasitic diseases in Latin America, its eradication requires the identification of knowledge gaps and the continuous development of diagnostic instruments, treatment schemes and cost-effective public health strategies PAHO, 2017), all this can be achieved with the investigation.

Bibliometric studies play a crucial role, since it quantifies scientific activity in a certain field of science; allowing us to make a balance on the scientific evidence (Glänzel, 2003). Likewise, it allows us to identify research areas and knowledge gaps, in order to help define future research and intervention priorities (Kokol *et al.*, 2021).

Due to the above, the aim of this study was to describe the scientific production on Malaria in Latin America, in Scopus, during 2011 to 2020.

Materials and methods

Study design

Observational study, bibliometric type

Source of information

The Scopus database (https://www.scopus.com/home.uri) was used to collect articles published on Malaria in Latin America. The usage of Scopus as a source of information is justified because it is a bibliographic base of abstracts and citations of articles from scientific journals with more than 22.000 titles from 5.000 international publishers, it allows a multidisciplinary vision of science, and specially medicine[7].

The search was conducted on March 4, 2021. The search strategy used for Scopus:

(TITLE ("Plasmodium falciparum" OR "PLASMODIUM vivax" OR "Plasmodium malariae" OR "Plasmodium ovale" OR malaria OR "P. vivax" OR "P. falciparum" OR "p. malariae" OR "P. ovale") OR (KEY ("Plasmodium falciparum" OR "PLASMODIUM vivax" OR "Plasmodium malariae" OR "Plasmodium ovale" OR malaria OR "P. vivax" OR "P. falciparum" OR "p. malariae" OR "P. ovale"))) AND (AFFILCOUNTRY (argentina OR bolivia OR brazil OR chile OR colombia OR "Costa Rica" OR cuba OR ecuador OR "El Salvador" OR guatemala OR haiti OR honduras OR mexico OR mejico OR nicaragua OR panama OR paraguay OR peru OR "Puerto Rico" OR "Dominican Republic" OR uruguay OR venezuela OR "Latin America" OR caribbean)) AND PUBYEAR > 2010 AND PUBYEAR < 2021 AND (LIMIT-TO (SRCTYPE , "j")) AND (EXCLUDE (DOCTYPE , "er"))

Analysis variables

The bibliometric analysis of the scientific production on Malaria in Latin America was evaluated according to the following variables:

1.-Scientific production: quantifies the number of publications of each journal per year.

2.-Editorial characteristics of the journals: scientific journals with the highest production, language and quartile of the journal

3.-Characteristics of the authors: number of authors, institutional affiliation of the corresponding author, country of the corresponding author.

4.-Characteristics of the published articles: type of study, thematic area of the study, funding entity, intervention population.

Data collection

In a first stage, the articles that met the inclusion criteria were collected, which were: articles in IMRD format including systematic reviews and meta-analyzes, human beings as the study population, and malaria as the main variable of the research. The selection process was carried out by four of the authors who previously underwent calibration and concordance tests. In the second phase, the variables of interest were collected from each selected

article. In both phases, the discrepancies were compared by a fifth author, and if discrepancies were found, they were solved by consensus.

Ethical considerations

Due to the nature of the study, the approval of an ethics committee was not required, since the published scientific articles are in the Scopus database, are available and are publicly accessible.

Analysis of data

For the compilation and processing of the data, the software Microsoft Excel v. 2019. Statistical quantification was carried out through the statistical package STATA v 16.0, for the descriptive analysis, percentages and frequency measures, mean scores of the variables were obtained.

Results

590 articles were included, a continuous growth of scientific production is observed, noting in 2020 a greater publication of scientific articles compared to the other years (Figure 1).

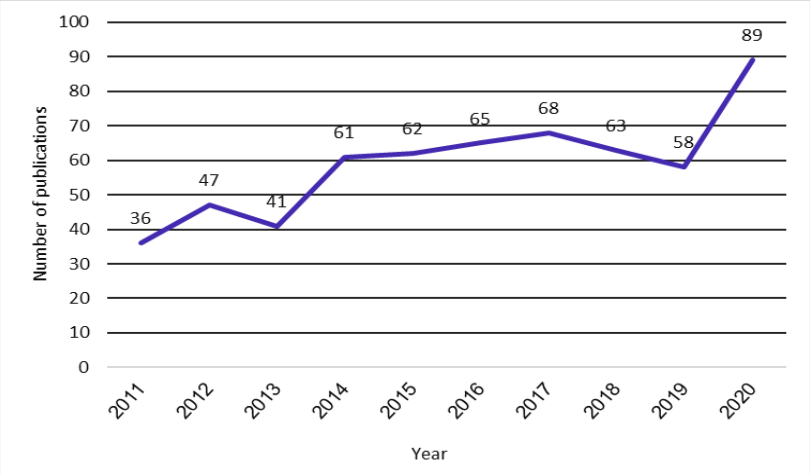

Figure 1. Annual scientific production of articles in IMRD format on malaria in Latin America, from 2011 to 2020 in Scopus

In relation to the production of articles; according to the country of the journal, a predominance of the United Kingdom is observed with 223 (37,79%), followed by the United States 166 (28,13%), Brazil 68 (11,52%), Colombia 33 (5,59%), Netherlands 22 (3,725) (Figure 2).

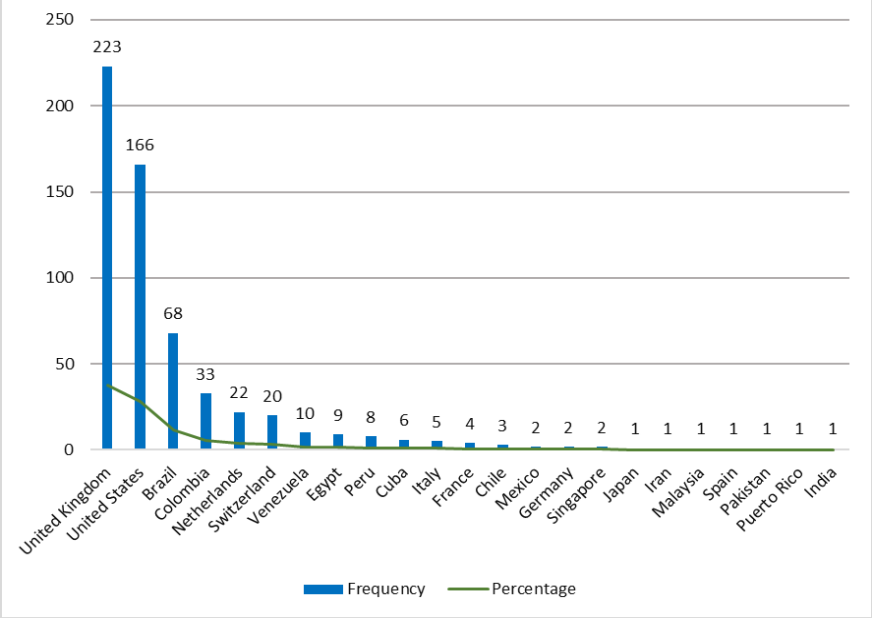

Figure 2. Scientific production according to the country of the magazine of articles in IMRD format on malaria in Latin America, from 2011 to 2020 in Scopus

Regarding the journals with the highest production, a supremacy of Malaria Journal 141 (23.90%) is observed, followed by PloS ONE 48 (8,14%), American Journal of Tropical Medicine and Hygiene 40 (67,7%) and PLoS Neglected Tropical Diseases 35 (5,93%), among the main ones. Most of the articles were written in English with 506 (85,76%), followed by Spanish 60 (10,17%) and Portuguese 21 (3,56%). Likewise, it is observed that the journals classified in Q1 were the most frequent with 415 (70,33%), followed by Q3 with 79 (13,39%), Q2 with 68 (11,53%), and Q4 with 28 (4,75%). In addition, most of the studies were funded 485 (82,20%) and 93 (16,98%) did not report it (Table 1).

Table 1. Editorial characteristics of the articles in IMRD format published on malaria in Latin America, from 2011 to 2020 in Scopus

Journal characteristics		n	%
Top ten scientific journals with the highest production (n=120)			
1.	Malaria Journal	141	23,90
2.	PloS ONE	48	8,14
3.	American Journal of Tropical Medicine and Hygiene	40	6,77
4.	PLoS Neglected Tropical Diseases	35	5,93
5.	Revista da Sociedade Brasileira de Medicina Tropical	20	3,39
6.	Memorias do Instituto Oswaldo Cruz	20	3,39
7.	Biomédica	19	3,20
8.	Acta Tropica	13	2,20
9.	Scientific Reports	10	1,69
10.	Revista Peruana de Medicina Experimental y Salud Publica	8	1,36
Languages			
English		506	85,76
Spanish		60	10,17
Portugues		21	3,56
Other		3	0,51
Quartile			
Q1		415	70,33
Q2		68	11,53
Q3		79	13,39
Q4		28	4,75

Regarding the characteristics of the authors, an average of 9,35 per article was found, the most frequent affiliation of the corresponding author was the Fundação Oswaldo Cruz (Fiocruz) 53 (8,985), followed by the University of Antioquia 42 (7,115), University of Sao Paolo 30 (5,08%), and the Federal University of Pará 20 (3,385), among the main ones. Regarding origin, most of the corresponding authors were from Brazil 271 (45,95%), followed by Colombia 114 (19,32%), the United States 72 (12,20%) and Peru 26 (4,40%) (Table 2).

Table 2. Characteristics of the authors of articles in IMRD format published on malaria in Latin America, from 2011 to 2020 in Scopus

Authors' characteristics		
Numbers of authors		
Media	9,35	
D.S	1,66	
Institutional affiliation of the corresponding author	n	%
Fundação Oswaldo Cruz (Fiocruz)	53	8,98
Universidad de Antioquia	42	7,11
Universidad de Sao Paolo	30	5,08
Universidade Federal do Pará	20	3,38
Universidade Federal de Mato Grosso	16	2,71
Centers for Disease Control and Prevention	16	2,71
Universidad Peruana Cayetano Heredia	14	2,37
Corresponding Author's Country	n	%
Brazil	271	45,93
Colombia	114	19,32
United States	72	12,20
Peru	26	4,40
United Kingdom	15	2,54
Spain	11	1,84
Venezuela	8	1,35
Haití	6	1,02
Honduras	6	1,02
Mexico	5	0,84
Other	56	9,49

After the normalization of the results, a total of 14,146 authors were identified in which it was specified that a many researchers have more than five contributions (703 authors), which represents 0.05% of the total number of producers. The density map reflects the growth of the research community, for the moment, it is still fragmented into 26 clusters, headed by Lacerda MVG, followed by Monteiro WN, Gamboa D, Siqueira AM and Herrera S, among the most important (Figure 3).

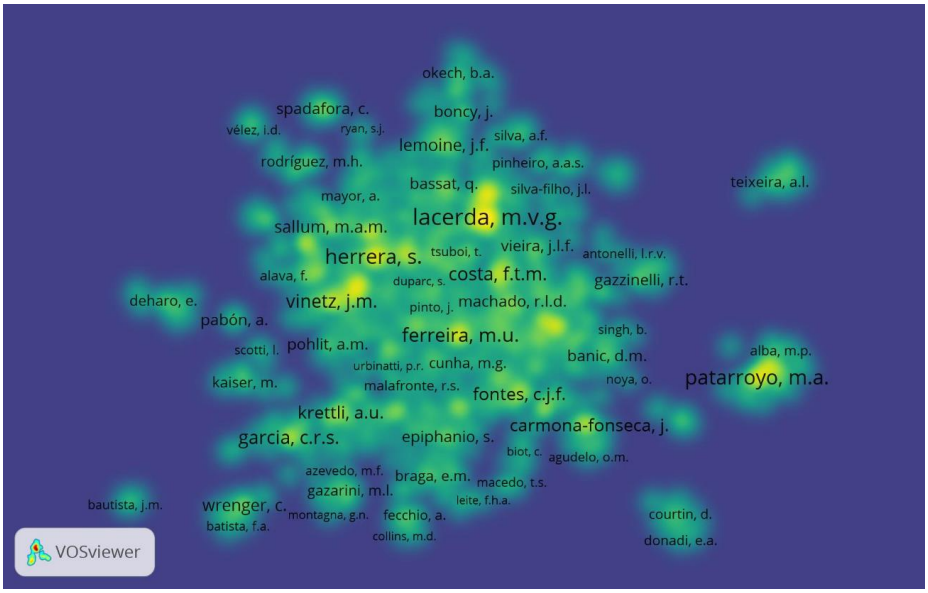

Figure 3. **Density map of the authors of articles in IMRD format published on malaria in Latin America, from 2011 to 2020 in Scopus**

The most frequent type of study was descriptive 274 (46,44%), followed by analytical 216 (36,61%), experimental 65 (11,02%). Regarding the thematic area, the epidemiological type 260 (44,07%) was more frequent, followed by treatment 87 (14,75%), diagnosis 64 (10,85%), clinical 56 (9,49%) and the majority of studies focused on people from the community 286 (48,47%), followed by patients 282 (47,79%). The most influential funding entity was the Conselho Nacional de Desenvolvimento Científico e Tecnológico 117 (11,44%), followed by the National Institutes of Health (NIH) 67 (6,55%), Coordenção de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) 37 (3,62%), among the most important (Table 3).

Table 3. Characteristics of the articles in IMRD format published on Malaria in Latin America during 2011 to 2020 in Scopus

Characteristics of the published articles (n = 590)		n	%
Study Type			
Descriptive		274	46,44
Analitycal		216	36,61
Experimental		65	11,02
Systeman Review and Meta-analysis		21	3,56
Qualitative Study		14	2,37
Thematic area of the study			
Epidemilogy		260	44,07
Clinic		56	9,49
Prevention		39	6,61
Diagnosis		64	10,85
Treatment		87	14,75
Other		84	14,23
Study Population			
Community people		286	48,47
Patients		282	47,79
Does not apply		22	3,74
Top Ten finacial entities			
1.	Conselho Nacional de Desenvolvimento Científico e Tecnológico	117	11,44
2.	National Institutes of Health (NIH)	67	6,55
3.	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)	37	3,62
4.	Universidad de Antioquia	35	3,42
5.	Departamento Administrativo de Ciencia, Tecnología e Innovación (Colciencias)	32	3,13
6.	Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)	32	3,13
7.	Bill & Melinda Gates Foundation	31	3,03
8.	National Institute of Allergy and Infectious Diseases (NIAID)	26	2,54
9.	Fundação Oswaldo Cruz (Fiocruz)	22	2,15
10.	Fogarty International Center	17	1,66

In relation to the ten most cited articles in the Scopus database, it is observed that the article with the highest number of citations was the one written by Murray CJL, *et al.,* In 2014 with the title "Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013" with 612 citations **(**Table 4).

Table 4. Top 10 articles in IMRD format on Malaria in Latin America, from 2011 to 2020 in Scopus

Author, year	Title	Journal	Country	Quartile	SJR 2020	Number of citations
Murray CJL *et al.*, 2014	Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013	Lancet	United States	Q1	13.1	612
Llanos-Cuentas A *et al.*, 2014	Tafenoquine plus chloroquine for the treatment and relapse prevention of Plasmodium vivax malaria (DETECTIVE): A multicentre, double-blind, randomised, phase 2b dose-selection study	Lancet	United States	Q1	13.1	168
Lacerda MVG, *et al.*, 2012	Postmortem characterization of patients with clinical diagnosis of plasmodium vivax malaria: To what extent does this parasite kill?	Clinical Infectious Diseases	United Kigdom	Q1	3.44	127
Brasil P *et al.*, 2017	Outbreak of human malaria caused by Plasmodium simium in the Atlantic Forest in Rio de Janeiro: a molecular epidemiological investigation	Lancet Global Health	United Kigdom	Q1	7.97	77
Lacerda MVG *et al.*, 2019	Single-dose tafenoquine to prevent relapse of plasmodium vivax malaria	New England Journal of Medicine	United States	Q1	19.89	71
Barbosa S *et al.*, 2014	Epidemiology of Disappearing Plasmodium vivax Malaria: A Case Study in Rural Amazonia	PLoS Neglected Tropical Diseases	United States	Q1	1.99	62
Weiss GE *et al.*, 2011	A positive correlation between atypical memory B cells and plasmodium falciparum transmission intensity in cross-sectional studies in Peru and Mali	PloS ONE	United States	Q1	0.99	60
Marques MM *et al.*, 2014	Plasmodium vivax chloroquine resistance and anemia in the western brazilian amazon	Antimicrobial Agents and Chemotherapy	United States	Q1	2.07	56
Lança, EFC *et al.*, 2012	Risk factors and characterization of plasmodium vivax-associated admissions to pediatric intensive care units in the brazilian amazon	PloS ONE	United States	Q1	0.99	52
Antonelli LRV *et al.*, 2014	The CD14+CD16+ Inflammatory Monocyte Subset Displays Increased Mitochondrial Activity and Effector Function During Acute Plasmodium vivax Malaria	PLoS Pathogens	United States	Q1	3.72	50

Discussion

Malaria is a life-threatening disease caused by parasites that are transmitted to humans by the bite of infected mosquitoe (PAHO, 2021); in tropical countries, it is one of the world's largest contributors to death and illness in children and adults (WHO, 2006). Scientific production on malaria has increased over the years; this increase may be due to the fact that malaria was the object of wide attention as a priority global health problem at the beginning of the 21st century (WHO, 2015).

Malaria brings health, economic and social consequences; that is why various national and international institutions have decided to promote research in this field, with the aim of strengthening the capacity for development or optimization of control strategies in endemic countries to be able to curb this infectious disease González-Bacerio *et al.*, 2011).

It was observed that the majority of scientific publications on malaria were published in the Malaria Journal with 141 articles (23.9%). This result was similar to that reported by Mwendera *et al.,* 2017; this could be due to the fact that this journal is important in malaria research in general, as described in a study conducted by Waleed *et al.,* where Malaria Journal had a higher number of citations compared to other journals, in addition to being commonly cited in the majority of active magazines (Sweileh *et al.,* 2016).

Regarding the production according to the country of the journal, the United Kingdom has the vast majority of publications with 223 articles, followed by the United States -this differs from that reported by Garrido-Cárdenas *et al.,* (2019) where the leading country was the United States, followed by the United Kingdom.

In Latin America, the country with the most scientific production was Brazil with 68 articles. This could be possible because it is a tropical country; and also reported a total of 194,370 confirmed cases of malaria in 2017, compared to other countries in the region, such as Peru (55,367 cases / year) and Colombia (54,102 cases / year) (PAHO, 2017).

Regarding the quartile of the journals, there was a predominance of quartile 1 (Q1) with 70.33%. This would be beneficial since the journals have a greater impact and the articles have a greater probability of visibility and influence in their area, resulting in a greater number of citations.

Most of the articles reviewed were written in English. This could be due to the fact that the largest production of articles was carried out by journals belonging to countries such as the United Kingdom and the United States, both journals having English as their native language. According to the report by Di Bitetti and Ferreras, (2017), authors decide to publish in English because they have a greater probability of being cited if they are written in this language and can obtain a greater number of citations than those published in other languages.

Our study found that the Fundação Oswaldo Cruz *was* the institutional affiliation of the most frequent correspondent author, denoting that this institution continues to contribute significantly in the field of malaria research, as confirmed by a worldwide bibliometric analysis, which considers it among the 13 institutions with more than 180 publications on malaria (1916–2018), being one of the only 2 South American institutions in this ranking (Garrido-Cárdenas *et al.*, 2019). It was also found that Brazil is the country of affiliation of the majority of correspondent authors, which is similar to another study on scientific production in Latin America of neglected infectious diseases that includes malaria, where Brazil was observed as the country with the highest number of authors of published articles (Collazo *et al.*, 2016).

A predominance of Brazilian entities was found in our top ten funding institutions, the main ones being the Conselho Nacional de Desenvolvimento Científico e Tecnológico y Coordção de Aperfeiçoamento de Pessoal de *Nível* Superior (CAPES), similar to what was reported in a bibliometric study on publications in Portuguese, where they also make up the top ten (Antunes *et al.*, 2019).. This could be due to the fact that both institutions belong to ministries of the Brazilian government, which have decrees that finance and promote research in their country.

Most of the articles in our study were carried out in Brazil and Colombia, which is similar to that reported by Muñoz-Urbano *et al.*, (2014), where both countries have the highest production of articles in Scopus (1980-2013) with 33,0% and 11,3%, respectively.

Likewise, our study showed that most of the investigations were descriptive and, in less quantity, experimental studies. This could be due to the greater complexity of these studies, in addition to the cost and time involved19. Another aspect to highlight is the higher frequency of epidemiology studies, unlike those reported by 19. Zurita-Cruz *et al.*, (2018),, in which more clinical research stands out. It could be considered that this is due to the fact that in Latin America, malaria is more prevalent and this leads to epidemic growth (Grillet *et al.*, 2021).

The population in which most of the studies were carried out was in the community. This could be due to the thematic area of the articles included, since they focus on epidemiological and public health studies in which factors are evaluated. About risk; strategies for the elimination of the vector, epidemiological characteristics of the regions and populations prevalent in malaria, temporal and spatial associations that generally aim to measure the interaction of the vector with the population and propose measures for its prevention.

The Latin American scientific production on malaria in Scopus has been increasing with more publications in non-Latin American Q1 journals, of which Malaria Journal is the one with the highest number of publications, and articles in English also predominated. As the corresponding author and with Brazilian institutions as their affiliation, there was a significant participation of Brazilian researchers. Most of the studies are descriptive related to epidemiology, and there are few qualitative studies. Efforts are required to increase scientific production in the rest of the Latin American countries with a high prevalence of malaria.

Conflict of interest

The authors declare that they have no conflict of interests.

Thanks

To our Alma Mate /Self-financed.

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