

Malaria in Sub-Saharan Africa: Current Situation and Future Strategies

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Abstract. Malaria is a life-threatening disease caused by parasites, which can be transmitted by mosquitoes. Some population groups, such as newborn babies, children under five, and people in pregnancy, are vulnerable to malaria and may likely develop severe diseases. Nearly half of the population around the world was at risk of developing malaria in 2020, even though many countries have successfully eliminated malaria already. Thus, there is an urgent need to eradicate malaria around the world. Although malaria incidence has decreased significantly due to the worldwide implementation of various interventions, sub-Saharan Africa (SSA) holds a significant portion of the cases and deaths. Thus, it is critical to reduce malaria incidence in SSA in order to reduce the global malaria burden. This article summarizes the policies implemented from past to present in SSA the challenges that the region currently encounters, and future strategies the region should develop based on the success of past practices of other countries.

Keywords: Malaria, Sub-Saharan Africa, Intervene, Policy.

1. Introduction

Malaria is a severe disease caused by *Plasmodium* parasites. Female Anopheles mosquitoes that carry the parasites may easily transmit malaria to humans. Malaria becomes one of the serious public health problems around the world. It is still one of the major diseases that cause many deaths worldwide, especially within developing regions. The symptoms developed, such as fever and headache, usually appear one to two weeks after the infection and are difficult to diagnose. Without early diagnosis and proper treatment may lead to severe illness and death. Although many countries have successfully eliminated malaria, it was estimated that almost 50% of the population around the world was at risk of developing malaria in 2020 [1]. Malaria nowadays still affects many developing countries in both the subtropics and tropics. The SSA region accounted for above 90 percent of all malaria cases and deaths around the world [2]. Some population groups are at a higher risk of malaria and developing severe diseases, such as pregnant women and people under five years of age [1]. In 2016, more than 70% of deaths caused by malaria in SSA occurred in children under five [2]. Existing interventions such as Roll Back Malaria (RBM) in 1998 were effective to control malaria [2]. However, further actions are needed to help in reducing SSA's burden of malaria. Clarifying the challenges that SSA faces, such as poverty, geographic conditions, and government support, can help to better create country-specific interventions for further malaria control. Saving SSA from serious malaria situation is critical to the future eradication of malaria worldwide. This literature review summarizes malaria interventions in SSA and their challenges, with the goal of providing guidance for effective interventions that could be implemented in the region to help eradicate malaria in the future.

2. Policies from Past to Present in SSA

In the 1940s, during World War II, DDT spraying emerged as an effective intervention against malaria by the US Army. With the success of DDT in malaria elimination, DDT spraying became widely adopted by many malaria control programs soon. However, its massive application resulted from drug resistance in mosquitoes, which was first found in 1951. After that, the first program for global malaria elimination called GMEP was launched by WHO. GMEP became highly successful

in malaria eradication from more than twenty countries in Europe, the Americas and Asia. However, the widespread of using DDT and chloroquine in the long term led to drug resistance issues, and finally, GMEP was suspended in the late 1960s. Malaria cases quickly rose to the pre-intervention level in the presence of abruption of the malaria elimination attempt. As the cases continually increased, it led to an epidemic level in SSA in the 1990s [3]. A new global strategy called RBM initiative was launched to halve the mortality caused by malaria [4]. More and more tests, rapid treatments, and simple interventions such as insecticide-treated bed nets (ITNs) were implemented by RBM [3].

The financial investment dramatically rose from US \$960 million (2005) to US \$2.5 billion (2014), although there was more than a US \$5 billion shortage to meet the target of malaria control [5]. At the same time, the spending on ITNs and other effective interventions reached US\$ 1.6 billion in 2014 from only US\$ 40 million in 2004 [6]. In 2018, a new strategy for malaria elimination was the “High burden to high impact” (HBHI) response catalyzed by WHO and the RBM partnership. 11 countries led the HBHI approach, and 10 of the countries came from SSA [5]. Malaria control in SSA has improved dramatically as a result of these initiatives. The deaths caused by malaria declined significantly from 2000 (680,000) to 2019 (386,000). Meanwhile, malaria mortality was reduced dramatically by 67% [5].

3. Challenges within SSA

Despite the success of the previous interventions implemented in the SSA region, some challenges include financial situation, climate factors, and COVID-19 pandemics that restrict the prevention, treatment, and eradication of malaria.

3.1. Financial Burden

Poverty is a major problem that leads to a high malaria prevalence in SSA. It becomes a complicated issue since poor finances bring a high malaria burden while malaria stunts economic growth.

Malaria brings an economic burden on health systems. According to WHO, SSA has spent around US\$ 300 million annually on case management of malaria alone since 2000, while the gross domestic product of SSA was only around US\$ 1600 billion in 2020 [5]. In SSA, the cost of malaria may be substantial for the governments and people, especially for low socioeconomic groups. A study found that poor households spend more than one-third of their income on malaria, while high-income households only spend 1% of their income [7]. In Malawi, the lowest income households spend 32% of annual household income, giving a high cost of malaria, compared with 4.2% towards an average household income level [8]. It is difficult for the poorest group to afford simple interventions such as ITNs. More than half the population in Greater Kisii, Kenyan, is considered poor. Using ITNs costs around US\$ 13.5, nearly twice the annual expenditure on health care (Figure 1). Protecting themselves from malaria by using ITNs consumes almost one-third of poor households' average monthly income (US \$42) [8], leading to a heavy economic burden on poor households, and subsequently promoting malaria growth. Furthermore, poor housing and less access to health services are still unsolved problems under poverty, increasing the risk of malaria among poor households in SSA.

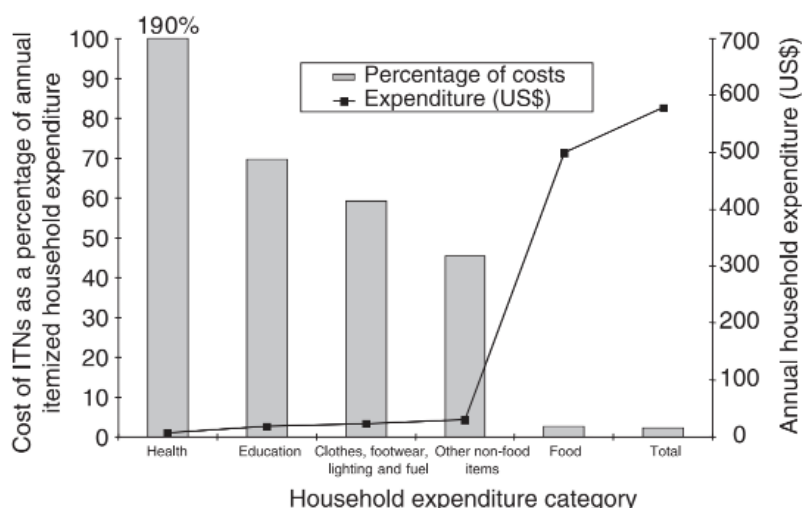


Figure 1. Annual Household Expenditure and cost of ITNs in Greater Kisii in Kenya [10].

The line graph shows the household expenditure every year while the bar graph indicates proportion of the cost of ITNs on the household expenditure every year.

While poverty keeps malaria growing, malaria stifles economic growth and causes poverty. SSA's per capita gross national product fell by more than 40% between 1960 and 1999, while the death rate went up obviously from 100 to 160 per 100,000 at the same time [5]. The study found that the loss of GDP of Uganda in 2003 was about US \$11 million, which is substantial [9]. Eradicating malaria becomes a complex problem to tackle under poverty and the negative feedback loop between malaria and financial costs.

3.2. Climate Conditions and Climate Change

While the economic condition has an enormous impact on malaria control, climate factors also cause a high incidence of malaria in low-income countries with high malaria infection.

Temperature and rainfall as two important climate factors significantly affect malaria transmission. The temperature has an enormous effect on the vector mosquito's survival and the parasite development in the mosquitoes. There is a low survival rate of the mosquito when the temperature is below 18-degree Celsius, while a temperature above 22-degree Celsius gives a constant survival rate [10]. Similarly, the parasite *Plasmodium falciparum* requires a suitable temperature (above 18-degree Celsius) to develop in the vector mosquito [11]. The study indicated that a temperature range within 18 to 32-degree Celsius gives a constant malaria transmission since it accelerates the vector mosquito and parasite development [11]. Most regions within SSA have a tropical climate with an average temperature of around 18-degree Celsius, which is suitable for malaria transmission [12]. Rainfall provides a suitable habitat for mosquitoes breeding and accelerates malaria transmission. The studies investigated that rainfall positively correlates with *Plasmodium* parasites breeding [13]. Similar findings were conducted in different countries in SSA. A study in Kenya indicated that rainfall leads to a high malaria incidence after two months of rainfall [14]. Similarly, a study suggested that the level of mean rainfall was positively associated with malaria incidence in lagging of two to four months in Ethiopia [15].

Climate change becomes one major obstacle to reaching the target of malaria prevention and eradication since malaria transmission is seriously influenced by climate. It has become a global issue and has irreversible impacts worldwide, such as melting glaciers, heat waves, and warming oceans.

Climate change has an enormous impact on the El Niño cycle which increases the local temperature and rainfall, which is associated with the probability of malaria epidemics. In Colombia and Venezuela, a study showed that malaria cases had increased more than one-third under environmental conditions related to the El Niño effect [16]. Many countries in Africa, such as Kenya, Uganda, Burundi, Ethiopia, and Rwanda, experienced severe malaria epidemics between the late

1980s and 2003, when El Niño events frequently showed [17]. The effect of El Niño on malaria transmission is also significant in arid areas such as north Kenya where there was a severe epidemic due to flooding caused by El Niño.

Climate change will promote malaria transmission in malarious and non-malarious areas and in new regions where environmental conditions are not suitable for malaria transmission. Temperature and rainfall rising increase the probability of the vector mosquito proliferation at higher altitudes, promoting malarious transmission in new regions [16]. The first malaria vector in Nyeri, a town at high latitudes and located in the central Kenya highlands, was reported in 2005. Elevated temperature is the major reason malaria transmission started in a too cool place to provide a suitable condition for malaria transmission. From 1994, the mean annual temperature permanently raised above 18 degrees Celsius, which is the threshold temperature for malaria transmission (Figure 2) [17]. The number of malaria cases increased continually since 1994 and significantly rose in 2003 during an El Niño period.

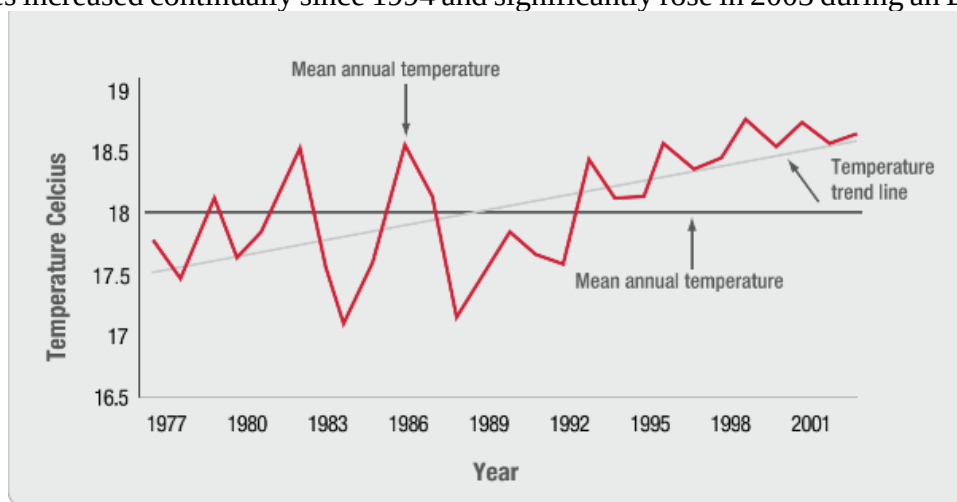


Figure 2. The shift of mean annual temperature in Central Kenya Highlands in 1990s [17].

3.3. COVID-19 Pandemic

The COVID-19 pandemic poses a threat to other diseases' control, including malaria. The malaria control supplies delivered through health delivery systems can prevent 100 million new cases each year [18]. The COVID-19 pandemic disrupts supply delivery, causes misdiagnoses, leads to ineffective treatments, and increases malaria mortality. The implementation of malaria prevention interventions, including ITN, IPT, and seasonal malaria chemoprevention, is disrupted by lockdown and travel restrictions. For further malaria prevention, the malaria programs should ensure the delivery of malaria control measures and continually provide malaria services while adding the COVID-19 safety protocols. The similarity of symptoms between COVID-19 and malaria can lead to misdiagnosing, such as fever and cough [18]. Malaria patients can be easily misdiagnosed as COVID-19, ignoring the possibility of malaria. This may result in false treatments and increased untreated malaria cases. COVID-19 and malaria co-infection may cause false diagnoses, inappropriate treatments, and increase deaths from malaria.

4. Future Strategies for Malaria Eradication in SSA

China became malaria-free in 2021. As the first malaria-free country among the WHO Western Pacific countries, China may be able to share its success and eradication journey with malaria-affected countries throughout the world.

4.1. Elimination Journey in China from the 1950s

Malaria cases in China had reached 30 million per year in the 1940s [19]. The Chinese government began providing antimalarial medicines to prevent people at risk and treatments for people who get

malaria. A research project called the 523 projects was initiated by the government in 1967 in China to find new malaria therapies [19]. It led to the findings of Artemisinin-based Combination Therapies, which are the most effective antimalarial drug until today. China became the first one to try to implement ITNs nationwide by the early 1980s [20]. The substantial implementation of ITNs dramatically decreased both cases and deaths by the late 1980s. The National Malaria Eradication Programme was launched in 2010 and aimed at achieving malaria eradication by 2020 [21]. The efforts were made together by different ministries such as health, education, finance, and technology. This led to a significant decrease in malaria cases. In 2014, there were only less than 60 indigenous cases, which was reduced by 98.6% from 2010, with more than 4,000 indigenous cases [19]. In 2017, China reached zero indigenous cases and was officially awarded malaria-free four years later by WHO.

4.2. What SSA can learn from China's success

One of the World Health Assembly's current policies is offering technical guidance to malaria-endemic areas in order to achieve a 90 percent decrease in the global malaria burden [22]. It underlines the significance of increasing investments in various categories such as diagnostic testing, preventive measures, treatments, malaria surveillance, and associated research. SSA countries could employ this strategy and develop strategies that learn from China.

First, countries within SSA should be aware of the urgent need for government intervention. The government is continually involved in malaria interventions in China's malaria elimination journey. Sustaining funding from the government is also necessary for malaria control since malaria eradication takes a long time. Second, policies of economic growth certainly need to be developed. Like the other countries that eradicated malaria, such as the United States, China achieved malaria-free when its economic boom [3]. Stable economic growth and abolishing extreme poverty become extremely important for malaria eradication in SSA. Third, policies to expand access to affordable health services in low socioeconomic regions are required since China provides affordable malaria diagnosis and treatment services for all citizens [19]. Lastly, collaboration with other countries is an integral part of eradicating malaria. The China-Tanzania pilot project was adopted in 2015, and three years later, the incidence of malaria in Tanzania had dropped by more than 80% [23]. Recently, a collaboration network was established between Africa and China. In 2020, the Chinese National Institute of Parasitic Diseases collaborated with WHO and Harvard School of Public Health [24]. China supported Africa in academic research on malaria and established a China-African network. As Tanzania, some countries such as Cameroon, Zambia, and Sierra Leone established networks with China [22]. The collaboration network encourages countries to share health products, techniques, and interventions to give a sustainable strategy for eradicating malaria.

5. Conclusion

Malaria is the leading cause of death and disease in many countries. Among these regions, SSA still holds a significant portion of malaria cases and deaths. Although SSA faces real challenges in the aspect of financial situation, climate factors, and COVID-19 pandemics during its malaria eradication journey, eradicating malaria within the SSA region has become an urgent need due to the severity of the malaria situation within the region. China is the first declared malaria-free among the WHO countries in the Western Pacific Region. SSA should adopt effective strategies from China and keep the governments involved, the steady economy growing, the health systems strengthening, and the collaboration network developing. While adopting the previous practical policies, new strategies specific to the countries are needed to further reductions in malaria.

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