

# Rolling back malaria in Africa – challenges and opportunities to winning the elimination battle

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A high-level review was conducted of the literature pertaining to the challenges and opportunities for eliminating malaria on the African continent. Although malaria mortality and morbidity are on the decline, the disease remains one of public health importance. Africa has invariably borne the brunt of the disease, recording the highest number of cases and deaths. However, with greater emphasis being placed on the disease by the international community, partnerships have developed to boost malaria elimination efforts on the continent. One such initiative is the Roll Back Malaria (RBM) partnership which aims to facilitate malaria elimination through increasing resources and awareness. Many cross-border initiatives have been established which treat malaria as a regional problem rather than a country-specific one. Accelerated malaria control efforts have led to a 37% decrease in cases and 60% reduction in deaths. Multi-country efforts have resulted in marked reductions of transmission in the region. Although there have been noteworthy gains in curtailing the disease, new challenges have arisen. The main among these are residual malaria and outdoor biting. One of the main drivers of residual malaria is insecticide resistance. Adding to the burden of residual transmission is the discovery of new vectors that may exist at low densities. To exacerbate these issues is the challenge of malaria imported from high- to low-transmission areas. Nevertheless, compared with the historical picture, we are winning the battle against malaria. Countries in Africa are being certified malaria-free. Partnerships have been developed to take forward the RBM Global Malaria Action Plan. Elimination agendas can only be successful if funding remains sustainable, with greater reliance on domestic funding.

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About 90% of all malaria deaths in the world occur in sub-Saharan Africa, where the most dangerous parasite, *Plasmodium falciparum*, is spread by *Anopheles gambiae*, the most efficient vector.<sup>[1]</sup> Malaria and underdevelopment are closely intertwined. Over 40% of the world's population live where there is a risk of malaria.<sup>[1]</sup> The disease causes widespread premature death and suffering, imposes financial hardship on poor households, and impedes socio-economic growth.<sup>[2]</sup> Malaria is directly responsible for one in five childhood deaths in Africa.<sup>[1]</sup> Though malaria remains a major challenge, huge progress has been made since the beginning of the century; its recent resurgence in Africa contrasts dramatically with the global decline in mortality since 1900.

World War II encouraged the development of new tools for the control of malaria in Africa, such as chloroquine<sup>[3]</sup> and DDT.<sup>[4]</sup> The potential of these innovations was realised when the World Health Organization (WHO) proposed the Global Malaria Elimination (GMEP) programme in 1955.<sup>[5]</sup> However, in 1969 the WHO decided that sub-Saharan Africa was not ready for the elimination programme.<sup>[6]</sup> The WHO concluded that the protracted transmission season, combined with the high degree of malaria endemicity in the region, rendered Africa unresponsive to a large-scale eradication programme. African programmes were thus designed to control rather than eliminate the disease. At this stage, indoor residual spraying (IRS) was the only vector control strategy and already there was mounting resistance to all classes of insecticides. During the mid-1980s, insecticide-treated bed nets were widely distributed at a time when chloroquine efficacy was rapidly diminishing.<sup>[7,8]</sup> Following the failure of GMEP in Africa, four decades passed before malaria in Africa took centre stage in the international public health arena, especially in terms of financing.<sup>[9]</sup> The WHO recognised that concerted action would be required to control malaria on the continent and that malaria could no longer be addressed as a

country-specific problem but rather as a regional issue.<sup>[10]</sup> Malaria control strategies were harmonised in the region so that a concerted effort could be made to push back the frontiers of malaria and to eventually eliminate the disease from the continent.

Malaria can be prevented, diagnosed and treated with a combination of available tools, but decreasing malaria transmission requires global commitment. Recently, co-ordinated action by organisations and countries has successfully mitigated the impact of malaria. One of the oldest such initiatives, the Roll Back Malaria (RBM) partnership, was launched in 1998 by the WHO with the goal of providing a co-ordinated global approach to fighting malaria. The RBM mobilises resources for action and forges consensus among partners. Partners, such as the Elimination 8 (E8) in southern Africa, have joined forces to accelerate malaria control measures at country level, co-ordinating their activities to exclude any form of duplication and fragmentation and to ensure optimum usage of the resources (Fig. 1). Thus, early diagnosis and prompt treatment with an effective drug, as well as efficacious vector control and enhanced surveillance, are being recommended.

There has been a concerted international effort since the early 2000s to tackle malaria, which has led to dramatic reductions in the disease, especially in southern Africa (Fig. 2). WHO estimates show that in 2015 there were 212 million malaria cases and 439 000 deaths globally – a 37% decrease in the incidence of malaria compared with 15 years ago, and a 60% reduction in deaths. Most of the gains occurred in Asia and at the periphery of distribution of the disease in Africa. However, a challenge is that sub-Saharan Africa still shoulders 90% of existing cases and 92% of deaths from the disease. It is encouraging that 34 countries are poised for the elimination programme, many of them on the African continent. In the next 10 years, South Africa's (SA) neighbouring countries should have eliminated malaria.

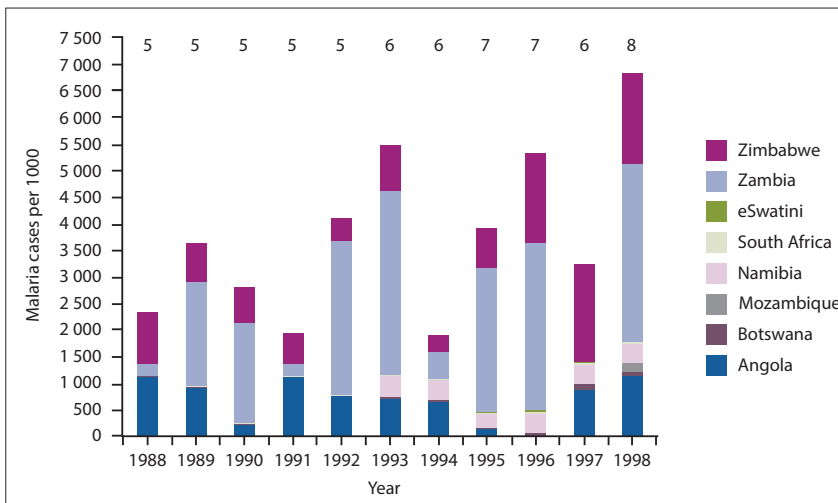


Fig. 1. Malaria cases reported for E8 countries from 1988 - 1998 (numbers above columns indicate number of countries providing data).

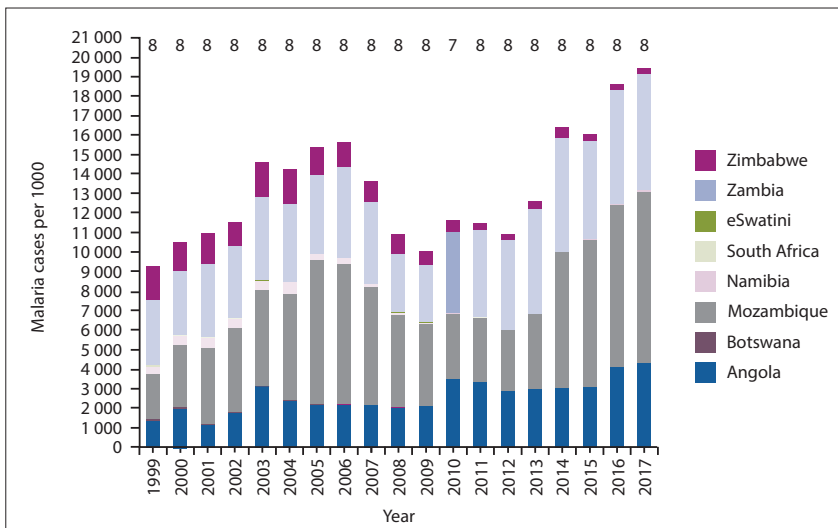


Fig. 2. Malaria cases reported for E8 countries from 1999 - 2017 (numbers above columns indicate number of countries providing data).

In the present review we focus on the literature that highlights the challenges towards achieving elimination and sustaining the impact attained, as well as the lessons learnt from countries that have already achieved elimination.

### Methodology

This is not intended to be a systematic review, but rather aims to present the challenges that need to be overcome and the successes that have been made in achieving malaria elimination. The research question therefore was twofold: firstly, to examine the hurdles that are preventing elimination from being achieved and, secondly, to highlight the successes that have already been attained. As the subject of this review is quite topical, a literature search was completed

using PubMed to find articles addressing the research questions. When available, SA literature was included.

### Results and discussion

The articles selected underline the impediments that are preventing attainment of the elimination goal, as well as the sustainability of gains that have already been achieved. As some countries in Africa have already achieved elimination, the lessons to be learnt from these successes are also summarised.

#### Multi-country efforts to eliminate malaria

Malaria is a regional problem and not a country-specific one; therefore, what happens in one country affects neighbouring countries. This was the

premise under which the Lubombo Spatial Development Initiative (LSDI) was developed between Mozambique, SA and Swaziland (now known as eSwatini). Through implementing evidence-based vector control and case management, malaria prevalence in Mozambique decreased by 80% while the incidence in SA and Swaziland decreased by 98%, so enabling these countries to adopt an elimination agenda.<sup>[11]</sup>

Following the achievement of the LSDI, the MoSaSwa (Mozambique, SA and Swaziland) initiative was built on the platform developed by the LSDI<sup>[12]</sup> and it has already had a great impact on the disease burden in southern Mozambique, enabling the country to target elimination by 2030. The Trans-Kunene Malaria Initiative between Namibia and Angola has successfully reduced malaria in their border regions. A smaller initiative between Zimbabwe and Zambia (Zim-Zam) has been instrumental in reducing malaria in the border areas of these two countries. All these initiatives have contributed to significantly decreasing the burden of disease in the participating countries, thus paving the way for elimination by 2030. Malaria elimination efforts in the 8 southernmost African countries are being facilitated by the E8 initiative to enable and accelerate zero local transmission in the 4 frontline countries (Botswana, Namibia, SA, Swaziland) by 2020 and the second-line countries (Angola, Mozambique, Zambia, Zimbabwe) by 2030 through the provision of a joint platform for collaboration and joint strategic programming.<sup>[13]</sup>

### Challenges for elimination

#### Residual malaria

The sustained use of long-lasting insecticidal nets (LLINs) and IRS has reduced malaria transmission. However, these interventions are only effective when the human hosts are indoors; they afford no protection to individuals outside their homes. Insecticide-induced avoidance of contact with treated surfaces within houses and early exit from them, minimises exposure of vectors which feed indoors upon humans.<sup>[14]</sup> Vectors are opportunistic, and able to feed upon animals, thus avoiding contact with IRS insecticides. Behaviour modification occurs in mosquitoes, causing them to rest outdoors and avoid contact with insecticide-treated surfaces of nets and walls, enabling low-level transmission. Residual malaria transmission is therefore defined as all forms of transmission that can persist after achieving full universal

coverage with effective malaria control interventions.<sup>[15]</sup> Residual transmission is a significant challenge to ongoing malaria elimination efforts, owing to insecticide and drug resistance, and novel tools are required to overcome these challenges. According to Killeen,<sup>[15]</sup> the issue of residual malaria can be addressed by novel or improved vector control strategies that address residual transmission. Such strategies enhance control of vectors that enter houses to feed and/or rest by killing, repelling or excluding them.

#### Outdoor transmission

In response to the insecticidal pressure from long-term use of IRS and LLINs, vectors have modified their behaviour to avoid contact with insecticides.<sup>[16]</sup> In order to feed before their hosts go indoors, mosquitoes are now biting earlier and outdoors. This is a major setback, as the main interventions provide protection to people only within IRS-sprayed houses or those sleeping under a bednet. To overcome this problem, larval source management is advocated as one strategy. Studies in Kenya<sup>[17]</sup> indicate that outdoor baited traps can divert mosquitoes from feeding on people to entering these traps. Further studies need to be conducted to identify ways of overcoming outdoor transmission.

#### Insecticide and drug resistance

Major drivers of residual malaria are vector resistance to insecticides and parasite resistance to antimalaria drugs. Resistance has been reported to all classes of insecticides currently approved by the WHO for use in IRS programmes. The most widespread resistance is to pyrethroid insecticides in terms of geography and species of vectors. However, there are new insecticide classes and insecticide mixtures that have shown potential for replacing DDT, which is the current gold standard.<sup>[18,19]</sup> The main drawback of the new insecticides is the cost of purchasing them as well as their application.

Drug resistance is also on the increase, beginning in the early 1980s with resistance to chloroquine, followed by resistance to sulfadoxine-pyrimethamine in the mid- to late 1990s. Artemisinin-based combination therapy (ACT) was introduced into Africa in 2004 in Zambia for the first time and has since become the drug of choice for the management of malaria infections. There is already widespread tolerance to ACT in Myanmar and Thailand<sup>[20]</sup> and the potential for resistance to artemisinin has been identified in Angola.<sup>[21]</sup> The efficacy of currently available ACTs is diminishing and there is no existing replacement drug. There is a potential new drug that has been identified by researchers funded by the South African Medical Research Council (SAMRC) that has gone into first-in-man studies.

#### New vectors

One of the factors contributing to residual malaria is the unknown role of secondary vectors. Traditional malaria control tools have targeted only *Anopheles gambiae* s.s., *An. arabiensis* and *An. funestus*. Targeting control measures at the three species has resulted in huge reductions in the burden of disease. However, new vectors have in recent times been identified.<sup>[22]</sup> It may also be that these new vectors which feed and rest outdoors, contribute to very low levels of transmission.

#### Imported malaria

Imported malaria has been described as an infection that was acquired in an endemic area by an individual (either a tourist or local) but diagnosed in a non-endemic country after development of the clinical disease.<sup>[23]</sup> Currently, the biggest threat to elimination efforts are the risk of resurgence of malaria owing to imported cases.<sup>[24]</sup>

Given the high receptivity to malaria in previously endemic areas of the country owing to prevalence of the vector mosquito, such cases pose a significant threat for the reintroduction of malaria to malaria-free areas. These cases occur via infected people entering the country and becoming ill on arrival, or vehicles returning from high-transmission countries with malaria-infected mosquitoes that cause outbreaks in the destination areas.

#### Sustaining the gains

Although Africa has historically had a high transmission rate,<sup>[25]</sup> southern Africa has nevertheless been particularly successful in reducing its case load over the past decade (Fig. 2). The Seychelles and Mauritius have eliminated malaria, as they have had no new local transmissions in recent years.<sup>[26]</sup> This reflects reductions in several of SA's neighbouring countries such as Botswana, Namibia and Swaziland, where malaria mortality rates are close to zero. In SA, there was a significant peak of 64 622 cases in 2000. Since then, case numbers have dwindled to between 6 000 and 10 000 in recent years. However, in the past two seasons, large numbers of cases were reported from the southern African region, most notably in the E8 countries (Fig. 2).<sup>[13]</sup>

In 2015, there were roughly 212 million malaria cases and an estimated 439 000 malaria deaths.<sup>[27]</sup> Increased prevention and control measures have led to a 29% reduction in malaria mortality rates globally since 2010. Sub-Saharan Africa continues to carry a disproportionately high share of the global malaria burden. In 2015, the region was home to 90% of malaria cases and 92% of malaria deaths. In the past 15 years, there has been tremendous progress at a global level in the fight against malaria. According to the World Malaria Report,<sup>[28]</sup> malaria case incidence reduced by 41% and malaria mortality rates reduced by 62% between 2000 and 2015.<sup>[27]</sup> At the beginning of 2016, malaria was endemic in 91 countries and territories, down from 108 in 2000.<sup>[29]</sup> Despite this progress, malaria continues to exact a heavy toll.

Over the past three decades, there has been a dramatic decrease in the number of cases and deaths due to malaria. Only 5 countries on the African continent and 3 of the Indian Ocean Islands have been certified free of malaria by the WHO.<sup>[26]</sup> Botswana, Namibia, SA and Swaziland are likely to achieve zero local transmission in the next 5 years. The lessons learnt with regards to cross-border collaboration in SA and its neighbouring countries are of great importance and there is some urgency in cementing these successes.<sup>[11,12]</sup>

To sustain the gains made, especially when elimination has been achieved, is when the real challenges will emerge, the most important being sustainable funding in achieving the goal of elimination. Entering the eradication phase is a relatively new frontier for African countries, and a major concern is continued political support and donor fatigue. Countries reliant on international donor support will be most affected – and these are high-transmission countries such as Mozambique and Tanzania. The moment when control measures weaken, malaria is likely to rebound rapidly in the face of migration and importation from high-transmission neighbouring countries that are still fighting to bring malaria under control. This was the scenario in Sri Lanka in 1963<sup>[30]</sup> and Mauritius in 1975,<sup>[31]</sup> where malaria rebounded after cases had dropped to nearly zero.

#### Conclusion

Although there have been remarkable achievements in decreasing the burden of malaria in Africa, many barriers need to be overcome to reach elimination. This goal will require ongoing research to fill the knowledge gaps identified. With many countries targeting

elimination by 2030, there is a need to overcome the challenges facing the elimination agenda and to sustain the gains already attained. To address the elimination agenda, it is necessary to lobby for sustainable domestic funding to ensure that the disease does not rebound because of lack of resources. Also, cross-border initiatives need to be strengthened to pave the way for elimination and in preparation for the prevention of reintroduction once elimination is achieved.

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