https://rijournals.com/scientific-and-experimental-sciences/

RESEARCH INVENTION JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES 5(3):138-146, 2025

©RIJSES Publications

ONLINE ISSN: 1115-618X

PRINT ISSN: 1597-2917

https://doi.org/10.59298/RIJSES/2025/531138146

Narrative Review of Asymptomatic Malaria and Transmission

Mugisha Emmanuel K.

Faculty of Science and Technology Kampala International University Uganda

ABSTRACT

Asymptomatic malaria, defined as the presence of Plasmodium parasites in human blood without clinical symptoms, is a major barrier to malaria elimination. These silent infections occur across all endemic settings and represent a significant infectious reservoir that sustains transmission despite control efforts. Epidemiological evidence demonstrates that both children and adults in high-transmission areas frequently harbor subpatent infections that evade standard diagnostics, thereby undermining surveillance and treatment programs. Advances in molecular diagnostics, such as PCR and LAMP have revealed the high prevalence of asymptomatic carriers, highlighting their role in maintaining parasite reservoirs through both wet and dry seasons. Asymptomatic malaria complicates public health strategies, given that carriers do not seek treatment yet contribute substantially to the onward transmission of Plasmodium species to Anopheles vectors. Control measures such as mass drug administration, mass testing and treatment, chemoprevention, and vaccination are being explored, though each faces challenges of feasibility, drug resistance, and ethical considerations. Emerging technologies, including parasite genomics, sensitive biomarkers, and longitudinal cohort studies, offer opportunities to refine detection, monitor transmission, and design targeted interventions. Addressing asymptomatic malaria through integrated approaches that combine diagnostics, community engagement, and policy support is essential to accelerating progress towards malaria elimination.

Keywords: Asymptomatic malaria, Transmission dynamics, Molecular diagnostics, Mass drug administration (MDA) and Malaria elimination.

INTRODUCTION

Malaria is a parasitic disease caused by Plasmodium species that is transmitted via the bite of an infected female Anopheles mosquito. The disease is life-threatening and is primarily endemic in tropical and sub-tropical regions [1]. The World Health Organization (WHO) estimates approximately 228 million malaria cases and 405,000 fatalities in 2018 alone, most being children under the age of five. Current control strategies focus on case management, vector control, and surveillance; the most recent techniques augment these efforts with information and communication technology (ICT) systems such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain platforms [1, 6]. While malaria is typically characterized by a spectrum of symptoms, asymptomatic malaria lacks clinical signs of infection but involves the presence of malaria parasites in peripheral blood. It is a pressing issue across all transmission and age settings due to its ability to enable silent transmission and exacerbate elimination efforts [1]. Vector-borne diseases remain a substantial threat to global public health worldwide.

Understanding Asymptomatic Malaria

Falciparum Malaria Infection and Infectivity to Mosquitoes in Papua New Guinea Dolie D. Laishram, James W. Kazura, Ivo Mueller, Peter M. Siba, Leanne J. Robinson 2012 The effect of symptomatic status on the infectivity of four Plasmodium species to Anopheles farauti is investigated. Asymptomatic malaria is a common infection of major epidemiological importance, whose transmissibility influences malaria dynamics and the impact of control methods [1, 5, 7]. Many malaria-endemic regions, including parts of Papua New Guinea (PNG), experience transmission of four Plasmodium species: Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae and

Plasmodium ovale. High parasite prevalence is often sustained without apparent disease, even in young children. Combining parasite surveys with mosquito-feeding experiments, this study assesses the transmissibility to Anopheles farauti of P. falciparum, P. vivax, P. malariae and P. ovale from symptomatic and asymptomatic human infections in PNG [8-13]. Plasmodium vivax and P. ovale are more infectious than P. falciparum, the 360 infectiousness of asymptomatic P. malariae to mosquitoes is also reported [1, 14]. In retrospective data analysis, P. vivax and P. malariae infection intensities decline significantly with age, but asymptomatic and symptomatic P. vivax and P. falciparum infections occur at equivalent parasite densities apart from young children up to 4 years. Whereas parasite density is a significant determinant of mosquito infection success for all four Plasmodium species examined, non-linear models show transmission efficiency decreases with increasing parasite density for P. falciparum and to a lesser extent P. vivax [14-17]. If public health programmes are based on clinical surveillance, age-dependent patterns of parasite carriage and transmissibility complicate predictions of the effect on the infectious reservoir. P. vivax clearance rates of infection after treatment are slower than P. falciparum, so its relative transmission contribution increases among cases a few weeks post-treatment [18-21].

Definition and Characteristics

Malaria infections composed of asexual Plasmodium parasites are either symptomatic or asymptomatic. The presence of parasites in the blood without symptoms is the typical definition of an asymptomatic Plasmodium infection [22-24]. The characteristics of asymptomatic malaria are quite difficult to define reliably, especially because an infected individual lacks clinical symptoms and often carries subpatent parasite levels. The following section defines asymptomatic malaria at a higher level of abstraction to enable the examination of the potential roles of affected people in transmission [25-28]. Asymptomatic infections in endemic areas whose symptoms are suppressed by antimalarial treatment or partial immunity are a major concern for malaria elimination efforts. Subpatent malaria infections remain transmissible and tend to progress to chronic parasite carriage. Population surveys suggest that chronic asymptomatic malaria may exist in large parts of the population [29-32].

Epidemiology of Asymptomatic Malaria

Malaria transmission depends on host, parasite, and vector factors. Genotypic variation of Plasmodium falciparum determines erythrocyte receptor specificity and severity of infection [1]. Environmental drivers such as rainfall, temperature, and humidity modulate transmission by affecting mosquito population dynamics and parasite development. Malaria vectors in sub-Saharan Africa exhibit strong anthropophilic behaviour and preferentially feed indoors, both of which increase transmission in human populations [2]. The term "asymptomatic malaria" describes the presence of malaria parasite in the blood stream without clinical symptoms. Epidemiological studies have reported that a large proportion of Plasmodium infections across all communities are asymptomatic [1, 7]. Majority of asymptomatic malaria infections occur in stable transmission zones in children recovering from the acute disease episode and adults living in holo- and hyper-endemic areas 3. Asymptomatic malaria is routinely detected through microscopy and rapid diagnostic test (RDT), even though polymerase chain reaction (PCR) is more sensitive in detecting low-grade parasitaemia[8, 15].

Clinical Implications

Asymptomatic malaria has important implications for public health because these infections, which occur in all human malaria parasite species and in all transmission settings, contribute significantly to the infectious reservoir in endemic populations [1]. A major challenge in malaria control programmes is the detection and management of asymptomatic infections, which are not identified through passive case detection [1]. Mass screening and treatment approaches, using rapid diagnostic tests (RDTs), have been designed to target such infections; however, RDTs have limited sensitivity and several studies indicate that they miss a large proportion of asymptomatic infections[13, 15]. Mass drug administration has been employed in certain regions where the malaria burden is especially high and the detection and treatment of all infections is not feasible [1, 3, 9].

Transmission Dynamics

Malaria remains a leading public health concern in tropical and subtropical regions. In 2016 alone, 216 million cases were reported, resulting in the loss of almost half a million lives [1]. However, increasing evidence suggests that the burden of malaria may be underestimated, which in turn could jeopardize efforts to eliminate transmission. In high-transmission settings, a considerable population of both adults and children harbour asymptomatic malaria infections that sustain transmission and present major obstacles towards malaria elimination [4]. Addressing asymptomatic infections in malaria control programmes could therefore contribute significantly towards reducing the transmission of malaria in intermediate-to-high malaria transmission zones.

Asymptomatic malaria refers to individuals who carry the parasite without exhibiting any clinical symptoms and without seeking treatment [1, 4]. These carriers usually maintain low-density infections because the parasites consume fewer host cells. Unlike symptomatic cases, parasite densities in asymptomatic violations seldom exceed

the threshold necessary to induce detectable clinical symptoms such as fever, vomiting, chills, and headaches. Nevertheless, these infections have epidemiological relevance as they are often undetected by standard diagnostic methods and generally remain untreated. They sustain an infectious parasite reservoir and contribute substantially, sometimes by orders of magnitude, to the infectious reservoir driving transmission in many endemic settings[5]. Malaria transmission occurs through host-vector-parasite interactions and is influenced by vector biology, environmental conditions, and host and parasite characteristics. Anopheline mosquitoes transmit malaria parasites through blood feeding and parasite development within the female Anopheles mosquito. Anopheles vectors become infected when they ingest mature and differentiated male and female parasites (gametocytes) during blood feeding on an infected human[1, 5]. Housing conditions in endemic areas provide shelter for Anopheles mosquitoes, facilitating transmission. In the humid forest zones of Africa, the principal Anopheles species is Anopheles gambiae s.l, specifically Anopheles gambiae ss and Anopheles funestus. In the Sahel, malaria transmission is generally highly seasonal and occurs almost exclusively during the rainy season. However, the persistent asymptomatic infections carried through the dry season fuel the rapid resurgence of severe epidemic malaria immediately after the rains begin each year [1, 4, 5].

Role of Asymptomatic Carriers

Asymptomatic malaria significantly influences transmission dynamics across all endemic settings. These carriers largely remain unaccounted for within national programs because most control interventions depend on the presumptive detection and treatment of symptomatic individuals and their primary vector [1]. An estimated 25 identified Anopheles vectors drive transmission in sub-Saharan Africa, indigenous to one or more ecozones. To date the record is held by Nigeria with at least 19 primary and secondary vector species indigenous to the country. The persistence of transmission by indoor- and outdoor-biting mosquitoes remains a challenge to elimination efforts[1, 2]. Environmental drivers incite spectacular population increases of secondary species capable of reintroducing parasites to communities because of their different habitats and feeding preferences [5, 8]. Numerous epidemiological reviews demonstrate the historic importance of many of these secondary vectors across African settings and that parasite reservoirs are continuously maintained by a wide range of vector species with varied ecological preferences. Using Brazil as an example, Carnevale and Mouchet concluded that the problem of malaria transmission might well be due to a plurality of vectors rather than a single, highly efficient species[9, 10].

Vector Biology and Behavior

Anopheles gambiae and Anopheles funestus are the primary vectors of malaria in sub-Saharan Africa; important secondary vectors include Anopheles nili and Anopheles moucheti[1]. The Anopheles gambiae complex is defined by a number of sibling species which, aside from Anopheles gambiae sensu stricto, have no role in malaria transmission. Anopheles gambiae has a much shorter flight range than assumed by early studies, particularly when compared with Aedes aegypti (the urban mosquito vector for yellow fever and dengue). Flight distances of 1.75 km are common, and flight distances above 3 km are unusual for Anopheles gambiae[1, 3].

Environmental Factors Influencing Transmission

Environmental factors constitute a pivotal component of parasite transmission by influencing mosquito ecology and behavior and human activities [5]. The transmission of Plasmodium parasites requires the presence of both mosquito vectors and human hosts. Following a blood meal on an infected human, a Plasmodium parasite must develop and multiply within the mosquito before it can be transmitted to another human, in a process that takes at least 8 to 10 days [3]. When the parasite completes its development within the mosquito on a given day, the mosquito becomes capable of transmitting the infection to a human for the remaining duration of its life. Therefore, a mosquito must live long enough not only to acquire the parasite but also to enable the completion of its development and to subsequently transmit it, which directly affects its vectorial capacity[3, 5].

Diagnostic Approaches

Asymptomatic malaria cases present only low parasite densities; therefore, conventional diagnostic methods could result in under-diagnosis. Accurate diagnosis for asymptomatic malaria cases is a fundamental practice that could lead to the prevention of ongoing transmission [5]. Molecular diagnostic methods such as semi-nested multiplex PCR or reverse transcription PCR have been applied to identify individuals carrying very low parasite densities. The misuse of malaria meditations could lead to partial treatment; hence, there is a chance to develop a new malaria generation, which could affect control programmes. Although microscopic examination is the traditional method of malaria diagnosis, it requires complex processing procedures. Moreover, the limit of passive malaria diagnostic approaches does not guarantee the identification of asymptomatic carriers and this could raise the likelihood of parasite transmission in communities [5]. In this case, molecular diagnostic approaches are important to improve public health and to reduce the transmission of persistent parasites. As asymptomatic

patients could act as reservoirs in control programmes, vector populations will have a sustainable survival period for transmission and remain infectious during the dry season. This could raise the transmission risk of different parasites or parasite clones within the vector population [6]. The detection of every asymptomatic patient within a community is essential to implement alternative intervention strategies, such as targeted chemoprophylaxis or mass drug administration. The selection of options depends upon the identification of families or subpopulations that have a significant effect on malaria transmission [6]. The term of submicroscopic infections has been taken use to define any infection under the detection level of classical microscopic methods and rapid diagnostic tests (RDT). The development of molecular methods and minimally invasive biomarkers has accelerated the detection of large amounts of low-density infections during the last 20 years[5, 6].

Microscopy

Microscopy is the long-standing gold standard for detecting and quantifying malaria parasites in human blood. In population studies, a thick and thin blood smear is usually prepared from the same finger prick sample [6]. A thick smear contains 12 times more blood than a thin smear and is stained with 10% Giemsa for 10 minutes. Evaluation of parasite infection status begins with the thick smear, where the reader examines about 100 high-power fields (HPF) on a 100× objective. If no parasites are seen at this point, the slide is called negative. If parasites are detected, the reader switches to the thin smear to speciate the parasites [6]. The thick smear is preferred for charge-coupled device (CCD) microscopy because, although it has some loss of clarity compared to thin smears, it offers a much higher volume of blood to examine. Quantification of parasites is generally done by microscopy with a thick blood smear [7]. In many settings, parasitemia is reported as parasites per microliter of blood (parasites/μL) to provide a standard measure of parasite density. However, this requires an accurate blood volume estimate and a consistent method for counting white blood cells (WBCs), as parasitemia is frequently calculated by the formula [6,7]

Rapid Diagnostic Tests (RDTs)

Rapid diagnostic tests (RDTs) are devices that usually use a lateral flow immunochromatographic assay to detect the presence of malaria antigens in human blood [8]. They are used to diagnose malaria in acute-care settings and to conduct community-based surveys to estimate malaria prevalence. At transmission intensities where less than 5–10% of the people tested are positive according to microscopy, malaria RDTs (mRDTs) provide a rapid, economical, and accurate alternative to microscopy for population surveillance [9]. Community-based studies can be conducted with rapid diagnostic tests to identify and treat asymptomatic P. falciparum carriers, a source of transmission to mosquitoes [9]. The most commonly used RDTs detect one of two antigens: histidine-rich protein-2 (HRP2) found in P. falciparum and Plasmodium vivax lactate dehydrogenase (pLDH). Rapid diagnostic tests that detect only PfHRP2 have been shown to detect pfhrp2-deleted strains at a prevalence of 15%, posing a threat to malaria control and elimination efforts. Rapid diagnostic tests (RDTs) have considerable value as a surveillance tool for detecting P. falciparum and/or P. vivax parasites in their asexual stages in peripheral blood since they are comparable to expert microscopy up to densities of 20 parasites/μl and are simple to use. Malaria RDTs are an effective means of detecting asymptomatic P. falciparum carriers for subsequent treatment [8, 9].

Molecular Techniques

As asymptomatic malaria infections generate generally low parasite densities, standard microscopic examination often fails to detect all infected individuals [10]. Whereas microscopy routinely detects asexual blood-stage parasite densities exceeding ~50 parasites/μL, rapid diagnostic tests reveal parasites at 100–200 parasites/μL, and polymerase chain reaction (PCR) can detect densities low as 0.03–10 parasites/μL. Molecular techniques such as PCR and loop-mediated isothermal amplification (LAMP) offer improved sensitivity and specificity in the detection of Plasmodium parasites, even among asymptomatic carriers. In one setting, the sensitivity of the PCR technique remained approximately 97% up to 54 weeks post-treatment[10]. Employing pooling strategies in conjunction with molecular assays enables large-scale population screening for asymptomatic infections, with subsequent individual testing of positive pools increasing cost-effectiveness [10].

Impact on Malaria Control Programs

As symptomatic carriers act as reservoirs for the transmission of malaria, a significant challenge for malaria-control programs consists of the detection and management of asymptomatic infections [1]. Since parasite carriers neither seek treatment nor contribute to malaria morbidity, the testing and treatment of the entire population in highly endemic areas is not feasible, and mass drug administration may be considered as a complementary control measure, towards the reduction of the parasite reservoir [3].

Challenges in Detection

The Malaria Eradication Campaign of the 1950s was the first attempt to eradicate the parasite worldwide using the residual application of dichlorodiphenyltrichloroethane (DDT) [11]. While the effort was successful in

eradicating malaria in the United States and Europe, it failed in many developing countries and the World Health Organization ceased the Global Malaria Eradication Programme in 1969 because of limited success where the burden was the greatest. Malaria has been regulated to a control program in these countries during the last 50 years [11]. The efforts focused on reduction of morbidity and mortality due to falciparum malaria. Within low-transmission settings, most of the malaria burden occurs in urban areas where the rate is comparatively low. Urban settings have also created many complications in addressing control programs but the reduction in annual cases makes low transmission areas a priority during elimination strategies [11]. Microscopic and serological evidence indicates that clinical malaria cases may be the tip of an iceberg and the pool of asymptomatic infections is considered the major challenge for the elimination process [11]. These asymptomatic cases maintain the parasites in the vertebrate host and perpetuate the parasite life cycle via the vector without visible evidence. This carrier state is a valuable parasite survival strategy and, unless recognized and treated, the parasite will survive in the population indefinitely. The parasite can thus be considered a master at the evolutionary game where the costs of virulence cannot be balanced simply by transmission alone [11]. Certainly the cost of a low level of chronic virulence to the parasite is likely minimal, but there is probably still a considerable selective advantage of this carrier state to the parasite because of continued transmission. With this in mind, asymmetric virulence appears a more logical explanation for the outcome of the transmission–virulence trade-off [11]. The detection of asymptomatic infections is important in the course of malaria elimination. Several recent studies have tried to correlate asymptomatic disease and community treatment with parasite clearance; however, the goal to interrupt transmission of the parasite from an earlier intervention strategy, like mass drug administration, cannot be met without a reliable diagnostic technique [1, 11]. Additionally, the presence of asymptomatic cases is a key challenge to malaria control and elimination, as these silent infections are thought to be an important source of onward transmission, despite IAs remaining untreated. It has been widely suggested that future elimination efforts will need to tackle the asymptomatic reservoir through either vector control or more effective case management [1].

Strategies for Management

Given its private and seemingly innocuous character, asymptomatic malaria infections can easily be neglected by control efforts, even though they carry the potential to sustain a sufficient infectious reservoir to maintain transmission and initiate resurgences in areas where control has been successful [12]. Management programs range from maintaining the highest vigilance on possible cases to mass drug administration (MDA). The former approach relies heavily on case detection and follow-up, which mandates a sensitive and specific means of diagnosing asymptomatic infection and shedding of malaria parasites [12]. Although evidence-based guidelines have been proposed to stratify individuals most likely to harbor asymptomatic infections, they need to be tested in other contexts to assess generalizability. Regardless, MDA has been successfully used in many countries to interrupt malaria transmission under special circumstances. Both approaches remain special cases requiring careful consideration [12].

Role of Mass Drug Administration

Mass drug administration (MDA) involves administering antimalarials without prior diagnostic testing and has periodically been employed to reduce malaria transmission [12]. However, concerns regarding safety and the potential emergence of drug-resistant parasite strains have limited enthusiasm for widespread application. Mass testing and treatment (MTaT) represents a related strategy that actively seeks out infections before treatment, potentially curtailing unnecessary drug use and associated selection pressures [12]. Although each method carries challenges, the world health community has maintained cautious optimism about the role of MDA in appropriate settings [12]. The World Health Organization (WHO) recommends MDA primarily for outbreaks or when elimination is imminent. However, there remains a dearth of high-quality evidence evaluating the approaches across epidemiological contexts [12, 13]. A recent systematic review summarised the effects of MTaT on onward malaria transmission and probed contextual factors, effect modifiers, and insights from mathematical models to better inform implementation. Supporting epidemiological findings from Zanzibar indicated that two rounds of MDA with dihydroartemisinin-piperaquine plus a low single dose of primaquine did not significantly affect malaria incidence and transiently reduced asymptomatic infections by 10% [13]. The short-lived effect was attributed to suboptimal timing during the malaria season as well as insufficient rounds and importation of infections. Overall, evidence from low endemicity areas remains sparse and essential questions about optimal delivery and deployment persist [13]. In 2022, the WHO integrated additional evidence from systematic reviews and marked a step towards clarifying the role of proactive drug administration as part of integrated elimination efforts[13].

Public Health Implications

Malaria remains a major public health problem in many parts of the world, particularly in Africa. An estimated 214 million new cases and 438,000 deaths occurred worldwide in 2015 [1]. Because some asymptomatic individuals harbor gametocytes, which can infect mosquitoes, the presence of asymptomatic malaria presents a substantial challenge for disease-control efforts, especially in areas approaching elimination. Although asymptomatic infections have not received much research attention, they are increasingly viewed as a major obstacle to malaria elimination [3]. Understanding asymptomatic malaria and identifying asymptomatic individuals are required to design effective malaria-control programmes[3]. A series of epidemiological studies in two ecological zones in Ghana found that asymptomatic malaria is mainly caused by P. falciparum parasitism. A high asymptomatic burden (~20%) was found in both zones, with higher prevalence in the forest zone, which possesses climatic conditions (temperature, rainfall, vegetation) conducive to mosquito breeding. Among children aged 5–15 years, asymptomatic malaria was higher in males, indicating parasite–host interactions linked to behavioural or genetic factors[1, 3]. The occurrence of asymptomatic malaria also has implications for the community and public-health planning. Asymptomatic malaria describes infected individuals who do not show symptoms or clinical manifestations of the disease. Unlike symptomatic cases, these people do not seek treatment and, therefore, remain a persistent source of gametocytes (the transmissible forms of the parasite) [1, 3]. Infection can also persist for several months, thereby maintaining transmission for an extended period. Recent epidemiological studies have found that many malaria infections in endemic regions are asymptomatic and, hence, not detected by the health system, making asymptomatic malaria a major obstacle to malaria eradication [1, 3].

Asymptomatic Malaria in Endemic Regions

Asymptomatic malaria is characterized by the presence of Plasmodium parasites in an individual's bloodstream without apparent symptoms [1]. It is widespread in endemic regions and represents a significant obstacle to control and elimination efforts. Subpatent infections frequently escape routine diagnostics, remaining transmissible to anophelines and sustaining parasite reservoirs that perpetuate transmission [1]. Chronic asymptomatic carriage is common; observations from Senegal indicate that more than 90% of exposed individuals harbor parasites without symptoms, thereby acting as an effective reservoir for continuous transmission [1, 11]. Immunity associated with asymptomatic malaria consists of anti-disease immunity, which permits parasite carriage without manifestation of symptoms, and anti-parasite immunity, which suppresses parasite loads over prolonged exposure[11, 13]. The former allows for chronic infections, whereas the latter contributes to a gradual reduction in parasite density following sustained exposure.

Impact on Community Health

Malaria is a serious global health concern that threatens millions of people worldwide, especially those living in endemic settings [3]. Approximately 70% of those at risk of malaria in 2015 were in Africa, with nearly 99% of all malaria deaths occurring on that continent. About half of the world's population lives in areas of malaria transmission[3, 12]. The challenge of controlling and eliminating malaria has been exacerbated by the development of drug resistance to common treatments; for instance, resistance to the successor to chloroquine, sulfadoxine–pyrimethamine, has been detected in more than 60 countries. As a result, vector surveillance and control remain the most important malaria interventions to date [2, 5]. It has been widely reported that asymptomatic individuals bearing low-density parasitaemia are a significant reservoir of infection and may contribute an important fraction of the transmission burden [14].

Policy Recommendations

Chemoprevention with long-lasting safe antimalarial drugs can protect susceptible groups. Incorporating vaccination is a promising opportunity to provide similar protection towards elimination of transmission [7, 12]. A detailed understanding of asymptomatic carriage informs strategies for elimination of all malaria transmission. Mass testing and treatment (MTaT) strategies require further evaluation before routine implementation in elimination programmes [2, 12].

Future Directions in Research

The future of malaria research depends on the translation of developing technologies to capture the numerous nuances of transmission. Longitudinal studies that incorporate both genotyping and entomological surveys may provide the framework to delineate the complex interplay between human and mosquito populations [5, 9]. The emergence of gene-drive technologies is a potential component of elimination strategies, but the development of vaccines that target the transmission stage of the parasite will most certainly aid progress toward transmission interruption [5]. An extension of sampling protocols to include both surveillance of these new tools and to follow their implementation in the field represents a crucial and necessary next step in advancing malaria control[5].

Emerging Technologies

Emerging technologies enable studies of asymptomatic malaria and transmission to reduce this silent burden of disease. Plasmodium falciparum is the most deadly of the malaria parasites to affect humans [1, 10]. Asymptomatic Plasmodium falciparum infections in humans comprise infections in which parasites are detected by molecular methods such as polymerase chain reaction but not identified with microscopy or rapid diagnostic tests [5]. Such asymptomatic infections constitute a significant reservoir of transmission and thus pose a huge challenge to the control and elimination of malaria [5]. Although a variety of diagnostics are used routinely in the field, more sensitive methods need to be widely adopted to identify and treat these hidden infections and accelerate progress toward malaria elimination [3, 7]. Parasite genomics and other molecular technologies are poised to add additional resolution that can support efforts to monitor and interrupt malaria transmission. In this comprehensive narrative review, the authors describe the origins and health effects of asymptomatic malaria and focus on the use of emerging technologies to improve the understanding of onward transmission [1, 15]. Prospects for future research are discussed in light of identified knowledge gaps, with longitudinal cohort studies featured as a high priority [5, 8].

Longitudinal Studies

Mapping changes over time in endemic settings can assist understanding of transmission dynamics [4, 14]. To further reduce malaria morbidity and effectively interrupt transmission, it is important to understand human infectious reservoirs in various epidemiological settings. Because of complex epidemiological, ecological and human behaviour factors, the risk of infection can vary at different locations or spatial scales within a community, while complex patterns of vector transmission play a major role in maintaining malaria transmission [4]. Furthermore, biological and epidemiological mechanisms by which symptomaticity influences transmission remain unclear. Estimating the feasibility and efficacy of targeting asymptomatic infections as a means to reduce transmission in endemic settings requires longitudinal data [5]. A longitudinal cohort of households across three villages in Kenya was established in June 2017 and monitored until July 2018. All household members over the age of 1 year were offered enrolment, with demographic and behavioural questionnaires administered and blood samples collected monthly. Parasites detected in asymptomatic people were not treated. Logistic regression results indicated the odds of transmission from asymptomatic versus symptomatic infections. By providing an epidemiological overview of malaria transmission intensity, the results are relevant to designing tools for monitoring and surveillance targeting regions in the pre-elimination stages [15].

Vaccination Strategies

Several vaccines aimed at interrupting malaria transmission currently await evaluation in endemic settings. The WHO recommends their combined deployment with established control tools [5, 15]. An effective malaria vaccine should safeguard against infection, hinder the persistence of asymptomatic parasites within the host, and prevent onward transmission to the mosquito vector [5, 15]. Such a vaccine would decrease the presence of the parasite within the host, thereby interrupting the transmission cycle. It is conceivable that even a modest arrest of the onset of blood-stage infection could confer notable protection, given the several-day interval before the emergence of transmissible gametocytes [5].

CONCLUSION

Asymptomatic malaria represents one of the most critical challenges to malaria elimination efforts. Despite lacking clinical symptoms, asymptomatic carriers maintain low-density infections that remain transmissible to mosquito vectors and fuel ongoing transmission cycles. The silent burden they create is often underestimated due to limitations of conventional diagnostics, thereby allowing reservoirs of infection to persist within communities. Addressing asymptomatic malaria requires sensitive diagnostic tools, improved surveillance systems, and the integration of strategies such as mass drug administration, chemoprevention, and future vaccination programs. Importantly, the detection and treatment of hidden reservoirs must be adapted to local epidemiological contexts and supported by strong policy frameworks. Advances in molecular technologies and longitudinal studies offer promising opportunities to refine our understanding of asymptomatic transmission and inform targeted interventions. Ultimately, sustainable elimination of malaria will depend on tackling asymptomatic infections as a central component of global malaria control strategies.

REFERENCES

1. Laishram DD, Sutton PL, Nanda N, Sharma VL, Sobti RC, Carlton JM, Joshi H. The complexities of malaria disease manifestations with a focus on asymptomatic malaria. Malaria journal. 2012 Jan 31;11(1):29.
2. Gbalégba CG, Ba H, Silué KD, Ba O, Tia E, Chouaibou M, Tian-Bi NT, Yapi GY, Koné B, Utzinger J, Koudou BG. Distribution of Plasmodium spp. infection in asymptomatic carriers in perennial and low

seasonal malaria transmission settings in West Africa. Infectious diseases of poverty. 2018 Apr 1;7(02):19-31.

3. Mensah BA, Myers-Hansen JL, Obeng Amoako E, Opoku M, Abuaku BK, Ghansah A. Prevalence and risk factors associated with asymptomatic malaria among school children: repeated cross-sectional surveys of school children in two ecological zones in Ghana. BMC Public Health. 2021 Sep 17;21(1):1697.
4. Coulibaly D, Travassos MA, Tolo Y, Laurens MB, Kone AK, Traore K, Sissoko M, Niangaly A, Diarra I, Daou M, Guindo B. Spatio-temporal dynamics of asymptomatic malaria: bridging the gap between annual malaria resurgences in a Sahelian environment. The American Journal of Tropical Medicine and Hygiene. 2017 Oct 30;97(6):1761.
5. Sumner KM, Freedman E, Abel L, Obala A, Pence BW, Wesolowski A, Meshnick SR, Prudhomme-O'Meara W, Taylor SM. Genotyping cognate Plasmodium falciparum in humans and mosquitoes to estimate onward transmission of asymptomatic infections. Nature communications. 2021 Feb 10;12(1):909.
6. Gonçalves BP, Kapulu MC, Sawa P, Guelbéogo WM, Tiono AB, Grignard L, Stone W, Hellewell J, Lanke K, Bastiaens GJ, Bradley J. Examining the human infectious reservoir for Plasmodium falciparum malaria in areas of differing transmission intensity. Nature communications. 2017 Oct 26;8(1):1133.
7. Sumari D, Mugasa J, Selemani M, Shekalaghe S, Mugittu K, Gwakisa P. Prevalence of submicroscopic Plasmodium falciparum infections in asymptomatic children in low transmission settings in Bagamoyo, Tanzania. MalariaWorld Journal. 2016 Jun 17;7:6.
8. Tiono AB, Ouédraogo A, Diarra A, Coulibaly S, Soulama I, Konaté AT, Barry A, Mukhopadhyay A, Sirima SB, Hamed K. Lessons learned from the use of HRP-2 based rapid diagnostic test in community-wide screening and treatment of asymptomatic carriers of Plasmodium falciparum in Burkina Faso. Malaria journal. 2014 Jan 27;13(1):30.
9. Williams JE, Cairns M, Njie F, Laryea Quaye S, Awine T, Oduro A, Tagbor H, Bojang K, Magnussen P, Ter Kuile FO, Woukeu A. The performance of a rapid diagnostic test in detecting malaria infection in pregnant women and the impact of missed infections. Clinical Infectious Diseases. 2016 Apr 1;62(7):837-44.
10. Congpuong K, SaeJeng A, Sug-Aram R, Aruncharus S, Darakapong A, Meshnick SR, Satimai W. Mass blood survey for malaria: pooling and real-time PCR combined with expert microscopy in north-west Thailand. Malaria Journal. 2012 Aug 21;11(1):288.
11. Stresman G, Kobayashi T, Kamanga A, Thuma PE, Mharakurwa S, Moss WJ, Shiff C. Malaria research challenges in low prevalence settings. Malaria journal. 2012 Oct 25;11(1):353.
12. Bhamani B, Coma-Cros EM, Tusell M, Mithi V, Serra-Casas E, Williams NA, Lindblade KA, Allen KC. Mass testing and treatment to accelerate malaria elimination: A systematic review and meta-analysis. The American Journal of Tropical Medicine and Hygiene. 2024 Mar 12;110(4 Suppl):44.
13. Hetzel MW, Genton B. Mass drug administration for malaria elimination: do we understand the settings well enough?. BMC medicine. 2018 Dec 19;16(1):239.
14. Martins-Campos KM, Kuehn A, Almeida A, Duarte AP, Sampaio VS, Rodriguez ÍC, da Silva SG, Ríos-Velásquez CM, Lima JB, Pimenta PF, Bassat Q. Infection of Anopheles aquasalis from symptomatic and asymptomatic Plasmodium vivax infections in Manaus, western Brazilian Amazon. Parasites & vectors. 2018 May 4;11(1):288.
15. Andagalu B, Watson OJ, Onyango I, Opot B, Okoth R, Chemwor G, Sifuna P, Juma D, Cheruiyot A, Yeda R, Okudo C. Malaria transmission dynamics in a high-transmission setting of Western Kenya and the inadequate treatment response to artemether-lumefantrine in an asymptomatic population. Clinical Infectious Diseases. 2023 Feb 15;76(4):704-12.
16. Orji OU, Ibiam UA, Aja PM, Ugwu P, Uraku AJ, Aloke C, Obasi OD, Nwali BU. Evaluation of the phytochemical and nutritional profiles of Cnidoscolus aconitifolius leaf collected in Abakaliki South East Nigeria. World J Med Sci. 2016;13(3):213-217.
17. Enechi OC, Okpe CC, Ibe GN, Omeje KO, Ugwu Okechukwu PC. Effect of Buchholzia coriacea methanol extract on haematological indices and liver function parameters in *Plasmodium berghei*-infected mice. Glob Veterinaria. 2016;16(1):57-66.
18. Alum EU, Uti DE, Ugwu Okechukwu PC, Alum BN. Toward a cure–Advancing HIV/AIDS treatment modalities beyond antiretroviral therapy: A review. Med. 2024;103(27):e38768.
19. Obeagu EI, Bot YS, Obeagu GU, Alum EU, Ugwu Okechukwu PC. Anaemia and risk factors in lactating mothers: A concern in Africa. Int J Innov Appl Res. 2024;11(2):15-17.

20. Alum EU, Ibiam UA, Ugwuja EI, Aja PM, Igwenyi IO, Offor CE, Orji UO, Ezeani NN, Ugwu OP, Aloke C, Egwu CO. Antioxidant effect of Buchholzia coriacea ethanol leaf extract and fractions on Freund's adjuvant-induced arthritis in albino rats: A comparative study. 2022;59(1):31-45.
21. Offor CE, Ugwu Okechukwu PC, Alum EU. Determination of ascorbic acid contents of fruits and vegetables. Int J Pharm Med Sci. 2015;5:1-3..
22. Amusa MO, Adepoju AO, Ugwu Okechukwu PC, Alum EU, Obeagu EI, Okon MB, Aja PM, Samson AOS. Effect of ethanol leaf extract of *Chromolaena odorata* on lipid profile of streptozotocin-induced diabetic Wistar albino rats. IAA J Biol Sci. 2024;10(1):109-117.
23. Enechi YS, Ugwu OC, Ugwu Okechukwu PC, Omeh K. Evaluation of the antinutrient levels of *Ceiba pentandra* leaves. IJRRPAS. 2013;3(3):394-400.
24. Ugwu Okechukwu PC, Nwodo OFC, Joshua EP, Odo CE, Ossai EC. Effect of ethanol leaf extract of *Moringa oleifera* on lipid profile of malaria-infected mice. Res J Pharm Biol Chem Sci. 2014;4(1):1324-1332.
25. Ugwu OPC, Alum EU, Uhama KC. Dual burden of diabetes mellitus and malaria: Exploring the role of phytochemicals and vitamins in disease management. Res Inven J Res Med Sci. 2024;3(2):38-49.
26. Alum EU, Ugwu Okechukwu PC, Aja PM, Obeagu EI, Inya JE, Onyeije AP, Agu E, Awuchi CG. Restorative effects of ethanolic leaf extract of *Datura stramonium* against methotrexate-induced hematological impairments. Cogent Food Agric. 2013;9(1):2258774.
27. Offor CE, Nwankwegu FC, Joshua EP, Ugwu Okechukwu PC. Acute toxicity investigation and anti-diarrhoeal effect of the chloroform-methanol extract of the leaves of *Persea americana*. Iran J Pharm Res. 2014;13(2):651-658. PMID: 25237361; PMCID: PMC4157041.
28. Afiukwa CA, Oko AO, Afiukwa JN, Ugwu Okechukwu PC, Ali FU, Ossai EC. Proximate and mineral element compositions of five edible wild grown mushroom species in Abakaliki, southeast Nigeria. Res J Pharm Biol Chem Sci. 2013;4:1056-1064.
29. Ugwu OP, Alum EU, Ugwu JN, Eze VH, Ugwu CN, Ogenyi FC, Okon MB. Harnessing technology for infectious disease response in conflict zones: Challenges, innovations, and policy implications. Med. 2024;103(28):e38834.
30. Obeagu EI, Ugwu OPC, Alum EU. Poor glycaemic control among diabetic patients; A review on associated factors. Newport Int J Res Med Sci (NIJRMS). 2023;3(1):30-33.
31. Nwaka AC, Ikechi-Agba MC, Okechukwu PU, Igwenyi IO, Agbafor KN, Orji OU, Ezugwu AL. The effects of ethanol extracts of *Jatropha curcas* on some hematological parameters of chloroform intoxicated rats. Am-Eur J Sci Res. 2015;10(1):45-49.
32. Ezeani NN, Ibiam UA, Orji OU, Igwenyi IO, Aloke C, Alum E, Aja PM, Ugwu OP. Effects of aqueous and ethanol root extracts of *Olax subscopioidea* on inflammatory parameters in complete Freund's adjuvant-collagen type II induced arthritic albino rats. Pharmacogn J. 2019;11(1)

CITE AS: Mugisha Emmanuel K. (2025). Narrative Review of Asymptomatic Malaria and Transmission. RESEARCH INVENTION JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES 5(3):138-146. **https://doi.org/10.59298/RIJSES/2025/531138146**