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A Bibliometric Analysis Study of Global Academic Articles on Malaria and Contribution of Türkiye

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Abstract

Objective: Malaria is a parasitic infection that has a significant negative influence on public health around the world, including Türkiye in recent years with the prevalence of imported cases. This study was conducted to provide a bibliometric analysis of publications on malaria in Türkiye and worldwide, and to determine Türkiye's current position in malaria research.

Methods: This study was observational, descriptive, and retrospective designed study and utilized scientometric technique and scientific mapping. The research was conducted in the Web of Science online database. The MESH keywords (malaria OR plasmodium) were used. The title (TI) field and only Science Citation Index Expanded (SCI-E) index was used for the search queries. The following inclusion and exclusion criteria were applied: The studies published after the end of 2022 were excluded and only the articles were chosen according to the document type.

Results: On the basis of the defined search, 31376 articles were extracted from the WoS database indexed in the SCI-E category, for the period 1970-2022. The earliest article was published in 1970 and the most of the articles were published in 2021 (n=1274). There was a growth in publications number since end of the 1970s. A total 469 countries contributed the malaria literature. The United States of America (USA) (32.07%), England (18.56%) and France (9.90%) were the leading countries on the malaria literature according to the published article numbers. Türkiye ranked in 71st. A total of 80 articles were retrieved according to search criteria. The articles were cited 1347 times totally and 17.75 times per article. The mean of H index was 18. The earliest articles were published in 1987. The number of articles limited but since 2005 never dropped below two articles per year.

Conclusion: Scientific production from Türkiye is low. This topic can be improved by increasing both the financial support for and the involvement of researchers in national and international collaborative research projects.

Keywords: Bibliometric Analysis, Malaria, Plasmodium, Publications

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INTRODUCTION

Plasmodium genus protozoa, which are spread by an infected female *Anopheles* mosquito, cause malaria, a potentially fatal parasitic infection (1). People infected with malaria often experience symptoms such as fever, chills and sweating. If left untreated, *Plasmodium falciparum* infection has a bad prognosis and a high fatality rate (2).

According to World Health Organization (WHO) 2021 malaria report**,** mortality decreased consistently worldwide between 2000 and 2019, from 896000 in 2000 to 562000 in 2015 and to 558000 in 2019. A predicted 47000 (68%) of the additional 69000 fatalities from malaria were attributed to service interruptions during the Covid-19 pandemic, which resulted in a 12% increase in mortality from malaria in 2020 compared to 2019. 29 countries accounting for 96 percent of all malaria fatalities globally. Just over half of all malaria deaths worldwide in 2020 were caused by six countries: Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), Mozambique (4%), Angola (3%), and Burkina Faso (3%). In 85 malaria-endemic countries (including French, Guiana), there were an expected 241 million cases of malaria in 2020, up from 227 million in 2019, with most of this rise coming from the WHO African Region. There were 224 million probable malaria cases at the baseline year of 2015 for the Global Technical Strategy for Malaria 2016-2030 (3).

The revised WHO malaria guideline includes updates for intermittent preventive treatment during pregnancy, perennial malaria chemoprevention, formerly known as intermittent preventive treatment in infants, seasonal malaria chemoprevention, and new recommendations for intermittent preventive treatment in school-aged children, postdischarge malaria chemoprevention, and mass drug administration for malaria (4).

The ambitious objective of eliminating malaria by 2040 faces significant obstacles because to the wide variety and complexity of human malarias. *P. falciparum*-specific technologies have been developed with the aim of lowering the high loads of this parasite and the resulting morbidity and death. However, none of these techniques are well adapted to either the specific job of eliminating low-level transmission or dealing with all *Plasmodium* species and associated anopheline vectors, from a practical or technological standpoint. A strategy of attacking the easiest target species first and then moving on to the next has to be reexamined because all malaria species in humans contribute significantly to severe morbidity and death (5). The success in

lowering global mortality from *P. falciparum* malaria should not be sacrificed in favor of a focus on all *Plasmodium* species, but the aim of malaria control does not equal to merely reducing disease burden. All species must be included in malaria control since they can all result in morbidity and mortality (6)

While malaria was a common disease in Türkiye in previous years, indigenous malaria transmission has ended as a result of the successful studies carried out by the Ministry of Health of the Republic of Türkiye. Currently, only international malaria cases are reported. However, malaria cases originating from abroad are seen in Türkiye due to the presence of mosquito species that transmit malaria, climate and environmental factors, large population movements, and an increase in the number of people traveling to and coming from countries where malaria is endemic. Moreover, we continue our activities within the framework of the Malaria Elimination Program, as the risk of malaria still continues due to irregular migrants, our country's location in the subtropical region where malaria can spread, and the increase in average air temperatures due to climate change (7).

This study aims to quantitatively analyze pertinent research using a bibliometric analysis in order to describe the evolution and experience of global malaria literature and make comparisons with Türkiye.

METHODS

Study design

This study was observational, descriptive, and retrospective designed study and utilized scientometric technique and scientific mapping. Since there are no human or animal subjects involved, institutional review board permission is not required.

Data Collection

On August 8, 2023, a comprehensive search was conducted in the WoSCC of the ISI Web of Science (Thomson Reuters, Philadelphia, PA, USA) online database. This database contains articles from high-impact, highest scientific journals from throughout the world.

Terms and retrieval techniques used were as follows: The MESH keywords (malaria * OR *plasmodium**) were used. The title (TI) field and only Science Citation Index Expanded (SCI-E) index was used for the search queries.

The following inclusion and exclusion criteria were applied:

(1) The studies published after the end of 2022 were excluded;
(2) Only SCI-E index was used for the search queries.
(3) Only the articles were chosen according to the document type.
(4) The research areas were restricted only to 6 research areas (parasitology, tropical

medicine, microbiology, infectious diseases, immunology and general internal medicine).

Data Analysis

The journals, the authors and affiliations (institution or organization and country), the years that the articles were published, the citation numbers, the scientific categories, the keywords and automatically generated from the titles of the articles were all obtained using WoSCC.

The descriptive analysis of the publication years, citation counts, scientific categories, first authors, affiliations, nations, and journals was carried out using Microsoft Excel.

Statistical Analysis

The tables and graphs were created using Microsoft Word and Microsoft Excel, respectively. Data visualization was carried out using the VOSviewer 1.6.18 software (Leiden University, Leiden, The Netherlands) was used citation tree rings and lines to create the maps.

RESULTS

General features of the global articles

On the basis of the defined search, 31376 articles were extracted from the WoS database indexed in the SCI-E category, for the period 1970-2022. The earliest article was published in 1970 and the most of the articles were published in 2021 (n=1274). There was a growth in publications number since end of the 1970s (Figure 1). The annual number of publication was obviously related to publication year, and the correlation coefficient R2 reached 0.9466 (Figure 1).

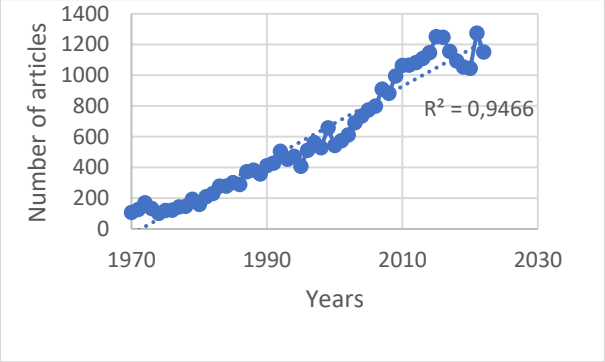

Figure 1. The growing number of the articles over the years.

A total 469 countries contributed the malaria literature. The United States of America (USA) (31.84%), England (18.57%) and France (9.99%) were the leading countries on the malaria literature according to the published article numbers (Figure 2).

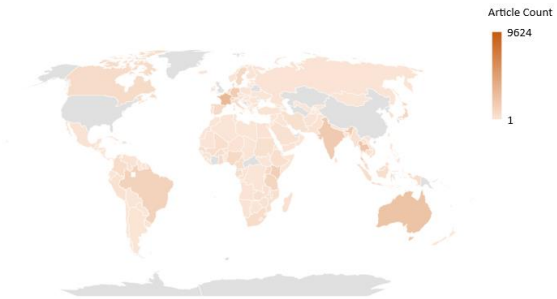

Figure 2. Global malaria research map

The vast majority of articles were from Parasitology, Tropical Medicine and Infectious Diseases research areas (Figure 3).

A total of 12014 affiliations/organisations globally contributed the global malaria research. The affiliations/organisations from England were ranked first in terms of according to the publication numbers (Table 1).

Table 1. Global ranking of affiliations/organisations on malaria research.

Affiliations/organisations	Record Count	% of 31376
University of London	2328	7.42
Udice French Research Universities	2077	6.62
London School of Hygiene Tropical Medicine	2044	6.51
University of Oxford	1841	5.87
Mahidol University	1479	4.71
Universite Paris Cite	1360	4.33
Le Reseau International Des Instituts Pasteur Riip	1252	3.99
National Institutes Of Health Nih Usa	1236	3.94
United States Department Of Defense	1232	3.93
Centers For Disease Control Prevention Usa	1214	3.87
University Of California System	1037	3.31
Walter Reed Army Institute Of Research Wrair	1019	3.25
Nih National Institute Of Allergy Infectious Diseases Niaid	997	3.18
Kenya Medical Research Institute	981	3.13
United States Army	960	3.06
Institut De Recherche Pour Le Developpement Ird	920	2.93
World Health Organization	867	2.76
Centre National De La Recherche Scientifique Cnrs	814	2.59
Institut National De La Sante Et De La Recherche Medicale Inserm	806	2.57
Minist HLTH	801	2.55
Institut Pasteur Paris	786	2.51
University Of Basel	748	2.38
Liverpool School Of Tropical Medicine	738	2.35
Swiss Tropical Public Health Institute	721	2.30
Indian Council Of Medical Research ICMR	700	2.23

*Showing 25 out of 12014 entries

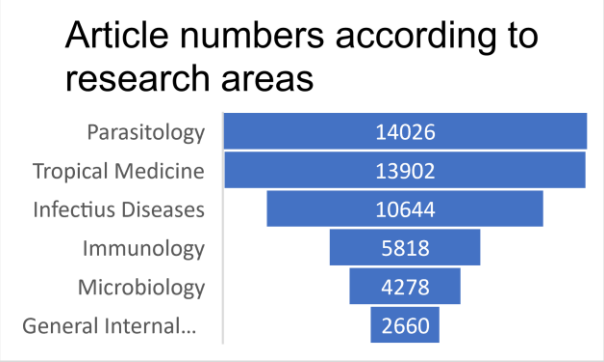

Figure 3. The summary of the article numbers according to research areas

General features of the articles from Türkiye

A total of 80 articles were retrieved according to search criteria. The articles were cited 1347 times totally and 17.75 times per article. The mean of H index was 18. The earliest articles were published in 1987 (8,9). The number of articles limited but since 2005 never dropped below two articles per year (Figure 4). The most of the articles were published in 2022 (n=9). Only 0.25% of the publications on malaria were made in Türkiye. Türkiye was ranking 71st place according to article numbers on malaria research in parasitology, tropical medicine, microbiology, infectious diseases, immunology and general internal medicine research areas (Table 2).

Harran University (18.75%), Erciyes University (10%) and Cukurova University (8.75%) were made the greatest contrubitions from Türkiye, according to search criteria (Table 3).

A total funding agency sponsored the Türkiye's publications on malaria (Table 4). Although funding agencies from different countries sponsored, the most sponsored funding agencies was the Scientific and Technological Research Council of Türkiye (TUBİTAK).

Table 2. Top 10 countries and Türkiye's place in the rankingon malaria research in parasitology, tropical medicine, microbiology, infectious diseases, immunology and general internal medicine research areas**.**

Ranking	Countries/Regions	Record Count	% of 31376
1	USA	10061	32.07
2	England	5824	18.56
3	France	3106	9.90
4	Australia	2362	7.53
5	Thailand	2112	6.73
6	India	1908	6.08
7	Switzerland	1883	6.00
8	Germany	1745	5.56
9	Kenya	1599	5.10
10	Netherlands	1516	4.83
71*	Türkiye	80	0.25

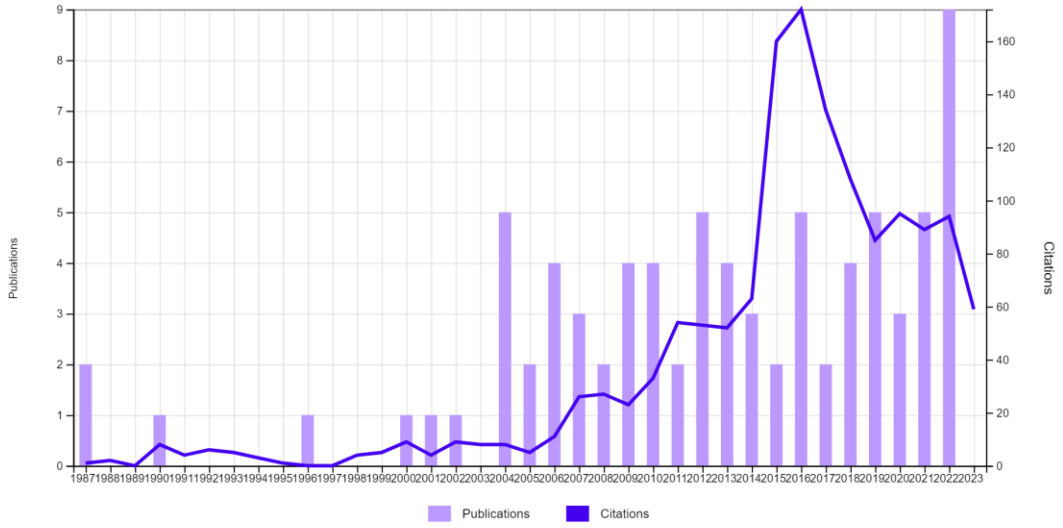

Figure 4. Number of articles and citations from Türkiye over the years.

Table 3. The ranking of affiliations/organisations on malaria research from Türkiye in selected research areas.

Affiliatons	Record Count	% of 80
Harran University	15	18.75
Erciyes University	8	10.00
Cukurova University	7	8.75
Ege University	7	8.75
Bezmialem Vakıf University	6	7.50
Celal Bayar University	5	6.25
Gülhane Military Medical Academy	5	6.25
Hacettepe University	5	6.25
Osaka University	5	6.25
Mersin University	4	5.00

*Showing 10 out of 200 entries

Table 4. The leading funding agencies of Türkiye's publications.

Funding Agencies	Record Count	% of 80
TUBİTAK	8	10.00
National Institutes of Health NIH USA	4	5.00
United States Department of Health Human Services	4	5.00
European Commission	3	3.75
Hitit University	2	2.50
Japan Society for the Promotion of Science	2	2.50
Ministry of Education Culture Sports Science and Technology Japan Mext	2	2.50
Ministry of Health Labour and Welfare Japan	2	2.50
National Natural Science Foundation of China	2	2.50
Near East University	2	2.50

*Showing 10 out of 51 entries

Mapping for article from Türkiye

In the publications made in Türkiye, cooperation has been made with authors from 17 different countries, mainly USA, Japan, China and Sweden (Figure 5).

262 researchers took part in the publications made in Türkiye, and Zeyrek FY (5 articles) were included in the publications at most. In the publications, it is seen that the cooperation between the authors is low (Figure 6).

The first five keywords used in publications in Türkiye were Malaria, *Plasmodium vivax*, Türkiye, *Plasmodium falciparum*, Nested-PCR (Figure 7).

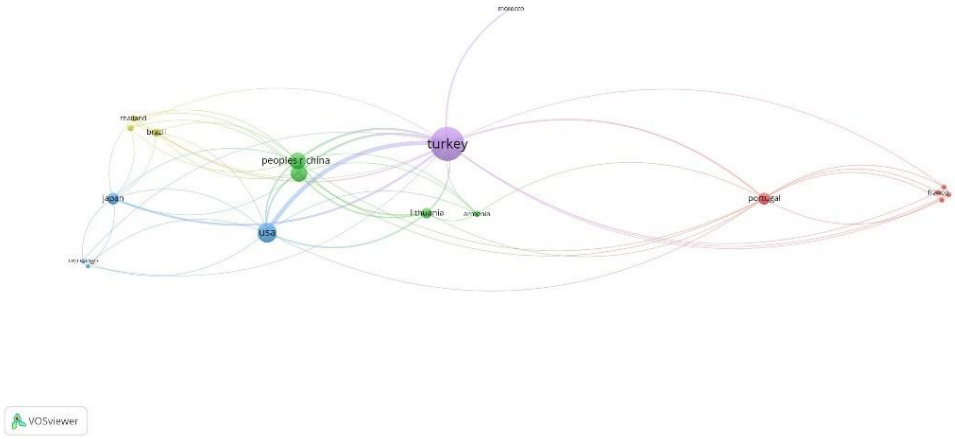

Figure 5: Collaboration map of authors from different countries involved in publications in Türkiye

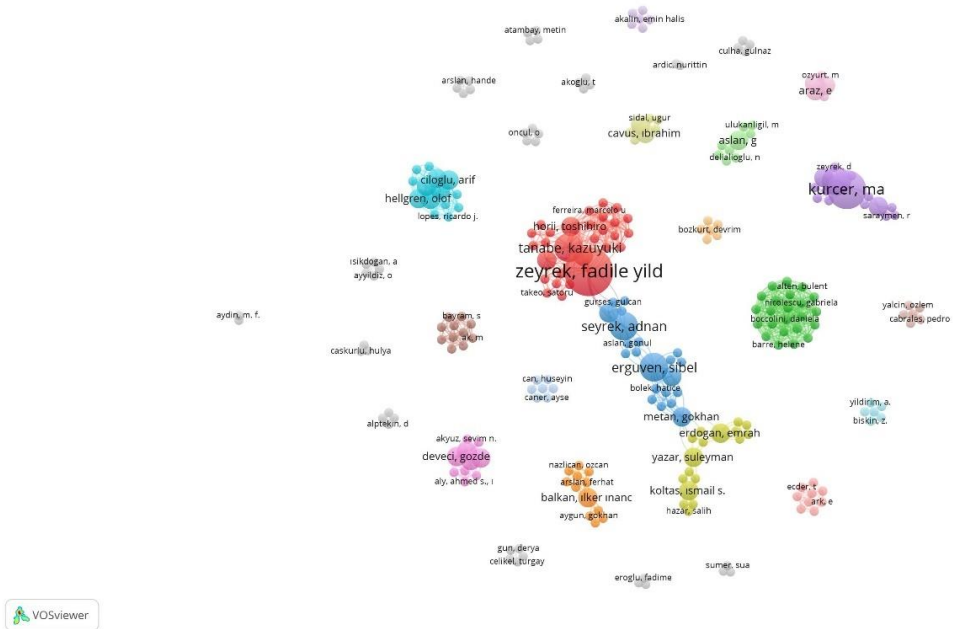

Figure 6. Collaboration map of authors in publications in Türkiye

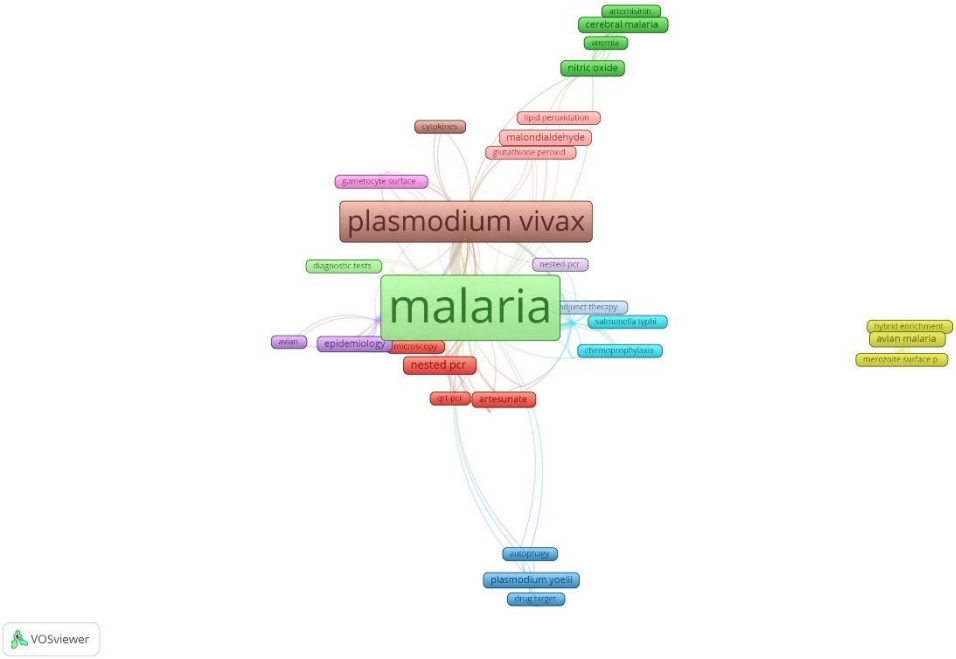

Figure 7. Map of keywords used in publications made in Türkiye

DISCUSSION

There have been a few bibliometric analyses of studies on malaria (10-16), but there is no similar study making a comparison with Türkiye. Studies conducted in the past, in particular on an analysis of global funding provided by research agencies for carrying out malaria research by different countries at different intervals of time, reveal that the country's research output and its quality heavily depend on the funds provided for research purposes (17, 18). This study aims to quantitatively analyze pertinent research using a bibliometric analysis in order to describe the evolution and experience of global malaria literature and make comparisons with Türkiye.

Even though the majority of prior studies (10-16) used databases like PubMed (web edition), MEDLINE, Scopus databeses etc. to analyze the global output of research on malaria in terms of disease burden, subfields of research, malaria vaccines, the amount and type of research conducted in developed and developing countries, the distribution of articles in journals, etc. We preferred WoS database and selected research areas.

Malaria has been an important health problem throughout history and has caused great harm to mankind, possibly leading to the destruction of many civilisations (19, 20). Today it is one of the world's major health problems. Throughout the world, public and private organisations interested in human health are prioritising studies on malaria. As a result, the number of studies on malaria is increasing, as is the number of publications on malaria in scientific

journals (21). With this study, it was understood that the increase in the number of publications was linear and the most publications were made in 2021. This result shows that malaria is still current worldwide and is still a serious health problem for humanity.

Malaria cases are mostly observed in some countries in Africa and Asia (22). In this study, however, it was understood that the USA and European countries were the countries that carried out the most studies on malaria. These countries are home to many international public and private organisations working to eradicate malaria. In addition, public and private organisations in these countries cooperate technologically, scientifically and politically to combat the disease (21). The efforts made in these countries in the past and present have not been without success. The global fight against malaria began in 1955 with a programme to eradicate mosquitoes using DDT. The programme covered the United States, southern Europe, the Caribbean and malaria-endemic areas of South Asia, but only three African countries (South Africa, Zimbabwe and Swaziland) were part of the programme. In 1975, the WHO announced that malaria had been eradicated from Europe and that all recorded cases were due to migration. After that year, malaria cases in Europe were linked to travel and migrants from endemic areas. Although the potential for the spread of malaria in Europe is very low, especially in the western and northern parts of the country, awareness of the disease needs to be raised and public health needs to be maintained at a high level to prevent the possibility of transmission to Europe (22). In addition, the fight against malaria in endemic areas should continue. The US and European countries are at the forefront of malaria research because of this awareness.

Malaria has been an epidemic in Anatolia throughout history and played a major role in the collapse of many ancient civilisations on the Aegean and Mediterranean coasts. Malaria continued to be a public health problem during the Ottoman Empire (23, 24). During the Balkan War and the First World War, almost three quarters of the population were reported to have malaria (25). The Ottoman Army suffered the most from malaria among many other factors during the First World War (24). During the War of Independence, due to the prevalence of malaria, the crops in the fields could not be harvested and flour or bread could not be sent to the soldiers fighting at the front. Immediately after the proclamation of the Republic (1924), anti-malaria programmes were prepared and the legal, organisational and material requirements necessary for the effective implementation of this programme were fulfilled. There were three major epidemics in Türkiye after the proclamation of the Republic. The first was between 1929 and 1944. During this period, the number of registered cases reached its peak in 1932 with

72500. After this year, the increase in the number of cases stopped and even started to decrease. However, a second epidemic began in 1939, the start of the Second World War, and the number of registered cases rose to 146000 in 1942. It was not until 1947 that this epidemic was brought under control. After that year and until 1975, the number of cases remained low and relatively stable (23). Past outbreaks show that even though malaria is under control in Türkiye, there is a potential for new outbreaks to occur. In Türkiye, an average of 200-250 cases of malaria of foreign origin are reported each year. On average, 1-4 people die each year from *P. falciparum* malaria of foreign origin. Most foreign cases acquire the parasite from African countries where malaria is endemic, such as Sudan, Nigeria, Equatorial Guinea, Uganda, Gabon and Ghana. *P. vivax* infections, which account for about 20 per cent of foreign malaria cases, are mostly acquired in countries such as Iran, Pakistan and Afghanistan (26). Türkiye has achieved a 99% reduction in malaria, from 11,381 cases in 2000 to nine relapses in 2010, thanks to its effective malaria control programme (27). There have been no locally acquired cases reported in Türkiye since 2010, but a locally acquired malaria case was reported in a patient with leukemia in 2023 (28).

This study shows that at least two studies per year have been conducted in Türkiye since 2005, and Türkiye ranks 71st in the world in this area. Harran University was identified as the university where the most studies were conducted. Migration from malaria endemic regions, the disappearance of physical borders between urban and rural areas, global climate change, the construction of many dams and the transition to irrigated agriculture, and the resistance of mosquitoes to insecticides and of the parasite to antimalarial drugs are increasing the possibility of malaria epidemics every day. For this reason, Türkiye should increase malaria awareness and continue to work on malaria in order not to lose the gains made in the fight against malaria in the past.

CONCLUSION

In conclusion, to enhance the impact of malaria research in Türkiye, it is advisable to promote national collaboration between basic research and clinical research institutes. This can be achieved through increased financial support from funding agencies for national collaborative research projects and fostering extensive international collaboration.

Limitations

This research has several limitations. It was not feasible to read all of the published articles in their entirety in order to offer further details. The options provided by database applications also place restrictions on the types of factors that may be examined in bibliometric research. Future research may examine other databases besides Thomson Reuters Web of Science. The

amount of citations and publication frequency in trachoma may be impacted by the fact that the present study only utilized one database search (WoS). We restricted the scope of our investigation by excluding non-English literature and papers that were not included in the WoS database. The documents other than search criteria were not included in the study and we did not make content analysis.

Ethics Committee Approval: The study complied with the Helsinki Declaration, which was revised in 2013. Ethics committee approval is not required as there is no human or animal research

Peer-review: Externally peer-reviewed

Author Contributions: Concept: SA, AE, HD, Design: SA, SA, Data Collection and Processing: SA, SA, AE; HD, Analysis and Interpretation: SA, SA, AE; HD, Writing: HD, SA, SA

Conflict of Interest: The author declared no conflict of interest.

Financial Disclosure: The authors declared that this study has not received no financial support.

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