

The path to eradication: a progress report on the malaria-eliminating countries



Gretchen Newby, Adam Bennett, Erika Larson, Chris Cotter, Rima Shretta, Allison A Phillips, Richard G A Feachem

In the past several years, as worldwide morbidity and mortality due to malaria have continued to decrease, the global malaria community has grown increasingly supportive of the idea of malaria eradication. In 2015, three noteworthy global documents were released—the WHO's Global Technical Strategy for Malaria 2016–2030, the Roll Back Malaria Partnership's Action and Investment to defeat Malaria 2016–2030, and *From Aspiration to Action: What Will It Take to End Malaria?*²—that collectively advocate for malaria elimination and eradication and outline key operational, technical, and financial strategies to achieve progress toward malaria eradication. In light of this remarkable change in global attitudes toward malaria elimination and eradication, and as the malaria community debates how and when to embark on this ambitious goal, it is important to assess current progress along the path to eradication. Although low-income, high-burden countries are often the focus when discussing the substantial challenges of eradication, the progress toward elimination in middle-income, low-burden countries is a major driver of global progress and deserves better recognition. Additionally, although global support and guidance is essential for success, malaria elimination and eradication efforts will ultimately be driven at the country level and achieved in a collaborative manner, region by region. In this Review, we examine the present status of the 35 malaria-eliminating countries, summarise existing national and regional elimination goals and the regional frameworks that support them, and identify the most crucial enabling factors and potential barriers to achieving eradication by a theoretical end date of 2040.

Introduction

For decades after the conclusion of the WHO's mid-20th century Global Malaria Eradication Programme (GMEP), a strategy of malaria eradication was no longer prioritised and the accepted global approach was one of sustained control. After the launch of the Roll Back Malaria Partnership (RBM) in 1998, the Millennium Development Goals in 2000, and the formation of new donor mechanisms including the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) in 2002 and the US President's Malaria Initiative in 2005, global malaria morbidity and mortality began to decrease. This decrease was accelerated by the development and scale-up of innovative interventions and effective control strategies and the unprecedented political and financial commitment from malaria-endemic countries. In 2007, in light of this extraordinary progress, Bill and Melinda Gates called for a renewed commitment to eradicate malaria.¹ Endorsed by the WHO Director-General and supported by nations and organisations throughout the malaria community, the push for national and regional malaria elimination quickly built momentum and the countries and regions already implementing elimination plans were given due recognition.^{2–4} A three-part strategy for eradication under the Global Malaria Action Plan (appendix) was developed by RBM, a rapidly growing number of countries set forth national elimination goals, and regional networks were formed to facilitate collaboration and bolster political and financial support for countries pursuing elimination.^{5–10}

Elimination is now considered an attainable goal by most national malaria programmes, and the idea of eradication is once again on the global health agenda. More than 100 countries have eliminated malaria in the past century. Between 2007 and 2013, four countries were certified as malaria-free by WHO (Armenia, Morocco,

Turkmenistan, and United Arab Emirates), an additional eight countries moved into the WHO's prevention of reintroduction phase after sustaining at least 3 years of zero local malaria transmission (Argentina, Egypt, Iraq, Georgia, Kyrgyzstan, Oman, Syrian Arab Republic, and Uzbekistan), and five others interrupted local transmission (Azerbaijan, Costa Rica, Paraguay, Sri Lanka, and Turkey).¹¹ The malaria map continues to shrink with global economic development and increasing political and financial support for elimination, and the toolkit of innovative technologies and interventions to defeat malaria continues to expand.¹²

This incredible progress, achieved in just 7 years, prompted Bill Gates to once again make a bold declaration in November, 2014: not only can malaria be eradicated, it can be achieved within a generation.¹³ As the global malaria community debates how and when to embark on this ambitious and aggressive eradication goal, articulating the great achievements made to date and elucidating the top priorities, challenges, and gaps will help inform these endeavours. In previous articles published in *The Lancet* in 2010^{6,14–16} and 2013,¹⁷ we described the concepts and rationale behind malaria

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Global Health Group,
University of California,
San Francisco, San Francisco,
CA, USA (G Newby MSPH,
A Bennett PhD, E Larson MSc,
C Cotter MPH, R Shretta MSc,
A A Phillips BA,
R G A Feachem DSc[Med])

Correspondence to:
Gretchen Newby, University of
California, San Francisco Global
Health Sciences, Mission Hall,
550 16th Street, San Francisco,
CA 94158, USA
gretchen.newby@ucsf.edu

Search strategy and selection criteria

In this review of published and unpublished literature, we searched Google, Google Scholar, and PubMed up to and including Dec 19, 2015, using the terms "malaria" and "elimination" or "eradication" and "regional" or "collaboration" or "progress" or "challenges" or "strategy" or "financing" or "importation" or "surveillance" or "advocacy" or "commitment" or "G6PD" or "knowlesi" or "primaquine". We searched only for English language results. References were also identified by cross-referencing bibliographies of relevant publications.

See Online for appendix

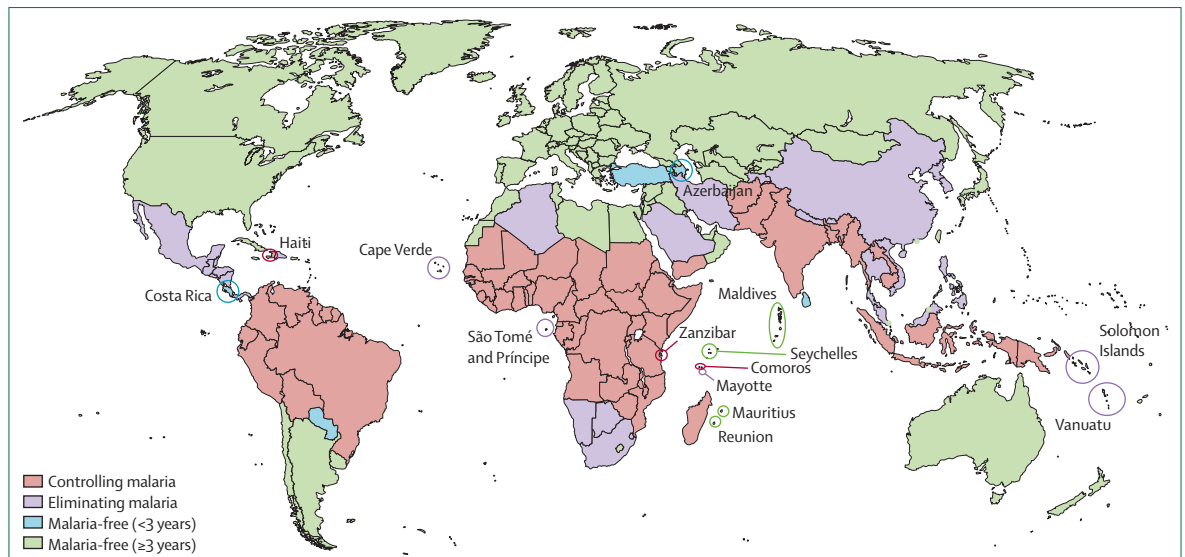


Figure 1: Categorisation of countries as malaria-free, eliminating malaria, or controlling malaria, 2015

The list of eliminating countries is evaluated annually using data collected from WHO's World Malaria Report; national malaria programme reports, elimination strategies, and operational plans; reports and updates from partner organisations and stakeholders; and other resources. When countries are certified by the WHO as malaria-free, or when they report three consecutive years of zero locally transmitted cases in World Malaria Report, they are removed from the eliminating country list. From Shrinking the Malaria Map.

For Shrinking the Malaria Map
see <http://www.shrinkingthemalariamap.org>

elimination from operational, technical, and financial standpoints, as well as the evolving epidemiological complexity of countries in low-transmission settings. As a continuation of that work, we present here the current status of the 35 malaria-eliminating countries, summarise existing national and regional elimination goals and the regional frameworks that support them, and identify the most substantial enabling factors and potential barriers to achieving eradication by a theoretical end date of 2040.

The 35 malaria-eliminating countries

A malaria-eliminating country describes a country that is in the process of moving from controlled low-endemic malaria to elimination, and fits into one of two categories: has assessed the feasibility of elimination, declared a national evidence-based goal, and has launched a malaria elimination strategy; or is strongly considering an evidence-based national elimination goal, has already made substantial progress in spatially progressive elimination, and is greatly reducing malaria nationwide.⁶ In September, 2015, there were 35 countries that met the malaria-eliminating criteria (figure 1, appendix), with national or regional elimination goals ranging from 2013 to 2035.^{14,18} Most of these countries are aiming to achieve elimination by 2020. From 2000 to 2013, these 35 countries reduced their malaria burden by a remarkable 90%, from 1·6 million reported cases down to 160 000 cases, and reported deaths due to malaria have decreased by 87% (figure 2). The trends observed in the malaria-eliminating countries are particularly impressive when compared with the decreases in global malaria morbidity (30% decrease) and mortality (47% decrease) between 2000 and 2013.¹¹

Three countries—Argentina, Kyrgyzstan, and Uzbekistan—were recently removed from the malaria-eliminating country list after achieving three consecutive years of zero local malaria transmission, WHO's criteria for the prevention of reintroduction phase.¹⁹ Argentina and Kyrgyzstan have initiated the process of malaria-free certification with WHO, as has Paraguay, an eliminating country that reached the 3-year mark of zero locally transmitted cases in October, 2014 (appendix).^{11,20} Sri Lanka, which reported its last local case in 2012, reached the 3-year mark in October 2015.²¹ Three other countries have achieved zero local transmission but have not yet sustained it for 3 consecutive years: Azerbaijan, which reported zero cases for the first time in 2013; and Costa Rica and Turkey, both of which reported local malaria cases in 2013 and 2014, but on investigation, all cases were determined to be relapsing infections of *Plasmodium vivax* acquired in previous years.^{11,22,23} These three countries met their elimination goals; notably, Costa Rica beat its national goal of 2020 by 7 years.

The other 30 malaria-eliminating countries have made great progress toward their elimination goals (appendix). In 2013, eight countries reported fewer than 50 locally transmitted cases (Algeria, Belize, Bhutan, Cape Verde, El Salvador, the French overseas territory of Mayotte, Saudi Arabia, Tajikistan); all but Mayotte have stated goals of elimination by 2020. Eight additional countries reported fewer than 800 cases (Botswana, China, Dominican Republic, Iran, Mexico, Panama, South Korea, Swaziland), and have set elimination goals ranging from 2017 to 2025.^{11,18} On the basis of present epidemiological status and recent trends, it seems that many of these 16 countries will achieve their stated

elimination goals early. The remaining 14 malaria-eliminating countries continue to make steady progress.

Despite their impressive achievements, the 35 malaria-eliminating countries face substantial challenges, and some have struggled to sustain their gains. Solomon Islands and Vanuatu are examples of lower middle-income island nations that have had difficulty maintaining robust malaria-elimination programmes in recent years. As a result of weak programme capacity, both countries have experienced periodic spikes in malaria cases that have proven challenging to bring under control. Sustaining domestic and international funding as malaria burden decreases is a serious concern for most of the eliminating countries, 15 of which are now upper-middle income and are no longer eligible for the donor funding that supported their transition from control to elimination.²⁴

Another major challenge for the 35 malaria-eliminating countries is the threat of malaria importation.²⁵ For example, four countries in southern Africa—Botswana, Namibia, South Africa, and Swaziland—are seeking to eliminate local transmission within the next 5 years, but many of their neighbours have much higher malaria burdens. Mobile and migrant populations moving across borders often serve as primary sources of imported malaria cases, which are likely to drive secondary transmission.^{26,27} These four malaria-eliminating countries all reported increases in malaria cases and deaths between 2012 and 2013, possibly arising from imported malaria. Importation from high-endemic neighbours is a common challenge across most of the 35 malaria-eliminating countries; many of those that have reduced local transmission since 2000 have also seen increases in imported cases.

Regional initiatives and progress toward elimination goals

Regional collaboration has been a key driver of progress for the 35 malaria-eliminating countries. Regional initiatives for malaria elimination have facilitated the coordination of interventions and the sharing of surveillance and coverage data, allowed for strengthened communication and knowledge-transfer between countries facing common problems, and helped generate much-needed political pressure on governments to increase support for malaria elimination. Since 2005, multicountry collaboration has been formalised under several regional initiatives, some of which have set ambitious regional elimination goals (appendix). In some regions, Mesoamerica for example, the regional goal is more aggressive than the milestones individual member nations had previously targeted, serving to push countries toward elimination faster than if they carried on alone. In regions that are inclusive of countries still in the control phase, such as Asia Pacific, the regional goal is more conservative than many of the national goals, which could serve to encourage countries with high transmission to catch up with their neighbours that are nearing elimination (figure 3).



Figure 2: Combined reported cases and deaths for the 35 malaria-eliminating countries, 2000–13

Data are sourced from World Malaria Report 2014 and publicly available national malaria programme reports. The definition of reported cases varies by year and by country: if countries distinguish between locally transmitted cases and imported cases when reporting, only those that were locally transmitted are represented in the graph; the countries that do make this distinction began reporting imported cases in different years; the following countries did not distinguish between locally transmitted and imported in reports between 2000 and 2013: Botswana, North Korea, Guatemala, Honduras, Namibia, Nepal, Nicaragua, Panama, Philippines, São Tomé & Príncipe, Solomon Islands, South Africa, Thailand, Vanuatu, Vietnam; the following countries did not report data on deaths in 2000: Botswana, Cape Verde, North Korea, Mayotte, Namibia, Nepal, Saudi Arabia, Swaziland, Tajikistan.

Two early regional elimination initiatives were launched in the mid-2000s with regional elimination goals of 2015. The WHO-EURO initiative was formalised in 2005 under the Tashkent Declaration.⁷ Six of the nine signatory countries—Armenia, Georgia, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan—have moved into the prevention of reintroduction phase, whereas the remaining three—Azerbaijan, Tajikistan, and Turkey—are in the elimination phase. In 2014, only two local malaria cases were reported throughout the entire EURO region, both in Tajikistan.²² However, about 5000 imported cases were reported in the region—largely from Pakistan, India, and Afghanistan—indicating the need to maintain regional collaboration to prevent the re-establishment of local transmission through active surveillance and cross-border coordination with other EURO countries, as well as neighbouring countries in the eastern Mediterranean region (EMRO) and the southeast Asian region (SEARO).²⁸ No local cases had been reported in the EURO region as of September, 2015.²⁹

The Malaria-Free Arabian Peninsula initiative focused on the two peninsular countries with continued transmission, Saudi Arabia and Yemen, and prioritised cross-border coordination of surveillance and vector control activities. Extensive financial support for Yemen was provided by Gulf Cooperation Council member countries.⁸ While escalating political instability in Yemen has prevented the country from improving its malaria situation, Saudi Arabia reported only 34 local cases in 2013.^{11,30}

In the Asia Pacific region, several regional bodies support malaria elimination. The first, the Asia Pacific Malaria Elimination Network (APMEN), was launched in 2009 as a network of countries, institutions, and

stakeholders working together to eliminate malaria by facilitating collaboration and knowledge sharing, conducting training and research, increasing the capacity and leadership of malaria programmes, and building the evidence base for a regional elimination framework.³¹ In the past 6 years, eight countries have joined the original ten country partners of APMEN, the most recent of which was Papua New Guinea in September, 2015.³² Participation in APMEN helps countries progress toward elimination by providing a forum to discuss programmatic and technical challenges and successes.^{9,33} For example, after learning of China's successful implementation of a rigorous surveillance and response system, other APMEN country partners have adopted the same approach.³⁴

APMEN works in tandem with the Asia Pacific Leaders Malaria Alliance (APLMA), an affiliation of heads of government formed in 2013 to accelerate progress toward regional elimination in 22 countries. Under the guidance of APLMA's co-chairs, regional leaders endorsed a goal of a malaria-free Asia Pacific by 2030 at the East Asia Summit in 2014.^{35,36} APLMA's strategic roadmap for malaria elimination, finalised in November, 2015, emphasises aggressive, evidence-based responses to artemisinin and insecticide resistance, support for high-risk and hard-to-reach groups, and the generation of new and innovative financing streams to address the growing funding gap for eliminating countries.³⁷

The 2030 malaria-free Asia Pacific goal is further supported by the WHO's Strategy for Malaria Elimination

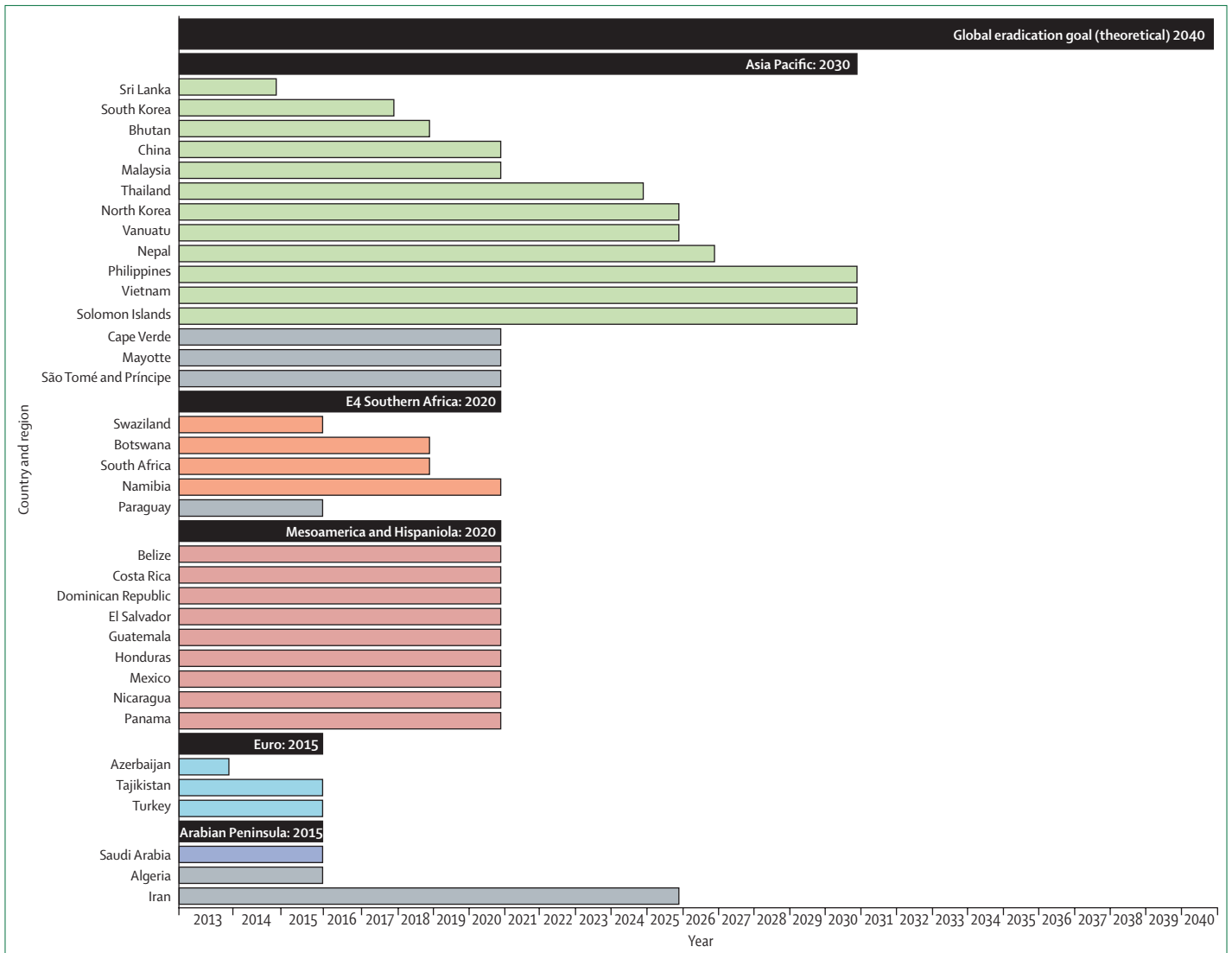


Figure 3: National, regional, and global goals for malaria elimination or eradication

Countries represented by grey lines are those that have national elimination goals only; black lines represent global and regional goals; the elimination goal for Solomon Islands is represented as 2030 in keeping with the goal set for Asia Pacific, however, the country has not yet revised its 2035 national goal to align with the more aggressive regional goal.

in the Greater Mekong Subregion, which includes Cambodia, Laos, Myanmar, Thailand, Vietnam, and China's Yunnan Province.³⁸ In view of the serious threat of *Plasmodium falciparum* resistance to artemisinin and the potential for it to spread to India and Africa, merely containing resistance has been deemed insufficient; elimination of regional *P falciparum* transmission is recognised as the only acceptable response to this threat.^{38,39} The strategy outlines a phased approach to elimination, with *P falciparum* transmission eliminated in all six countries by 2025, and all forms of malaria eliminated by 2030. These efforts are supported, partly, by the Regional Artemisinin Initiative grant from the Global Fund, which has allocated US\$100 million over 3 years to halt the spread of artemisinin resistance.^{38,40}

In southern Africa, malaria elimination is supported by the E8 initiative, launched in 2009 to push the region toward zero malaria transmission. Coordinated by the E8 Secretariat, the initiative facilitates collaboration and data-sharing across four malaria-eliminating countries at the frontline—Botswana, Namibia, South Africa, and Swaziland—and their second-line northern neighbours working to reduce transmission and achieve subnational elimination—Angola, Mozambique, Zambia, and Zimbabwe. The frontline countries are seeking to achieve elimination by 2020, a goal that is highly dependent on strong cross-border coordination with the second-line countries.^{27,41} The E8 was recently awarded a 3-year grant from the Global Fund to support regional surveillance activities, including the development of a shared surveillance system to track regional case trends in real time, the formation of malaria health posts in areas with poor access to health care, and the deployment of rapid response teams along national borders.^{27,41}

The African Leaders Malaria Alliance (ALMA)—a high-level coalition of 49 African Heads of Government—recently adopted the malaria elimination agenda and developed the 2030 Africa Malaria Elimination Scorecard to monitor and encourage progress across member nations. The African Union further endorsed this goal by calling for malaria elimination in Africa by 2030.⁴²

Ten member countries of the Council of Health Ministers from Central America and the Dominican Republic recently joined an initiative to eliminate malaria by 2020.⁴³ The initiative is receiving financial support through a grant from the Global Fund entitled Elimination of Malaria in Mesoamerica and Hispaniola (EMMIE), a performance-based, cash-on-delivery model designed to catalyse action toward elimination. The launch of EMMIE has driven some of the participating countries to reorient their malaria programmes to elimination, and led others to accelerate the elimination plans already in place to reflect the regional 2020 goal.^{43,44} Additional assistance for malaria elimination on Hispaniola by 2020 comes from a new consortium called Malaria Zero, which is assisting Haiti and Dominican Republic in the development and implementation of a collaborative elimination strategy.^{45,46}

Global strategies and progress toward elimination and eradication goals

The push to eliminate malaria has typically been a country's decision, often inspired by national reductions in burden, increased political commitment, and a readiness to take on the ambitious task. As more countries and regions are setting goals to eliminate, global donors and multinational agencies have grown increasingly supportive of the elimination agenda. Unwavering support at all levels—national, regional, and global—is essential to achieve malaria eradication, and global endorsement of the eradication agenda will help generate the leadership and guidance necessary for countries to strengthen their national programmes.

RBM's Action and Investment to defeat Malaria 2016–2030 (AIM) and WHO's Global Technical Strategy for Malaria 2016–2030 (GTS) both support the idea of elimination and eradication, stating that by 2020, malaria elimination will be achieved in at least ten countries that had transmission in 2015, and by 2030, elimination will be achieved in at least 35 countries, with an overall reduction in global malaria burden by 90% compared with 2015.^{47,48} Endorsed at the World Health Assembly in May, 2015, the GTS serves as the technical basis for national malaria strategic plans. AIM, the second generation of the Global Malaria Action Plan and launched in July, 2015, serves as a global advocacy instrument to ensure continued commitment and investment in malaria elimination and eradication, and positions malaria elimination as both benefiting from and contributing to the Sustainable Development Goals.

While the GTS and AIM support progressive elimination, a new global advocacy document,¹⁸ *From Aspiration to Action: What Will It Take to End Malaria?* seeks to revitalise a robust debate on global malaria eradication. Addressed to country leaders, global policy makers, donor countries, and partner institutions, *From Aspiration to Action* uses a theoretical eradication date of 2040 to anticipate requirements for resource mobilisation, new intervention and technology development, and strategy implementation to achieve a malaria-free world. The advocacy document also calls on the World Health Assembly to pass a resolution by 2020, committing to a goal of global malaria eradication.¹⁸

With the growing global enthusiasm for eradication, the targets set by GTS and AIM are probably more conservative than what is needed to achieve the theoretical 2040 eradication goal described in *From Aspiration to Action*. The trajectories these documents set for the next 15 years are quite cautious, putting the onus on the malaria community to make up tremendous ground in the final 10 years (2030–40) leading to eradication. Based on recent trends in epidemiology, funding, and political support, and taking into account the existing national and regional elimination goals, we project that up to 25 countries with transmission in 2015 can eliminate by 2020, and over 60 countries can eliminate by 2030,

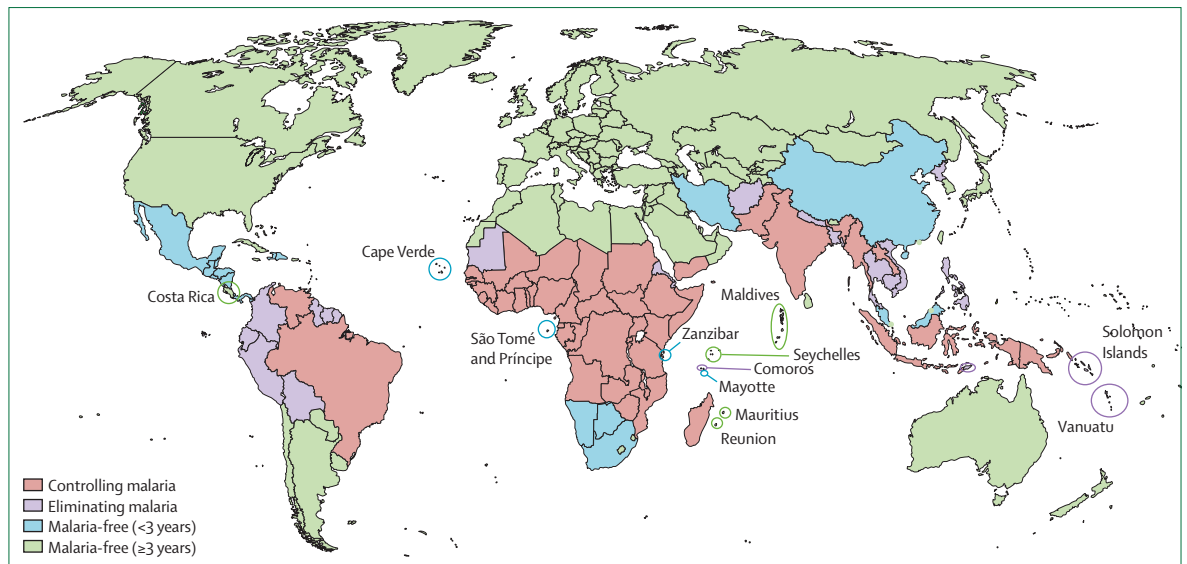


Figure 4: Categorisation of countries as malaria-free, eliminating malaria, or controlling malaria, 2020 projection²⁸

Elimination date projections are based on current national and regional goals as well as epidemiological progress as documented in WHO's annual World Malaria Report. For those countries that do not currently have clearly defined national or regional goals, elimination dates have been projected based on documented country-level efforts to reach pre-elimination status, recent epidemiological trends, geographical settings such as islands, and the necessary degree of ambition and optimism essential to achieve global eradication within a generation.

compared with the ten in 2020 and 35 in 2030 described in GTS and AIM (figure 4, figure 5).

Enabling factors for achieving malaria eradication

The announcement of a global eradication goal is likely to increase the visibility and importance of malaria elimination, potentially inspiring new donors and stakeholders to lend financial, technical, and innovative operational support. Although countries will face substantial challenges as they pursue elimination, there are several factors that will further bolster global progress toward malaria eradication.

The identification of the most effective mix of interventions and strategies that programmes can use for malaria elimination and the empowerment of programme managers to select the most appropriate combination of approaches for implementation in their unique settings are key for success. Elimination requires a more nuanced approach to intervention choice beyond traditional vector control and case management that must be tailored to suit the local eco-epidemiology. Within a country, different provinces or districts might use a wide variety of methods depending on the local vector, parasite, importation rates, and, most importantly, the behavioural profile of the target human population. Donors that finance malaria elimination and eradication efforts must support low-transmission programmes in the selection and funding of locally appropriate interventions, and in the provision of flexible management, capacity building, and leadership training for a cadre of surveillance and response officers who can guide their programmes toward interruption of

malaria transmission.⁴⁹ Appropriate intervention selection and strategy development for elimination hinges on a rigorous, ongoing process of scientific research, knowledge sharing, and monitoring and evaluation. The Malaria Eradication Research Agenda (malERA) initiative and the Malaria Eradication Scientific Alliance have supported these efforts since 2008.^{50,51}

Low-transmission settings present an opportunity to achieve malaria elimination, yet as cases decrease in number, they tend to become clustered in geographic locations and in specific population groups, identification of which presents new operational challenges.¹⁵ For an elimination programme, a strong surveillance system must enable the identification and classification of all foci of transmission and the targeting of appropriate resources and interventions in an aggressive and timely way. New surveillance methods such as spatial decision support systems (SDSS) that are linked to GPS-enabled smartphones and tablets or automated maps of transmission risk can support the identification and classification of hotspots, facilitate a rapid flow of data between levels of the health system, and generate real-time evidence to support the national programme in choosing interventions and targeting limited resources.^{52,53} The WHO recently published a series of toolkits to improve access to high-risk migrant and mobile populations in the Greater Mekong Subregion, better detect population movement and new malaria transmission foci, and strengthen surveillance and epidemic response to drug-resistant malaria parasites.⁵⁴ Similarly, methods for characterising high-risk populations and understanding and monitoring their

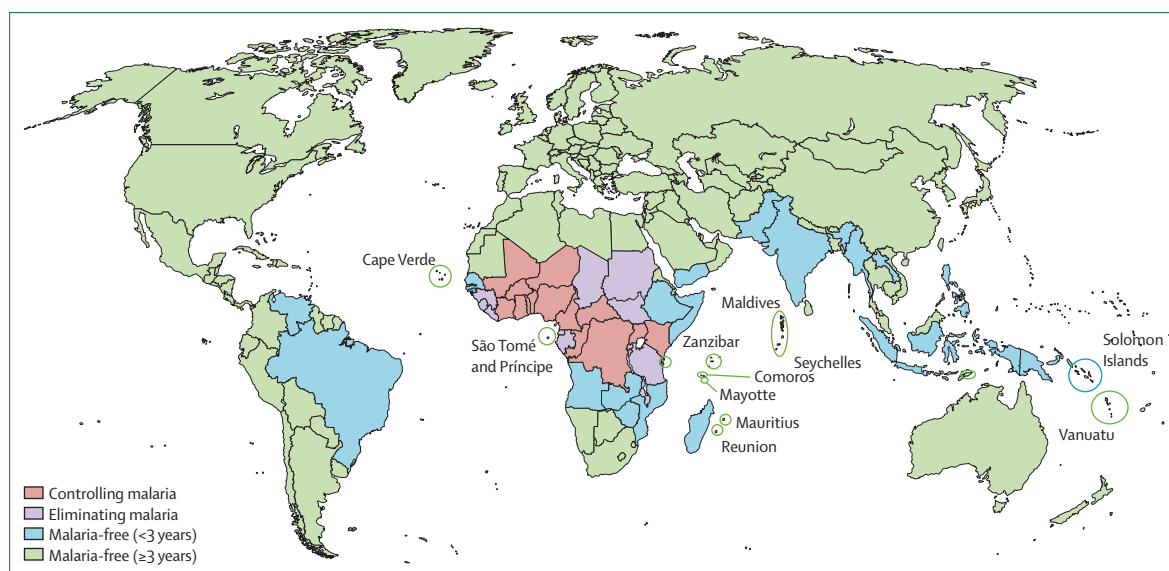


Figure 5: Categorisation of countries as malaria-free, eliminating malaria, or controlling malaria, 2030 projection¹⁸

Elimination date projections are based on current national and regional goals as well as epidemiological progress as documented in WHO's annual World Malaria Report. For those countries that do not currently have clearly defined national or regional goals, elimination dates have been projected based on documented country-level efforts to reach pre-elimination status, recent epidemiological trends, geographical settings such as islands, and the necessary degree of ambition and optimism essential to achieve global eradication within a generation.

behaviours and movements are increasingly being adapted from the HIV field, which will allow malaria programmes to appropriately tailor interventions to those population groups most at risk for infection.⁵⁵

Malaria elimination is a regional and global public good: as more countries eliminate malaria within their borders, the risk that they will export malaria to their neighbours is reduced, better enabling the next wave of countries to embark on their own elimination plans. As regional initiatives grow in number and scope, surveillance platforms that capture early signs of drug and insecticide resistance as well as population movement and regional hotspots of transmission, such as that under development for the E8, will enable cross-border data sharing and regional-level responses. Furthermore, these improvements to surveillance and regional collaboration also serve to strengthen the overall health systems of malaria-eliminating countries and will probably benefit the control, elimination, and eradication efforts of other diseases in the future.

Finally, advocacy has an essential role in bolstering political and financial support for malaria elimination. Key advocacy elements that have been identified as critical factors in infectious disease elimination are under development, including core advocacy messages, provision of advocacy tools, strong partnership-building, construction of a business case, and community engagement.⁵⁶ With the increasing focus on domestic financing mobilisation, these tools and approaches will need to be effectively deployed at the national level, particularly as countries near elimination, plan for prevention of reintroduction, and transition away from donor assistance.

Potential barriers to achieving malaria eradication

Despite the excellent progress and numerous enabling factors, serious challenges to achieving eradication remain that could serve as barriers to success if not adequately addressed. For the 35 malaria-eliminating countries, the most pressing dangers are a reduction of political commitment and an associated decrease in financing to finish the job and prevent reintroduction of malaria over time. These two factors—waning political commitment and decreasing budgets, particularly in the face of competing health priorities—have historically been associated with massive malaria resurgences, several of which occurred in countries that are once again attempting to eliminate malaria.^{57,58} Although the many declarations from national, regional, and global stakeholders to eliminate and eradicate malaria are promising, if political and financial commitment is not sustained, the goals will not be met. Further, failing to meet these goals could lead to disillusionment and undermine global progress and the prospects of eradication, mirroring the attitudes of the post-GMEP era.⁵⁹ A World Health Assembly commitment to achieving eradication will have an essential role in maintaining focus and momentum toward this ambitious goal. Additionally, as the global community begins to shape the eradication agenda, a substantial degree of country-level engagement and ownership over the process is key for ensuring national political support and buy-in.

According to modelling work,²⁴ an estimated US\$8.5 billion will be needed over the next 15 years to adequately support the malaria-eliminating countries in

their efforts to achieve elimination and prevent re-introduction of malaria. Largely responsible for funding interventions that enabled the global decreases in malaria incidence, external aid allocations have been waning in the past few years as a result of the global financial crisis. Multilateral and bilateral donor funds have trended toward supporting low-income, high-malaria burden countries. Thus, a growing number of eliminating countries are graduating away from donor support. In a recent analysis of the previous country list (appendix), the malaria-eliminating countries are projected to receive a 31% decrease in national funding allocations under the Global Fund's new funding model—a serious shortfall at a time when maintaining their gains and advancing the eliminating agenda are essential.⁶⁰ At the same time, while the national governments of the malaria-eliminating countries provide nearly 80% of funding for elimination efforts, domestic malaria budgets are often diverted toward more pressing disease priorities that are perceived as a greater threat to public health.⁶¹

Identification of new and innovative funding streams and advocating governments to maintain political support for malaria elimination are crucial to ensure successful achievement of eradication. Recent examples of promising new funding sources for elimination and eradication include the Regional Malaria and Other Communicable Disease Threats Trust Fund administered by the Asian Development Bank for malaria-endemic countries in the Asia Pacific; the Ross Fund, a joint partnership between the Government of the UK and the Bill & Melinda Gates Foundation to fund global malaria research and development; and the Lives and Livelihoods Fund, a partnership between the Islamic Development Bank and the Bill & Melinda Gates Foundation targeted toward Muslim countries to address a range of health and development issues, including malaria.^{62–64}

Other substantial challenges to achieving eradication are technical in nature, such as increasing drug and insecticide resistance, limited treatment options for *P vivax*, and the increasing number of *Plasmodium knowlesi* infections in the Asia Pacific region. The research and development pipeline for new malaria insecticides, drugs, and diagnostics is robust and will receive additional financial support through the Ross Fund, but new products will probably not be available for several years.^{38,39} The identification of an optimum mix of interventions, improvement of intervention targeting, and elimination of local reservoirs of drug resistant parasites could help slow the spread of insecticide and drug resistance in the meantime.^{38,39} Successfully combatting *P vivax* infections requires point-of-care diagnostics to detect glucose-6-phosphate dehydrogenase (G6PD) deficiency, a disorder that can lead to haemolytic anaemia in patients treated with primaquine, the only effective drug against the dormant liver stage of *P vivax*. G6PD detection kits are commercially available but not yet approved for use; drug alternatives to primaquine are under development.^{17,65}

The emergence of human *P knowlesi* infections in southeast Asia poses a unique threat to eradication, in that simian malaria parasites are very difficult to distinguish from human species and misdiagnosis is rampant. As a result, the extent of the *P knowlesi* burden and its transmission dynamics in human populations are largely unknown, and effective surveillance and prevention methods cannot be put in place. Additionally, a human malaria case caused by another simian parasite, *Plasmodium cynomolgi*, was recently detected in Malaysia and is morphologically identical to *P vivax*. Zoonotic malaria cases will probably continue to increase as urban development encroaches on the natural habitats of macaque monkeys, and new, more sensitive diagnostics will have a crucial role in preventing further spread.^{66,67}

Discussion

As global dialogue once again centres on malaria eradication and support for this ambitious goal grows, understanding the remarkable progress that has been made on a national and regional scale over the past 15 years is key. Although global focus on national malaria situations often focuses on Africa, huge strides toward elimination have been made in other parts of the world, facilitated by expanding regional platforms that have provided much needed political, financial, and technical support to participating countries. The progress made by countries in Asia Pacific, the eastern Mediterranean, Europe, and Latin America must continue to be celebrated and their lessons and challenges propagated to inform and inspire continuing elimination efforts in these regions and in Africa.

Global malaria eradication must be driven at the country level and achieved collaboratively, region by region. Looking to the future, existing and new regional initiatives have ample opportunity and room for growth. In the European region, a regional framework to prevent reintroduction and obtain malaria-free certification has been developed by WHO and member nations.²⁸ The Organization of Islamic Cooperation and the Islamic Development Bank, in cooperation with the Roll Back Malaria Partnership, recently called for increased political and financial commitment and collective action to control and eliminate malaria in Islamic countries in the eastern Mediterranean and African regions, which account for more than half of the global malaria burden.⁶⁸ In the Asia Pacific, APLMA has finalised its elimination roadmap and strategy to achieve the 2030 regional elimination goal, and a Malaria Elimination Dashboard is under development for the 22 countries in the region to measure and encourage progress.³⁷ Formalised commitments to regional goals such as these could encourage similar efforts on the national, regional, and global level.

When discussing global malaria goals and trends, it might be tempting to view the 35 malaria-eliminating countries as low priority compared with the high-burden, low-income countries where most malaria morbidity and

mortality occurs. This is a serious misconception. The progress in eliminating countries is a major driver of global progress, and success in these countries is a crucial step towards success in higher burden countries and, eventually, success in realising a malaria-free world. Maintaining the momentum of the eliminating countries is essential, requiring sustained focus, political and financial support, rapid responses to challenges and setbacks, and constant recognition and celebration of progress.

Contributors

RGAF and AAP led the development of the Review concept. All authors contributed to the development of the manuscript outline and structure. GN did a literature search, drafted the first version of the report, and generated the figures. All authors provided feedback and direction on the content and contributed to the drafting of the final version of the report and figures.

Declaration of interests

All authors work at the Global Health Group of the University of California, San Francisco, CA, USA. The Global Health Group exists in part to support global, regional, and country efforts to achieve evidence-based malaria elimination. RGAF chairs the Malaria Elimination Group. RGAF co-chairs the Asia Pacific Malaria Elimination Network and the Global Health Group is the co-secretariat of the network. The findings and conclusions in this Review are those of the authors and do not necessarily represent the views of their employing organisations or of the sources of funding.

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