

Review Article

Malaria successes and challenges in Asia

Rajesh Bhatia, Rakesh Mani Rastogi & Leonard Ortega

World Health Organization, Regional Office for South East Asia, Department of Communicable Diseases, New Delhi, India

ABSTRACT

Asia ranks second to Africa in terms of malaria burden. In 19 countries of Asia, malaria is endemic and 2.31 billion people or 62% of the total population in these countries are at risk of malaria. In 2010, WHO estimated around 34.8 million cases and 45,600 deaths due to malaria in Asia. In 2011, 2.7 million cases and >2000 deaths were reported. India, Indonesia, Myanmar and Pakistan are responsible for >85% of the reported cases (confirmed) and deaths in Asia.

In last 10 yr, due to availability of donor's fund specially from Global fund, significant progress has been made by the countries in Asia in scaling-up malaria control interventions which were instrumental in reducing malaria morbidity and mortality significantly. There is a large heterogeneity in malaria epidemiology in Asia. As a result, the success in malaria control/elimination is also diverse. As compared to the data of the year 2000, out of 19 malaria endemic countries, 12 countries were able to reduce malaria incidence (microscopically confirmed cases only) by 75%. Two countries, namely Bangladesh and Malaysia are projected to reach 75% reduction by 2015 while India is projected to reach 50–75% only by 2015. The trend could not be assessed in four countries, namely Indonesia, Myanmar, Pakistan and Timor-Leste due to insufficient consistent data.

Numerous key challenges need to be addressed to sustain the gains and eliminate malaria in most parts of Asia. Some of these are to control the spread of resistance in *Plasmodium falciparum* to artemisinin, control of outdoor transmission, control of vivax malaria and ensuring universal coverage of key interventions.

Asia has the potential to influence the malaria epidemiology all over the world as well as to support the global efforts in controlling and eliminating malaria through production of quality-assured ACTs, RDTs and long-lasting insecticidal nets.

Key words Disease burden; diversity in malaria situation; malaria elimination; malaria epidemiology; malaria intervention; *Plasmodium falciparum*

INTRODUCTION

Globally significant progress has been made in reducing malaria morbidity and mortality. Between 2000 and 2010, malaria mortality rate fell by 26% around the world, with 33% reduction in the African Region. During this period, an estimated 1.1 million malaria deaths were averted globally, primarily as a result of a scaling-up of interventions¹. In spite of the progress, malaria remains a major public health problem of concern globally. The disease is endemic in 104 countries and transmission is ongoing in 99 countries in 2012². Based on the latest

estimates by WHO, there were an estimated 219 million cases of malaria (range 154–289 million) and 660,000 deaths (range 610,000–971,000) in 2010². It is responsible for over 7% of deaths in children under five years in developing countries³; therefore, it is one of the leading causes of deaths among children. At global level malaria is considered as a problem mainly in the African continent as the same contributes around 88% of the total reported cases (microscopically confirmed + rapid diagnostic test—RDT confirmed) and 97% the reported deaths. The malaria problem is always associated with Africa due to very high burden of the disease in that continent. However, malaria inflicts the heaviest toll in several countries in Asia where it still remains at significant level and affects socioeconomic development. As Asian countries are undergoing rapid economic growth, these are also working together in addressing common challenges such as malaria. During the 7th East Asia Summit in November 2012, the leaders adopted a joint declaration for regional responses to control malaria and address the resistance to antimalarial medicines⁴. Historically and as projected, Asia has the potential to influence the malaria epidemiol-

The authors are staff members of the World Health Organization. The authors alone are responsible for the views expressed in this paper and they do not necessarily represent the decisions, policies or views of the World Health Organization.

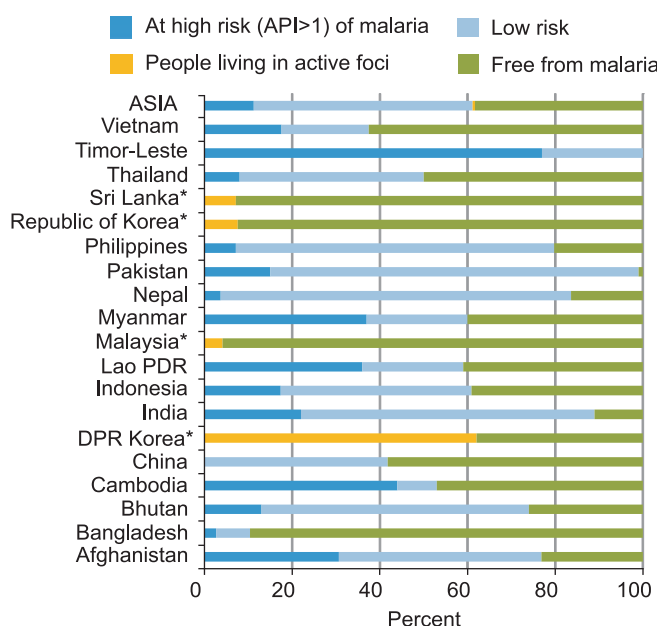
In this paper Asia is referred as an epidemiological block consisting of 19 countries, namely Afghanistan, Bangladesh, Bhutan, DPR Korea, India, Indonesia, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Leste, Cambodia, China, Lao PDR, Malaysia, Pakistan, Philippines, Republic of Korea and Vietnam from three Regions of WHO, namely South East Asia Region (SEAR), Western Pacific Region (WPR) and Eastern Mediterranean Region (EMR) where malaria is endemic.

ogy all over the world as well as support the global efforts to control malaria.

The main objective of this paper is to present comprehensive overview of the malaria situation in the malaria endemic countries of Asia, highlight the progress made by the National Malaria Control Programmes in controlling/eliminating malaria during 2000–11 and to identify the key challenges that need to be addressed to sustain the gains and contribute to the long-term goal of malaria elimination.

Population at risk

In Asia, out of the total population of 3.6 billion, as much as 62% people are at risk of contracting malaria, out of which 11% people are at high risk and 50% are at low risk² (Fig. 1). Among the population living in malaria endemic areas, infants, young children and pregnant women have been identified as high risk groups. Other groups of people who are at high malaria risk are mobile population particularly those engaged in forest-related economy, gem-mining, fishing, industrial activities and engaged in road construction work. In some countries, ethnic minorities, refugees, displaced persons, tourists and pilgrims also constitute high risk group. Also, most of the people living in border areas are at high risk of malaria². Many of these border areas are characterized by forest and forest fringe areas with high malaria transmission, poor geographical accessibility, high population mobility, and low population density. Large-scale population movement from highly endemic areas to low endemic zones has contributed substantially to the maintenance and spread of the disease^{5–6}.



*Countries in pre-elimination/elimination phase of malaria

Fig. 1: Population at risk of malaria in Asia 2011.

The malaria epidemiology is closely linked with the physical environment. The most prevalent malaria vectors are *Anopheles culicifacies* (Diptera: Culicidae), found in abundance in the plains; *An. dirus*, that breeds predominantly in forested areas and *An. minimus*, that is widespread in the forest-fringe areas. Most of the population in Asia lives in rice-growing areas and the plains, which are generally free of malaria transmission. The at-risk population are those who live in remote villages in or close to the forested and border areas where malaria vectors thrive and also accessibility to health services is very poor in these areas.

Disease burden

The burden of malaria in Asia is high and vary from country to country (Table 1). In 2011, four million malaria cases (presumed + confirmed) were reported, out of which 2.7 million cases could be confirmed by either microscopy or by RDT. Out of confirmed cases, >50% cases were due to *P. falciparum* (for calculation of *Pf*% only microscopically confirmed cases were considered because almost all the countries were using monovalent RDTs which can distort the *P. falciparum* proportion in the region) and 2030 malaria deaths were reported² (Table 1). It is important to notice that India, Indonesia, Myanmar and Pakistan are major contributors and account for >85% of the total confirmed cases and reported deaths in Asia during 2011 (Table 1). In the above mentioned countries, malaria burden within the country is not uniform and much higher mortality has been observed in certain geographical areas. In many countries, it has been observed from the national data that the high malaria incidence rates were mostly reported along the border areas with high population mobility, and low population density^{9–10}.

It should be noted that the country level data provide trends only and do not reflect the real malaria burden as the national data mainly cover the passive case detection from the public health facilities only. Further, the differences in diagnosis and reporting of malaria cases, and different treatment seeking behaviours by population, etc. make this issue more complicated. In most of the countries in Asia, there is no systematic inclusion of data from private practitioners, traditional healers, faith base organizations, self-medication, treatment by pharmacists and in some cases even data from community health workers is missing from the national data. All the above problems made it difficult to quantify the malaria burden accurately. Despite of the known limitations, the routine health information system should be recognized as useful, if not perfect, as the same is providing country information on major disease trends and mostly the sole source for detecting epidemics^{11–13}.

Table 1. Malaria profile of Asia 2011

Country	Presumed and confirmed malaria cases	Confirmed cases (Microscopically + RDTs)	Microscopically confirmed cases	Percent suspected malaria cases tested	Microscopically confirmed <i>P. falciparum</i>	<i>P. vivax</i>	<i>Pf%</i>	Malaria attributed deaths
Afghanistan	482,748	77,549	77,549	56.7	5,581	71,968	7.2	40
Bangladesh	51,773	51,773	20,232	100	17,543	2,579	86.7	36
Bhutan	207	194	194	100	87	92	44.8	1
Cambodia	57,423	57,423	13,792	100	7,054	5,155	51.1	94
China	4,498	3,367	3,367	100	1,370	1,907	40.7	33
DPRK	16,760	16,760	16,760	100	0	16,760	0	0
India	1,310,367	1,310,367	1,310,367	100	665,068	645,299	50.8	753
Indonesia	1,322,451	256,592	256,592	53.2	125,412	113,664	48.9	388
Lao PDR	17,904	17,835	6,226	100	5,770	442	92.7	17
Malaysia	5,306	5,306	5,306	100	973	2,422	18.3	–
Myanmar	567,452	465,294	91,752	91.6	59,604	28,966	65	581
Nepal	71,752	3,414	1,910	63.8	219	1,631	11.5	2
Pakistan	334,589	334,589	–	50	–	–	NA	–
Philippines	9,552	9,552	9,552	100	6,877	2,380	72	12
Republic of Korea	838	838	–	–	56	782	–	0
Sri Lanka	175	175	175	100	12	158	6.9	–
Thailand	24,897	24,897	14,478	100	5,710	8,608	39.4	43
Timor-Leste	36,064	19,739	19,739	92.8	14,261	3,758	72.2	16
Vietnam	45,588	16,612	16,612	99.1	10,101	5,602	60.8	14
Asia	4,360,344	2,672,276	1,864,603	95.8	925,698	912,173	49.6	2,030

NA—Not available. *Note:* *Pf* percentages are calculated based on microscopically confirmed *Pf* cases only. *Source:* World Malaria Report 2012.

In view of the above mentioned shortcomings and to have a comprehensive picture of malaria disease burden among the countries, WHO came forward with a method to estimate the said burden in any country in 2008 which can be updated using routine data every year¹⁴. Using that methodology, in 2010, WHO estimated around 34.8 million cases of malaria, and 45,600 deaths annually² in Asia (Fig. 2). The estimated cases and deaths vary from 757 cases and no deaths to 24 million cases and 29,400 deaths in the WHO member countries². This implies that the malaria status among the countries of Asia as well as their contributions to global burden are, however, not uniform.

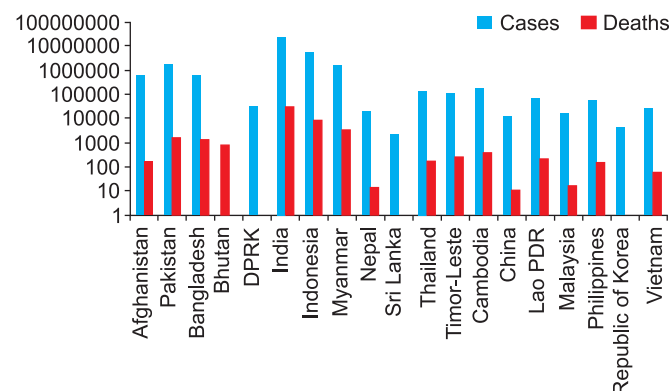


Fig. 2: Estimated cases and deaths in Asia 2010. *Source:* World Malaria Report 2012.

Huge diversity in malaria situation

As mentioned in the previous section, there is a huge diversity in malaria epidemiology which include diversity and heterogeneity of vector species^{15–17}, duration of transmission, various malaria paradigms, and population groups affected by malaria¹⁸. This diversity is also extended to prevailing malaria parasites formula also. In some countries, only *P. vivax* exists, viz. DPRK and Republic of Korea whereas there are some countries with predominance of *P. falciparum* with >65% of the microscopically confirmed cases, viz. Bangladesh, Cambodia, Myanmar, Timor-Leste, Laos and Philippines (Table 1). Also, there are four countries that are vivax dominated, namely Afghanistan, Malaysia, Nepal and Sri Lanka where from >80% of the microscopically confirmed cases of *P. vivax* are reported and three countries, namely Bhutan, India and Thailand where *P. falciparum* cases remain between 40 and 60%. Malaria situation vary substantially between countries and within a country, although common agendas exist, few countries and regions/areas need some unique solutions depending upon the local epidemiology and appropriateness to the place using local resources and communities. Success of village malaria workers/volunteers in Bangladesh, Cambodia, selected areas of India, Myanmar, Sri Lanka and Vietnam¹³ are the few examples that can be replicated.

Depending upon malaria epidemiology, malaria status and local conditions as mentioned above, there is huge diversity between countries regarding control and elimination phases of malaria in Asia. Of the above mentioned 19 malaria endemic countries, two countries, namely Sri Lanka and Korea are in elimination phase, three countries, namely Bhutan, DPR Korea and Malaysia are in pre-elimination phase, two countries, namely Philippines and China are progressing towards sub-national level elimination where as India, Nepal and Thailand could potentially move towards the pre-elimination phase by continuing their progress, assuring that all malaria cases are laboratory confirmed and inclusion the private sector in the health reporting² (Fig. 3).

The above mentioned diversity is also visible in demographic, economic and health characteristics of the countries which are engaged in malaria elimination (including pre-elimination and sub-national level elimination). There are seven countries of the region which fall under this category and out of these, one country belongs to lower income economy, four under lower middle in-

come group while one each in higher-middle and higher income economy categories. There is huge diversity in population which vary from 0.7 million in Bhutan to >1.3 billion in China. Similarly, life expectancy vary between 66 and 79 yr at birth, gross national income per head, health expenditure per head and private health expenditure (percent of total health expenditure) vary from US \$ 1890–21,530, US \$ 14–1168 and 14–67% respectively¹⁹.

Varying success in malaria control in Asia

Between 2000 and 2011, the countries in Asia have made good progress in controlling the disease. This success is due to several factors. One of the main reasons for achieving massive success was that national efforts and substantial investments in malaria control have yielded dividends in scaling-up evidence-based interventions that were adopted as part of their Malaria National Strategic Plans by the countries^{2, 20–21}. Also, the national efforts and commitments have been complemented by several international development partners and UN agencies. Improved surveillance, monitoring and evaluation, active involvement of

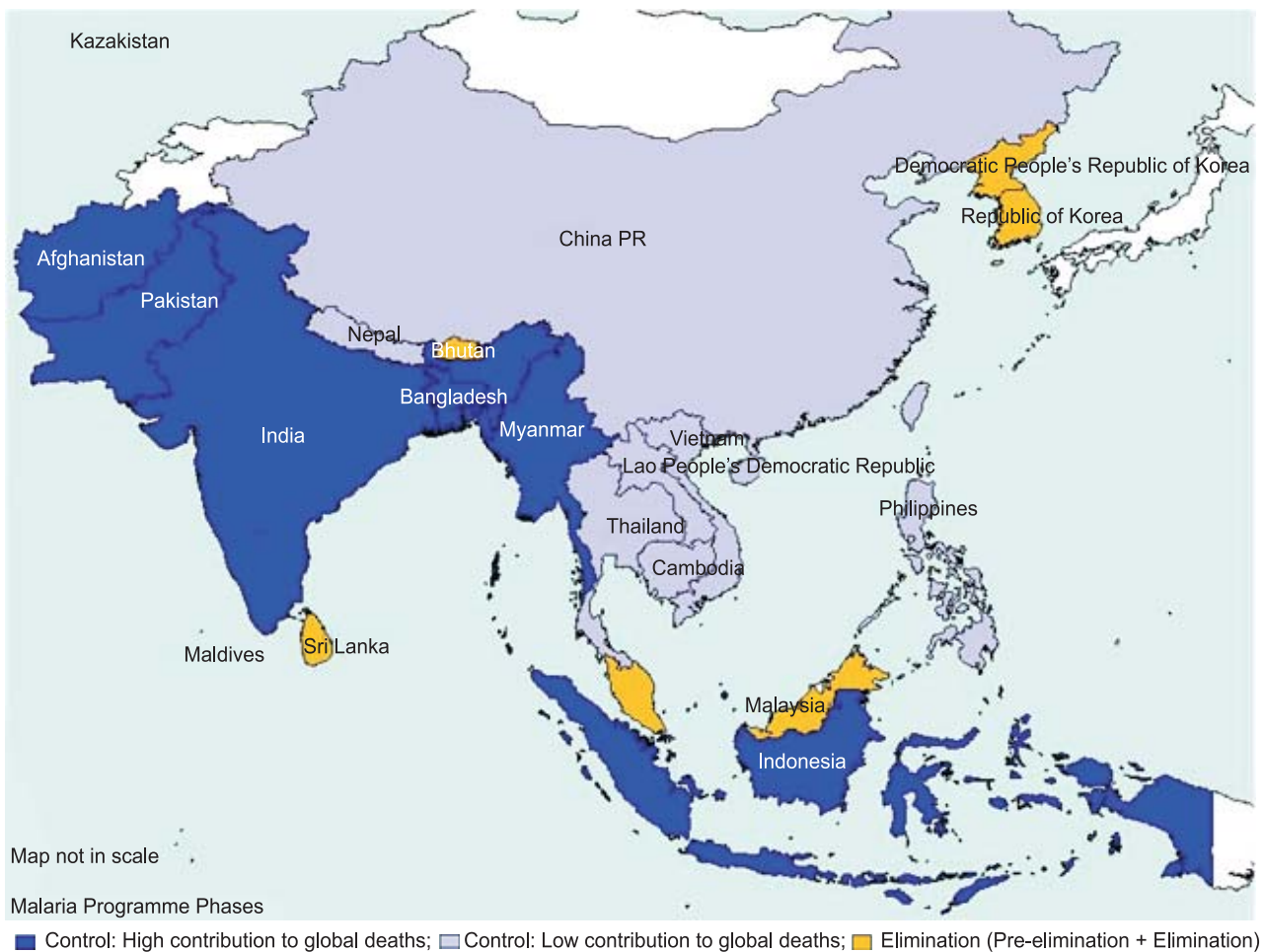


Fig. 3: Huge diversity in malaria endemic countries of Asia (Philippines and Thailand are involved in sub-national level elimination).

non-governmental organizations, the hard work of dedicated staff from general health services and national malaria control programmes and community participation in improving access to malaria control services played a vital role and made significant contribution to achieve the objectives of reducing the malaria burden. All these combined efforts lead to intensification of the interventions for malaria control in almost every country in Asia.

The availability and access to medicines, diagnostics and other commodities have improved significantly. However, the same is not in the case of high burdened countries, namely India, Indonesia, Myanmar and Pakistan. Similarly, there has been significant increase in the availability and use of parasitological testing in the last few years. Except Pakistan, Indonesia, Nepal and Afghanistan, the rate of testing of suspected malaria is over 90% in rest of the countries of Asia (Table 1).

Most of the increase in case finding is attributable to an increase in use of RDTs. The coverage under long-lasting insecticidal nets (LLINs) and indoor residual spray for vector control has increased tremendously. The highest number of LLINs are procured during 2010 in many countries. However, the same is not uniform in all the countries. As most of the countries are resource stricken, therefore, population at high risk is given preference over population at low risk for distribution of LLINs or con-

ducting IRS activity (Table 2). As a result of access to increased interventions, malaria morbidity and mortality have declined significantly in Asia. As compared to the data of the year 2000, the malaria incidence (confirmed by microscopy + RDTs) and mortality reduced by 34 and 79% respectively (Fig. 4).

As there is a huge diversity in malaria situation in Asia, there has been varying degree of success in containing/eliminating this disease in this region. The selected countries where confirmed malaria cases declined by >50% during 2000–11 are shown in Fig. 5.

The success rate among the countries which had already reduced their burden and among the high endemic countries was not the same. The impact on countries under varied malaria control/elimination phases were different as shown in Fig. 6.

Table 2. Malaria intervention status in Asia (2011)

Country	Percent Population at high risk potentially covered under ITNs	Percent Population at high risk potentially covered under IRS	Percent antimalarial coverage	Percent ACT coverage
Afghanistan	92.6	0	NA	NA
Bangladesh	100	0	100	100
Bhutan	100	100	58	100
Cambodia	67.8	0	100	100
China	100	100	NA	NA
DPRK	100	100	12	100
India	8.3	19.5	100	100
Indonesia	31.1	1.3	29	53
Lao PDR	48.2	0	100	100
Malaysia	100	100	100	100
Myanmar	24.1	0	96	100
Nepal	100	22.7	91	6
Pakistan	3	0	NA	NA
Philippines	100	15.5	NA	NA
Republic of Korea	100	0	72	NA
Sri Lanka	100	100	100	98
Thailand	0	7.6	100	100
Timor-Leste	43	11.6	100	100
Vietnam	16.3	10	100	100
Asia	21.6	14.8	100	100

NA—Data not available. *Source:* World Malaria Report 2012.

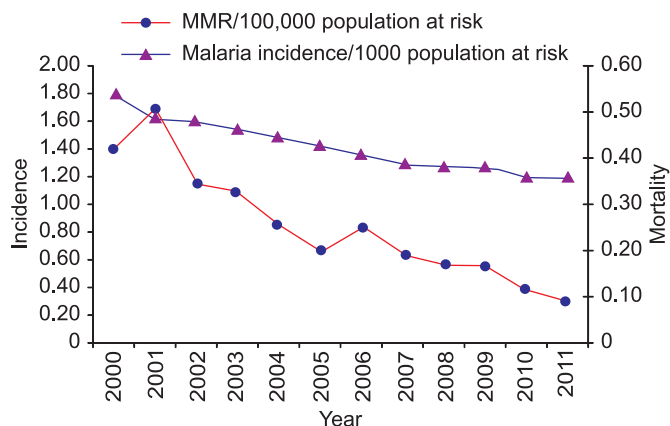


Fig. 4: Trends of malaria incidence and mortality in Asia 2000–11. *Source:* World Malaria Report 2012; Country reports submitted for WMR 2012.

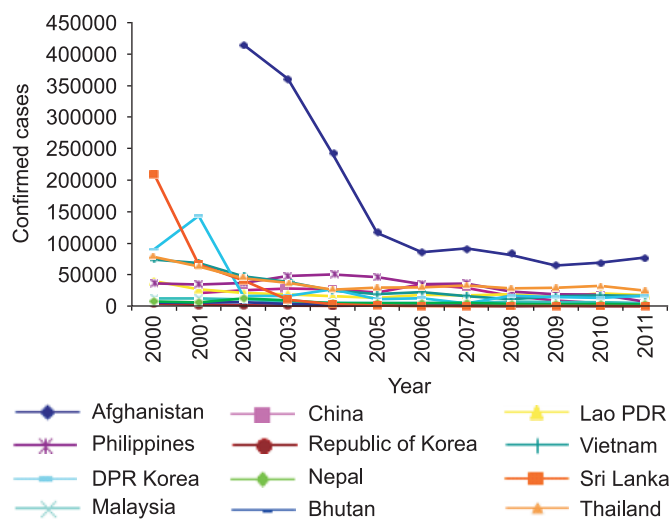


Fig. 5: Countries with >50% decrease in confirmed cases (microscopically confirmed + RDTs) of malaria in Asia (2000–11). *Source:* World Malaria Report 2012



Fig. 6: Summary of trends in reported malaria incidence (microscopically confirmed cases only) 2000–11. Source: World Malaria Report 2012.

In Asia region, 12 countries have registered decline in the incidence of microscopically confirmed malaria incidence rates of 75% or more between 2000 and 2011. Bangladesh and Malaysia are on track to achieve a 75% reduction by 2015 (a 75% reduction in malaria case incidence) is equivalent to an 8.83% reduction per year (compounded) between 2000 and 2015. Thus, to be on track to achieve the targets, countries need to have reduced the incidence of malaria by at least 64% between 2000 and 2011, and India is projected to reduce case incidence by 50–75% by 2015. It was not possible to discern the direction of trends in Indonesia, Myanmar, Pakistan and Timor-Leste owing to inconsistency of reporting overtime².

The biggest challenge is to bring the above mentioned five high burdened countries, namely India, Indonesia, Myanmar, Pakistan and Timor-Leste on track with >75% reduction in malaria incidence category along with the peers by 2015. In order to reach the desired goal, much greater scaling-up is mandatory in the direction of access to quality interventions in diagnostics, treatment and LLINs. Innovative approaches are needed to protect the people who are going to forest areas where LLINs are ineffective and special efforts need to be placed for reaching out to the unreached people. Needless to say that there is a need of strong political commitment as well as huge investment.

Malaria financing

Funding for malaria control has increased dramatically in the last decade globally. In Asia too, funding has

been increased from US \$ 66 million in 2000 to over US \$ 84 million in 2011 but the highest amount of US \$ 388 million was available in 2010 in Asia. Global fund continued to remain the major donor globally as well as in Asia^{2, 21}. Initially, up to 2005, the total donor’s share was <50% to the total available funds. The government has the major share as Global fund started providing grants from 2002 onwards only and grants were limited to few countries of the Asia only. But situation started changing thereafter as more and more countries started getting grants from the global fund in the region (Fig. 7). However, in 2011, the government funding again exceeded from donor’s contribution. It is important to notice that government commitment for malaria is reflected adequately through increased funding every year by almost

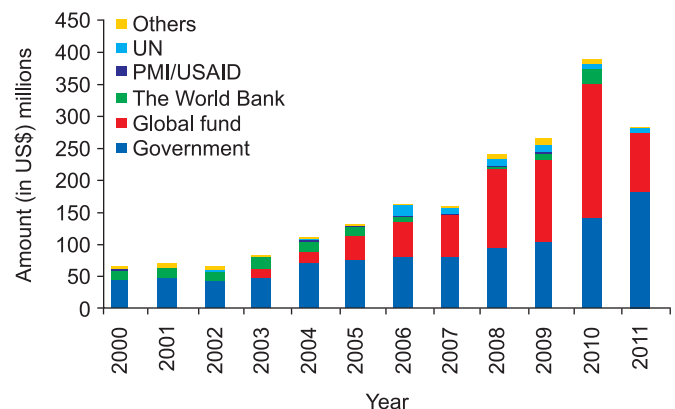


Fig. 7: Malaria financing status in Asia 2000–11. Source: World Malaria Report 2012.

all countries during the said period.

Although the total funding for malaria has been increased significantly but still the current funding for malaria programmes falls too short of the amount required to achieve universal access to malaria interventions^{2, 22} and most likely it will reduce further due to global recession. This implies that funding needs to be increased from existing levels through innovative financing, viz. bond mechanisms, taxes on discretionary items, insurance schemes and other fee-based initiatives and/or that malaria control programmes should seek cost savings, viz. more effective LLINs procurement, integrated approaches to case management and voluntary pooled procurement across countries, so that more can be done with existing funds.

In many settings, LLINs and other vector control interventions account for the majority of malaria programme expenditure^{2, 20–21}. LLINs have a limited lifespan and need to be replaced every 2 to 3 yr. In 2010, when the procurement of LLINs peaked in most of the Asian countries, funding is urgently needed to replace LLINs in 2013. Also, the overall levels of funding and the timing of funding is also critical. Experience has repeatedly shown that weakening of malaria control efforts leads to resurgences in malaria, with reductions in funding being the most important contributing factor. It is, therefore, essential that levels of funding for malaria control are at least maintained at previous levels if outbreaks are to be avoided, and increased if further reductions in malaria cases and deaths are to be attained.

Challenges

There are innumerable challenges that are obstructing the way of the Malaria Control Programmes of the member countries to reach the desired goal of malaria elimination in Asia. Some of them are summarised as under:

Plasmodium falciparum resistance to artemisinin

The emergence of *P. falciparum* resistance to artemisinin^{23–27} in Asia is the biggest threat to the entire world (Fig. 8). The Greater Mekong sub-region has been the epicenter for emergence of resistance in malaria parasites to several antimalarials in the past. These resistant parasites have moved from Mekong to other countries and even Africa.

So far, artemisinin resistance is restricted to Greater Mekong sub-region and the same will not be allowed to fulminate and spread²². Initial reports from Myanmar showed that resistance has not spread from earlier foci which is a good news. ACT resistance is the single factor that can neutralize the gains made in malaria control in the past decade. In the words of Dr Margaret



Fig. 8: Sites where suspected or confirmed artemisinin resistance has been detected as of 2012. Source: Emergency response to artemisinin resistance in the Greater Mekong sub-region: Regional framework for action 2013–15; WHO 2013.

Chan, “it is no exaggeration for me to say that the consequence of widespread resistance to artemisinins would be catastrophe”²⁸.

Resistance in micro-organisms is a complex problem which has behavioural, educational, biological, technical, economic and regulatory aspects. All these need to be addressed comprehensively and vigorously to preserve the efficacy of ACT, which is currently our best bet against malaria. The world can not afford to lose this tool. WHO has a global strategy for the prevention and control of artemisinin resistance which needs to be implemented in right earnest.

Control of outdoor transmission

It is linked to occupations, viz. agro-forestry, rubber plantation, mining, road and dam construction, etc. It is not amenable for current tools such as indoor residual spraying and long-lasting insecticidal nets to deal with it.

Control of vivax malaria

It is also one of the major technical challenges for malaria control in Asia. The problem of vivax malaria is often unnoticed. Factors influencing the dynamics of *P. vivax* transmission are similar to that of *P. falciparum*, but due to its biological characteristics, vivax malaria is more difficult to control than falciparum malaria. It is stronger to survive in natural conditions as compared to

P. falciparum. It is now increasingly realized that morbidity load due to vivax malaria is quite high and is likely to continue for longer period affecting the economic gains. The problem has been compounded by the emergence of chloroquine resistance in *P. vivax* in Indonesia, Papua New Guinea, Myanmar^{29–30}, etc. It is therefore, increasingly realized that problems related to vivax malaria should be addressed and rational control measures need to be intensified³¹. New drugs are needed to replace the 14-day treatment with primaquine to circumvent liver stages and prevent relapse. A diagnostic test for glucose-6-phosphate dehydrogenase deficiency is also needed for easy use at point-of-care.

Besides the technical challenges, there are some programmatic challenges also that are listed below:

Counterfeit/substandard drugs and irrational use of drugs

This is a growing problem throughout the Asia but specially has been the proliferation of counterfeit antimalarial drugs on the market. The inadvertent use of fake drugs has caused deaths from malaria that would otherwise have been avoidable. The counterfeit and substandard medicines are sold primarily in the informal sector, along international border areas. The parts of the region with long borders and many unofficial ports of entry are most difficult to control and are therefore vulnerable to the trafficking of fake drugs. Cross-country collaboration, though essential to halting the counterfeit drug trade, is a sensitive issue because many sources of counterfeit antimalarials are from neighbouring countries. In terms of multicountry studies, a survey conducted in sites in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam in 1999/2000 (using convenience sampling) found that 38% of 104 samples marked as oral artesunate were fake, containing no active ingredient^{32–33}. A similar survey conducted in 2002–03 found that 53% of the 188 artesunate blister packs collected were counterfeits³⁴.

The misuse of drugs is also an impediment to malaria control in the region. Over- or under-medication can lead to treatment failure and can allow the parasite to develop resistance. Drug-use surveys have reported a high degree of self-medication in parts of the Greater Mekong (for instance, results from a Lao PDR survey showed that about 53% of respondents self-medicated for malaria³⁵, which imposes difficulties in ensuring proper drug use). The problem of irrational drug use has increased with the expanding role of the private sector in malaria diagnosis and treatment. In Cambodia, it is estimated that the private sector has been the first point of contact for over 70% of people seeking malaria treatment³³.

Universal coverage of intervention

Although lot of progress has been made in this direction still more needs to be done to achieve universal coverage so that all people, and particularly high-risk groups, have access to key interventions. This requires, among other things, strengthening the health system, sustainable financing and innovative delivery mechanism.

CONCLUSION

The success of controlling any communicable disease lies in accessing the difficult to reach populations. The epidemiology of malaria is influenced by people living in forests, migrant, mobile and ethnic populations. Strong health systems can bring them into the gambit of efficient services and evidence based interventions can reduce disease burden through effective programme and community participation.

In short, a multitude of challenges need to be faced to combat malaria. These include productive collaboration, strong political commitment leading to substantial scaling-up and reaching out to unreached populations, building strong health systems, addressing resistance in parasites and mosquitoes which warrant effective regulatory machinery, and giving respect to contribution of vivax malaria which is being neglected but is insidiously becoming menacing. But the silver lining along with these challenges is that there is adequate capacity within Asia to grow raw material for artemisinin as 80% of the global production of the plant *Artemisia annua* is in China and Vietnam, 6 of the 9 WHO pre-qualified manufacturers of ACT are in Asia, 3 of the 6 manufacturers of RDT are in Asia and 4 of 10 WHO approved manufacturers of insecticide treated nets operate from Asia. This vibrant pharma industry is a great boon for Asian countries.

Malaria is a health problem but not a problem of health sector alone. A multi-sectoral response with development and implementation of Healthy Public Policies that provide a conducive environment and assured community participation are essential. Asia may have only small portion of the global burden of malaria but it has the potential threat to global health security. Containing malaria in Asia is critical to global public health. The industry in Asia can provide support to entire world in meeting requirements of medicines and commodities, given the right encouragement. Now with the availability of knowledge, lessons learnt from the past and availability of efficient tools which can be further improved and distributed through innovative delivery mechanisms, malaria could certainly be contained/eliminated in Asia. Just it needs to work in planned and comprehensive manner to achieve the objective of this article.

REFERENCES

1. Fact sheet (Malaria). Available from: <http://www.who.int/media/centre/factsheets/fs094/en/index.html>
2. *World Malaria Report 2012*. Geneva: World Health Organization 2012. Available from: http://www.who.int/malaria/publications/world_malaria_report_2012/en/index/html
3. *Children: Reducing mortality*. Geneva: World Health Organization. Available from: <http://www.who.int/mediacentre/factsheets/fs178/en/>
4. Available from: <http://www.jagranjosh.com/current-affairs/the-seventh-east-asia-summit-concluded-in-phnom-penh-cambodia-1353643820-1>
5. Tatem AJ, Smith DL. International population movements and regional *Plasmodium falciparum* malaria elimination strategies. *PNAS* 2010; 107(27): 12222–7.
6. Martens P, Hall L. Malaria on the move: Human population movement and malaria transmission. *Emerg Infect Dis* 2000; 6(2): 103–9.
7. Gould DJ, Scanlon JE, Ward RA. *Anopheles* vectors of malaria in Southeast Asia. *Army Science Conference Proceedings* 1966; 1: 361–73.
8. Trung HD, Van Bortel W, Sochantha T, Keokenchanh K, Quang NT, Cong LD, *et al.* Malaria transmission and major malaria vectors in different geographical areas of South East Asia. *Trop Med Int Health* 2004; 9: 230–7.
9. Liwang Cui, Guiyun Yan, Jetsumon Sattabongkot, Yaming Cao, Bin Chen, Xiaoguang Chen, *et al.* Malaria in the Greater Mekong sub-region: Heterogeneity and complexity. *Acta Trop* 2012; 121(3): 227–39.
10. Wernsdorfer WH, Chongsuphajaisiddhi T, Salazar NP. A symposium on containment of mefloquine-resistant falciparum malaria in Southeast Asia with special reference to border malaria. *Southeast Asian J Trop Med Public Health* 1994; 25(1): 11–8.
11. Cibulskis RE, Bell D, Cristophel E, Jeffrey Hii, Charles Delacollette, Nathan Bakayaita, *et al.* Estimating trends in the burden of malaria at country level. *Am J Trop Med Hyg* 2007; 77 (6 Suppl): 133–7.
12. Guitran JO, Delacollette C, Trigg P. Systems for early detection of malaria epidemics in Africa: An analysis of current practices and future priorities. WHO/HTM/2006.1115.2006 (Accessed on March 20, 2009).
13. WHO expert committee on malaria. *World Health Organ Tech Rep Ser* 2000; 892: 1–74. (Accessed on December 20, 2009).
14. *World Malaria Report 2008*. Geneva: World Health Organization 2008. Available from: <http://www.who.int/malaria/wmr2008/malaria2008.pdf>
15. Dudley Stamp L. A regional and economic geography. London: Methuen & Co. Ltd. 1962.
16. Subbarao SK. Anopheline species complexes in Southeast Asia. *Tech Rep Ser* No. 18. New Delhi: World Health Organization, Regional Office for Southeast Asia 1998.
17. Morgan Katy, Somboon Pradya, Walton Catherine. Understanding *Anopheles* diversity in Southeast Asia and its applications for malaria control (CH-10). *Anopheles* mosquitoes — New insights into malaria vectors. Manguin Sylvie, editor. Available from: <http://www.intechopen.com/books/anopheles-mosquitoes-new-insights-into-malaria-vectors/understanding-anopheles-diversity-in-southeast-asia-and-its-applications-for-malaria-control>
18. Dash AP, Valecha N, Anvikar AR, Kumar A. Malaria in India: Challenges and opportunities. *J Biosci* 2008; 33(4): 583–92.
19. Richard GA Feachem, Allison A Phillips, Jimee Hwang Chris Cotter, Benjamin Wielgosz, Brian M Greenwood, *et al.* Shrinking the malaria map: Progress and prospects. *Lancet* 2010; 376(9752): 1566–78.
20. The global fund to fight aids, tuberculosis and malaria (GFATM). Available from: <http://www.theglobalfund.org/en/about/diseases/malaria/>
21. *World Malaria Report 2011*. Geneva: World Health Organization. Available from: http://www.who.int/malaria/world_malaria_report_2011/9789241564403_eng.pdf
22. Roll back malaria partnership 2008. *The Global Malaria Action Plan for a Malaria-Free World*. Available from: <http://www.rbm.who.int/gmap>
23. Emergence of artemisinin resistance on Thai-Myanmar border raises spectre of untreatable malaria. Welcome Trust Press release 2012. Available from: <http://www.wellcome.ac.uk/News/Media-office/Press-releases/2012/WTVM054882.htm>
24. Enserink M. Malaria: Signs of drug resistance rattle experts, trigger bold plan. *Science* 2008; 322: 1776.
25. Noeld H, Se Y, Schaecher K, Smith BL, Socheat D, Fukuda MM. Evidence of artemisinin-resistant malaria in western Cambodia. *N Engl J Med* 2008; 359: 2619–20.
26. Update on artemisinin resistance – April 2012. Available from: <http://www.searo.who.int/entity/malaria/en/index.html>
27. Global plan for artemisinin resistance containment (GPARC). Geneva: World Health Organization. Available from: <http://www.who.int/malaria/publications/atoz/9789241500838/en/>
28. DG speeches. Available from: http://www.who.int/dg/speeches/2011/malaria_plan_2011012/en/index.html
29. Baird JK, Basri H, Purnomo, Bangs MJ, Subianto B, Patchen LC, *et al.* Resistance to chloroquine by *Plasmodium vivax* in Irian Jaya, Indonesia. *Am J Trop Med Hyg* 1991; 44(5): 547–52.
30. Marlar-Tham, Myat-Phone-Kyawb, Aye-Yu-Soea, Khaing-Khaing-Gyia, Ma-Sabaia, Myint-Oo, *et al.* Development of resistance to chloroquine by *Plasmodium vivax* in Myanmar. *Trans R Soc Trop Med Hyg* 1995; 89: 307–8.
31. Mendis Kamini, Sina Barbara J, Marchesini Paola, Carter Richard. The neglected burden of *Plasmodium vivax* malaria. *Am J Trop Med Hyg* 2001 (Suppl 1–2) 64: 97–106.
32. Newton PN, Fernandez FM, Plancon A, Dallas C, Mildenhall, Michael D Green, Li Ziyong, *et al.* A collaborative epidemiological investigation into the criminal fake artesunate trade in South East Asia. *PLoS Med* 2008; 5: 2.
33. Newton PN, Proux S, Green M, Smithuis F, Rozendaal J, Looareesuwan S, *et al.* Fake artesunate in Southeast Asia. *Lancet* 2001; 357: 1948–50.
34. Dondorp AM, Newton PM, Mayxay M, Van Damme W, Smithuis FM, *et al.* Fake antimalarials in Southeast Asia are a major impediment to malaria control: Multinational cross-sectional survey on the prevalence of fake antimalarials. *Trop Med Int Health* 2004; 9: 1241–6.
35. Lao PDR National Health Survey 2001.

Correspondence to: Dr Rakesh Mani Rastogi, World Health Organization, Regional Office for Southeast Asia, Mahatma Gandhi Marg, Indraprastha Estate, New Delhi–110 002, India.
E-mail: rastogir@who.int