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Socioeconomic Determinants of Malaria Persistence

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ABSTRACT

Malaria remains one of the most devastating parasitic diseases globally, disproportionately affecting low- and middle-income countries, particularly in sub-Saharan Africa and parts of Asia. While biological and environmental factors are widely acknowledged in malaria transmission, socioeconomic determinants significantly influence its persistence and impact. Poverty, limited education, poor housing, inadequate healthcare access, cultural beliefs, and agricultural practices collectively sustain transmission cycles and exacerbate vulnerability. Income inequalities hinder access to preventive measures, education shapes awareness and adoption of interventions, and health system disparities dictate treatment outcomes. Environmental factors, urbanization trends, and climate change further interact with these socioeconomic conditions to sustain disease prevalence. The economic burden of malaria extends beyond healthcare costs to productivity losses, poverty entrenchment, and slowed national development. Evidence from case studies across Africa and beyond underscores the importance of integrating socioeconomic interventions into malaria control policies. Addressing malaria persistence requires holistic strategies that combine biomedical tools with social, economic, and governance reforms aimed at breaking the cycle of disease and poverty.

Keywords: Malaria persistence, socioeconomic determinants, Poverty and health inequality, Access to healthcare, and Economic impact.

INTRODUCTION

Malaria is a widespread mosquito-borne parasitic disease that, with an estimated 214 million cases and 438,000 deaths in 2015, imposes a significant health burden on much of the developing world [1]. The socioeconomic determinants of malaria are a relatively understudied element of the disease. Socioeconomic factors serve to maintain large at-risk populations in endemic areas and thereby contribute to malaria persistence [2, 9]. The disease is a major cause of death and suffering in many developing nations, predominantly in Africa and Asia. Numerous environmental and socioeconomic causes have been linked to the continued presence of malaria in affected regions. Malaria has been especially devastating to nations with poor economies and stagnant growth. Households with higher incomes can afford preventive and treatment measures, as well as maintain sanitary living conditions [1,9]. Conversely, households with limited incomes often live in environments where disease vectors are abundant; malaria can therefore be a poverty-causing mechanism that traps households in cycles of insufficient growth. Government programs and international cooperation can create advancements for nations combating the effects of malaria [1,9].

Understanding Malaria

Malaria remains the world's most significant parasitic disease and one of the leading causes of morbidity and mortality among children in the developing world. Globally, 3.3 billion people in 106 countries and territories are at risk of malaria, with 1.2 billion people at high risk 2. Consequently, one child dies of malaria every 30 seconds, with 6000 deaths recorded daily [1, 3]. Eighty percent of the deaths occur in five countries, four of which are in Africa. Malaria is caused by the transmission of protozoan parasites of the genus Plasmodium from an infected to a non-infected individual via infected female Anopheles mosquito bites. The four species of malaria parasites that cause human infection include Plasmodium malariae, Plasmodium vivax, Plasmodium ovale, and Plasmodium falciparum [1, 3, 4]. Malaria remains the parasitic disease with the greatest impact on health and wealth. Of the malaria parasites, Plasmodium falciparum is the type responsible for the greatest morbidity and mortality [1]. In 2012, for example, the estimated worldwide malaria figures showed 207 million infected cases and about 627,000 deaths. Regionally, Sub-Saharan Africa alone accounts for about 80% of deaths worldwide, with nearly one-quarter of the disease burden in the developing world attributed to it [3].

Overview of Malaria

Malaria remains one of the most widespread and severe global health problems, with nearly 40% of the world's population at some risk of infection and an estimated 1.2 million deaths in 2010 [1]. The World Health Organization (2016) identifies malaria as endemic in over 100 countries and a major cause of morbidity and mortality among children under five [2]. The disease is caused by unicellular protozoan parasites from the Plasmodium species, which are passed to humans through the bite of infected female Anopheles mosquitoes [4]. The spread of malaria depends on the complex relationship among the mosquito, the Plasmodium parasite, and the human hosts. A number of environmental prerequisites must be satisfied for malaria transmission to occur [1, 4]. The mosquito must oviposit and the eggs must develop in water bodies; the consistency of their breeding places influences Anopheles distribution, density, and seasonal abundance. The higher the mosquito density, the higher the level of malaria transmission [1, 3]. Humid climates promote higher malaria prevalence because Anopheles mosquitoes live longer in humid environments, enabling the parasite to complete the necessary part of its life cycle within the mosquito before transfer to the human host [1, 4]. The external temperature must be sufficiently high and stable to support the development of the parasite in the mosquito. Rainfall is typical of regions with considerable malaria prevalence because it ensures the presence and persistence of breeding sites for mosquitoes. When the external temperature is low, the time required for the mosquitoes to become infective often exceeds the mosquito's lifespan, and malaria transmission ceases. The complexity of malaria control is heightened by the plurality of parasite, vector, and human host species involved in transmission, each with specific geographic distributions that overlap only in relation to particular transmission cycles [4].

Global Burden of Malaria

Malaria is a disease caused by Plasmodium parasites transmitted through Anopheles mosquito bites[1]. Of the five Plasmodium species infecting humans, P. falciparum causes most deaths, particularly in sub-Saharan Africa, and P. vivax is more common outside Africa [1]. The distribution of malaria is highly heterogeneous, varying dramatically on local and regional scales. Approximately 109 countries are malaria-endemic, containing an estimated 3.2 billion people at risk; in 2020, there were roughly 241 million cases and 627,000 deaths [2]. The disease's life cycle begins when an infected mosquito introduces sporozoites into a human host; these travel to the liver, where they mature and then enter the bloodstream to infect red blood cells. Some parasites develop into sexual stages (gametocytes), which can be taken up by another mosquito to perpetuate the cycle. Socioeconomic factors play a major role in malaria transmission, with poverty, housing conditions, and access to prevention and treatment influencing exposure and disease outcomes [1, 2].

Transmission Dynamics

Transmission dynamics govern the spread of malaria within human and mosquito populations. The parasite's extrinsic development in the mosquito vector averages 9 to 12 days, contingent upon environmental temperatures and humidity [2]. At 25°C, the cycle proceeds within 9 to 21 days; below a threshold temperature, development ceases, halting transmission. Incidence peaks elevate during periods of high mosquito densities and encounter rates, such as rainy seasons. Malaria presented estimates in 2015 indicate 212 million cases and 429,000 deaths globally, predominantly among children under five [5]. Prevalence, intensity, and severity relate to environmental, household, and health systems interactions. Socioeconomic determinants, including income, education, health infrastructure, and housing, complexly mediate transmission and disease manifestations. Seasonal and climatic fluctuations modulate vector populations exposed to parasitic infection, prompting spatial, temporal, and environmental variabilities in malaria risk [2, 5].

Socioeconomic Factors

Socioeconomic and environmental determinants contribute to the resurgence and persistence of vector-borne diseases. In Zimbabwe, malaria-related morbidity and mortality continue to impose a burden on socioeconomic development [1, 2]. Despite dramatic declines in malaria incidence achieved through multipronged approaches, it remains a leading cause of morbidity, accounting for a significant proportion of outpatient consultations, admissions, and deaths [2]. Malaria consists of a complex biological system involving interactions among the vector mosquito, parasitic agent, and humans. Epidemiological studies have revealed that environmental factors influence malaria transmission. Malaria occurrence is determined by household socioeconomic factors that provide a framework for understanding the persistence of the disease. Exploration of household arrangements and socioeconomic characteristics informs intervention strategies and guides efforts to enhance community health and empowerment. Within a country, a positive association links socioeconomic status (SES) with the adoption of preventive technologies and a negative association links SES with infection. Sociological theory suggests that when effective prevention or treatment exists for a disease, social actors mobilize resources, money, knowledge, and social capital to access these technologies and thereby mitigate risk [1, 4]. The social epidemiological literature attributes the uptake of preventive medicine to SES [1]. Malaria remains a disease of poverty because its burden is related to social inequalities such as poor nutrition and lack of access to sanitation and health education. Malaria is also characterized by a dramatic social gradient in developed countries due to inequalities in access and knowledge [5]. A set of socioeconomic factors specifies where people live and the distribution of risk. Cluster and district-level variability indicate that SES also influences malaria risk. Across Africa, a substantial social gradient surfaces in general knowledge about prevention, while the prevalence of fever is concentrated among the most disadvantaged [1, 2].

Income Levels

The socio-economic environment plays a significant role in the persistence of malaria around the world. As low income hinders access to essential goods and services such as prevention, treatment, and health education, it increases the general risk of infection [1, 6]. Income also represents an improved living standard, characterized by drinking water, sanitation, and housing structures, among other factors, that also influence transmission [1, 6]. These variables therefore delineate social groups at higher risk, most often the poorest and least educated. Such groups are also less likely to dispose of the financial and cognitive resources needed to seek help when it is most necessary. Malaria is a major public health challenge, particularly in low-income countries. It is responsible for particularly high costs through its direct mortality and morbidity effects, combined with poor economic performance [7]. In sub-Saharan Africa, where the disease burden is greatest, the risk directly decreases with increasing income and wealth, both at the individual and household levels [6]. Within the region, for example, Ghanaian outpatient admissions related to malaria amount to 32–42% and the disease is a leading cause of death. Social groups have therefore been widely investigated to identify the epidemiological trends driving persistence. Both at the individual and group levels, the poorest bear the greatest incidence [7]. They face the greatest infection risks and often have the lowest immunity levels. Such a scenario has major consequences at the household level because of income losses combined with increased expenditure for access to care [1,6, 7].

Education and Awareness

Education plays a fundamental role in the onset and persistence of infectious diseases. In addition to other socio-economic factors, education strongly influences the persistence of malaria. Individuals with limited education are typically less aware of prevention methods and symptom recognition [1, 11]. They thus are unlikely to take precautionary measures or seek early diagnosis, increasing the risk of severe complications. Cross-sectional data from the Demographic and Health Surveys (DHS) collected between 2010 and 2018 from 11 African countries confirm that education is a major determinant of malaria prevalence; women with no or limited schooling are more likely to have children infected with malaria, in every country studied[8]. Such differences are due to the impact of education on preventive strategies, healthcare-seeking behaviour, and possibly on the ability to acquire effective treatment [8]. Maternal education emerges as the key socio-economic predictor of malaria infection among children less than five years of age [8]. Poor education negatively affects malaria prevalence also by limiting understanding of the transmission process and the adoption of preventive measures. Educational attainment is thus crucial in eliminating malaria in malaria-endemic countries. Similarly, an analysis of the 2011 Mother and Child Health (MDHS) survey data from Madagascar showed that higher education plays a protective role in curtailing the spread of the disease [1, 18]. Poor education may constrain access to local or regional networks fostering innovative solutions, while the density of schooling levels influences both the social and geographic distribution of knowledge. In Madagascar, socio-economic status and the mother's education determine knowledge on how to prevent malaria, affect the ability to afford medication, and place households at different levels of risk because of their geographic locations [1].

Access to Healthcare

The prevalence of malaria also depends on an individual's access to preventive treatment and care after infection [1, 2]. According to sociological theory, when treatment or prevention exists for a disease, individuals use resources like money and knowledge to obtain protective technologies and reduce risk. Merely distributing a convenient technology does not ensure equitable use because the ability to adopt a preventive measure depends on access to relevant information, materials, and services [2, 3]. Globally, only approximately 24% of febrile children receive a malaria diagnostic test, but treatment and prevention vary strongly by socioeconomic position and education, with poorer and less educated households experiencing greater infection and death rates [3, 6].

Housing and Living Conditions

Housing is another important factor in the risk of transmission of malaria [3]. The age of housing is a crucial factor in determining the risk of malaria transmission among children. There is a strong association between the quality of housing and the reduction in malaria risk in Sub-Saharan Africa [2]. In addition to housing quality, overcrowding significantly contributes to malaria transmission. A lack of adequate space in homes leads to an increased risk of transmission of infection from one infected person to another within the same home unit. Poor crowding implies that the houses are unable to protect the inhabitants from infection through effective barriers, either physically or chemically [2]. It is an indication that it is difficult to control the environment in terms of breeding sites around the home during the transmission seasons, since many people live in one place. Urban malaria is exceptionally associated with informal or squatter human settlements, which are a disproportionate feature of fast-growing cities in tropical regions [1, 2]. These settlements, constructed mainly by the poor, are characterized by improper planning and poor environmental conditions.

Environmental Influences

Malaria transmission depends critically upon temperature and rainfall [2]. Modulation of key transmission parameters such as mosquito development, survival, and biting rates, and the parasite extrinsic incubation period, establishes temperature as a key determinant of the vectors' capacity to transmit malaria [2]. Rainfall generates surface-water pools that provide breeding sites for the mosquito vector, while humidity influences the adult mosquito's survival [4, 6]. Elevated temperatures coupled with decreased rainfall and a switch from natural to human-made breeding sites can produce explosive malaria epidemics in semi-arid regions. Extreme climatic events tend to occur under the influence of regional phenomena such as El Niño-Southern Oscillation (ENSO). Household determinants for malaria include gender, age range, occupation, type of housing and construction materials, household hygiene, lighting, sanitary facilities, household location and distance to water sources and health facilities, income, education, knowledge of malaria, religion and culture, nutritional status, presence of other diseases, and intervention strategies [1, 2]. Malaria-related morbidity and mortality in Zimbabwe continue to impact the country's socioeconomic development, with various factors influencing the disease. Malaria incidence declined from 136 per 1,000 population in 2000 to 22 per 1,000 population in 2012, thanks to intervention programs, yet the disease remains a leading cause of morbidity, with 480,000 cases and 713 deaths in 2014. The occurrence of malaria depends on biological and environmental factors affecting the mosquito vector, humans, and the parasite [1, 2].

Climate Change

Climate change represents a significant environmental factor influencing malaria persistence globally. Research conducted for Ghana examines the relationship between climatic variables and malaria prevalence, integrating socioeconomic covariates often excluded from biophysical analyses [10]. The study identifies humidity and rainfall as predictors of malaria prevalence, with an observed increase associated with rainfall [9]. Socioeconomic factors also determine prevalence; higher rates occur where there is a larger proportion of middle-income households and households lacking formal education [8]. Notably, prevalence demonstrates significant regional variation. The analyzed climatic parameters correspond to the ecological needs of malaria vectors and parasites. The female Anopheles mosquito transmits malaria and breeds in aquatic environments during three of its four life stages, underscoring the influence of regional hydrological conditions on malaria transmission [8, 9]. Climate change, particularly an increase in global temperature, is expected to shorten the life cycles of vectors and parasites, raising the risk of infection, especially in regions with inadequate healthcare and vector control. Episodes of extreme weather provide additional insight into how socioeconomic and environmental variables affect malaria. In September 2007, East Africa experienced unprecedented flooding, which contributed to outbreaks of both malaria and diarrheal diseases [9, 10].

Urbanization

Urbanization influences malaria acquisition in several ways, with increased urbanicity generally associated with lower malaria prevalence. An urban-rural classification is typically used to differentiate the two environments, but a continuous scale of urbanicity provides a more refined description of related health issues [11, 12]. Malaria transmission is heterogeneous and varies spatially even in high-endemic areas, and several studies suggest that urbanization is linked to a decreasing malaria incidence [11]. Moreover, urban water bodies, a preferred source of breeding for vectors, are comparatively scarce and often polluted, thereby contributing to a further reduction of breeding sites. Along with vegetation cover and air temperature, the shorter flight range of vectors in urban settings contributes to the spatially described decline of malaria risk in the city. Both in Dakar and Ouagadougou, where urban plots show a continuous gradient of increasing urbanicity toward the city centre, a decline in malaria risk from the periphery to the centre was observed[11].

Agricultural Practices

Farming remains the principal livelihood for nearly all families in Zimbabwe, with less than 3% engaged in other income-generating activities. Greater involvement in agricultural work is associated with a higher risk of malaria infection, likely due to increased exposure to vectors attracted to farm hosts [13, 17]. However, farming also generates income that can be used to improve other malaria determinants, such as the quality of housing. Unlike the findings in Zimbabwe, inhabitants of Uganda's Nagongera subcounty depend mostly on subsistence agriculture, yielding low incomes and limiting the capacity to address housing conditions [12, 15]. The predominant crops farmed tend to have waterlogged environments conducive to mosquito breeding; there is no prominent alternative economic activity that could substantially enhance incomes in this region. Where agriculture is practiced, the majority of households engage in farming primarily for subsistence rather than commercialization. Approximately 74% of farm households report at least one incidence of malaria a year [12, 13]. Limited access to health services compounds this burden; farmers residing farther from health facilities frequently resort to self-medication and traditional herbs, which are ineffective against malaria [3, 9]. Larger farmland areas directly increase the incidence rate of malaria; for instance, each unit increase in farm size corresponds to a 0.014 rise in the incidence rate. Greater exposure during farming activities makes the main breadwinner's health crucial for productivity; when incapacitated by malaria, the household's ability to sustain daily work and agricultural output declines, further restricting income and undermining efforts to improve living conditions. Age negatively correlates with incidence: older household heads have higher malaria rates, possibly due to light to moderate immunity. Educational attainment also inversely affects malaria risk, as higher levels correspond to reduced incidence, underscoring education's role in prevention and control [12].

Cultural Aspects

The widespread perception of "malaria" as a "fever" complicates disease prevention and control [13, 14]. Beliefs about causality are not always consistent with scientific evidence and vary across socioeconomic groups. Houses and land closest to the rivers are more affected by severe and repeated malaria attacks because of potential mosquito breeding sites in the swamps, and also because the inhabitants are mostly unable to afford protection. Higher-SES respondents are more likely to describe "malaria" as a mosquito-borne disease, while lower-SES groups give a wide variety of explanations rooted in the cultural domain [3, 16]. Historically, a number of factors have affected the control and elimination of the disease, ranging from inadequate attention to the disease to widespread development strategies, but the occurrence of malaria in the highlands of Madagascar in recent years cannot, nevertheless, be fully accounted for [1]. Despite declining trends, the burden of malaria continues to be a formidable one in many countries, both in terms of morbidity and mortality. Biological, ecological, and epidemiological aspects of malaria transmission have been extensively studied; however, there is evidence to suggest that socio-economic factors and health care availability may also play an important role in the persistence of the disease [2, 17].

Cultural Beliefs and Practices

As with most infectious diseases, the pattern and distribution of malaria are determined by the dynamic interaction between agent, host, and environment. However, people and demographic factors are central to any understanding of the epidemiology of the disease [4]. Demographic patterns provide an inventory of people and their characteristics, whereas patterns of behaviour influence the degree of risk to any demographic subgroup. Finally, activity modifies the likelihood of being infected given the risk present in an environment. Social and economic factors are crucial to the persistence of malaria [13, 14]. Poverty is often cited as a cause, along with poor housing, lack of education, inadequate prospects of employment and income, poor diet, inadequate health delivery services and health education, and the absence of effective preventive measures[2]. Urban malaria can result from a combination of these and other factors not normally present in rural areas, such as the abundance of A. aegypti in cities and towns. Other factors lead indirectly to the development of malaria, e.g., major development projects that cause sudden population changes and sometimes an absence of government control[3, 8].

Community Engagement

Malaria continues to cause nearly 400,000 deaths each year, with most fatalities occurring in sub-Saharan Africa. Nearly half the world's population remains at risk of infection. On the path towards elimination, malaria transmission becomes increasingly concentrated in specific geographical pockets, vulnerable populations, and demographic groups [4, 5]. The 'last mile' to malaria elimination is filled with greater complexities. Community engagement (CE) has received increased attention in the recent COVID-19 pandemic due to an unprecedented burden on healthcare systems around the world, and has been identified as an essential component of malaria elimination strategies [4, 17]. Malaria elimination programmes, therefore, need sustained investment in CE to achieve elimination goals. CE encompasses a variety of activities aimed at achieving specific malaria-related outcomes. When programmes were administered by colonial governments, CE was often implemented to create demand for services or to compel participation in interventions [3, 17]. While CE in the 21st century has moved away from mobilising populations for top-down objectives, participation in malaria initiatives is still not always voluntary. Recipient populations tend to prefer CE approaches that acknowledge their personal circumstances and offer agency. CE requires programmes capable of implementing intervention packages that extend beyond biomedical tools, and incorporate community voices and local perspectives, particularly in tailoring interventions to hard-to-reach groups. Communities have a substantive role in shaping these initiatives, influencing when and how individuals participate in activities intended to improve community health. CE remains a critical component for eliminating malaria and restricting the spread of drug- and insecticide-resistant parasites and vectors [14, 15, 16].

Policy and Governance

National health policies and government programs address malaria through strategies such as vector control, chemotherapy, vaccine development, and early diagnosis, aiming to reduce transmission and provide effective treatment [16]. International efforts foster cooperation among governments to oversee prevention, detection, and treatment activities, requiring various degrees of research and surveillance [12, 16]. Continued investment in research and community support, coupled with aggressive application of current insecticides, drugs, and diagnostic tools, is critical to decreasing morbidity and mortality [1]. Various strategies focus on preventing initial infection (prophylaxis), reducing disease severity, or speeding recovery. Prevention employs insecticides, bed nets, protective clothing, and removal of mosquito habitats; treatment uses chemotherapy and vaccines.

Health Policies

Public health interventions play a key role in disease control and prevention. Some interventions require physical infrastructure, such as sanitation and health care facilities, whereas others require knowledge and behaviour change, such as the use of insecticides and the management of stagnant water that serves as a breeding ground for mosquitoes [4, 6]. The former are expensive to introduce and maintain relative to the economic circumstances in many countries where malaria is endemic [3]. The global strategy for malaria control and elimination, therefore, recommends interventions that are not resource-intensive, such as insecticides and insecticide-treated mosquito nets, for household use [3, 15]. Many countries have policies that explicitly or implicitly address malaria [7, 16]. At the Global Malaria Summit held in the United Kingdom in 2021, for instance, the Government of Tanzania signed the Call to Action on Malaria, a global declaration designed to increase malaria interventions, control, and elimination. Many governments also have national malaria control programmes that provide free diagnosis and treatment of malaria and distribute impregnated nets to the public [4, 5]. Many also regulate the importation of anti-malarial drugs and restrict the sale of prescription drugs to protect the public from exploitation. International bodies and funding agencies such as the World Health Organization (WHO), welfare organisations, and charitable trusts also have various programmes to help countries to combat malaria; the WHO provides technical support for national programmes, helps in training personnel, and provides financial support to countries in need[7, 16].

Government Initiatives

The government plays an important role in controlling and eradicating malaria through medical treatment and prevention. Direct funding is dispersed to health care facilities equipped with drugs and insecticide-treated bed nets via primary health care programs [2]. The scope of government support, which includes financing via taxation, recruitment and training of personnel, and maintenance of infrastructure, varies by country. Governments also contribute resources to international efforts such as Roll Back Malaria, and the Global Fund to Fight AIDS, Tuberculosis, and Malaria [1, 13]. The persistence of elevated levels of malaria in many regions of the world reflects, in large part, inadequate government support.

International Cooperation

International cooperation played a catalytic role in malaria elimination. Between 2000 and 2020, 96 countries controlled malaria, while the remainder, mostly in the Sahel, coastal West Africa, and Papua New Guinea, still witnessed localized variation in transmission [2, 17]. Since then, the global caseload has been estimated at 241 million cases, which in Africa largely results from the recently reemergent Anopheles funestus 6. Several 2030 targets are currently under review, especially with respect to PfPR30–40[3, 5]. What the historical record shows is that neither economics nor climate change alone can explain contemporary manifestations, especially in light of the varying experiences of regions such as Madagascar and recently independent southern African states [16]. In the absence of significant income growth, development challenges are currently best framed as multifactorial, and resolving the preceding appears to require a combination of rapid creative and collaborative problem-solving (with a heavy emphasis on future-proofing), ongoing diligence, and institutional capacity[3, 14]. A promising approach builds upon a longstanding perception that malaria mortality lies at the "cores" of civilizational collapse, and hence the very enduring of colonial administrations while also remaining a powerful indicator of contemporary state failure, even in predominantly nonmalaria-seasonal settings[2, 5]. Various phenomena identified with "state failure" are already known to increase malaria risk, and so it is important to understand why it should appear quite so dominant and variable by geographical space and time. The examination then predicts that, conditional on a wide variety of prerequisites, a very strong correlation between PFPR and state capacity should emerge under stable administrative conditions [2, 18]. The full picture also requires insight into the role of state capacity in reducing PFPR, which physics-based arguments interpret as a form of "friction." Ratios of PFPR between successful and challenger states favor a single interpretation, which is further confirmed by the tendency of irregular governance around the Sahelian "epicenters" to delay malaria elimination far longer than the quality of climate can explain[2, 16].

Economic Impact of Malaria

The economic impact of malaria extends beyond health considerations, influencing societal structures and individual livelihoods [1, 3]. Direct costs include expenditures on treatment, prevention, and vector control measures. Indirect costs, often more substantial, encompass reductions in agricultural productivity, school attendance, and overall economic growth [3]. The disease also imposes broader consequences, such as environmental degradation, educational setbacks, and poverty perpetuation, which feed back to fuel transmission dynamics [1]. Malaria constitutes a significant impediment to socioeconomic development, with annual GDP losses estimated between 0.6 and 1.3% in highly endemic countries, primarily in sub-Saharan Africa.

Cost of Illness

The economic consequence of malaria encompasses both direct and indirect expenses borne by individuals, households, and their wider communities [17]. Direct expenditures refer to the outlays involved in diagnosing and treating the illness, including the costs of drugs and payments for medical consultations and laboratory investigations. In many malaria-endemic regions, a greater proportion of the population relies on private facilities than on public healthcare providers [18]. The private sector is often preferred for reasons of better quality, proximity, shorter waiting times, and greater flexibility in payment; however, its services and drugs tend to be costlier. Moreover, the choice of care provider is influenced by economic status, geographical accessibility, and perceived disease severity [4, 8]. In addition to direct costs, the overall economic impact of malaria includes productivity losses associated with treatment-seeking and convalescence, delays in pursuing alternative activities, and the time lost while caring for sick relatives and seeking care on their behalf. Such economic burdens result in a substantial annual drain on household resources; with limited capacity to cope, many families resort to the sale of their assets or deplete their savings, thereby entering a cycle of poverty[3, 6, 12]. Consequently, the microeconomic effects of malaria extend well beyond each clinical episode, influencing broader household stability and well-being.

Impact on Productivity

Malaria has a significant detrimental effect on economic development, health expenditures, and consequently on household and individual economic status, particularly when access to preventative and curative treatment is lacking [1]. Malaria imposes substantial microeconomic and macroeconomic costs that influence decisions about land use or migration, wealth accumulation, fertility, and schooling, which in turn shape malaria risk. Estimates suggest an average loss of eight work or school days for each untreated malaria episode, resulting in enduring socioeconomic impacts on individuals and communities [2]. Because the disease predominantly afflicts the economically and socially disadvantaged, its economic and social consequences exacerbate existing inequities.

Long-term Economic Consequences

An attack of malaria does not need to be fatal or particularly severe to have long-term economic consequences. Malaria-induced morbidity frequently causes a temporary loss in labour supply, placing huge strains upon household budgets [2]. Regarding a household functioning with only one or two primary wage-earners, relationships between serious illness and the ability to earn income receive emphasis, and latent economic consequences become apparent[3, 17]. Modelling suggests a deep and long-term impact on economic growth rates and levels. Attempts made to associate malaria prevalence with average income per prime-age adult in a Malawian agricultural labour market show informality and temporality, the headings most closely associated with economic activity in high-risk domains[6, 15]. Moreover, models implementing forward-looking microeconomic behaviour indicate that reduced investment in physical and human capital may be a key mechanism for the observed differences. "Downstream" consequences on assets and future earnings mask an ongoing income loss after an illness event ends, and large drops in lifetime earnings are predicted by simulation [1]. Modelling done in a geographical setting emphasizes the importance of investigating interactions between economic, political, and natural environments when trying to explain the persistence of malaria and related impediments to economic development.

Case Studies

In the Mutasa district of Zimbabwe, various household factors influence malaria prevalence, including gender, household age structure, occupation, housing type and materials, hygiene, lighting, sanitation facilities, location, proximity to water sources and health facilities, wealth, education, knowledge of malaria, cultural practices, nutritional status, coexisting diseases, and intervention strategies[3, 6]. Despite a reduction in incidence from 136 per 1,000 in 2000 to 22 per 1,000 in 2012, malaria remains a leading cause of morbidity, with 480,000 cases and 713 deaths reported in 2014. The occurrence of malaria depends on the mosquito vector, human hosts, parasites, and environmental conditions. Research emphasis has tended to focus on biological factors rather than household determinants [2]. In the Gambia, non-severe malaria among children is related to socioeconomic and environmental factors [5, 17]. Comparable studies have similarly implicated socioeconomic and environmental determinants in Peru, Yemen, Tanzania, and other contexts. Access to healthcare and socioeconomic status strongly influence children's vulnerability to malaria, while spatial variation in infection prevalence within northeastern Tanzania is also associated with socioeconomic indicators. These collective findings underscore the importance of spraying, bed nets, and wealth in modulating malaria risk [18]. A systematic review spanning 1980 to 2018 identified 33 social determinants of malaria [2]. Increased risk is associated with adulthood, nighttime outdoor activity, and failure to adopt preventive measures. Intermediate determinants encompass dwellings characterized by poor physical and sanitary infrastructure, overcrowding, forested locations, and the presence of domestic animals. Socioeconomic factors involve engagement in agro-forestry, migration, low income, and limited education. Malaria generates substantial economic losses, contributing to poverty and educational setbacks [4].

Regional Case Study 1

Malaria persists in Sub-Saharan Africa due to climatic, environmental, and socioeconomic factors, despite global efforts to control the disease [6]. Socioeconomic inequalities play a major role in the prevalence of malaria throughout Sub-Saharan Africa, and the disease disproportionately affects the poorest segments of the population. Malaria transmission exhibits strong spatial heterogeneity at the subnational level, influenced by ecological conditions, housing quality, population mobility, and socioeconomic status [3]. Household determinants of malaria include gender, household age, occupation, type of housing, household hygiene, lighting, sanitary facilities, household location, water sources, health facilities, household income, education, knowledge of malaria, religion, culture, nutritional status, presence of other diseases, and malaria intervention strategies [2]. The Intermittent Preventive Centre for Malaria in Pregnancy (IPTp) remains one of the most efficacious tools to prevent malaria during pregnancy; however, socioeconomic barriers restrict access to services that provide IPTp [2, 6].

Regional Case Study 2

Malaria continues to impose a substantial public health burden in several countries despite significant declines over the past 15 years; Zimbabwe remains among the most affected [2]. Reasons for its persistence remain poorly understood, hampering efforts to achieve further reductions [10, 12]. Plasmodium parasites are transmitted by Anopheles mosquitoes; malaria disproportionately affects young children and pregnant women due to their relative immunity [6]. The life cycle comprises the initial liver stage and the subsequent erythrocytic cycle, the latter causing symptoms. The 2016 introduction of a pilot malaria vaccine offers hope, although mechanisms of immunity remain unclear. Recent work supports an inverse relationship between malaria prevalence and socioeconomic status, potentially explaining persistence [2, 8]. Environmental factors such as arid climates, deforestation, irrigation, rainfall, and temperature also contribute; associated environmental changes induced by socioeconomic factors remain largely unexplored. Active case detection indicates a strong socioeconomic component behind malaria occurrence in Mutasa District, Zimbabwe. Receiving wood or food from neighbors correlates with both malaria risk and socioeconomic status, suggesting complex interactions drive transmission[3, 16]. To curb malaria through socioeconomic mechanisms, a spatially explicit understanding of transmission processes is needed to guide targeted interventions. Socioeconomic status acts as a barrier to malaria elimination; without appropriate measures, the disease will persist despite ongoing efforts.

Comparative Analysis

Combating infectious diseases such as malaria requires the identification of not only the immediate biological drivers of transmission but also the underlying social determinants that mediate exposure of human populations to pathogens [2, 7]. An extensive body of social science research demonstrates the importance of socioeconomic status in shaping malaria risk globally, with poor individuals living either in high-endemic rural areas or malaria-receptive urban environments or migratory groups as the most vulnerable [1]. This section presents recent data from Madagascar on social inequalities in malaria prevention and prevalence among children under 5 years and women aged 15–49, alongside spatial patterns of socioeconomic inequalities in the prevalence of malaria across sub-Saharan Africa [5, 9].

Interventions and Solutions

Preventing malaria requires a comprehensive approach combining vector control, access to effective treatment, and community engagement [2, 9]. Preventive measures include insecticide-treated mosquito nets, indoor residual spraying using insecticides, and larval source management that targets mosquito breeding sites. Climate-based early warning systems provide forecasts of transmission risk, enabling targeted vector control and seasonal chemoprevention [9]. Treatment guidelines from the World Health Organization (WHO) specify artemisinin-based combination therapies for uncomplicated Plasmodium falciparum malaria [11, 12]. For severe malaria, the recommended first-line treatment involves parenteral artesunate, followed by a full course of artemisinin-based combination therapy once the patient can tolerate oral medication. Access to effective medicines and diagnostic testing remains a significant barrier, especially in the private sector and among vulnerable populations such as children under five, pregnant women, and individuals with HIV/AIDS [2]. Community participation plays a critical role in the success of vector control programmes [5]. Local knowledge of regions with high malaria incidence and of mosquito habitats can inform targeted interventions. Such involvement also fosters sustained community support for elimination efforts by increasing engagement with health interventions and enhancing resilience to future parasite reintroductions [5].

Preventive Measures

The primary determinants of malaria transmission appear to be improper use of preventive measures and barriers to accessing healthcare [2, 16]. Preventive methods are available in endemic regions, but deploy their protective effects variably due to differences in spending and environmental conditions, such as the availability of indoor window screens and pesticides [2, 15]. Although indoor residual spraying is effective in some locations, existing government programs often fail to reach the most vulnerable populations; the decline of malaria incidence in the pre-intervention period reflects greater overall health investments. Conventional interventions designed around the epidemiological context, therefore, require adaptations that prioritize the management of socioeconomic determinants [4, 13]. Screening is a reasonably effective cascade step, with better knowledge of malaria and adherence to preventive procedures reducing the burden substantially. Improving the distribution of preventive tools is crucial for reducing incidence, but demands an assessment of education, information transmission, and access barriers before additional investments can be justified [1, 15]. Targeted communication technologies that fulfill awareness needs provide a complementary route to improved control if precautionary measures have yet to penetrate low-income subpopulations.

Treatment Strategies

All Plasmodium infections are treated with antimalarial drugs, for example, P. falciparum infections with artesunate–mefloquine, P. vivax infections with chloroquine, and the combined infections also with artesunate-mefloquine [5]. The choice of artemisinin-based combination therapy depends on local resistance and national guidelines [5, 8].

Community-Based Approaches

Malaria remains among the world's most challenging infectious diseases, with an estimated 3.3 billion people, nearly half the global population, exposed to risk, contributing to around 660,000 deaths and 249 million cases reported in recent years [3, 15]. Increased efforts are needed to sustain long-term malaria elimination strategies, probing factors impeding progress [2, 11]. As an ancient disease, malaria has shaped global history since the origin of mankind. It is transmitted to humans chiefly through the bite of infected Anopheles mosquitoes released during the transition from aquatic to terrestrial life [2, 15]. Transmission depends on conducive environments for mosquito breeding, often in stagnant water supporting larval development and the simultaneous presence of infected humans [3, 16]. Mosquitoes inject plasmodium parasites along with other blood proteins during feeding, and disease propagation requires uninterrupted cycles of mosquito–human contamination, with parasites multiplying both hosts before subsequent spread [2]. High transmission persists when preventive or therapeutic measures are insufficient, and environmental conditions favour ample mosquito populations [1].

Future Directions

Future Directions Research on the socioeconomic determinants of malaria transmission has paved the way for a new generation of malaria control strategies, focused on social characteristics that enable transmission [4]. These new techniques highlight questions ripe for further investigation [3, 18]. For example, the vectors of malaria clearly depend on such socioeconomic characteristics as access to housing and netting, but many of the underlying behaviors do not depend on social characteristics, or are, indeed, rooted in the fundamental biology of the mosquitoes [4, 17]. In addition, many personal decisions proceed independently of the state and socioeconomic status; for instance, there is little mistaking the anopheles mosquito when it bites, and few have developed immunity to its bite in places where malaria and the mosquito are highly prevalent. Qualitative studies exploring how individuals respond to human–mosquito contact would provide important insights [2, 6].

Research Gaps

Understanding the determinants of persistent malaria presents an extensive and multidisciplinary agenda. Given the continued challenge of malaria elimination, researchers need to broaden the scope of inquiry by asking new questions and designing innovative studies on the socioeconomic determinants of malaria persistence [4, 6]. There is therefore a pressing need to develop more nuanced approaches and novel methodologies applied to socioeconomic determinants of health to more effectively reduce malaria transmission and finally put an end to this disease [4]. The literature on malaria acknowledges the existence of a wide range of social determinants that are believed to impact the persistently high rates of malaria in certain population groups, but few attempts have been made to collate them. Reliance on academic literature means that certain determinants, such as the impact of gender roles, have yet to be unpacked, while others, like the influence of poverty, are found in abundance [5].

Innovative Solutions

A suite of sociodemographic and economic factors drives the persistence of malaria in low- and middle-income countries. Cost-effective approaches that do not increase pressures on existing public services could also contribute to weaker and more fragmented pathogen transmission networks [18]. Innovative solutions have positive externalities for humanitarian responses and act synergistically with control and elimination efforts [13, 17]. In Zimbabwe, existing malaria control programmes remain ad hoc, and malaria control measures predicated on national or district scale data are less sensitive to the underlying spatial dimension of malaria risk [2].

CONCLUSION

Malaria persists as a major global health challenge not solely due to biological or environmental drivers, but largely because of entrenched socioeconomic inequalities. Poverty, poor housing, limited education, inadequate healthcare access, and cultural perceptions remain central to sustaining transmission in endemic regions. The economic consequences of malaria, ranging from direct treatment costs to long-term productivity losses, reinforce cycles of poverty and hinder national development. Climate change, urbanization, and agricultural practices further complicate malaria dynamics, often disproportionately affecting marginalized populations. Therefore, eliminating malaria requires a multidimensional approach that integrates socioeconomic interventions with biomedical strategies. Policies must prioritize poverty alleviation, education, improved housing, equitable healthcare access, and robust community engagement, while fostering international cooperation and sustained governance commitment. Only by addressing these interlinked determinants can malaria control progress towards lasting eradication and socioeconomic transformation in endemic regions.

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