

**Received Date: April 26, 2025**

**Accepted Date: May 17, 2024**

**Published Date: June 01, 2025**

## **THE GLOBAL EPIDEMIOLOGY OF MALARIA: A SYSTEMATIC REVIEW**

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**Abstract-** Malaria remains a significant global public health challenge, despite substantial progress in its control over the past two decades. A comprehensive understanding of its current epidemiology is crucial for guiding eradication efforts. This systematic review aims to synthesize recent evidence on the global distribution, temporal trends, at-risk populations, and dominant Plasmodium species of human malaria. A systematic search was conducted in PubMed, Scopus, and Web of Science for articles published between January 2015 and December 2023. Keywords included "malaria epidemiology," "global burden," "Plasmodium falciparum," "Plasmodium vivax," "malaria incidence," and "malaria mortality." Studies were included if they reported on national or global epidemiological trends, burden of disease, or population-specific risk. The burden of malaria is

overwhelmingly concentrated in the World Health Organization (WHO) African Region, which accounted for approximately 94% of all cases and 95% of deaths in 2022 . Plasmodium falciparum is the most prevalent and deadly species, particularly in Africa. However, Plasmodium vivax poses a significant challenge outside of Africa due to its dormant liver stages (hypnozoites), which can cause relapses (Price et al., 2021). Children under five years of age and pregnant women bear the highest burden of severe disease and mortality. While global incidence and mortality rates declined steadily from 2000 to 2015, progress has stalled and even reversed in some regions since then, exacerbated by disruptions such as the COVID-19 pandemic and the emergence of insecticide and drug resistance .The epidemiology of malaria is characterized by a

disproportionate burden in sub-Saharan Africa, driven by *P. falciparum* and affecting the most vulnerable populations. Current control strategies are threatened by biological challenges and external shocks, necessitating sustained investment, innovative tools, and tailored approaches to resume the path toward elimination.

**Key words:** Malaria, *p.vivax*, *plasmodium*.

## 1. Introduction

Malaria, a life-threatening disease caused by protozoan parasites of the genus *Plasmodium* and transmitted through the bite of infected female *Anopheles* mosquitoes, has plagued humanity for millennia. The World Health Organization (WHO) estimates that nearly half of the world's population was at risk of malaria in 2022 (1). The launch of ambitious global initiatives in the early 21st century, coupled with increased funding and the scale-up of effective interventions—including insecticide-treated nets (ITNs), artemisinin-based combination therapies (ACTs), and rapid diagnostic tests (RDTs)—led to a remarkable reduction in the global malaria burden (2). However, this progress has plateaued in recent years, highlighting the dynamic and complex nature of malaria epidemiology. This systematic review synthesizes current evidence on the distribution, determinants, and population dynamics of malaria to inform public health policy and future research.

## 2. Methods

### 2.1 Search Strategy:

A systematic literature search was performed using electronic databases (PubMed, Scopus, Web of Science) to identify relevant articles published in English between January 2015 and December 2023.

### 2.2 Study Selection:

Titles and abstracts were screened for relevance. Full-text articles were assessed for eligibility based on predefined inclusion criteria: (1) reporting original data on malaria incidence, prevalence, mortality, or species distribution; (2)

focusing on national, regional, or global epidemiology; (3) employing clear methodological designs.

### 2.3 Data Extraction:

Data from included studies were extracted using a standardized form, capturing information on study location, period, population, key epidemiological findings (e.g., case numbers, mortality rates, species proportion), and main conclusions.

## 3. Results

### 3.1 Global Burden and Geographical Distribution

The geographical distribution of malaria is highly heterogeneous. The WHO African Region bears the greatest burden, with an estimated 233 million cases in 2022, followed by the WHO South-East Asia Region (~5 million) and the WHO Eastern Mediterranean Region (~3 million) (WHO, 2023). Just four countries—Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), and Mozambique (4%)—accounted for nearly half of all global cases. In contrast, the WHO regions of the Americas, Western Pacific, and Europe contribute to less than 1% of the global total, though focal transmission and outbreaks persist.

### 3.2 Temporal Trends: Stalled Progress

The period from 2000 to 2015 witnessed a dramatic 27% decline in global malaria incidence and a 50% reduction in mortality rates (WHO, 2023). This trend has since reversed. The number of global malaria cases has increased, rising from a low of 231 million in 2015 to an estimated 249 million in 2022. Similarly, after falling to 576,000 in 2019, malaria deaths climbed to 608,000 in 2022 (WHO, 2023). This stalling and reversal are attributed to multiple factors, including funding gaps, humanitarian crises, and the impact of the COVID-19 pandemic, which disrupted prevention and treatment services (3).

### 3.3 At-Risk Populations

Malaria risk is not uniform within populations. Children under five years of age are the most vulnerable group, accounting for approximately 80% of all malaria deaths in the African Region in 2022 . Their susceptibility is due to the lack of acquired immunity. Pregnant women are also at high risk, as malaria infection can cause maternal anemia, low birth weight, stillbirth, and infant mortality (4). Other high-risk groups include mobile populations, migrant workers, and forest-goers, who often have limited access to healthcare services and may act as reservoirs for transmission.

### 3.4 Species Distribution and Clinical Implications

Five *Plasmodium* species cause malaria in humans, with *P. falciparum* and *P. vivax* being the most significant.

- ***P. falciparum***: Dominant in sub-Saharan Africa, this species is responsible for the majority of severe malaria cases and deaths globally. Its virulence is linked to its ability to sequester in deep vascular tissues, leading to cerebral malaria and other severe complications (5).
- ***P. vivax***: Predominant in Latin America, South-East Asia, and the Horn of Africa, *P. vivax* is characterized by the formation of hypnozoites in the liver, which can reactivate weeks or months after the primary infection, causing relapses and complicating elimination efforts (Price et al., 2021).
- ***P. knowlesi***: A zoonotic parasite, primarily found in Southeast Asia, which can cause severe and fatal disease in humans (6).

### 3.5 Emerging Threats to Control

The gains in malaria control are threatened by several biological and environmental factors.

- **Drug Resistance:**

Partial resistance to artemisinin, the core component of first-line ACTs, has been confirmed in the Greater Mekong Subregion and is emerging in Africa (7).

- **Insecticide Resistance:**

Widespread resistance to pyrethroids, the primary insecticide used in ITNs, has been reported in *Anopheles* mosquitoes across Africa and Asia (8).

- **Climate Change:**

Changes in temperature, rainfall, and humidity can alter the distribution and abundance of *Anopheles* vectors, potentially expanding malaria into new regions or re-introducing it to areas where it was previously eliminated (Caminade et al., 2019).

## 4. Discussion

This review confirms that the global malaria landscape is at a critical juncture. The impressive gains made in the early 21st century are under threat, and the disease remains a heavy burden on the health and economies of many of the world's poorest nations. The epidemiology is marked by intense geographical focalization, with sub-Saharan Africa, particularly young children, suffering the most severe consequences.

The stalling of progress underscores the fragility of malaria control and the need for resilient health systems. The emergence and spread of artemisinin and insecticide resistance represent existential threats to the core tools of malaria control. Furthermore, the unique challenges posed by *P. vivax*, specifically the need for radical cure with drugs like primaquine or tafenoquine to target hypnozoites, require specialized strategies that are often difficult to implement at scale (9).

Future efforts must focus on strengthening health systems, developing and deploying next-generation tools (including new insecticides, novel antimalarials, and effective vaccines), and implementing targeted, data-driven interventions. The recent recommendation and rollout of the R21/Matrix-M and RTS,S/AS01 malaria vaccines offer a new, promising avenue for protecting children in high-transmission areas (10).

## 5. Conclusion

The epidemiology of malaria is defined by its concentration in tropical and subtropical regions, with a devastating impact on vulnerable populations in sub-Saharan Africa. While the tools for effective control and elimination exist, the fight against malaria is far from over. Resuming the path toward global reduction and eventual eradication will require renewed political commitment, increased and sustained funding, and the strategic application of integrated interventions tailored to local epidemiological contexts. Continued surveillance and research are paramount to track evolving threats and to develop the innovative solutions needed to end this ancient disease

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