



Short Communication



Malaria vaccine: The lasting solution to malaria burden in Africa

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ABSTRACT

Malaria is one of the deadliest infectious diseases in Africa. Many measures have been taken over the past few years to reduce the burden of malaria on public health following the recommendation of WHO, still, malaria has continued to rake devastation in Africa. Combating malaria in Africa has grown into an international concern. The eradication of malaria is a long-standing goal of public health initiatives globally. The development of vaccines will go a long way to provide the required immunity needed for the people living with malaria or vulnerable to malaria. It is imperative that a vaccine should be produced and rolled out for use, especially during the time of the COVID-19 pandemic when attention is given to mitigating the impact of the pandemic on public health. The malaria vaccine will reduce the number of hospital admission for malaria illness among children and other age groups. Africa will need to build strong innovations to overcome country-specific challenges in vaccination drive, human resources, and supply chain management. Accelerating education, sensitization, diagnosis, and eradication through joint efforts of the government, healthcare professionals and general population will help to prevent the dual synchronous epidemic of COVID-19 and Malaria in Africa.

1. Introduction

Most of the malaria cases and deaths are reported widely in the African continent, this is due to the ubiquitous level of the parasite *Plasmodium falciparum* that is spread by the female anopheles mosquitoes in Africa [1]. Among the five parasites species that cause malaria in human beings, *P. falciparum* and *P. vivax* pose the greatest menace [1]. In 2018, *P. falciparum* accounted for 99.7% of estimated malaria cases in the world health organization (WHO) African region, 50% of the malaria cases in the WHO South-East Asia region; 71% of the malaria cases in the Eastern Mediterranean, and 65% of the malaria cases in the Western

Pacific [2]. The WHO African region carries a disproportionately high share of the global malaria burden [3]. In 2019, the African region accounted for 94% of Malaria cases and deaths [1,3].

Malaria posed a threat to over half of the world's population in 2019, however, Sub-Saharan Africa accounts for the majority of malaria incidence. Besides, the WHO regions of Eastern and Mediterranean, South-East Asia, Western Pacific, and the Americas were also at risk. Niger (4%), Mozambique (4%), Burkina Faso (4%), United Republic of Tanzania (5%), Democratic Republic of Congo (11%), and Nigeria (23%) accounted for over half of all Malaria deaths globally in 2019 [4]. Malaria eradication has been a long-standing agenda of public health

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interventions globally. Malaria remains one of the deadliest infectious diseases globally, by maintaining the top 10 causes of early death according to the 2017 Global Burden of Disease study [5].

1.1. Challenges facing malaria in Africa

Malaria has claimed millions of lives in Africa over the years. Despite medical advances, the malaria burden continues to be a problem. Malaria causes so many illnesses and deaths in Africa, consequently, national economies suffer great loss. However, countries of low-income and lower-middle-income countries in sub-Saharan Africa fall into a cycle of disease and poverty due to depletion of human capital and finance [6]. Consequently, countries are less able to finance or sustain intervention programs, and malaria prevails.

Without adequate health financing, health systems are threatened, the rate of research declines, the purchase of essential commodities for malaria vector control falls off such as long-lasting insecticide-treated nets (LLINs), indoor residual spraying (IRS) rapid diagnostic testing equipment (RDTs), microscopy equipment, and antimalarial drugs such as artemisinin combination therapy (ACTs) for treatment and intermittent preventive therapy. Skilled human resources and health workers cannot be managed without proper incentives. The supply and distribution of drugs and other interventions are also inadequate. These together lead to poor health service quality [7]. Supplying effective drugs and commodities for malaria prevention in Africa become a challenge because the structure of supply chains resembles the administrative structure of different African countries, as a result, multiple tiers or stopping points emerge which often negatively influence the distribution [8].

Africa also face challenges with infrastructure, getting products to the most remote locations and storing them properly remains a big challenge, even with storage facilities, these centers are usually out of stock of at least 30% of the core medicines [9]. Poor supply chain management is not necessarily limited to an infrastructural problem but could be an issue of poor information flow and weak incentives for the personnel involved, the shortage of adequately trained procurement and supply management officers, lack of coordination, multiplicity in reporting requirements for different donors, and weak inventory management capacities.

In Kenya, a recent study by Were *et al.*, highlighted the socioeconomic inequality in the utilization of malaria interventions [10]. Malaria, the top endemic in Kenya, with 70% of the population at risk was reported as the most prevalent case in the people of the poorest socioeconomic quintiles compared with the less poor quintiles. The poorer socioeconomic groups showed no significant difference in care-seeking behavior compared to the less poor quintiles.

However, the poorest groups were less likely to get adequate access to the most effective medications, which could be because of geographical or social inequalities that make primary health centers inaccessible. Another study in Nigeria showed that in the Southeastern region, the wealthier population presented more cases of malaria compared to the poor population [9]. However, it is important to note that malaria is often misdiagnosed and the wealthier socioeconomic class has better access to healthcare. The disparity of Malaria outcomes among social classes highlights the deep complexity of the situation where the poor don't have access to quality healthcare providers and medical checks due to social-economic factors like poverty and low income, also poverty and low medical awareness create an imbalance between having an early diagnosis to treat malaria accurately with medical intervention.

However, most of the poor people adopt conventional treatment to treat themselves without precise medical diagnosis [26], this, therefore, raises the prevalence of malaria-like diseases which share similar symptoms like high fever, headache, vomiting, muscle pain, sore throat and among others, such disease include Chikungunya, Dengue virus, Zika virus etc [27,28]. Malaria, just like every other primary infection,

can cause a patient with sickle cell to experience a discomfort emergency or a sequestration collapse; this is in addition to the fact that malaria will render sickle cell patients' anaemia worse, perhaps to the point of being life-threatening [29]. Significant demographic research conducted in Kenya found that infants with sickle cell do not have an increased risk of contracting malaria compared to healthy children; nonetheless, the risk of dying of infants with sickle cell who contracted malaria was almost ten times greater than that of healthy children [30].

Due to health financing constraints and the poor human resource management that take out the incentive to work efficiently or remain in Africa, a great number of these doctors and nurses that were so expensive to train migrate, fueling the deep complexity of the crisis of human resources for healthcare in Africa [10–15]. In 2020, Niger presented the highest rate of illiteracy of 35%, which have reflection on the account of 4% of all Malaria cases globally, an alarming statistic because Niger had a population of close to 23 million in the same year. In Niger, Malaria is a common cause of absenteeism from school, and sometimes the elder siblings need to stay home to help, and because of the absence of universal health coverage, families that fall below the poverty line due to the cost of health care cannot afford education and this throws them into a cycle of illiteracy and poor access to healthcare [16].

Research findings that have been undertaken to assess the worldwide economic strain and cost of malaria have typically focused on personal and governmental healthcare costs related to disease and even some estimate of the revenue that is forfeited due to malaria mortality and morbidity [21–25]. In this context, "individual health care costs" refer to the money spent on one's own health in areas such as preventing disease, diagnostic, treatments, and maintenance [22]. Bed nets, hospital attention, anti-malarial medication, and conveyance to and from treatment centers, as well as any further care needed, all contribute to these costs [23]. Healthcare costs borne by the public sector other than the commercial sector include those for illness prevention as well as treatment [23]. Government investments in areas such as vector control, healthcare infrastructure, educational programs, and scientific inquiry are included [24]. Lost wages due to malaria and malaria-related disease are often measured by multiplying the number of workdays missed by the average daily salary in the affected area [24]. Foregone income due to early death is computed by capitalizing the predicted incomes for different age ranges, basic lifespan data, and age-specific fatality rates [24].

Those in the bottom income quintile bear a disproportionately heavy burden, according to these findings [23,24]. However, the estimates, which are often less than 1% of GDP, fail to take into account the full extent to which the condition hinders long-term growth in the economy [25]. Essentially, conventional studies have employed accounting methods that assume the monetary costs of malaria can be calculated by multiplying the average cost of a personal episode of illness by the total number of cases experienced, and then adding any operating expenses frittered away in prevention and treatment [22–24]. Such approaches may be reasonable when there are only a few cases of a disease (for example, when there are diseases in the United States and other countries due to tourism in malaria-endemic regions), but they make little sense when applied to circumstances with high transmission [25].

2. Malaria vaccine in Africa

Malaria is the most common and preventable infectious disease in Africa, the estimated number of malaria death stood at 409,000 in 2019 [17]. Out of the total death in 2019, 67% (274,000) of death occur in children under five [18]. Many measures have been taken in the past few years to reduce the burden of malaria infection, these measures include seasonal prevention therapy and distribution of LLIN at hot spot areas in each African country. Despite the large pool of financial and human resources to mitigate the malaria incidence rate in Africa, the endemic countries in Africa still face the challenge of inadequate funding, and a weak healthcare system, which has a great effect on the prevention and

treatment of malaria strategies in Africa.

Hence, there is a need for a better strategy to reduce the burden. These burdens can be reduced by providing a lasting solution to curb the spread of malaria. However, to relieve the burden, the development of vaccines will go a long way to provide the required immunity needed for the people living with malaria or vulnerable to malaria. It is imperative that a vaccine should be produced and rolled out for use, especially during the time of the COVID-19 pandemic when attention is given to mitigating the impact of the epidemic on public health.

Thanks to the effort of WHO that ensure that a malaria vaccine is produced, in 2019 the pilot malaria vaccination project started in three hotspot zone in sub-Saharan Africa that experiences high rate of malaria infections, this project was implemented by WHO and supported by other partners like UNICEF, PATH [19].

Three African countries that were used for the Pilot project include Malawi, Ghana, and Kenya; the purpose of the pilot is to evaluate the:

1. The efficacy of the vaccine,
2. The possibilities of delivering the required dosage in routine immunization context,
3. The vaccine's safety profile in the context of routine use.

The RTS, S Malaria vaccine that is the first vaccine effective against *Plasmodium falciparum*, which is the most common deadly Malaria parasite globally [20]. The vaccine was developed more than three decades now, by GSK with collaboration with PATH's Malaria vaccine initiative and a network of African research centers. Children will receive the first vaccination age 5–6 month and the second dosage at age two years because of how vulnerable they are to the malaria parasite. However, the vaccine cannot be administered to all African countries till lesson learnt from the pilot implementation to ensure effective broader use of the vaccine.

3. Recommendations

To improve Malaria vaccination efforts, broad-based interventions and innovations need to be developed to properly manage health financing, and to provide efficient human resources, to reduce inequality, to ensure that knowledge, prevention, and treatment are improved among Africa's most vulnerable populations and to provide the necessary infrastructure and supply of effective drugs and vaccines.

Africa needs stakeholders to focus on developing effective transport management systems, information networking systems for improved communication among tiers leading to a streamlined flow of data; it needs to focus on developing inventory management policies with strong involvement from the government with clear responsibilities and roles ruled out.

Another major recommendation is the need for proactive leadership and increased epidemiological surveillance in Africa. Inter-communication within the national healthcare system should be enhanced to increase monitoring and recording of cases and increasing preparedness.

Africa needs to build strong innovations to overcome country-specific challenges in human resource and supply chain management. Better-educated mothers strongly influence efforts put into preventing and treating Malaria in their households and ensure the education of their children. Children with mothers whose education was beyond primary school level are less likely to be Malaria-positive; this emphasizes the need for educating male and female populations. With great efforts to reduce the statistics of Africa's illiterate population, the challenge of Malaria will show a great decline.

Many countries in Africa are resource poor and are unable to meet the health care need of the population. This must change and actions from all sectors of the economy to alleviate and eventually eradicate the burden of Malaria through vaccines in Africa. Political actors must be willing to invest more in public health measures that will translate to

eradication of Malaria through vaccines in Africa. There are other actors and player in the eradication of Malaria through vaccines in Africa. These actors and players include international donors, local and international non-governmental organizations whose ideals and agenda may not be in tune with the Ministry of Health of health authority of the nation concerned. In other to achieve a united focus in the eradication of Malaria, all players at different levels will need to come to the table and forge a common agenda that is in the interest of the population.

International donors, local implementing partners, political decision-makers, and prevailing conditions are all interwoven and kinked in decision-making. How health problems are articulated, the interest of policy stakeholders, or institutional arrangements governing decision-making all play important roles in shaping when, how or why certain forms of evidence are utilized. This inter-play and the attendant forces pose a challenge for Malaria eradication as the intended actions of funders and local prevailing conditions may clash and, in the process, affect program implementation and planning.⁴⁰

A summary of challenges, opportunities, and recommendations regarding Malaria vaccine in Africa is provided in Fig. 1.

4. Conclusion

The emergence of COVID-19 in Africa complicates the prevalence of Malaria and progress in Malaria vaccine in the region, hence creating a dual synchronous epidemic in the Africa, which presents an urgent threat to the healthcare system. Accelerating education, sensitization, diagnosis and eradication efforts requires a joint responsibility from healthcare professionals, the government, institutions and the entire populace at large.

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Author contributions

ATA, MMH: conceived the idea, designed the study and drafted the manuscript.

AOA, ATA, MAB, AFO, MMH: conducted literature search and created the illustrations.

DOK, MS, MSH, MB, MMH: revised the manuscript critically and refined the illustrations.

MMH, ATA, JOI, AAA and AOA: revised the final version of the manuscript critically and gave the final approval.

Data availability statement

Not applicable.

Registration of research studies

1. Name of the registry: NA
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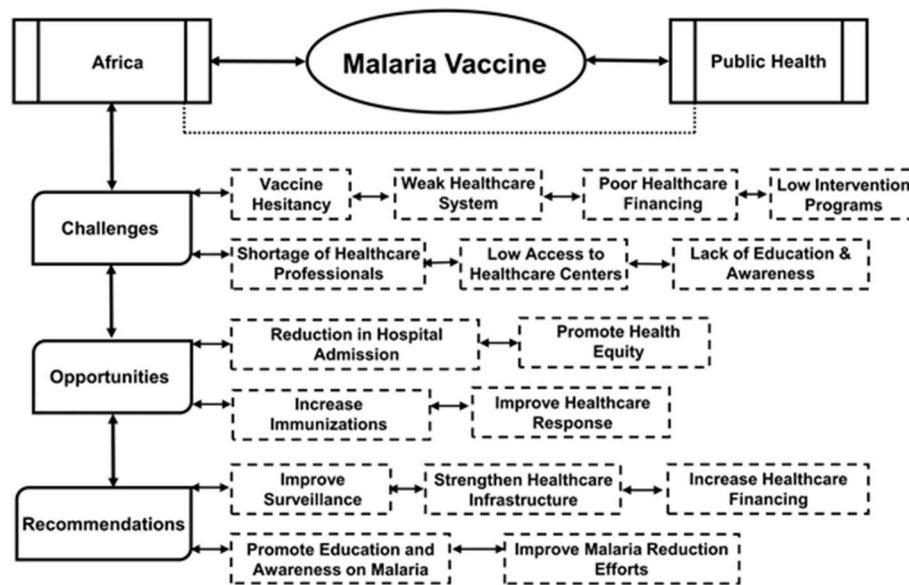


Fig. 1. An overview of challenges, opportunities, and recommendations to combat malaria in Africa.

Consent

NA.

Declaration of competing interest

NA.

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