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RESEARCH INVENTION JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES 5(3):195-202, 2025

©RIJSES Publications

ONLINE ISSN: 1115-618X

PRINT ISSN: 1597-2917

https://doi.org/10.59298/RIJSES/2025/531195202

Narrative Review of Funding Challenges in Malaria Research

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ABSTRACT

Malaria research remains severely underfunded despite its global health significance. This paper examines the evolving landscape of malaria research funding, emphasizing public-private partnerships, innovative financing mechanisms, and the role of technology in mobilizing resources. It examines future directions, including engaging new donors, leveraging mobile and web-based fundraising, and enhancing collaboration among researchers, policymakers, and international organizations. Persistent inequities in funding allocation and challenges in sustaining research efforts are discussed. The study underscores the need for diversified funding streams, stronger regional commitments, and evidence-driven communication strategies to sustain progress toward malaria control and eradication.

Keywords: Malaria Research, Public-Private Partnerships, Innovative Funding Mechanisms, Donor Engagement and Health Policy and Investment.

INTRODUCTION

The fight against malaria the world's most important parasitic disease and a major cause of maternal and child mortality requires continuous and concerted research efforts [1]. The availability of financial support plays a critical role not only in the growth of malaria research as a scientific discipline but also in malaria control and eradication worldwide [2]. A narrative review of funding challenges facing malaria research, together with recommendations for overcoming these challenges and improving the allocation of funds, is presented [1]. Malaria is the most lethal parasitic disease worldwide and a major cause of maternal and child mortality [1]. In 2015, an estimated 3.2 billion people were at risk of infection; 214 million malaria cases were reported in 2015 and 438,000 deaths were attributed to the disease most were children under the age of 5 years. Malaria represents a large-scale burden on families and communities, especially in sub-Saharan Africa [2]. In addition to the public health morbidity burden for affected countries, malaria also represents a hindrance to economic development in malaria-endemic countries [2]. Malaria research is of vital importance to improve the global understanding of the parasite, the disease it causes and the transmission mechanism, to develop new drugs, vaccines, vector control, detection techniques and public health policies, and to provide up-to-date data for modelling of the health-care and economic burden. All of these are crucial for efforts to eliminate malaria altogether and for the sustenance of a malaria-free world [3].

Overview of Malaria Research

Malaria research encompasses a broad spectrum of investigations undertaken in malaria-endemic regions as well as in non-endemic areas, where the disease is predominantly encountered among travelers returning from endemic zones [1]. Since the recognition of Plasmodium falciparum as the protozoan responsible for human malaria in 1880, and following the initial demonstration of malaria transmission in 1898, scientific progress has been substantial [2]. Common research objectives include identifying emerging drug and insecticide resistance, elucidating mechanisms of malaria infection and pathogenesis, and designing effective tools for diagnosis, treatment, control and elimination, with the ultimate humanitarian goal of eradication [13]. Significant advancements have recently been made in understanding the phenotypic spread of resurgent vector populations, evolutionary development of climate-related insecticide resistance, regional variations in resistance patterns,

functional mechanisms underlying resistance, parasite invasion pathways, and the development of new vector control tools [4].

Importance of Funding in Malaria Research

Ongoing malaria research plays a fundamental part in achieving the goal of malaria eradication, yet an increasingly limited funding environment leaves the progress vulnerable to disruption [7]. For example, funding constraints can directly impede the discovery of improved medicines or effective vaccines [3]. Support is required across multiple activities and stages, ranging from basic science to the operation of clinical trials to the implementation of public health initiatives [1]. Funding levels are therefore likely to significantly shape the pace of malaria research and influence the progress that can be achieved [4].

Current Funding Landscape

Malaria research is funded mainly through public resources due to its global health impact but also receives significant private sector support [5]. International organizations and NGOs play a critical role as well [4]. Malaria research examines aspects such as parasite biology and drug resistance, vaccine efficacy, and new drug and insecticide candidates [8]. Funding drives large-scale preclinical and clinical trials needed for regulatory approval and phase IV trials to test absorptive and delivery capacities of nation states. Limited funding creates a bottleneck that slows the development of control and eradication tools [10]. Public funding makes up the majority of the commitment, but the private sector and other entities also help fill the gaps [11]. These funding avenues face intense competition for scarce resources, which can delay progress, reduce the scope of clinical studies, and even halt trials altogether when adequate funding cannot be sourced on time[14].

Public Funding Sources

Sustained adequate funding is pivotal to enabling progress towards comprehensive and lasting malaria control and ultimate eradication [1]. Multiple alternative streams of financial support exist for malaria research, including both public and private resources [3]. As of 2010, official development assistance constituted approximately 60% of health aid, while 37% was derived from non-governmental organizations and foundations. Large-scale, multilateral initiatives such as the Global Alliance for Vaccines and Immunization and the Global Fund to Fight AIDS, Tuberculosis, and Malaria have emerged to augment and concentrate the funding process [1]. Intergovernmental agencies engaged in malaria funding include the US Organisation for Economic Cooperation and Development, the European Commission, the World Bank, and the Asian Development Bank [7]. Individual countries such as the United Kingdom, the Netherlands, and Switzerland maintain dedicated funds for malaria interventions and research. Governmental malaria research institutes also provide substantial financial propane [4]. The World Health Assembly has endorsed a substantial increase in global financial support for malaria control worldwide [5]. Implementation regularly includes a clear financial sustainability and transition plan [8]. Clear coordination exists between current global funding initiatives, although closer coordination and transparency between national, multinational, and private players would yield substantial benefits [3]. A number of agencies and multilateral organizations are responsible for the majority of public investment in malaria research, including the Medical Research Council, Defence Science and Technology Laboratory, and Department for International Development in the United Kingdom, Health Research Council and the Malaghan Institute in New Zealand, the National Institutes of Allergy and Infectious Diseases, Army Research Office, and Bill and Melinda Gates Foundation in the USA, and the European Commission Framework program [7].

Private Sector Contributions

Business enterprises contribute through workforce malaria control by investing in treatment, prophylaxis, or anti-mosquito interventions and by raising employee and community awareness [1]. A study in Ghana found that businesses lose approximately 9% of annual revenue per employee to malaria, underscoring the incentive for private investment in control programs, particularly in highly endemic areas. Initial business expenditure for malaria prevention and treatment in sub-Saharan Africa was estimated at US$12 million in 2005 [5]. Commercial firms fund malaria research within enterprises that sell products such as antimalarial drugs, diagnostics, or insecticides, as part of development efforts that are not readily quantifiable [2]. Malaria funding from mining companies in South Africa has enabled entomological and epidemiological studies on malaria spatiotemporal variation and environmental drivers [6]. Other private-sector enterprises addressing research funding consist of charitable institutions and foundations. Access to new research and products is a strong motivation for business contributions. During 1999–2013, donations and grants accounted for 4–14% of annual funding and 12–17% of approved activities associated with malaria control funding [15].

International Organizations and NGOs

Funding from international organizations and NGOs makes up substantial shares of malaria research investment, demonstrating their importance in the funding landscape [1]. The World Health Organization (WHO) intensifies international research collaboration and applies complex data models to estimate malaria data and trends[13].

The Global Fund to fight AIDS, Tuberculosis and Malaria (Global Fund) reports that donations from foundations and corporations, primarily from the Gates Foundation, make up the majority of funding with financing reaching $4.1 billion [2]. Through their African Malaria Partnership grant scheme that awards around $10 million yearly to malaria research-submitted proposals, the European and Developing Societies Clinical Trials Partnership (EDCTP) establishes multi-country consortia to encourage further public and/or private sector contributions in malaria research [7, 12]. Even with funding abundance from these organizations and NGOs, drastic funding drops experienced since 2008, the need for equitable funding distribution, and calls for political prioritization stimulate the ongoing search for additional funding [8, 14].

Challenges in Securing Funding

Malaria is a life-threatening disease that is transmitted to people through the bites of infected female Anopheles mosquitoes [13]. The impact of malaria is globally distributed, with wide variation in the rates of infection and death. The World Health Organization (WHO) estimated 219 million cases of malaria globally and a death toll of 435,000 in 2017[15]. Plasmodium falciparum accounts for the greatest share of infections and malaria-related deaths across the world, while Plasmodium vivax contributes a large number of malaria infections outside of Sub-Saharan Africa [14]. Malaria is most common in low- and middle-income countries due to a range of health, economic and environmental factors. Effective prevention and treatment of malaria has the potential to avert death, substantially reduce the health burden and contribute to economic growth [11]. The controlled, and eventual eradication of malaria relies heavily on malaria research [13]. Malaria research includes a wide range of activities with the shared goal of controlling and eradicating the disease [9]. Some of the key strands of malaria research are: fundamental science to develop a better understanding of the biology and epidemiology of malaria; research to develop more effective and efficient anti-malarial drugs; studies to better understand drug resistance to these drugs; research of insecticide resistance in the malaria vector; the evaluation of malaria control interventions are only a few areas of work to highlight [8]. Malaria research typically consists of a sequence of activities from basic research and drug discovery, through clinical trials and product development, to health systems and policy research. Funding is vital for each of the strands of malaria research at each stage [13]. Lack of funding can lead to the delay of research projects, which in turn can prevent products from making their way into the market. It can lead to fewer clinical trials being undertaken, a lack of post-marketing surveillance, as well as delay the introduction of research findings into healthcare policy [8]. Impact on funding has been, and on-going, delays progress in the search for better monitoring, treatment and control. Despite the great promise malaria research offers, lack of funding continues to adversely affect research output [1].

Competition for Limited Resources

Securing funding for malaria research presents a formidable challenge due to the intense competition for limited financial resources [2]. Malaria remains one of the most pressing public health threats in tropical developing countries, with 3.3 billion people at risk. Although the number of deaths associated with the disease has gradually decreased over the years, much research is still necessary to advance control and eradication [2]. The World Health Organization places the estimated cost at approximately US $6 billion to scale up malaria control interventions to reach globally agreed-upon targets for 2009–2015, well above the levels currently being received. More than US $2 billion, or double the 2007 current levels, must be invested annually to maintain and increase coverage of malaria interventions [2]. Yet malaria research competes, unsuccessfully, with other avenues of investigation, some of which have less compelling reasons for prioritization [3]. Malaria control efforts lack adequate funding, with the disease's share of international aid continuing to decline over the period from 2000 to 2010[13]. Low- and lower middle-income countries receive the least amount of malaria funding per person at risk and per death[14]. Furthermore, countries in economic and health transitions tend to receive the lowest amount of financing for malaria control [3]. Thus, funding for malaria control is not sufficient in absolute terms and does not meet the principle of vertical equity in many countries which relates to the allocation of resources according to health needs [15]. Competition among artemisinin manufacturers in China and India had stimulated the supply before 2004, but caused shortages in 2004 because anticipated donor fund increases did not materialize [6]. As many monoclonal antibodies target malaria antigens, the successful production of a specific antibody could radically transform the malaria field and shift interest away from the development of a vaccine; however, securing funds to bring such an antibody to clinical trials is a major challenge [4]. Moreover, a major bottleneck in drug development is the capacity to go from discovery to early stage development [10]. Parts of the pharmaceutical industry reluctant to base their activities on a vast array of academic discoveries are usually unwilling to support further research [14]. With public funding restricted and commercial drug companies protective of their means, this bottleneck continues to present a major obstacle towards overcoming the impending resistance to artemisinin derivative[2]. While it is generally recognized that malaria is a major global health issue, it competes with many other diseases for public and private funding [3]. Major financial awards tend to target the most pressing diseases

and take on a competitive and selective aspect, but they do not necessarily reflect the objectives of the scientific community or the current health burden [14]. As a consequence, currently available funding is often insufficient to cover even the essentials to preserve a credible national and international scientific effort [11]. The scientific community must be supported above the winning of individual projects [7].

Economic Factors Affecting Funding

International funding for infectious diseases globally has been declining over the past several decades [1]. At the same time, resources for malaria research and control remain significantly below the level required to meet international development goals [1, 2]. Economic downturns have adversely affected international assistance across multiple sectors, including health. Economic factors complicate decisions concerning the level and allocation of funding for malaria research more broadly [4]. They also influence the extent to which malaria remains a local or global concern. At prevailing income levels, the burden of malaria falls disproportionately on the most poor and vulnerable populations within endemic countries [1]. GDP growth in low-income countries may therefore raise the likelihood of sustained reductions in transmission [5]. In the interim, the costs and benefits of fever treatment and population risks also hold the potential to restrict the willingness or ability to pay for and finance malaria control services, both domestically and through international assistance programmes[6]. Economic factors are therefore likely to have an impact not only on the affordability of research among potential tax payers, but also on people's propensity to support it given competing demands, especially where economic considerations take precedence over public health measures [3].

Political Will and Prioritization

National governments in malaria-endemic countries reallocate funds situated to malaria control and research towards pressing health priorities [7]. Political commitment, competing issues, and insufficient prioritization also limit new donor assistance [8]. Throughout the decade of intensified malaria control, funding sharp increases are plausible only in tragic circumstances, such as HIV/AIDS and the West African Ebola outbreak. The Plateau in funding since 2015 already undermines global malaria investments and could affect future commitments [7].

Impact of Funding Shortages

Long-term commitment from endemic countries and development partners is vital to ensure that malaria financial needs are met and that the required strategies and innovations in drugs, insecticides, diagnostics, and vaccine development continue to be developed [3]. In Asia, obtaining funding for clinical trials is challenging because malaria is a low priority and it is difficult to find financial support to initiate malaria drug development [2]. Delays in research and progress in malaria control caused by financial shortfalls will almost certainly contribute to higher rates of mortality and morbidity [4]. Consequently, sustainable financial support is essential to ensure the continuation of research and development into effective medicines and disease control methods [5].

Delay in Research Progress

Across the world, funds for malaria research have significantly increased over the past few years [1]. Funding is an important component of the global fight against malaria since uninterrupted progress in research tackling epidemiology, pathogenesis, molecular and mechanistic studies; drug and vaccine development depends largely on the timely availability of funds [5]. Despite the increased funding overall, at the individual project level, many malaria research projects may not be sanctioned the required funds after selection and recommendation by the funding agencies which, in turn, causes delays in research progress [5]. Funding for malaria research begins with the preparation and development of a concept which also gets evaluated from a financial planning perspective. Proposals, submitted by research organizations, get scrutinized, and only those meeting all the eligibility criteria proceed to the next stage which ultimately leads to recommendation for funding [4]. Though adequate funding implementation and execution may begin at this stage, the final allocation of funds depends upon the availability of uncommitted funds in the budget of the particular funding agency [4]. The flow of funds also depends on the factors such as the number of proposals sanctioned under the same scheme, the average size of grant, and the balance of funds allocated to ongoing projects awarded in the previous calls or schemes [4]. During the selection process, many good quality proposals may remain under-funded even after the successful completion of all stages and therefore could not be funded and resubmitted to other agencies [8]. Funds available initially for the selected projects are allocated among the institutes proposing the projects only after the approval from the Institute Research and Ethics Committees and other regulatory and statutory committees [10]. In some cases, the funds for research selected and recommended for one project may be re-appropriated for some other activities during the sanction and allocation process resulting in a further loss of individual funding cases. Other systems in place include one-time funding, fellowship, financial provisions for contingent expenditure, instruments and equipment, consumables, travel, contingency and infrastructure for the newly sanctioned projects [9]. However, no provision is made for salary support to either research staff or scientists and officers at the various levels that invariably

results in a staff crunch on the initiation of the project [8]. Timely availability of financial allocation is therefore critical to ensuring steady progress in research projects which would, in turn, lead to continual advances in malaria research. Most of the laboratories engaged in malaria research are study-duration oriented, and any interruptions in the flow of funds may result in the loss of both material and personnel [8].

Limitations on Clinical Trials

Malaria trials in Africa constitute a significant proportion of the global research efforts, though limitations on clinical trials persist as a consequence of funding shortages [13]. The ongoing scarcity of malaria funding delays many research projects, and the current levels of funding prove insufficient to complete the range of necessary studies [9]. Clinical investigations form an essential link in the path from molecular biology to the application of insecticides and drugs; these trials are necessary for the implementation of interventions such as vaccines, antimalarials, and insecticide-treated nets [11]. Despite the existence of projects in the planning stage, health services currently lack sufficient data to incorporate these promising developments into their programmes[10]. Efforts to achieve control and eradication of malaria will rely heavily on progress from these investigations. While some research can be conducted without extensive financial support, most projects, and particularly all clinical trials, depend on adequate funding [15].

Effects on Public Health Initiatives

Ensuring adequate funding is not only pivotal for research activities but also fundamentally influences the efficacy of public health programs [10, 4]. Historical precedents demonstrate that effective control of diseases like smallpox and polio hinged on consistent financial support, without which eradication efforts stagnate and reversals occur. A similar dependency characterizes malaria interventions; successful deployment of tools such as long-lasting insecticide-treated nets (LLINs) demands both upfront and maintenance funding [3]. Restricted resources consequently curtail coverage and dampen the potential impact of control measures. Similarly, the development of emerging vector control products evidenced by a deluge of patent applications cannot translate into public health benefits absent appropriate investment [6]. The resultant slowdown in the cascade from discovery to adoption is particularly detrimental because it reduces preparedness to counter growing insecticide resistance [10].

Case Studies of Successful Funding Models

The remaining funds flow through innovative mechanisms such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM) and the Global Malaria Action Plan (GMAP), both well established in malaria control and elimination [6]. In 2016, the Global Fund launched the "Strategic Framework and Investment Portfolio," a streamlined process focusing on 12 core interventions, including vector control, diagnosis, treatment, health system strengthening, prevention among pregnant women and vulnerable groups, advocacy, and incubation of innovation [6]. The Bill & Melinda Gates Foundation (BMGF) play a pivotal role, contributing $328 million annually, primarily to product development partnerships. Although BMGF funding has plateaued at about $450 million per year since 2011, it remains the third-largest contributor after the United States and the United Kingdom, alongside the World Bank and the United Nations [3]. Public and philanthropic funding mechanisms can be augmented by enticements such as the Orphan Drug Act, Priority Review Vouchers, or avenues for innovative financing [3]. The Coalition for Epidemic Preparedness Innovations (CEPI) exemplifies the power of collective global finance, supporting the development of vaccine candidates against emerging infectious diseases, including the initiation of phase II trials [6]. In December 2019, the WHO announced a new generation of malaria vaccines. This initiative further underscores the evolving landscape of funding models and the importance of sustained investment in malaria research [3].

Partnerships between Public and Private Sectors

Malaria research and development depend critically on funding, but securing adequate resources represents a key challenge [6]. Partnerships between public and private sectors already address these issues [10]. Almost all drugs in the global infectious disease pipeline originate from the private sector [14]. Public-private partnerships complement direct public investment by reducing industry risk and increasing leverage on corporate contributions [11]. Partnerships often involve governments, NGOs, suppliers, distributors, and private companies. A major study emphasized three characteristics of successful partnerships: commitment to a common purpose, clearly defined roles for all stakeholders, and open, frequent communication [13]. The Tanzania National Voucher Scheme (TNVS) exemplifies a public-private partnership model, introducing a subsidized system to increase access to insecticide-treated nets. Analysis highlighted the importance of stakeholder commitment, role clarity, and communication during both pre-implementation and implementation phases [12]. Public-private partnerships thus contribute to addressing the funding gap. Other successful models and innovative mechanisms also merit consideration [10].

Innovative Funding Mechanisms

Innovative funding mechanisms have been developed to bridge gaps in the traditional funding landscape [3]. These mechanisms explore alternative avenues for raising and allocating resources, facilitating increased investment in malaria research [6]. Ideas under consideration include advanced market commitments, impact investment, and social impact bonds, which could offer new sources of funds for malaria initiatives [6]. In addition, philanthropic funding from foundations such as the Bill & Melinda Gates Foundation continues to play a major role in supporting innovative malaria research projects [3].

Future Directions for Funding Malaria Research

Malaria research requires sustained and well-coordinated investment to make strides in control and, eventually, elimination [9]. Funding streams must continue to grow while diversifying, especially in light of economic challenges that limit global contributions [8]. The biggest malaria-endemic populations remain woefully underfunded: most countries spend less than US$1 annually per person at risk, far short of what is needed to make progress. Only about 17% of the Global Fund's approved disbursements go to Asia, home to nearly half the population exposed to the most dangerous parasite species [7]. Yet the tools that currently drive declining transmission cannot do so indefinitely, nor can any single approach dismantle the problem. Operational and implementation interventions then will play a growing role in the years to come, and generating evidence to inform their deployment depends on funding being secured[4]. Technology-driven fundraising mechanisms coupled with targeted communications can engage new donor communities, reinforce existing partnerships, and facilitate catalytic interventions at zero marginal cost to donors [2]. Mobile technologies are used already, as are micro-donations and crowd-sourcing platforms, while social media provides a low-cost medium for engaging new audiences. Strategic communication is arguably the most important element, shaping the story that underpins any appeal, and helping to ensure that messaging is tailored to each new context and audience [5].

Leveraging Technology for Fundraising

Malaria research is constrained by inadequate funding, and fundraising can potentially be enhanced through the application of technology [7]. Fundraising for malaria research is a challenging and highly competitive undertaking, where needs frequently exceed resources [14]. Adoption and application of relevant technologies may provide substantial assistance. Technology-enabled solutions are more efficient and may remove many existing barriers to fundraising. They can dramatically increase the scope of information about malaria research that is accessible to donors, opening up channels for funding [8]. The ability to unearth funds from less traditional sources, such as from social media or web-platforms, is expanding. Technology has an equally important role in the distribution of accumulated funds within the research community [6]. It can be used to quickly and efficiently identify the most relevant and successful research proposals, thereby assisting funding agencies in optimally allocating resources[1]. The availability of resources for malaria research will continue to be insufficient until major breakthroughs occur in the current fundraising model, either on the side of donors or funders [15]. Improvements in fund distribution alone cannot mitigate large-scale deficits. In the absence of such breakthroughs, concepts of malaria research dependent on large upfront financial investments are simply too risky for real-world implementation [12]. Circumstances relating to competing activities suggest that perspectives on malaria research that require very low commitments from investors, but still offer significant potential impact, are more suitable in this environment. Current malaria diagnostics can be very effective, and it may be that the translational gap lies elsewhere [13]. Realigning research focus and fundraising approaches can further support advancements toward malaria control and eradication.

Engaging New Donors

The ongoing lack of therapeutic options and the emerging threat of resistance increase the urgency and the costs associated with finding new solutions [6]. Consequently, attempts should be made to identify new donors and available sources of cash in malaria endemic countries and make maximum use of new technologies and social media to generate the required funds [6]. The decision of the European Union to include malaria research among its priorities for the 2014–2020 periods is an illustration of the benefit of being able to present a compelling argument for financing that is based on the broader impact of malaria [3]. Approaches to increase direct funding from malaria endemic countries may be very difficult to implement in low-income countries where social programs and health systems are already under-funded, but they are probably more reasonable in some middle-income countries [1]. East Asian countries have had significant declines in malaria over the last decade and the expectation is that they will be almost free of the disease by 2020. As malaria becomes more localized, national funds might be used to support local incentives and financiers [1]. For example, parts of rural Yunnan Province where malaria remains a problem are undergoing very rapid social development and the introduction of new financing mechanisms should be a priority. The advantages of "going regional" have been recently acknowledged by the Global Fund with the launch of the Regional Artemisinin Resistance Initiative, which supports cross-border

collaborations in the Greater Mekong Subregion [6]. The rise of the mobile phone and internet technologies provides new opportunities to collect information, increase awareness and mobilize resources [9]. The Malaria Elimination Programme in Mesoamerica and Hispaniola (EMMIE) proposes to create the "Malaria Box," a smartphone application that includes information and generates contributions and micro-payments for malaria research [15]. The major advantage of this approach is that each user is also a potential source of revenues through social networking [3]. While the model can support research in a very specific way, it has the potential to trigger a much more general discussion around preferential tax and trade policies, especially for new markets for agricultural products from endemic countries, e.g., fair trade or organic labeling, micro-credits and other financial incentives [14]. These could be used to support malaria control and elimination activities and encourage the redirection to malaria of national resources whose origins would have remained far from the disease [14]. In summary, the funding challenges faced by malaria research have broader consequences because they directly influence efforts to control, eliminate and eradicate the disease. Securing adequate resources remains a difficult task and innovative approaches should be considered carefully and implemented rapidly [14].

Recommendations for Stakeholders

Growing-group collaboration provides a useful framework for informing efforts to increase funding for malaria research [1]. For public health authorities and policymakers, growing-group collaboration clarifies how intensifying efforts to eliminate and eventually eradicate malaria requires increasing levels of investment in the development of new tools to accelerate the decline of malaria transmission [3]. It also specifies the consequences of inadequate investment in malaria research and development [1]. For scientific investigators, the concept of growing-group collaboration emphasizes the importance of advocating widely for additional funding and support for malaria research [3]. Growing-group collaboration suggests the absence of natural barriers and the presence of a communicative network that extend throughout the malaria-research community and beyond [1]. Accordingly, malaria researchers who cultivate and solicit the support of individuals outside their fields are likely to be more successful in the future than those who do not [3].

Policy Recommendations

Given the central role international health assistance plays in hopefully eliminating malaria in sub-Saharan Africa by 2030, improving funding flows is urgent [15]. Policymakers should increase investment in malaria research through domestic and interregional transfers, to complement or even replace volatile international transfers [1]. Additional analyses with more detailed data would help explain the sources of funding inequity and inform efforts to enhance equity at both the international and within-country levels [3].

Strategies for Researchers

Malaria research is at a historical crossroads [1]. Investigators face a uniquely complex array of competing challenges and dramatically fewer funding options than just two years ago; and, coincidentally, the usual new funding sources are more competitive and selective than at any time in memory [15]. Malaria research funding is more difficult to obtain in 2015 than in 2013 or 2014, and that is true for virtually every type of malaria research, every relevant national program, and every global initiative [15]. Consequently, research investigators have been forced into a situation for which there is no historical precedent [1, 15]. Grants are scarce, fiercely competitive, and chronically under-funded; yet malaria control cannot be maintained, let alone further improved; development and deployment of new drugs, vaccines, and other interventions cannot be supported; and the fundamental, theoretical and policy-related breakthroughs necessary for future generation of oversight systems are lagging well behind the global momentum that is driving them [15]. Meanwhile, economic and health development change demand that an informed nation be one step ahead of the problems facing it, rather than one step behind[1]. Under this "new normal" of malaria control and research funding, the following list defines, describes and prioritizes the sorts of efforts investigators consider most important, urgent and responsive to the perceived challenges: Sustain bolstered PIs during transition [1]. As previous "pools" of steady support have exhausted collapse or been forced to divert to other malaria-related objectives or diseases, a handful of investigators remain highly active, well-trained and performing research of ongoing quality [15]. Efforts that attempt to limit or prevent the loss of these investigators and their complementary skill-sets must be among the highest priorities for any system that intends to maintain reasonable continuity during the current funding transition. Target geographically-relevant science [5]. The extremely broad geographical distribution of many malaria researchers makes a mal-distribution of talent, resources, and evidence-based science impossible [2]. Efforts that centralize or coordinate the focus of malaria science at the national, regional, or global level therefore represent a prime mechanism for ensuring that the greatest number of users will directly benefit from the most complete and relevant analyses [1, 15].

CONCLUSION

Adequate funding for malaria research and development is critical to achieving the long-term goal of global eradication. Despite notable progress, current funding structures remain fragmented and insufficient to sustain innovation and implementation. Public-private partnerships have demonstrated success in bridging resource gaps, while technology-driven fundraising and innovative financing models represent new frontiers in resource mobilization. However, disparities in funding allocation, particularly across malaria-endemic regions, persist and hinder equitable progress. Future strategies must therefore prioritize sustainability, inclusivity, and collaboration among stakeholders. Governments, the private sector, and international donors should commit to strengthening research capacity and supporting localized solutions tailored to regional realities. By aligning financial innovation with evidence-based policy and scientific collaboration, the global community can overcome funding challenges and accelerate the pathway toward a malaria-free world.

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CITE AS: Bwanbale Geoffrey David (2025). Narrative Review of Funding Challenges in Malaria Research. RESEARCH INVENTION JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES 5(3):195-202. https://doi.org/10.59298/RIJSES/2025/531195202