



# WORLD MALARIA REPORT 2012





WHO GLOBAL MALARIA PROGRAMME

# WORLD MALARIA REPORT

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*“Behind the statistics and graphs lies a great and needless tragedy: malaria still takes the life of an African child every minute.”*

# Foreword



**Dr Margaret Chan**  
**Director-General**  
**World Health Organization**

The past five years have seen an impressive increase in international funding for malaria prevention, control and elimination. Following the call in 2008 by United Nations

Secretary-General, Ban Ki-moon for universal access to malaria interventions, we saw a rapid expansion in the distribution of life-saving commodities in sub-Saharan Africa, the continent with the highest burden of malaria. The concerted effort by endemic country governments, donors and global malaria partners has led to strengthened disease control and visible results on the ground. During the past decade, an estimated 1.1 million malaria deaths were averted, primarily as a result of a scale-up of malaria interventions.

However, the available funding still falls short of the resources required to reach the health-related Millennium Development Goals and other internationally-agreed global malaria targets. An estimated US\$ 5.1 billion is needed every year between 2011 and 2020 to achieve universal access to malaria interventions. At present, only US\$ 2.3 billion is available, less than half of what would be needed. There is an urgent need to identify new funding sources in order to further scale up and sustain malaria control efforts, and to protect the investments made in the last decade. We also need to examine new ways to make existing funds stretch further by increasing the value for money of malaria commodities and the efficiency of service delivery.

The *World Malaria Report 2012* brings together the latest available data from malaria-endemic countries and partners, and contains valuable analyses of progress and trends. Behind the statistics and graphs lies a great and needless tragedy: malaria – an entirely preventable and treatable disease – still takes the life of an African child every minute. The most vulnerable communities in the world continue to lack sufficient access to long-lasting insecticidal nets, indoor residual spraying, diagnostic testing, and artemisinin-based combination therapies. Unfortunately, only modest increases in access to these interventions were observed between 2010 and 2011 – the first such plateauing in the past 5 years. It is imperative that we act now to ensure that the recent momentum, and its results, are not diminished.

In addition, while our current tools remain remarkably effective in most settings, resistance to artemisinins – the key compounds in artemisinin-based combination therapies – has been detected in four countries of South-East Asia, while mosquito resistance to insecticides has been found in 64 countries around the world. While such resistance has not yet led to operational failure of malaria control programmes, urgent and intensified efforts are required to prevent a future public health disaster.

We are three years away from the target date set for the Millennium Development Goals. As the report demonstrates, 50 countries are on track to reduce their malaria case incidence rates by 75%, in line with the World Health Assembly and Roll Back Malaria targets for 2015. However, these 50 countries account for only 3% (or 7 million) of the total estimated malaria cases worldwide. International targets for malaria will not be attained unless considerable progress is made in the 14 highest burden countries, which account for an estimated 80% of malaria deaths.

Tracking progress is a major challenge in malaria control. Malaria surveillance systems detect only around 10% of the estimated global number of cases. Stronger malaria surveillance systems are urgently needed to enable a timely and effective malaria response in endemic regions, to prevent outbreaks and resurgences, to track progress, and to hold governments and the global malaria community accountable. In as many as 41 countries around the world, making a reliable assessment of malaria trends is currently not possible due to incompleteness or inconsistency of reporting.

On World Malaria Day this year, I travelled to Namibia to launch the *T3: Test. Treat. Track.* initiative, urging countries and partners to scale up diagnostic testing, quality-assured treatment and surveillance for malaria. WHO has also made available new global surveillance manuals for malaria control and elimination and published the Global Plan for Insecticide Resistance Management in malaria vectors. These practical documents will help countries update and refocus their national malaria strategies to achieve better results with the limited resources available. In addition, the newly constituted WHO Malaria Policy Advisory Committee recommended Seasonal Malaria Chemoprevention for the control of malaria in the Sahel sub-Region of Africa. This simple and inexpensive intervention has the potential to prevent more than 75% of uncomplicated and severe malaria among children younger than five years of age.

Defeating malaria will require a high level of political commitment, strengthened regional cooperation, and the engagement of a number of sectors outside of health, including finance, education, defence, environment, mining, industry and tourism. The fight against this disease needs to be integrated into the overall development agenda in all endemic countries. We cannot achieve further progress unless we work tirelessly to strengthen health systems and ensure that sustained and predictable financing is available. This report shows how far we have come in the struggle against malaria; we must act with urgency and determination to keep this tremendous progress from slipping out of our grasp.

A handwritten signature in black ink, appearing to read 'M. Chan'.



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# Summary and Key Points

The *World Malaria Report 2012* summarizes information received from 104 malaria-endemic countries and other sources, and updates the analyses presented in the 2011 report. It highlights the progress made towards the global malaria targets set for 2015 and describes current challenges for global malaria control and elimination.

The past decade has witnessed tremendous expansion in the financing and implementation of malaria control programmes. International disbursements for malaria control rose steeply from less than US\$ 100 million in 2000 to US\$ 1.71 billion in 2010 and were estimated to be US\$ 1.66 billion in 2011 and US\$ 1.84 billion in 2012. Analysis indicates that as funding has risen, international disbursements have been increasingly targeted to the African Region, to countries with the lowest gross national income (GNI) per capita, and to countries with the highest malaria mortality rates. Domestic government funding for malaria control programmes also increased through 2005–2011 and was estimated at US\$ 625 million in 2011.

While still falling short of the US\$ 5.1 billion required to achieve universal coverage of malaria interventions, the financing provided for malaria control has enabled endemic countries to greatly increase access to malaria preventive interventions as well as diagnostic and treatment services. The percentage of households owning at least one insecticide-treated net (ITN) in sub-Saharan Africa is estimated to have risen from 3% in 2000 to 53% in 2011, and remained at 53% in 2012. Household surveys indicate that approximately 90% of persons with access to an ITN within the household actually use it. The percentage protected by indoor residual spraying (IRS) in the African Region rose from less than 5% in 2005 to 11% in 2010 and remained at that level in 2011. For malaria diagnostic testing and treatment, the numbers of rapid diagnostic tests (RDTs) and artemisinin-based combination therapies (ACTs) procured is increasing, and the percentage of suspected cases that receive a parasitological test has also risen, from 68% globally in 2005 to 77% in 2011, with the largest increase in sub-Saharan Africa. But the increase in diagnostic testing rates between 2010 and 2011 was just 1%.

It appears that the rapid increase shown by these measures of programme performance up to 2010 has tended to level off recently in parallel with a leveling of funding, and that millions of people continue to lack access to preventive therapies, diagnostic testing and quality-assured treatment. Considerably more work is needed before the target of universal access to malaria preventive interventions, diagnostic testing and appropriate treatment will be attained. A further complication is that resistance to artemisinins – the key compounds in artemisinin-based combination therapies – has been detected in 4 countries of the South-East Asia Region, while mosquito resistance to insecticides has been found in 64 countries around the world.

Of 99 countries with ongoing malaria transmission in 2011, 58 submitted sufficiently complete and consistent data on malaria cases between 2000 and 2011 to enable an assessment of

trends to be made. Based on these reported data, 50 countries are on track to meet WHA and RBM targets: to reduce malaria case incidence by 75% by 2015, including 9 countries in the African Region. However, the 58 countries that submitted sufficiently complete and consistent data account for only 15% of estimated cases worldwide; surveillance systems are weakest where the malaria burden is highest. There is a critical need to strengthen malaria surveillance in the remaining 41 countries which account for 85% of estimated malaria cases, so that programmes can identify and direct resources to the populations most in need, respond to outbreaks of disease, and assess the impact of control measures.

Because countries with higher numbers of cases are less likely to submit sufficiently consistent data, it is necessary to draw inferences about trends in some countries using estimates of numbers of cases. The estimated numbers of malaria cases and deaths are accompanied by a large degree of uncertainty, but suggest that reductions in malaria case incidence and mortality have occurred faster in countries with lower initial numbers of cases and deaths. Nonetheless, greater numbers of cases and deaths are estimated to have been averted between 2001 and 2010 in countries which had the highest malaria burdens in 2000. If the malaria incidence and mortality rates in 2000 had remained unchanged over the decade, 274 million more cases and 1.1 million more deaths would have occurred between 2001 and 2010. The majority of cases averted (52%) and lives saved (58%) are in the 10 countries which had the highest estimated malaria burdens in 2000. Thus, malaria programmes have had their greatest impact where the burden is highest.

The enormous progress achieved appears to have slowed recently. International funding for malaria control has levelled off, and is projected to remain substantially below the US\$ 5.1 billion required to achieve universal coverage of malaria interventions. The number of ITNs procured in 2012 (66 million) is far lower than in 2011 (92 million) and 2010 (145 million). With the average useful life of ITNs estimated to be 2 to 3 years, ITN coverage is expected to decrease if ITNs are not replaced in 2013. There is an urgent need to identify new funding sources to maintain and expand coverage levels of interventions so that outbreaks of disease can be avoided and international targets for reducing malaria cases and deaths can be attained.

## Policy development; updated policies, manuals and plans; and global targets for malaria control and elimination

*In 2011, WHO completed a major re-design of its policy-setting process, resulting in the creation of the Malaria Policy Advisory Committee (MPAC), which held its inaugural and second meetings in 2012. Several new and updated malaria control policies, operational manuals, plans and initiatives were released in 2012. A*

*comprehensive set of indicators has been developed to track progress towards internationally-agreed malaria targets.*

1. The MPAC came into operation in 2012, with a mandate to provide strategic advice and technical input to WHO on all aspects of malaria control and elimination. In accordance with the MPAC recommendations, WHO released a new policy on Seasonal Malaria Chemoprevention (SMC) and updated policies for Intermittent Preventive Treatment of malaria in pregnancy (IPTp) and for single-dose primaquine as a gametocytocide for treatment of *Plasmodium falciparum* malaria in selected settings.
2. Position statements were released on larviciding in sub-Saharan Africa and on the effectiveness of non-pharmaceutical forms of *Artemisia annua*. Surveillance manuals were published in April 2012 as part of the “T3: Test. Treat. Track.” initiative, urging endemic countries and stakeholders to scale up diagnostic testing, treatment, and surveillance for malaria. The *Global Plan for Insecticide Resistance Management in malaria vectors* was launched in May 2012, providing a global blueprint for managing insecticide resistance.

## Financing malaria control

*The total international and domestic funding committed to malaria control was estimated to be US\$ 2.3 billion in 2011, substantially less than the amount that will be needed to reach the global targets.*

3. International disbursements to malaria-endemic countries increased every year from less than US\$ 100 million in 2000 to US\$ 1.71 billion in 2010 and were estimated to be US\$ 1.66 billion in 2011 and US\$ 1.84 billion in 2012. The leveling off in funds available for malaria control has been primarily due to lower levels of disbursements from the Global Fund. In 2011 the Global Fund also announced the cancellation of Round 11 of Grant Awards.
4. Reported data suggest that domestic financing for malaria has increased in all WHO Regions during 2005–2011 except the European Region. The Region of the Americas and the African Region report the greatest expenditure on malaria control. Total domestic spending in 2011 was estimated to be US\$ 625 million in 2011.
5. Global resource requirements for malaria control were estimated in the 2008 Global Malaria Action Plan (GMAP) to exceed US\$ 5.1 billion per year between 2011 and 2020. In Africa alone, the resource requirements estimated by GMAP were, on average, US\$ 2.3 billion per year during the same period. Combining both domestic and international funds, the resources available for malaria control globally were estimated to be US\$ 2.3 billion in 2011, leaving a gap of US\$ 2.8 billion. Projections of both domestic and international resources available between 2013 and 2015 indicate that total funding for malaria control will remain at less than US\$ 2.7 billion, substantially below the amount required to achieve universal access to malaria interventions.
6. Historical funding patterns indicate that international funding for malaria control has been targeted to countries with lower GNI per capita and higher mortality rates, particularly those in Africa. Domestic funding for malaria per person

at risk is highest in the European Region and the Region of the Americas and lowest in the South-East Asia Region. Countries in the highest quintile of GNI per capita invest much more money per capita in malaria control than countries from other quintiles. These wealthier countries have lower malaria burdens, accounting for just 1% of estimated cases in 2010 and 0.3% of deaths. The high expenditures are partly related to the drive towards elimination of malaria in some countries. Countries with larger populations at risk of malaria – and the highest malaria mortality rates – have lower levels of domestic malaria funding per capita than countries with lower malaria burdens.

## Progress in vector control

*During the past decade, coverage with vector control interventions increased substantially in sub-Saharan Africa, with household ownership of at least one ITN reaching an estimated 53% by 2011 and remained at 53% in 2012. However, due to fewer deliveries of ITNs and increasing mosquito resistance to insecticides, recent successes in malaria vector control may be jeopardized.*

7. By 2011, 32 countries in the African Region and 78 other countries worldwide had adopted the WHO recommendation to provide ITNs to all persons at risk for malaria. A total of 89 countries, including 39 in Africa, distribute ITNs free of charge.
8. Every year, an estimated 150 million ITNs are needed to protect all populations at risk of malaria in sub-Saharan Africa. Between 2004 and 2010, the number of ITNs delivered annually by manufacturers to malaria-endemic countries in sub-Saharan Africa increased from 6 million to 145 million. However, in 2011 only 92 million ITNs were delivered by manufacturers, while 66 million are estimated to be delivered in 2012. The numbers delivered in 2011 and 2012 are below the number of ITNs required to protect all populations at risk, and they will not fully replace the ITNs delivered 3 years earlier, indicating that ITN coverage will decrease unless deliveries are massively increased in 2013.
9. The percentage of households owning at least one ITN in sub-Saharan Africa is estimated to have risen from 3% in 2000 to 53% in 2011, and remained at 53% in 2012. The proportion of the population sleeping under an ITN, representing the population directly protected, also increased from 2% in 2000 to 33% in 2011, and remained at 33% in 2012.
10. Analysis of household survey data indicates that a high percentage (approximately 90%) of the population with access to an ITN within the household actually uses it, suggesting that efforts to encourage ITN use have been successful, and that the main constraint to increasing the number of at-risk persons sleeping under an ITN is insufficient availability of nets. However, the population that uses available nets includes households in which nets are used beyond their assumed capacity of 2 persons per net as well as those in which nets are not used to full capacity, indicating that further work is needed to ensure that all available nets are fully utilized.

11. The proportion of the population sleeping under an ITN is higher in wealthier, urban areas, and lower among older children. Disparities in ITN access should diminish as programmes move towards universal coverage.

### Indoor residual spraying

12. IRS remains a powerful vector control tool for reducing and interrupting malaria transmission. In 2011, 80 countries, including 38 in the African Region, recommended IRS for malaria control.

13. In 2011, 153 million people were protected by IRS worldwide, or 5% of the global population at risk. In the African Region, the proportion of the at-risk population that was protected rose from less than 5% in 2005 to 11% in 2010 and remained at that level in 2011, with 77 million people benefiting from the intervention.

### Insecticide resistance

14. Mosquito resistance to at least one insecticide used for malaria control has been identified in 64 countries. In May 2012, WHO and RBM released the *Global Plan for Insecticide Resistance Management in malaria vectors*, a five-pillar strategy for managing the threat of insecticide resistance.

15. Monitoring insecticide resistance is a necessary element of the implementation of insecticide-based vector control interventions. In 2011, 77 countries reported that they had adopted the policy of insecticide resistance monitoring.

## Progress on chemoprevention

*Among 25 countries reporting this information to WHO, the percentage of pregnant women attending antenatal clinics who received 2 doses of Intermittent Preventive Treatment during pregnancy ranged from 30% to 57% in 2011. Recent WHO recommendations on Intermittent Preventive Treatment for infants and Seasonal Malaria Chemoprevention for children await adoption and implementation by endemic countries.*

16. Intermittent preventive treatment (IPT) is recommended for population groups in areas of high transmission who are particularly vulnerable to *Plasmodium* infection and its consequences, particularly pregnant women and infants. In sub-Saharan Africa, an estimated 32 million pregnant women and a large portion of the estimated 28 million infants born each year would benefit from IPT. In addition, about 25 million children in the Sahel subregion of Africa could be protected from malaria through seasonal malaria chemoprevention (SMC).

17. A total of 36 of 45 sub-Saharan African countries had adopted IPT for pregnant women (IPTp) as national policy by the end of 2011. This policy was also adopted by Papua New Guinea (Western Pacific Region) in 2009.

18. Among 25 of the 36 high-burden countries in the African Region which have adopted IPTp as national policy – and for which data are available – 44% (range 30%–57%) of pregnant women attending antenatal clinics received 2 doses of IPTp in 2011, in line with the WHO recommendation at that

time. Since October 2012, WHO recommends IPTp at each scheduled antenatal visit after the first trimester.

19. In 16 countries in the African Region for which household survey data were available for 2009–2011, the weighted average of all pregnant women who received 2 doses of IPTp during pregnancy was low, at 22% (range 5%–69%), primarily due to low coverage in Nigeria and the Democratic Republic of the Congo.

20. All infants at risk of *P. falciparum* infection in sub-Saharan African countries with moderate-to-high malaria transmission and low levels of parasite resistance to the recommended agent sulfadoxine-pyrimethamine should receive preventive malaria treatment through immunization services at defined intervals corresponding to routine vaccination schedules. Only one country, Burkina Faso, has adopted a national policy of IPT for infants (IPTi) since the WHO recommendation was issued in 2009.

21. In March 2012, WHO issued a recommendation on seasonal malaria chemoprevention for children aged 3–59 months. No endemic country has yet adopted SMC, but several countries involved in evaluating the policy have indicated that they plan to expand SMC coverage beyond their study populations. The release of implementation guidance, *Seasonal Malaria Chemoprevention with Sulfadoxine-pyrimethamine plus Amodiaquine in Children: a Field Guide*, by WHO in December 2012 should facilitate rapid scale-up of this important intervention.

## Progress in diagnostic testing and malaria treatment

*The numbers of procured rapid diagnostic tests (RDTs) and artemisinin-based combination therapies (ACTs) are increasing, and the reported rate of diagnostic testing in the public sector in the African Region has increased from 20% in 2005 to 47% in 2011. However, many fever cases are still treated presumptively with antimalarials without parasitological diagnosis, and not all confirmed malaria cases receive appropriate treatment with a quality-assured anti-malarial.*

### Diagnostic testing

22. Implementation of universal diagnostic testing in the public and private sectors would substantially reduce the global requirements for antimalarial treatment. In 2011, 41 of 44 countries with ongoing malaria transmission in the African Region and 46 of 55 countries in other WHO Regions reported having adopted a policy of providing parasitological diagnosis for all age groups. This represents an increase of 4 countries in the African Region since 2010.

23. Malaria diagnostic testing is provided free of charge in the public sector in 84 countries around the world. The proportion of suspected malaria cases receiving a diagnostic test in the public sector increased from 20% in 2005 to 47% in 2011 in the African Region and from 68% to 77% globally. Most of the increase in testing in the African Region is attributable to an increase in the use of RDTs, which accounted for 40% of all cases tested in the Region in 2011.

24. The number of patients tested by microscopic examination increased to a peak of 171 million in 2011, with India accounting for over 108 million blood slide examinations. The number of RDTs supplied by manufacturers increased from 88 million in 2010 to 155 million in 2011. This included increased sales for both *P. falciparum*-specific tests and combination tests that can detect more than one parasite species.
25. A total of 49 countries reported deployment of RDTs at the community level and 12 million patients were reported as having been tested through such programmes in 2011. Data from a limited number of countries suggest that diagnostic testing is less available in the private sector than in the public sector.

## Treatment

26. ACTs are recommended as the first-line treatment for malaria caused by *P. falciparum*, the most dangerous of the *Plasmodium* parasites that infect humans. By 2011, 79 countries and territories had adopted ACTs as first-line treatment for *P. falciparum* malaria. *P. vivax* malaria should be treated with chloroquine where it is effective, or an appropriate ACT in areas where *P. vivax* is resistant to chloroquine. Treatment of *P. vivax* should be combined with a 14-day course of primaquine to prevent relapse.
27. From reports of manufacturers and the Affordable Medicines Facility-malaria (AMFm) initiative, the number of ACT treatment courses delivered to the public and private sectors globally increased from 11 million in 2005 to 76 million in 2006, and reached 278 million in 2011. The increases in ACT procurement in 2011 occurred in large part as a result of the AMFm initiative, managed by the Global Fund. Although the AMFm accounted for a substantial portion of public sector sales, the total amount of ACTs procured for the public sector showed a year-on-year decrease between 2010 and 2011.
28. It has been difficult to track the extent to which patients with confirmed malaria received antimalarial medicines because information linking diagnostic testing and treatment has been limited in both household surveys and routine health information systems. An estimate of the proportion of patients in the public sector potentially treated with ACTs (and not a less effective antimalarial) can be made by comparing the number of ACT treatments distributed by national programmes with the number of presumed (treated without testing) and confirmed (by microscopy or RDT) *P. falciparum* malaria cases reported (or estimated cases if reported data are lacking). This proportion varies by WHO Region, reaching 52% in the African Region in 2011.
29. In 12 countries in the African Region with household surveys during 2010–2011, the proportion of febrile children given antimalarial treatment who received ACTs was greater among children treated in the public sector and in the formal private sector than in the informal private sector or in the community. In some countries the proportion of all febrile children given antimalarials who receive ACTs remains low, which implies that a proportion of patients with malaria do not receive appropriate treatment.
30. In the African Region in 2011, the total number of tests (both microscopy and RDTs) was less than half the number of ACTs distributed by national malaria control programmes, indicating that ACTs are given to many patients without confirmatory diagnostic testing.

## Antimalarial drug resistance

31. WHO recommends that oral artemisinin-based monotherapies should be progressively withdrawn from the market and replaced with ACTs, a policy endorsed by the World Health Assembly in 2007. The number of countries which still allow the marketing of these products has decreased from 55 countries in 2008 to 16 countries as of November 2012, of which 9 are in the African Region. The number of pharmaceutical companies marketing these products has dropped from 38 in 2010 to 28 in 2011. Most of the countries that allow marketing of these medicines are in the African Region, while most of the manufacturers are in India.
32. Therapeutic efficacy studies remain the gold standard for guiding drug policy and should be undertaken every 2 years. In 2010 and 2011, studies of first- or second-line antimalarial treatments were completed in 47 of 71 countries where *P. falciparum* efficacy studies were possible, an increase from 31 countries during 2008–2009. (In 28 countries with ongoing malaria transmission, efficacy studies are impracticable because of low malaria incidence, or because they are endemic for *P. vivax* only.) Studies were planned in 49 countries during 2012, including 29 countries in Africa.
33. Parasite resistance to artemisinins has now been detected in 4 countries of the Greater Mekong subregion: Cambodia, Myanmar, Thailand and Viet Nam. Despite the observed changes in parasite sensitivity to artemisinins, ACTs continue to cure patients provided that the partner drug is still efficacious. In Cambodia's Pailin province, resistance has been found to both components of multiple ACTs, and special provisions for directly observed therapy using a non-artemisinin-based combination (atovaquone-proguanil) have been put in place.

## Malaria surveillance

*Malaria surveillance systems currently detect only 10% of cases estimated to occur annually. Case detection rates are lowest in countries with the highest numbers of malaria cases.*

34. The proportion of malaria cases seeking treatment in public sector health facilities, tested and reported (the "case detection rate"), is less than 20% in 39 of the 99 countries with ongoing malaria transmission. These 30 countries account for 185 million cases of malaria or 78% of the estimated global total. Impediments in case detection vary by WHO Region: in the African and Western Pacific Regions, the main constraint is the small proportion of patients attending public facilities who receive a diagnostic test for malaria, whereas in the South-East Asia Region, the most important issue is the high proportion of patients who seek treatment in the private sector.



35. For countries in the phase of malaria control (as opposed to elimination), surveillance systems do not need to detect all cases in order to achieve their objectives which are primarily to assess trends over time and identify geographic differences in malaria incidence. However, in 41 countries around the world which account for 85% of estimated cases, it is not possible to make a reliable assessment of malaria trends due to incompleteness or inconsistency of reporting over time. Thus, surveillance systems appear to be weakest where the malaria burden is greatest; urgent action is needed to improve malaria surveillance in these settings.
40. Progress in reducing malaria case incidence and mortality rates has been faster in countries with lower numbers of cases and deaths. Nonetheless, greater numbers of cases and deaths are estimated to have been averted between 2001 and 2010 in countries which had the highest malaria burdens in 2000. If the malaria incidence and mortality rates estimated for 2000 had remained unchanged over the decade, 274 million more cases and 1.1 million more deaths would have occurred between 2001 and 2010. The majority of cases averted (52%) and lives saved (58%) are in the 10 countries which had the highest estimated malaria burdens in 2000. Such estimations indicate that malaria programmes are having their greatest impact where the burden is highest.

## Changes in malaria incidence and mortality

*Approximately half of countries with ongoing malaria transmission are on track to meet the World Health Assembly (WHA) and RBM target: to achieve a 75% reduction in malaria cases by 2015, compared to levels in 2000. While 50 countries are on track to reach the target, progress in more than a third of countries cannot be assessed due to limitations in their reported data. Further progress towards international malaria targets depends on achieving substantial gains in the highest burden countries.*

36. Of 99 countries with ongoing malaria transmission, 58 submitted sufficiently complete and consistent data on malaria cases between 2000 and 2011 to enable an assessment of trends to be made. Based on these reported data, 50 countries, including 9 countries in the African Region, are on track to meet the WHA and RBM target to reduce malaria case incidence by 75% by 2015. A further 4 countries are projected to achieve reductions of between 50% and 75%. Malaria case incidence increased in 3 countries of the Region of the Americas.
37. Of the 104 endemic countries in 2012, 79 countries are classified as being in the malaria control phase, 10 are in the pre-elimination phase, 10 are in elimination phase. Another 5 countries without ongoing transmission are classified in the prevention of re-introduction phase.
38. There were an estimated 219 million cases of malaria (range 154–289 million) and 660 000 deaths (range 610 000–971 000) in 2010. The estimates for 2010 have been updated since they were first published in the *World Malaria Report 2011* after a process of country consultation. Country-level malaria estimates available for 2010 show that 80% of estimated malaria deaths occur in just 14 countries and approximately 80% of estimated cases occur in 17 countries. Together, the Democratic Republic of the Congo and Nigeria account for over 40% of the estimated total of malaria deaths globally. The Democratic Republic of the Congo, India and Nigeria account for 40% of estimated malaria cases.
39. Malaria is strongly associated with poverty. Estimated malaria mortality rates are highest in countries with a lower GNI per capita. Countries with higher proportions of their population living in poverty (less than US\$ 1.25 per person per day) have higher mortality rates from malaria. Within countries, parasite prevalence rates in children are highest among poorer populations and in rural areas.
41. There are many inherent uncertainties in any approach to producing estimates of malaria case incidence and mortality, and in analyses based on these estimates. The global malaria community needs to increase its efforts to support malaria-endemic countries in improving diagnostic testing, surveillance, vital registration, and routine health information systems, so that accurate information on malaria morbidity and mortality can be obtained.





# Introduction

**This edition of the *World Malaria Report* summarizes the current status of malaria control in all affected countries worldwide. It reviews progress towards internationally agreed targets and goals, describes trends in funding, intervention coverage and malaria cases and deaths.**

Malaria is caused by five species of parasites of the genus *Plasmodium* that affect humans (*P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae* and *P. knowlesi*). Malaria due to *P. falciparum* is the most deadly form and it predominates in Africa; *P. vivax* is less dangerous but more widespread, and the other three species are found much less frequently. Malaria parasites are transmitted to humans by the bite of infected female mosquitoes of more than 30 anopheline species. Globally, an estimated 3.3 billion people were at risk of malaria in 2011, with populations living in sub-Saharan Africa having the highest risk of acquiring malaria: approximately 80% of cases and 90% of deaths are estimated occur in the WHO African Region, with children under five years of age and pregnant women most severely affected.

Malaria is an entirely preventable and treatable disease, provided the currently recommended interventions are properly implemented. These include (i) vector control through the use of insecticide-treated nets (ITNs), indoor residual spraying (IRS) and, in some specific settings, larval control; (ii) chemoprevention for the most vulnerable populations, particularly pregnant women and infants; (iii) confirmation of malaria diagnosis through microscopy or rapid diagnostic tests (RDTs) for every suspected case, and (iv) timely treatment with appropriate anti-malarial medicines (according to the parasite species and any documented drug resistance).

The *World Malaria Report* is a key publication of the WHO Global Malaria Programme (GMP), providing over the years a historical record of the global malaria situation and the progress made through national and international efforts to control the disease. GMP has four essential roles: (i) to set, communicate and promote

the adoption of evidence-based norms, standards, policies and guidelines; (ii) to ensure ongoing independent assessment of global progress; (iii) to develop strategies for capacity building, systems strengthening and surveillance; and (iv) to identify threats to malaria control and elimination, and new opportunities for action.

The *World Malaria Report* presents a critical analysis and interpretation of data provided by national malaria control programmes (NMCPs) in endemic countries. In 2012 there are 99 countries and territories with ongoing malaria transmission and 5 countries in the prevention of reintroduction phase, making a total of 104 countries and territories in which malaria is presently considered endemic. Standard reporting forms were sent in March 2012 to the 99 countries with ongoing malaria transmission and two countries that recently entered the prevention of reintroduction phase. Information was requested on (i) populations at risk (ii) vector species (iii) number of cases, admissions and deaths for each parasite species (iv) completeness of outpatient reporting (v) policy implementation (vi) commodities distributed and interventions undertaken (vii) results of household surveys, and (viii) malaria financing. **Table 1.1** summarizes the percentage of countries responding by month and by WHO Region in 2012.

Information from household surveys was used to complement data submitted by NMCPs, notably the Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS) and Malaria Indicator Surveys (MIS). These surveys provide information on the percentage of the population that sleeps under a mosquito net, and of children with fever who are treated and the medication they receive. Information on malaria financing was obtained from the Organisation for Economic Co-operation and Development (OECD) database on foreign aid flows and directly from the Global Fund and the US President's Malaria Initiative (PMI).

**Table 1.1** Percentage of reporting forms received by month and by WHO Region, 2012

WHO Region	June	July	August	September	October	Total countries/ areas
African				98%	98%	44
Region of the Americas				90%	100%	21
Eastern Mediterranean			40%	70%	90%	10
European	50%	100%	100%	100%	100%	6
South-East Asia		100%	100%	100%	100%	10
Western pacific	40%	100%	100%	100%	100%	10
<b>Total</b>	<b>7%</b>	<b>26%</b>	<b>30%</b>	<b>94%</b>	<b>98%</b>	<b>101</b>

Source: NMCP data.

Data were analysed and interpreted by WHO staff at headquarters and regional offices, in extensive consultation with WHO country offices and NMCPs regarding the interpretation of country information. Assistance in data analysis and interpretation was also provided by the African Leaders Malaria Alliance (ALMA), the Institute of Health Metrics and Evaluation (IHME), the Malaria Atlas Project (MAP), US Centers for Disease Control and Prevention (CDC), the Global Fund, the Monitoring and Evaluation to Assess and Use Results Demographic and Health Surveys (MEASURE DHS) project, and the United Nations Children's Fund (UNICEF).

The following chapters consider the policies and interventions recommended by WHO, the implementation of interventions, and the impact on malaria cases and deaths from a global and regional perspective.

**Chapter 2** summarizes the WHO policy setting process and the policies and strategies recommended by WHO to achieve the internationally agreed goals for malaria control and elimination. The goals and targets for malaria control and elimination and recommended indicators of progress are described.

**Chapter 3** reviews recent trends in international and domestic financing in relation to the resource requirements for meeting global malaria control targets. It considers the observed distribution of malaria funding in relation to different models of resource allocation.

**Chapter 4** reviews the commodity needs for malaria vector control. It considers the policies that national programmes have adopted for vector control implementation and the progress made towards universal access to ITNs and IRS. An update is provided on the growing problem of insecticide resistance and the appropriate monitoring and management of resistance.

**Chapter 5** reviews progress in implementation of chemoprevention, particularly the intermittent preventive treatment of malaria in pregnancy and in infants, and the introduction of seasonal chemoprevention in older children. It also reports on the current status of malaria vaccine development.

**Chapter 6** reviews the commodity needs for malaria diagnostic testing and treatment. It reports on the extent to which national

programmes have adopted policies for universal diagnostic testing of suspected malaria cases and examines trends in the availability of parasitological testing. The adoption of policies and implementation of programmes for improving access to effective treatment for malaria are reviewed. Progress in the withdrawal of oral artemisinin-based monotherapies from the market, the current status of drug efficacy monitoring, recent trends in antimalarial drug resistance and efforts to contain artemisinin resistance are also reported.

**Chapter 7** examines the extent to which malaria surveillance systems are able to detect malaria cases and explores the existing factors which influence case detection rates, by WHO Region. It also briefly examines how well surveillance systems can assess trends over time and provides information on geographical differences in malaria incidence.

**Chapter 8** reviews trends in *reported* malaria cases for 58 countries which have reported consistently between 2000 and 2011; for countries with low numbers of cases, their progress towards elimination is summarized. An analysis is presented of the global distribution of the *estimated* numbers of cases and deaths for countries with ongoing transmission and trends in *estimated* malaria cases and deaths 2000 to 2010.

**Regional Profiles** summarize the epidemiology of malaria in each WHO Region, trends in malaria case incidence, and the links between malaria trends and malaria programme implementation.

**Country Profiles** of 99 countries with ongoing malaria transmission are provided, followed by **Annexes** which give data by country for the malaria-related indicators.

South Sudan became a separate State on 9 July 2011 and a Member State of WHO on 27 September 2011. South Sudan and Sudan have distinct epidemiological profiles comprising low transmission and high transmission areas respectively. For this reason data up to June 2011 from the high transmission areas of Sudan (9 southern states which correspond to South Sudan) and low transmission areas (15 northern states which correspond to contemporary Sudan) are reported separately.

# Policies, strategies, goals and targets for malaria control and elimination

This chapter summarizes (i) the policies and strategies recommended by WHO to achieve the internationally agreed goals for malaria control and elimination, (ii) the need for surveillance systems, and (iii) indicators of progress.

## 2.1 Policy development

The WHO Global Malaria Programme (GMP), in keeping with its normative role for malaria prevention, control, and elimination, embarked on a major review and re-design of its policy-setting process in 2011. The conclusion of that process was the creation of the Malaria Policy Advisory Committee (MPAC) which came into operation at the start of 2012 following approval by the WHO Director-General of its terms of reference and membership. The members were selected by a review panel following an open call for member nominations. The mandate of the MPAC is to provide strategic advice and technical input to WHO on all aspects of malaria control and elimination, as part of a transparent and timely policy-setting process that is responsive to a rapidly changing malaria landscape.

The MPAC advises WHO on:

1. appropriate malaria policies and standards based on data from malaria programme implementation by member states and malaria control partners as well as reviews of the best available evidence;
2. engagement of WHO in malaria-related initiatives;
3. major issues and challenges to achieving global malaria goals;
4. the identification of priority activities to address identified challenges.

The MPAC met for the first time in January 2012 and again in September 2012. In future it is scheduled to meet in March and September every year; all related documents are available on the MPAC website (1).

The MPAC has 15 members who serve in an independent, personal and individual capacity and represent a broad range of disciplines, expertise, and experience. WHO may also set up MPAC Evidence Review Groups (ERGs) on a time-limited basis to help address specific questions identified by MPAC. Depending on the nature and complexity of the issue concerned, the MPAC may, in certain cases, recommend that it could be most efficiently addressed through a standing Technical Expert Group (TEG).

MPAC meetings are held primarily in open session. In addition to 4 standing Observers (Global Fund, Roll Back Malaria Partnership, UNICEF, and the Office of the United Nations Secretary General's Special Envoy for Malaria), and 7 rotating National Malaria Control Programme Managers, any member of the global

malaria community is welcome to attend. Interventions from observers participating in MPAC discussion are at the invitation of the Chair.

### Box 2.1 New or updated WHO policies, operational manuals, guidelines, and strategies for malaria control and elimination in 2012

#### New Policies:

- Seasonal Malaria Chemoprevention (SMC) for *Plasmodium falciparum* malaria control in highly seasonal transmission areas of the Sahel subregion in Africa, March 2012 (2).

#### Updated Policies:

- Intermittent Preventive Treatment of malaria in pregnancy using Sulfadoxine-Pyrimethamine (IPTp-SP), October 2012 (3).
- Single dose primaquine as a gametocytocide in *Plasmodium falciparum* malaria, October 2012 (4).

#### Position Statements:

- WHO interim position statement on larviciding in sub-Saharan Africa, March 2012 (5).
- WHO position statement on effectiveness of non-pharmaceutical forms of *Artemisia annua* against malaria, June 2012 (6).

#### Operational manuals, handbooks and guidelines:

- Disease surveillance for malaria control: an operational manual, April 2012 (7).
- Disease surveillance for malaria elimination: an operational manual, April 2012 (8).
- Guidelines for procuring public health pesticides, 2012 (9).
- Management of severe malaria: A practical handbook. Third edition, December 2012 (10).
- Seasonal Malaria Chemoprevention with sulfadoxine-pyrimethamine plus amodiaquine in children: a field guide, December 2012 (11).
- Information note on recommended selection criteria for procurement of malaria rapid diagnostic tests (RDTs), April 2012 (12).

#### Strategies, Action Plans and Initiatives:

- Global Plan for Insecticide Resistance Management in Malaria Vectors (GPIRM), May 2012 (13).
- T3: Test. Treat. Track. initiative (Box 2.1), April 2012 (14).

A draft agenda and details on how to register are made available approximately 2 months prior to every biannual meeting. MPAC decisions are taken in closed session, and are agreed by consensus. MPAC conclusions and recommendations are published within 3 months of every MPAC meeting in the *Malaria Journal* as part of a series (15). Policy statements, position statements, and guidelines that arise from the conclusions and recommendations of the MPAC are formally issued and disseminated to member states by the WHO Global Malaria Programme. To date, meeting sessions have focused on: a policy for Seasonal Malaria Chemoprevention (SMC); the use of single dose primaquine as a *P. falciparum* gametocytocide; an update on the use of sulfadoxine-pyrimethamine for Intermittent Preventive Treatment (IPT) of malaria in pregnancy; an interim position statement on the role of larviciding for malaria control in sub-Saharan Africa; improving the criteria for Rapid Diagnostic Test procurement; and the need for developing a Global Technical Strategy for Malaria Control and Elimination 2016–2025, which will also serve to underpin the next version of the Global Malaria Action Plan.

In addition, MPAC has been briefed on: the development of the RTS,S/AS01 malaria vaccine; methods for estimation of malaria burden; the AMFm independent evaluation and promoting quality-assured diagnostic testing and treatment in the private sector; artemisinin resistance in the Greater Mekong subregion; policy-setting for vector control; country classification criteria; and the process for updating the WHO Malaria Treatment Guidelines. In all of these topics MPAC has provided input or will do so in the near future.

## 2.2 Malaria control policies and strategies

The strategic approaches to malaria control come within two major domains: (i) prevention and (ii) case management. Together, these strategies work against the transmission of the parasite from mosquito vector to humans (and from humans to the mosquito vector), and the development of illness and severe disease.

### 2.2.1 Malaria prevention through malaria vector control

The goals of malaria vector control are two-fold:

- to protect individual people against infective malaria mosquito bites
- to reduce the intensity of local malaria transmission at community level by reducing the longevity, human-vector contact and density of the local vector mosquito population.

The most powerful and most broadly applied interventions are (i) long-lasting insecticidal nets (LLINs) and (ii) indoor residual spraying (IRS). These interventions work by reducing human-vector contact and by reducing the lifespan of adult female *Anopheles* mosquitoes (so that they do not survive long enough to transmit the parasite).

Insecticide-treated nets (ITNs), which include both LLINs and conventional nets that are later treated with an insecticide, work both by protecting the person sleeping under the net (individual level) and by extending the effect to an entire

area (community level). Since 2007, WHO has recommended universal coverage with ITNs (preferably LLINs), rather than a pre-determined number of nets per household or exclusively targeting household members at high risk (pregnant women and young children).

IRS involves the application of residual insecticides to the inner surfaces of dwellings where many vector species of anopheline mosquito tend to rest after taking a blood meal (16). IRS is effective in rapidly controlling malaria transmission, hence in reducing the local burden of malaria morbidity and mortality, provided that most houses and animal shelters (>80%) in targeted communities are treated (17).

Achieving universal coverage with effective vector control requires a sustained programme of vector control delivery operations which are carried out correctly and on time. This in turn requires specialized personnel at national, provincial, district and community levels. As well as practical experience in the delivery of vector control interventions, these teams must also have the capacity to monitor and investigate vector-related and operational factors that may compromise intervention effectiveness, for which specialized entomological knowledge and skills are essential.

### Box 2.2 New and updated vector control plans, position statements, and guidelines developed in 2011–2012

- Global Plan for Insecticide Resistance Management in Malaria Vectors (GPIRM), May 2012 (13);
- Interim position statement on larviciding in sub-Saharan Africa, March 2012 (5);
- Guidelines for procuring public health pesticides, 2012 (9)
- A proposal to improve value for money in LLIN procurement through market competition based on cost per year of effective coverage rather than unit price, November, 2011 (18);
- Draft interim recommendations on the sound management of packaging for Long Lasting Insecticidal Nets (LLINs), November 2011 (19)
- Updated WHO position statement on the use of DDT in malaria vector control, 2011 (20)

WHO recommendations for malaria vector control are the following:

#### Insecticide-treated nets

1. As high coverage rates are needed to realize the full potential of vector control, WHO recommends that in areas targeted for malaria prevention, and for which ITNs are selected as the vector control method, they should be made available to all people at risk, i.e. universal access (21). Because of the operational advantages of LLINs over ITNs, and the fact that the vast majority of nets being procured and distributed today are indeed LLINs, the remainder of this section will refer to LLINs rather than ITNs. In order to meet the target of universal access, it is currently proposed that 1 LLIN should be distributed for every 2 persons. At the household level, the distribution of 1 LLIN for every 2 members of the household will entail rounding up in households with an odd number of

members (e.g. 3 LLINs for a household with 5 members, etc.) Because of this rounding up, the achievement of 1 LLIN for every 2 people at household level requires an overall ratio, for procurement purposes, of 1 LLIN for every 1.8 people in the target population (17).

2. LLINs should be provided either free of charge or be highly subsidized. Cost should not be a barrier to making them available to all people at risk of malaria, especially those at greatest risk such as young children and pregnant women (27) as well as remote rural communities with least ability to purchase outright or provide a supplemental co-payment.
3. Universal access to LLINs is best achieved and maintained by a combination of delivery systems. The basic concept is a combination of 'catch up' and 'keep up'. Catch up involves mass distribution campaigns which can rapidly achieve universal coverage of LLINs. However, it is essential to complement such campaigns with continuous 'keep up' delivery systems, particularly routine delivery to pregnant women through antenatal services and to infants at immunization clinics. It should also be noted that targeted distribution to infants and pregnant women will eventually fall short of the quantity needed to maintain universal coverage, and other strategies involving further campaigns may be required (21).
4. In order to be protected, households must not only own LLINs but also use them. Behaviour change interventions including information, education, communication (IEC) campaigns and post-distribution "hang-up campaigns" are strongly recommended, especially where there is evidence of their effectiveness in improving LLIN usage (27).
5. Only LLINs recommended by the WHO Pesticide Evaluation Scheme (WHOPES) should be procured by national programmes and partners for malaria control. At present there are 13 recommended products (22). Detailed guidance on good practice in the handling and use of pesticides, and on quality control in procurement, can be found on the WHOPES website (23). Independent quality control of products (including insecticides) should be undertaken before shipment, to ensure that substandard products are not delivered to countries. The supplier of pesticide should bear the cost of analysis, including the cost of sending samples to an accredited or recognized laboratory for analysis on behalf of countries that do not have adequately equipped or staffed national quality control laboratories (9).
6. It is now recognized that the lifespan of LLINs is variable, among settings and among products. Therefore, all large-scale LLIN programmes (including those implemented by NGOs) should make efforts to monitor LLIN durability in the local setting, using standard methods published in 2011 (24). The collection of local data on the comparative durability of alternative LLIN products, using rigorous and auditable methods, is expected to enable procurement decisions to be made on the basis of price per year of protection rather than unit price per net; this in turn is expected to bring rapid and potentially substantial cost savings. This is important because LLINs represent a large proportion of the global malaria control budget (18). Efforts are also under

way to develop more varied and sophisticated methods for testing the durability of LLINs under simulated laboratory conditions.

#### Indoor residual spraying

7. IRS is applicable in many epidemiological settings, provided the operational and resource feasibility are considered in policy and programming decisions. IRS requires specialized spray equipment and techniques, and the equipment, the quality of application, as well as monitoring and disposal capabilities must be scrupulously maintained given the difficulty of carrying out spray operations.
8. Currently 12 insecticides belonging to 4 chemical classes are recommended by WHOPES for IRS (25). An insecticide for IRS is selected in a given area on the basis of data on resistance, the residual efficacy of the insecticide, costs, safety, and the type of surface to be sprayed.
9. DDT has a comparatively long residual efficacy ( $\geq 6$  months) as an insecticide for IRS. The use of DDT in agriculture is banned under the Stockholm Convention, but countries can use DDT for IRS for as long as necessary and in the quantities needed, provided that the guidelines and recommendations of WHO and the Stockholm Convention are all met, and until locally appropriate, cost-effective alternatives are available for a sustainable transition from DDT (20).

#### Larval control

10. In a few specific settings and circumstances, the core interventions of IRS and LLINs may be complemented by other methods, such as larval control including environmental management. However, WHO recommends larviciding only in settings where mosquito breeding sites are few, fixed, findable and easy to identify, map and treat. In other circumstances, it is very difficult to find a sufficiently high proportion of the breeding sites within the flight range of the vector (5). Currently 10 compounds and formulations for mosquito larval control are recommended by WHOPES (26). In Africa, larviciding interventions are most likely to be appropriate in urban settings, and are unlikely to be cost effective in most rural settings where malaria mosquitoes breed in many small water sources such as hoof prints and fallen leaves (5).

### 2.2.2 Insecticide resistance

#### Development and launch of The Global Plan for Insecticide Resistance Management in malaria vectors (GPIRM)

11. Insecticide resistance has been detected in 64 countries with ongoing malaria transmission, affecting all major vector species and all classes of insecticides. In 2011, the World Health Assembly and the Board of the Roll Back Malaria Partnership requested WHO to draft a global strategy to provide a basis for coordinated action to maintain the effectiveness of vector control interventions.

The GPIRM was developed through a broad-based consultation with over 130 stakeholders representing all constituencies of the global malaria community, including malaria-endemic countries, multilateral agencies, development partners, academia, and industry. The strategy was launched in May 2012 and is based on 5 pillars:



- (i) Plan and implement insecticide resistance management strategies in malaria-endemic countries.
- (ii) Ensure proper, timely entomological and resistance monitoring and effective data management.
- (iii) Develop new, innovative vector control tools.
- (iv) Fill gaps in knowledge on mechanisms of insecticide resistance and the impact of current insecticide resistance management strategies.
- (v) Ensure that enabling mechanisms (advocacy, human and financial resources) are in place.

The GPIRM (13) provides detailed technical recommendations on both monitoring and managing insecticide resistance in different settings, depending on the extent and mechanisms of insecticide resistance, and the type of vector control interventions used.

### Resistance management

12. The spread of insecticide resistance, especially pyrethroid resistance in Africa, is a major threat for vector control programmes. Insecticide resistance management has to be considered as important as epidemiology and cost-effectiveness in all programmatic decisions about vector control, including the selection of insecticides for IRS (25). In particular:

- Resistance management measures should be part of every vector control programme and deployed pre-emptively (ideally initiated even prior to the selection of insecticides for initial rounds of spraying), without waiting for signs of the presence of resistance or of control failure.
- A substantial intensification of resistance monitoring is needed, using both bioassay (susceptibility) tests and genetic methods. Resistance monitoring should be seen as a necessary element of any medium or large scale deployment of an insecticidal intervention (including LLIN distribution by NGOs); it is the responsibility of the implementing agency to make sure that this testing is done properly. All data on vector resistance should be submitted (in confidence if necessary) to the NMCP within 3 months of the test performance, even if the study is not yet complete. Donors financing insecticide procurement should ensure that the decision regarding the choice of insecticide is supported by adequate and up-to-date information on resistance among local anopheline vectors.
- Using the same insecticide for multiple successive IRS cycles is not recommended; it is preferable to use a system of rotation with a different insecticide class being used each year. In areas where IRS is the main vector control intervention, this rotation system may include the use of a pyrethroid.
- In areas with high LLIN coverage, pyrethroids should not be used for IRS.

13. Currently, vector control interventions rely heavily on one class of insecticides, the pyrethroids, and pyrethroids are the only class used on currently recommended LLINs. The preservation of pyrethroid susceptibility in target vector populations should therefore be a key priority in the choice of vector control methods. The combination of non-pyrethroid IRS with LLINs involves significantly increased costs, but it has two expected advantages. First, there is evidence that the presence of a non-pyrethroid on the wall reduces

the strength of selection for pyrethroid resistance that might occur as a result of a LLIN in the same room; this combination is therefore recommended as one means of insecticide resistance management (13). Second, there is evidence suggesting that the combination of IRS and LLINs is more effective than either intervention alone, especially if the combination helps to increase overall coverage with vector control or in managing insecticide resistance through insecticide rotations (27). However, further data collection is needed to strengthen the evidence base for the effectiveness of these interventions. It should be noted that in areas with high levels of LLIN coverage in which pyrethroid resistance is identified, focal IRS is recommended. Broad deployment of IRS and LLINs in combination, while potentially very effective, is currently financially unsustainable.

### 2.2.3 Preventive chemotherapy

Preventive chemotherapy is the use of complete treatment courses of effective antimalarial medicines for the targeted populations at risk of malaria for preventive purposes, with the goal of preventing malaria infection and thereby reducing morbidity and mortality due to malaria. The two strategies presently recommended by WHO are Intermittent Preventive Treatment (IPT) and Seasonal Malaria Chemoprevention (SMC).

(i) IPT is the administration of a full course of an effective antimalarial treatment at specified time points to a defined population at risk of malaria, regardless of whether they are parasitaemic, with the objective of reducing the malaria burden in the specific target population.

#### Intermittent preventive treatment in pregnancy (IPTp)

Based on a recent review of the evidence (28) and assessment by the MPAC, in areas of moderate to high malaria transmission WHO recommends IPTp with sulfadoxine-pyrimethamine (SP) for all pregnant women at each scheduled antenatal care visit. The first IPTp-SP dose should be administered as early as possible during the 2nd trimester of pregnancy. Each SP dose should be given at least 1 month apart and the last dose can be administered up to the time of delivery.

#### Intermittent preventive treatment in infants (IPTi)

All infants at risk of *P. falciparum* infection in countries in sub-Saharan Africa with moderate to high malaria transmission should receive 3 doses of SP along with the DPT2, DPT3 and measles vaccines through the routine immunization programme (29, 30).

(ii) SMC is the intermittent administration of full treatment courses of an effective antimalarial medicine during the malaria season to prevent malarial illness in children aged between 3 and 59 months, with the objective of maintaining therapeutic antimalarial drug concentrations in the blood throughout the period of greatest malaria risk. WHO recommends the use of SMC in areas of highly seasonal malaria transmission<sup>1</sup> across the Sahel subregion of Africa. SMC should be administered through a complete treatment course of amodiaquine plus sulfadoxine-pyrimethamine at monthly intervals beginning at the start of

1. Areas where on average more than 60% of clinical malaria cases occur within a maximum of 4 months.



the transmission season, to a maximum of 4 doses during the malaria transmission season (2).

## 2.2.4 Diagnosis and treatment of malaria

The main objectives of an antimalarial treatment policy are:

- to reduce morbidity and mortality by ensuring rapid, complete cure of *Plasmodium* infection, thus preventing the progression of uncomplicated malaria to severe and potentially fatal disease, as well as preventing chronic infection that leads to malaria-related anaemia;
- to curtail the transmission of malaria by reducing the human parasite reservoir; and
- to prevent the emergence and spread of resistance to antimalarial medicines.

The 2nd edition of the *WHO Guidelines for the treatment of malaria* was published in March 2010 and was updated in April 2011, recommending injectable artesunate for the management of severe malaria in all age groups and epidemiological settings (31).

WHO recommendations for diagnosis and treatment:

Prompt parasitological confirmation by light microscopy, or alternatively by rapid diagnostic tests (RDTs), is recommended in all patients with suspected malaria before treatment is started. Antimalarial treatment solely on the basis of clinical suspicion should only be considered when a parasitological diagnosis is not accessible<sup>2</sup>. Treatment based on diagnostic testing is good clinical practice and has the following advantages over presumptive treatment of all fever episodes:

- improved care of parasite-positive patients because of confirmation of infection;
- identification of parasite-negative patients, for whom another diagnosis must be sought and treated accordingly;

2. Within a short time (less than 2 hours) of the patient's presentation at the point of care.

- avoidance of the use of antimalarial medicine in parasite-negative patients, thereby reducing side effects, drug interactions and selection pressure for drug resistance;
- better public trust in the efficacy of artemisinin-based combination therapy (ACT) when it is used only to treat confirmed malaria cases;
- confirmation of malaria treatment failures, and
- improved malaria case detection, surveillance, and reporting.

Uncomplicated *P. falciparum* malaria should be treated with an ACT. The 5 ACTs currently recommended for use by WHO are artemether plus lumefantrine, artesunate plus amodiaquine, artesunate plus mefloquine, artesunate plus sulfadoxine-pyrimethamine, and dihydroartemisinin plus piperaquine. The choice of the ACT should be based on the therapeutic efficacy of the combination in the country or area of intended use. Artemisinin and its derivatives should not be used as monotherapies for the treatment of uncomplicated malaria as poor adherence to the required 7-day course of treatment results in partial clearance of malaria parasites which will promote resistance to this critically important class of antimalarials.

*P. vivax* malaria should be treated with chloroquine in areas where this drug is effective; an appropriate ACT (not artesunate plus sulfadoxine-pyrimethamine) should be used in areas where *P. vivax* resistance to chloroquine has been documented. Both chloroquine and ACTs should be combined with a 14-day course of primaquine for the radical cure of *P. vivax* malaria in order to prevent relapses, subject to consideration of the risk of haemolysis in patients with G6PD deficiency.

Severe malaria should be treated with injectable artesunate and followed by a complete course of an effective ACT as soon as the patient can take oral medications. Where complete parenteral treatment of severe malaria is not possible, e.g. in peripheral health posts, patients should be given pre-referral treatment and referred immediately to an appropriate facility for further

### Box 2.3 The T3: Test. Treat. Track. initiative: Scaling up diagnostic testing, treatment and surveillance for malaria

On World Malaria Day 2012, WHO Director-General Margaret Chan launched a new initiative called T3: Test. Treat. Track (14) urging malaria-endemic countries, donors and the global malaria community to scale up diagnostic testing, treatment and surveillance for malaria. The initiative calls on endemic countries and stakeholders to ensure that every suspected malaria case is tested, that every confirmed case is treated with a quality-assured antimalarial medicine, and that every malaria case is tracked in a surveillance system.

T3 is derived from, and builds on, the following core WHO documents:

- *Universal Access to Malaria Diagnostic Testing: an Operational Manual*, 2011
- *Guidelines for the Treatment of Malaria, Second Edition*, 2010
- *Disease surveillance for malaria control: an operational manual*, 2012 (7)

- *Disease surveillance for malaria elimination: an operational manual*, 2012 (8)

Accurate diagnosis will significantly improve the quality of patient care and ensure that antimalarial medicines are used rationally and correctly. The scale-up of quality-assured antimalarial medicines in the public and private sectors will ensure that all patients with confirmed malaria receive prompt treatment. Improved surveillance for malaria cases and deaths will help ministries to determine which areas or population groups are most affected and help target resources to where they are most needed.



treatment. Options available for pre-referral treatment are: artesunate (rectal), quinine (IM), artesunate (IM) or artemether (IM).

In settings with limited health facility access, diagnosis and treatment should be provided at community level through a programme of community case management (formerly known as home-based management) of malaria. With the introduction of malaria RDTs, malaria can be distinguished from non-malaria febrile illnesses which also need appropriate care, notably pneumonia which is a major cause of childhood mortality. The new strategy targeting the diagnosis and treatment of malaria, pneumonia and diarrhoea at community level is termed integrated community case management (iCCM) of childhood illness.

Based on a recent review of the evidence (32) and assessment by the MPAC, WHO recommends that in areas where there is a threat of artemisinin resistance and in areas targeted for falciparum malaria elimination, and where a single dose of primaquine as gametocytocide for *P. falciparum* malaria is not yet implemented, a single 0.25 mg base/kg primaquine dose should be given to all patients with confirmed falciparum malaria on the first day of ACT treatment, except to pregnant women and infants <1 year of age.

### 2.2.5 Management of antimalarial drug resistance

Antimalarial drug resistance is a major public health problem which hinders the control of malaria. Continuous monitoring of the efficacy of and resistance to antimalarial drugs is important to inform treatment policy and ensure early detection of changing patterns of resistance. Resistance is occurring as a consequence of several factors, including poor treatment practices, inadequate patient adherence to prescribed antimalarial regimens, and the widespread availability of artemisinin-based monotherapies and substandard forms of the drug. In recent years, parasite resistance to artemisinins – the key compounds in ACTs – has been detected in four countries of the Greater Mekong subregion: Cambodia, Myanmar, Thailand and Viet Nam.

WHO recommends that countries routinely conduct therapeutic drug efficacy studies to allow for measurement of the clinical and parasitological efficacy of medicines and the detection of small changes in treatment outcome when monitored consistently over time. These studies are considered the 'gold standard' for determining antimalarial drug efficacy, and their results are the primary data used by national programmes to revise their national malaria treatment policies for first- and second-line drugs and ensure appropriate management of clinical cases. Therapeutic drug efficacy studies are also used to detect suspected artemisinin resistance, defined as an increase in parasite clearance time, as evidenced by  $\geq 10\%$  of cases with parasites detectable on day 3 after treatment with an ACT.

To interpret and compare results within and between regions and to follow trends over time, therapeutic efficacy monitoring must be conducted with similar standardized procedures. WHO updated the protocol for assessing antimalarial drug efficacy in 2009 (33). WHO has also developed a guideline on genotyping malaria parasites to distinguish between reinfection and recrudescence, which is necessary as part of therapeutic efficacy testing (34). The following recommendations are drawn from the 2009 edition of *Methods for surveillance of antimalarial drug efficacy* (31).

WHO recommendations for management of antimalarial drug resistance are as follows:

1. National malaria control programmes should establish sentinel sites (selected health facilities) for the surveillance of antimalarial drug efficacy. Experience suggests that 4–8 sites per country will achieve a balance between representativeness and practicality. The sentinel sites should represent all the epidemiological strata in the country but it is essential to select a 'manageable' number of sites to ensure proper monitoring and supervision.
2. Efficacy of first- and second-line medicines should be tested at least once every 24 months at all sites. For the purposes of comparability, assessments should always be conducted at the same time of year.
3. A follow-up of 28 days is recommended as the minimum duration for medicines with elimination half-lives of less than 7 days (amodiaquine, artemisinin derivatives, atovaquone–proguanil, chloroquine, lumefantrine, quinine, and sulfadoxine-pyrimethamine). For medicines with longer elimination half-lives (mefloquine, piperazine), a longer follow-up period of 42 days is necessary.
4. The standard protocol to test the efficacy of medicines against *P. falciparum* needs adjustment for *P. vivax*. Since *P. vivax* infection has a dormant liver stage and therefore the potential to relapse, many countries recommend primaquine therapy for radical cure. Administration of primaquine concurrently or soon after administration of chloroquine may conceal resistance to chloroquine alone, resulting in underestimation of the risk of therapeutic failure or resistance to chloroquine. Therefore, in certain cases primaquine therapy should be postponed until after the 28-day follow-up. Nonetheless, if local health policy includes mandatory administration of primaquine with chloroquine, the failure rate should be considered to be that of the combination regimen.
5. Countries should consider changing the first-line treatment for malaria if the total failure rate (defined as the sum of the patients presenting with early treatment failure, late clinical failure or late parasitological failure) exceeds 10%. The selection of a new antimalarial treatment for use at public health level in the context of national treatment guidelines should be based on an average cure rate of  $\geq 95\%$  as assessed in clinical trials (31).

While therapeutic efficacy studies conducted according to a standard protocol provide an excellent indication of drug efficacy, additional studies are needed to confirm and characterize drug resistance. These additional studies include: (i) in vitro studies to measure the intrinsic sensitivity of parasites to antimalarial drugs; (ii) molecular marker studies to identify genetic mutations and subsequently confirm the presence of mutations in blood parasites; and (iii) pharmacokinetic studies to characterize drug absorption and drug action in the body. WHO has prepared a field manual on in vitro assays (35) and on methods for assessing exposure to antimalarial drugs (36).

#### Artemisinin resistance

Over the last decade, most countries endemic for *P. falciparum* have shifted their national treatment policies to ACTs, although

therapeutic efficacy studies are still not routinely conducted in many of these countries (37). The development of parasite resistance to artemisinins – the key compounds in ACTs – is a major public health concern. In recent years, artemisinin resistance has been detected in four countries of the Greater Mekong subregion: Cambodia, Myanmar, Thailand and Viet Nam. If artemisinin resistance were to spread to India or sub-Saharan Africa, the global consequences could be dire, as no alternative antimalarial medicine is available at present with the same level of efficacy and tolerability as ACTs.

WHO's current working definition of artemisinin resistance is:

- an increase in parasite clearance time, as evidenced by  $\geq 10\%$  of cases with parasites detectable on day 3 after treatment with an ACT (suspected resistance); or
- treatment failure after treatment with an oral artemisinin-based monotherapy with adequate antimalarial blood concentration, as evidenced by the persistence of parasites for 7 days, or the presence of parasites at day 3 and recrudescence within 28–42 days (confirmed resistance)<sup>3</sup>.

In January 2011, WHO released the *Global Plan for Artemisinin Resistance Containment* (GPARC) (37), outlining the necessary actions to contain and prevent resistance to artemisinins.

Five activities are recommended by the GPARC as important for successful management of artemisinin resistance:

1. Stop the spread of resistant parasites. In areas for which there is evidence of artemisinin resistance, an immediate comprehensive response using a combination of malaria control and elimination measures is needed to stop the survival and spread of resistant parasites.
2. Increase monitoring and surveillance to evaluate the threat of artemisinin resistance. Regular monitoring and surveillance are essential to rapidly identify new foci of resistant parasites and to provide information for containment and prevention activities. Countries endemic for malaria should undertake routine monitoring of antimalarial drugs at sentinel sites every 24 months in order to detect changes in their therapeutic efficacy.
3. Improve access to diagnostics and rational treatment with ACTs. Programmes should ensure: consistent, accurate diagnostic testing of suspected malaria cases; better access to ACTs for confirmed cases; compliance with ACT treatment; removal from the market of oral artemisinin-based monotherapies as well as substandard and counterfeit antimalarial medicines.
4. Invest in research related to artemisinin resistance. Research is important to improve understanding of resistance and the ability to manage it. Priority should be given to research in five disciplines: laboratory research, research and development, applied and field research, operational research, and mathematical modeling.
5. Motivate action and mobilize resources. Successful implementation of the GPARC will depend on motivating many

3. This definition is prone to confounding factors (known and unknown) such as splenectomy, haemoglobin abnormalities and reduced immunity.

stakeholders at global, regional and national levels to support or conduct the recommended activities.

Neither the mechanism of artemisinin resistance, nor a molecular marker to screen for it, has yet been identified.

### Box 2.4 The Technical Expert Group (TEG) on Antimalarial Drug Resistance and Containment

The Technical Expert Group (TEG) on antimalarial drug resistance and containment is a standing committee set up following the recommendations to WHO elaborated at the inaugural meeting of the Malaria Policy Advisory Committee (MPAC) in January 2012. The TEG is tasked with advising the MPAC on policy and recommendations regarding antimalarial drug resistance and containment. The specific roles and responsibilities of the TEG include: evaluating the data being generated on drug resistance; providing evidence-based advice on standards for monitoring antimalarial drug resistance; providing recommendations on the strategies to detect drug resistance and to prevent its spread; and identifying research priorities on drug resistance and containment. The MPAC will review the TEG recommendations.

## 2.3 Malaria surveillance

The design of malaria surveillance systems depends on two factors: (i) the level of malaria transmission and (ii) the resources available to conduct surveillance. In the control phase in areas of moderate to high transmission, there are often so many malaria cases that it is not possible to examine and react to each confirmed case individually: rather, analysis must be based on aggregate numbers, and action taken at a population level. As transmission is progressively reduced, it becomes increasingly possible, and necessary, to track and respond to individual cases. Indeed in the elimination phase, malaria programmes need to detect each infection, whether or not it is symptomatic, and conduct an investigation of each case to ascertain whether infection was imported or locally acquired and undertake appropriate control measures. The principal feature of surveillance systems in different stages of control are summarized below. Further details can be found in the operation manuals (i) *Disease surveillance for malaria control* (7) and (ii) *Disease surveillance for malaria elimination* (8), which were launched in Namibia by the WHO Director-General on World Malaria Day 2012.

### 2.3.1. Malaria surveillance systems in the control phase: high and moderate transmission settings

Registers of individual cases are maintained at health facilities, which allow recording of diagnostic tests performed and test results. Given the high frequency of malaria cases and the limited resources for maintaining an extensive recording and reporting system, malaria surveillance systems rely on the reporting and use of aggregate data by district and higher administrative levels. Malaria surveillance is frequently integrated into a

broader system of health information or communicable disease surveillance.

At the health facility level, case-based surveillance of malaria inpatient cases and deaths is undertaken with the aim of responding to cases of severe disease and attaining a target of zero malaria deaths. Cases are graphed monthly to assess the extent to which control measures are reducing the incidence of malaria.

At district and national levels, cases and deaths are summarized monthly on 5 control charts, in order to assess the efficacy of malaria control interventions and identify trends that require an urgent response. The control charts cover: (i) malaria incidence and mortality rates; (ii) proportional malaria incidence and mortality rates; (iii) general patient attendance rates; (iv) diagnostic activity (annual blood examination rate); and (v) quality of diagnosis and health facility reporting. Analysis is also undertaken by health facility catchment area and by district in order to set priorities for malaria control activities.

### 2.3.2. Malaria surveillance systems in the control phase: low transmission settings

Registers of individual malaria cases are maintained at health facilities, with records of the diagnostic tests performed and the results. As well as aggregate data being reported to district and higher administrative levels, line lists of inpatients and inpatient deaths are forwarded to district level, and, when case loads and district capacity permit (for example, < 150 patients per district per month), lists of all confirmed cases are submitted monthly. At health facility level, case-based surveillance of malaria cases and deaths is undertaken, with the aim of identifying population groups with the highest malaria incidence and probable sources of infection. Cases are graphed daily or weekly to identify trends that require attention and are mapped by village to identify clusters of cases.

At the district level, malaria cases and deaths are summarized weekly or monthly on the same 5 control charts used in high-transmission settings, in order to assess the impact of malaria control interventions and identify trends that require urgent response. Analysis is undertaken by health facility catchment area and by village in order to set priorities for activities. A register of severe cases and deaths is maintained and investigations undertaken to identify and address programme weaknesses.

At national level, cases and deaths are summarized monthly on the 5 control charts in order to assess the impact of malaria control interventions. Analysis is undertaken by district in order to set priorities for activities.

### 2.3.3. Malaria surveillance systems in the elimination phase

Case-based surveillance is carried out and each confirmed case is immediately notified to district, provincial and central levels. A full investigation of each case is undertaken to determine whether the infection was imported, acquired locally by mosquito-borne transmission (indigenous or introduced) or induced. The national reference laboratory reconfirms all positive test results and a sample of negative test results, and organizes laboratory participation in a national quality assurance network.

Each new focus of transmission is investigated, including an entomological investigation, to ascertain risk factors and devise the optimal strategies for control. The focus is classified, and its status is updated continuously.

The malaria programme monitors the extent of surveillance, mainly by tracking blood examination rates by village and by month in high-risk foci and comparing the number of diagnostic tests done with the number expected.

Programme managers at district level keep: (i) malaria case investigation forms, patient records, focus investigation forms and a register of foci with changes in status; (ii) maps showing the distribution of cases by household, vector breeding places, possible sites of transmission and geographical features, such as hills, rivers and roads; and (iii) data on integrated vector control interventions.

Full documentation of programme activities and surveillance results is kept securely at national level in preparation for certification of malaria elimination.

## 2.4 Malaria elimination

### Box 2.5 Definitions of control, elimination, certification and eradication (38)

**Malaria control:** the reduction of the malaria disease burden to a level at which it is no longer a public health problem.

**Malaria elimination:** the reduction to zero of the incidence of infection caused by human malaria parasites in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

**Certification of malaria-free status:** granted by WHO after it has been proven beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in an entire country for at least 3 consecutive years.

**Malaria eradication:** permanent reduction to zero of the worldwide incidence of infection caused by a particular malaria parasite species.

From a country perspective, interruption of local mosquito-borne malaria transmission, i.e. elimination of malaria, is the ultimate goal of malaria control. The WHO recommendations regarding malaria elimination are summarized below: (38, 39)

1. In areas of high, stable transmission, where a marked reduction in malaria transmission has been achieved, a 'consolidation period' should be introduced, in which (i) achievements are sustained, even in the face of limited disease; (ii) control strategies are reviewed; (iii) health services adapt to the new clinical and epidemiological situation including reduced levels of immunity; and (iv) surveillance systems are strengthened to allow rapid response to new cases. This transformation phase precedes a decision to re-orient programmes towards elimination. As countries achieve marked reductions in levels of transmission, they should review their malaria control strate-



- gies. It is crucial to avoid failure to sustain malaria control and the resulting resurgence of malaria, as has occurred in the past.
2. Countries with low, unstable transmission should be encouraged to proceed to malaria elimination. Before making this decision, however, countries should take account of the overall feasibility, including entomologic situation, programmatic capacity, fiscal commitment, political commitment, and potential threats to success, including the malaria situation in neighbouring countries. Malaria elimination may require regional initiatives and support, and will require strong political commitment.
  3. Countries with an absence of locally acquired malaria cases for 3 consecutive years, and with sufficiently robust surveillance and reporting systems in place to demonstrate this achievement, are eligible to request WHO to initiate procedures for certification that they are malaria-free.
  4. Failure to sustain malaria control will result in a resurgence of malaria. Therefore, public and government commitment to intensified malaria control and elimination needs to be sustained even after the malaria burden has been greatly reduced.
- Malaria control today relies heavily on a limited number of tools, in particular artemisinin derivatives and pyrethroids, both of which can become less effective because of resistance. The future of global malaria control and elimination therefore depends on the ability of research and development to deliver

**Table 2.1 Updated Global Malaria Action Plan (GMAP) objectives, targets, and milestones beyond 2011**

Objective	Targets	Milestones
<b>Objective 1 Reduce global malaria deaths to near zero by end 2015</b>	<b>Target 1.1 Achieve universal access to case management in the public sector.</b> By end 2013, 100% of suspected malaria cases receive a malaria diagnostic test and 100% of confirmed cases receive treatment with appropriate and effective antimalarial drugs.	None, as the target is set for 2013.
	<b>Target 1.2 Achieve universal access to case management, or appropriate referral, in the private sector.</b> By end 2015, 100% of suspected malaria cases receive a malaria diagnostic test and 100% of confirmed cases receive treatment with appropriate and effective antimalarial drugs.	By end 2013, in endemic countries, 50% of persons seeking treatment for malaria-like symptoms in the private sector report having received a malaria diagnostic test and 100% of confirmed cases having received treatment with appropriate and effective antimalarial drugs.
	<b>Target 1.3 Achieve universal access to community case management (CCM) of malaria.</b> By end 2015, in countries where CCM of malaria is an appropriate strategy, 100% of fever (suspected) cases receive a malaria diagnostic test and 100% of confirmed uncomplicated cases receive treatment with appropriate and effective antimalarial drugs, and 100% of suspected and confirmed severe cases receive appropriate referral.	1. By end 2012, all countries where CCM of malaria is an appropriate strategy have adopted policies to support CCM of malaria (including use of diagnostic testing and effective treatment). 2. By end 2013, in all countries where CCM of malaria is an appropriate strategy, 80% of fever cases receive a malaria diagnostic test and 80% of confirmed cases receive treatment with effective antimalarial drugs.
<b>Objective 2 Reduce global malaria cases by 75% by end 2015 (from 2000 levels)</b>	<b>Target 2.1 Achieve universal access to and utilization of prevention measures.</b> By end 2013, in countries where universal access and utilization have not yet been achieved, achieve 100% access to and utilization of prevention measures for all populations at risk with locally appropriate interventions.	None, as the target is set for 2013.
	<b>Target 2.2 Sustain universal access to and utilization of prevention measures.</b> By 2015 and beyond, all countries sustain universal access to and utilization of an appropriate package of preventive interventions.	From 2013 through 2015, universal access to and utilization of appropriate preventive interventions are maintained in all countries.
	<b>Target 2.3 Accelerate development of surveillance systems.</b> By end 2015, all districts are capable of reporting monthly numbers of suspected malaria cases, number of cases receiving a diagnostic test and number of confirmed malaria cases from all public health facilities, or a consistent sample of them.	By end 2013, 50% of malaria endemic countries have met the 2015 target.
<b>Objective 3 Eliminate malaria by end 2015 in 10 new countries (since 2008) and in the WHO European Region</b>		By end 2013, malaria is eliminated in 3 new countries.

**Table 2.2** Indicators for measuring progress towards GMAP objectives and targets

GMAP Objective or Target	Key Indicator	Further Analysis	Supporting Indicator
<b>Objective 1</b> Reduce global malaria deaths to near zero* by end 2015	→ Inpatient malaria deaths per 1000 persons per year	→ Has health facility reporting completeness changed over time?	→ Completeness of monthly health facility reports
	→ <b>All-cause under 5 mortality rate</b>	→ What factors are responsible?	→ <b>Program coverage (detailed below)</b>
<b>Target 1.1</b> Achieve universal access to case management in the public sector	→ Proportion of suspected malaria cases that receive a parasitological test		
<b>Target 1.2</b> Achieve universal access to case management, or appropriate referral, in the private sector	→ <b>Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick</b>	→ Are people seeking advice or treatment for fever and from where?	→ <b>Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought</b>
	→ Proportion of confirmed malaria cases that receive first-line antimalarial treatment according to national policy	→ Are adequate quantities of antimalarial medicines available?	→ Proportion of health facilities without stock-outs of key commodities by month
<b>Target 1.3</b> Achieve universal access to community case management (CCM) of malaria	→ <b>Proportion receiving first-line treatment among children under 5 years old with fever in the last 2 weeks who received any antimalarial drugs</b>		
<b>Objective 2</b> Reduce global malaria cases by 75% by end 2015 (from 2000 levels)	→ Confirmed malaria cases (microscopy or RDT) per 1000 persons per year	→ Has diagnostic effort changed over time?	→ Annual blood examination rate
		→ Has health facility reporting completeness changed over time?	→ Completeness of monthly health facility reports
		→ Have test positivity rates changed over time?	→ Malaria test positivity rate
	→ Parasite prevalence: proportion of children aged 6–59 months with malaria infection	→ Is there other evidence of morbidity change?	→ <b>Proportion of children aged 6–59 months with a hemoglobin measurement of &lt;8 g/dL</b>
<b>Target 2.1</b> Achieve universal access to and utilization of prevention measures**	→ <b>Proportion of population with access to an ITN within their household</b>	→ How many households have at least one ITN?	→ <b>Proportion of households with at least one ITN</b>
		→ How many households have enough ITNs for each occupant?	→ <b>Proportion of households with at least one ITN for every two people</b>
		→ Were enough ITNs delivered to ensure at least one ITN per two people at risk?	→ Proportion of population at risk potentially covered by ITNs distributed
		→ Are specific risk groups receiving ITNs?	→ Proportion of targeted risk group receiving ITNs
	→ <b>Proportion of population that slept under an ITN the previous night</b>	→ Are specific population groups using ITNs?	→ <b>Proportion of children under 5 years old who slept under an ITN the previous night</b>
			→ <b>Proportion of pregnant women who slept under an ITN the previous night</b>
		→ Are available ITNs being used?	→ <b>Proportion of existing ITNs used the previous night</b>
		→ Proportion of population protected by IRS within the last 12 months	
<b>Target 2.2</b> Sustain universal access to and utilization of prevention measures**	→ <b>Proportion of households with at least one ITN for every two people and/or sprayed by IRS within the last 12 months</b>	→ How many households have been reached with at least one vector control method?	→ <b>Proportion of households with at least one ITN and/or sprayed by IRS within the last 12 months</b>
	→ <b>Proportion of women who received intermittent preventive treatment for malaria during ANC visits during their last pregnancy</b>	→ Is IPTp received by all pregnant women who attend ANC?	→ Proportion of women attending ANC who received at least two doses of IPT
	→ Percent of districts reporting monthly numbers of suspected malaria cases, number of cases receiving a diagnostic test and number of confirmed malaria cases		
<b>Target 2.3</b> Accelerate development of surveillance systems			
<b>Objective 3</b> Eliminate malaria by end 2015 in 10 new countries (since 2008) and in the WHO European Region	→ Number of new countries in which malaria has been eliminated	→ What are the trends in malaria cases?	→ Number of active foci reported per year
			→ Number of cases by classification (indigenous, introduced, imported, induced)
		→ How strong are surveillance systems?	→ Proportion of private facilities reporting to national malaria surveillance system

■ Indicator derived from household surveys

\* In areas where public health facilities are able to provide a parasitological test for all suspected malaria cases, near zero malaria deaths is defined as no more than 1 confirmed malaria death per 100,000 population at risk.

\*\* Universal access to and utilization of prevention measures is defined as every person at risk sleeping under a quality insecticide-treated net or in a space protected by indoor residual spraying and every pregnant woman at risk receiving at least one dose of intermittent preventive treatment (IPTp) during each of the second and third trimesters (in settings where IPTp is appropriate).



a steady output of tools to replace those which become ineffective because of resistance, and to devise new tools to make elimination of malaria possible in high transmission situations.

## 2.5 Goals and targets for malaria control and elimination

Malaria control forms part of Millennium Development Goal (MDG) 6, Target 6.C – to have halted by 2015 and begun to reverse the incidence of malaria and other major diseases. Given that malaria accounted for 7% of post-neonatal child deaths globally in 2010 and 15% of post-neonatal child deaths in Africa (40), it is also central to MDG 4, Target 4.A – to reduce by two thirds, between 1990 and 2015, the under-five mortality rate. Malaria control is additionally expected to contribute to achievement of MDG 1 (eradicate extreme poverty & hunger), MDG 2 (achieve universal primary education) MDG 3 (promote gender equality and empower women), MDG 5 (improve maternal health) and MDG 8 (develop a global partnership for development).

In 2005, the World Health Assembly set as a target the reduction of malaria cases and deaths by 75% by 2015 (41). In 2011 the RBM partnership updated the objectives, targets and milestones set out in the Global Malaria Action Plan in 2008 (42). The update retains the objective to reduce malaria cases by 75% from 2000 levels by 2015, but also has a more ambitious target, the reduction of malaria deaths to near zero by 2015 (see **Table 2.1**).<sup>4</sup> The objectives of mortality and morbidity reduction are linked to targets for malaria prevention and case management, and to the milestones for individual years before 2015. Another objective is to eliminate malaria by the end of 2015 in 10 new countries (since 2008) and in the WHO European Region.

## 2.6 Indicators of progress

The updated objectives, targets and milestones not only provide direction for the implementation of malaria control programmes but also a framework for monitoring and evaluation. A list of recommended indicators against each target is shown in **Table 2.2**. With one exception, the selection of indicators is the same as those outlined previously in the *World Malaria Report 2011* (43), but arranged according to the updated objectives and targets. The exception is that malaria-specific mortality, as measured through verbal autopsy, has been excluded as a means of routine malaria mortality monitoring owing to lack of specificity in most settings. Indicators that can be generated from household surveys are shown in bold. In some cases, the indicators generated by household surveys, such as parasite prevalence, do not measure a target directly but the indicator is in widespread use and therefore placed by the most appropriate RBM target.

4. In areas where public health facilities are able to provide a parasitological test to all suspected malaria cases, near zero malaria deaths is defined as no more than 1 confirmed malaria death per 100 000 population at risk.

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# Financing malaria control

**This chapter reviews (i) recent trends in international and domestic financing for malaria control in relation to resource requirements, and (ii) the observed distribution of malaria funding in relation to different models of resource allocation.**

## 3.1 International financing of malaria control

International disbursements to malaria-endemic countries increased every year from less than US\$ 100 million in 2000 to US\$ 1.71 billion in 2010 and were estimated to be US\$ 1.66 billion in 2011 and US\$ 1.84 billion in 2012 (**Figure 3.1, Box 3.1**). The Global Fund remains the largest source of funding for malaria control globally, accounting for 39% of estimated disbursed funds in 2011 and 40% in 2012. The recent leveling off in the rate of increase in funds available for malaria control has been primarily due to lower levels of disbursements from the Global Fund in 2011 and 2012 compared to 2009 and 2010 when it accounted for 58% of funds disbursed (reflecting the large amounts allocated to

malaria in Rounds 8 and 9 of grant awards). In 2011 the Global Fund announced the cancellation of Round 11 of Grant Awards. A Transitional Funding Mechanism was established to ensure continuity of programmes in countries due for grant renewal in Round 11 but the mechanism does not allow for further scale-up of programmes. In 2012 the Global Fund Board approved a new funding model which will be implemented between 2013 and 2014 (**Box 3.2**). AMFm operations will be integrated into the new Global Fund grant management process (**Box 3.3**). The reductions in Global Fund disbursements have been offset by increased funding from the US President's Malaria Initiative (PMI) and the United Kingdom's Department for International Development (DFID), which accounted for 31% and 11% respectively of estimated disbursements in 2011–2012.

Estimates of the funds available for malaria control between 2012 and 2015 are projected from formal commitments made by funding agencies or, if data are not available, from pledges (**Box 3.1**). The analysis foresees modest increases in international funding for malaria control of 8% in 2013 and 6% in 2014 compared to 2012.

### Box 3.1 Sources of information on international funding for malaria control

The Global Fund provides information on disbursements for malaria control continuously on line and data were available for the purpose of this report up to November 2012 (1).

For the Global Fund, actual disbursements are shown up to November 2012 and annualized by multiplying by 12/11. Future funding is assumed to follow the grant disbursements in the forecast of assets presented to the Global Fund 28th Board Meeting in November 2012 (2) with malaria funding comprising 28% of future disbursements, in keeping with the proportion of disbursements attributed to malaria observed between 2010 and 2012.

For other development agencies information on disbursements is available up to, and including, 2010 through the OECD Development Co-operation Directorate data base on official development assistance (3). For 2011 and 2012 PMI funding is estimated at US\$ 547 million based on the commitments in PMI's Operational Plans (4,5), and is assumed to be held at that level until 2015. DFID funding to endemic countries for malaria control, excluding the funds it provides to AMFm, is projected to increase from US\$ 77 million in 2010 to US\$ 375 million in 2015. Future funding for DFID was estimated as the average of a lower case scenario (amounts allocated for malaria control in country operational plans (6)) and an upper case scenario (a total of US\$ 500 million allocated to malaria control excluding Global Fund and other contributions). Funding from the PMI and DFID are

subject to annual legislative review. For the World Bank, future funding is assumed to remain at 2010 levels, the latest year for which data are available, at US\$ 72 million. This assumption is also made for agencies falling into the "other" category of **Figure 3.1**. AMFm disbursements in 2010 and 2011 totaled US\$ 139 million excluding supporting interventions (7), with a total of US\$ 245 expected to be disbursed during 2012 and 2013. AMFm funding beyond 2013 is uncertain, and is excluded from the graph (applications for AMFm funding will be rolled into general Global Fund grant applications in the future, see **Box 3.3**). AUSAid projected disbursements include US\$ 100 million pledged in November 2012 over the course of 4 years, commencing 2013 (8).

*Notes:*

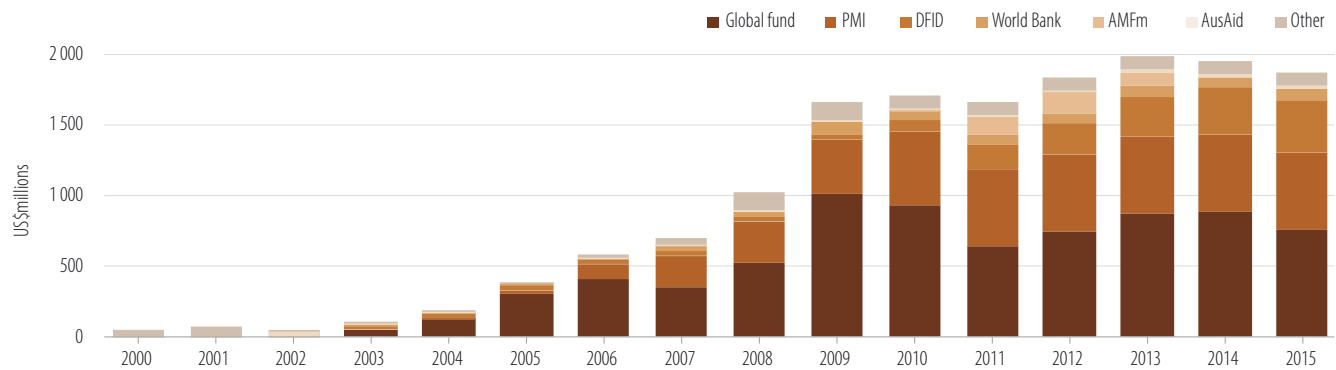
**Pledge:** A non-binding announcement to contribute a certain amount of funds.

**Commitment:** A firm obligation to provide money for malaria control activities or purchasing commodities.

**Disbursement:** A disbursement is the transfer of funds which places resources at the disposal of a government or other implementing agencies.

**Expenditure:** The use of funds to pay for commodities, buildings, equipment, salaries or services (including training, supervision, quality control, monitoring and surveillance etc.).

**Figure 3.1** Past and projected international funding for malaria control 2000–2015



Source: See Box 3.1.

## 3.2 Domestic financing of malaria control

WHO obtains information on domestic financing from data submitted by NMCPs for the *World Malaria Report*. Such reports include malaria-specific expenditures incurred by NMCPs for commodities, programme supervision and management, training, and behavioural change interventions. They exclude general health systems spending such as the cost of health workers, hospitals, clinics and other infrastructure for the treatment of malaria, which are typically provided by the national

governments or supported by non-governmental organizations (NGOs).

Where NMCP data were unavailable, published estimates of domestic financing for 2006–2010, derived from information contained in Global Fund grant applications, were used (10). Reported data suggest that domestic financing for malaria increased in all WHO Regions between 2005 and 2011 except in the European Region (Figure 3.2). The Region of the Americas and the African Region report the greatest expenditure on malaria control. Total domestic spending was estimated to be US\$ 625 million in 2011.

### Box 3.2 Summary of the Global Fund New Funding Model – November 2012

The Global Fund announced on November 15<sup>th</sup> 2012 the adoption of a new method of funding programmes in HIV, TB and malaria (9). The new funding model will replace the rounds-based system, used by the Global Fund from 2002 to 2010. Key features of the new funding model are:

#### 1. Fund allocation

Resources available for allocation to countries will be determined every 3 years in alignment with the Global Fund replenishment cycle.

A notional funding amount for each disease will be determined (for 1 year until a new formula is developed) based on historical expenditure i.e. 52% for HIV, 32% for malaria and 16% for TB.

Countries will be grouped into Country Bands based upon a composite score which is a combination of a country's GNI and its disease burden. There will be 4 Country Bands as follows, with the Board retaining the right to review the composition of bands prior to each allocation period:

- Band 1: Lower income<sup>1</sup>/high burden
- Band 2: Lower income/low burden
- Band 3: Higher income/high-medium burden
- Band 4: Specific high risk populations

After making the global disease split (i.e. 52% for HIV, 32% for malaria and 16% for TB), until a new formula is determined, the Board

1. "Lower income" is defined as less than US\$ 1200 GNI per capita based on World Bank data. "Higher income" is defined as greater than US\$ 1200 GNI per capita.

will then apportion a share of the total available funding to each of the Country Bands. As a hypothetical example: Band 1 might contain 29 countries and receive 52% of the available funding; Band 2, 20 countries and 7% fund allocation; Band 3, 17 countries and 31% fund allocation; Band 4, 60 countries and 10% fund allocation.

As part of this allocation, the Board will divide the total resources allocated to each of the Country Bands into Indicative Funding and Incentive Funding. Indicative Funding will allow predictability for applicants' prioritized needs, whereas Incentive Funding will encourage high impact/performance to obtain additional funding.

Funding for the 3 diseases – HIV, tuberculosis and malaria – will be allocated in one block to recipient countries which will then decide upon the allocations to each of the 3 disease programmes.

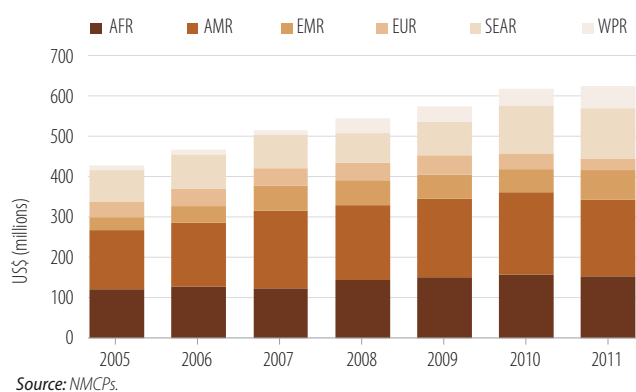
#### 2. Access to funding

The Global Fund will transition to the new funding model immediately, with pilot testing of the system in a transition phase during 2013. Before the end of 2012, the Board will advise as to the level of uncommitted assets which will be made available during the transition phase. The Secretariat will then invite selected countries to participate in the transition phase.

Countries that are not selected to participate in the transition phase will nevertheless be encouraged to develop their national strategies. This will ensure that Concept Notes articulating full expressions of demand can be developed and ready to request funding, based on the replenishment in early 2014.



**Figure 3.2 Domestic funding for malaria control 2005–2011**



### 3.3 Comparison of resources available and resource requirements

Global resource requirements for malaria control were estimated in the 2008 Global Malaria Action Plan (GMAP) to exceed US\$ 5.1 billion per year between 2011 and 2020. In Africa alone, the resource requirements estimated by GMAP were, on average, US\$ 2.3 billion per year during the same period (11). Combining both domestic and international funds, the resources available for malaria control globally were estimated to be US\$ 2.3 billion in 2011, leaving a gap of US\$ 2.8 billion. Projections of both

domestic and international resources available indicate that total funding for malaria control will remain at less than US\$ 2.7 billion between 2013 and 2015.

In an effort to estimate future spending shortfalls, the Roll Back Malaria Harmonization Working Group supported 41 malaria-endemic countries in sub-Saharan Africa to undertake gap analyses in 2012. The gap analysis estimates the resources required to achieve universal coverage of malaria control interventions between 2012 and 2015 and identifies resources already committed. Each country generates its own projections of resources required, which means that the estimates may not be standardized across countries, but do reflect the gaps that the countries expect. In line with the GMAP, the gap analysis suggests that an average of US\$ 2.1 billion per year is required between 2012 and 2015 to achieve universal coverage in the 41 participating countries. Taking account of the funds already secured by countries, the financing gap amounts to US\$ 3.8 billion between 2012 and 2015.

### 3.4 Raising additional funds

As current funding for malaria programmes falls short of the amount required to achieve universal access to malaria interventions, this implies that funding needs to be increased from existing levels and/or that malaria control programmes should seek cost savings so that more can be done with existing

#### Box 3.3 Affordable Medicine Facility-malaria (AMFm)

The Affordable Medicines Facility–malaria (AMFm) has been hosted as a separate business line within the Global Fund since 2008. It is a financing mechanism designed to expand access to quality-assured artemisinin-based combination therapies (QAACs) by increasing their availability and decreasing their prices relative to less effective antimalarial medicines and artemisinin monotherapies. Its goals are to reduce malaria-related deaths and delay the onset of resistance to artemisinin. The AMFm operates through three parallel mechanisms: (i) negotiations with pharmaceutical manufacturers to reduce ex-factory prices of QAACs for public and private sector buyers; (ii) further reductions of the price paid by primary buyers (importers) through a subsidy (“co-payment”) paid on their behalf directly to manufacturers; and (iii) supporting interventions at country-level to facilitate the safe and effective scale-up of access to QAACs.

The AMFm Phase 1 has been funded from 2010 to 2012 from two sources: (i) a co-payment fund of approximately US\$ 338 million to subsidise ACTs, financed by UNITAID, the governments of the United Kingdom and Canada, and the Bill & Melinda Gates Foundation, and (ii) a further amount of US\$ 127 million to finance supporting interventions at country level, funded from the re-programming of ACT procurement funds from existing Global Fund malaria grants in the pilot countries.

The AMFm has been implemented through the public, private for-profit, and private not-for-profit sectors in 9 pilot trials in 8 countries: Cambodia, Ghana, Kenya, Madagascar, Niger, Nigeria, Uganda, and United Republic of Tanzania (Mainland and Zanzibar). Implementation of Phase 1 started in mid-2010 with the signing of grant agree-

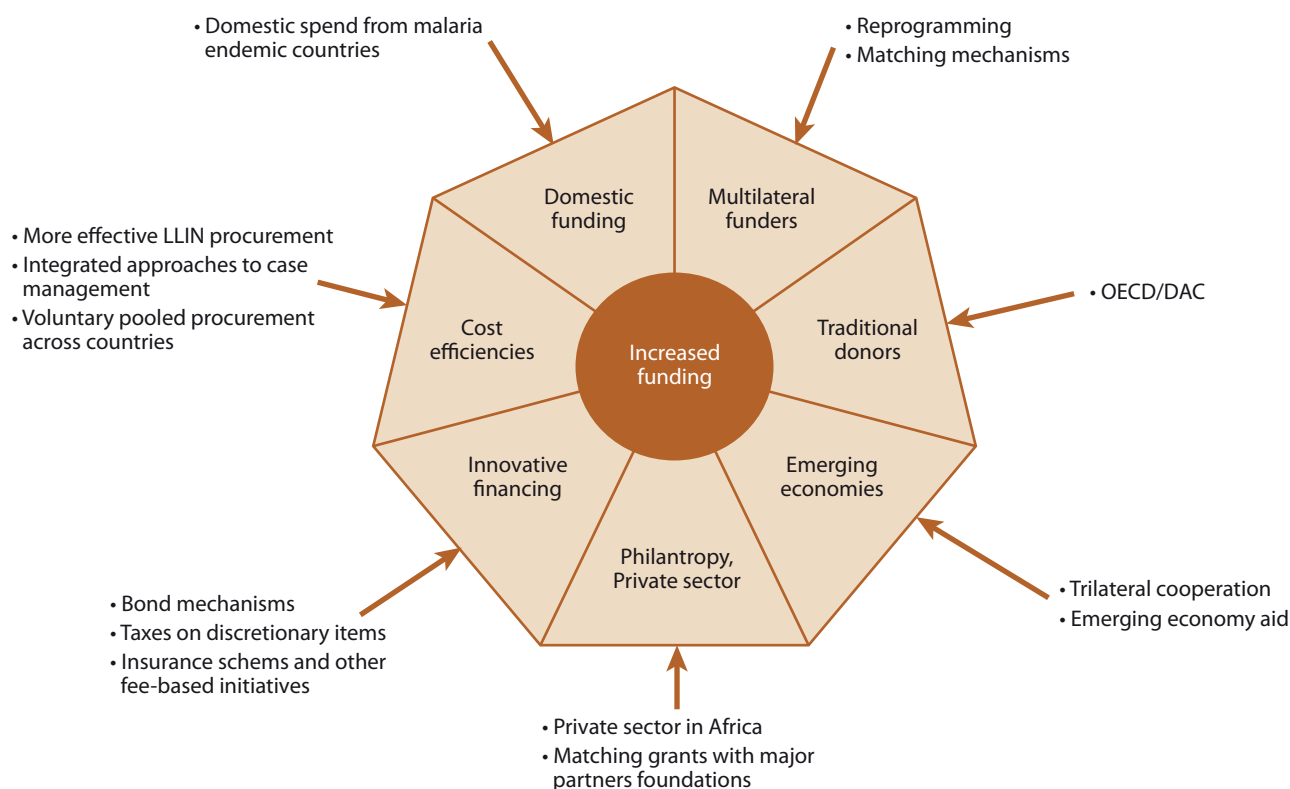
ments with the Global Fund and the ordering of co-paid ACTs by in-country buyers, and will end on 31 December 2012.

In line with WHO recommendations, the Global Fund at its 28th Board Meeting in November 2012, agreed that in order to improve the targeting of malaria treatment, efforts are necessary to improve access to affordable and quality-assured malaria diagnostic testing as an integral part of future initiatives aiming at improving access to ACTs in both the public and private sectors (9).

The Global Fund Board decided to modify the existing AMFm business line by integrating the current operations (price negotiations with manufacturers, direct co-payments from the Global Fund to manufacturers on behalf of approved first-line buyers, and use of supporting interventions) into the new Global Fund grant management and financial processes. Existing pilot countries will continue to receive support in 2013, considered to be a transition period, to ensure a smooth and orderly transition to the new co-payment mechanism. For this the Global Fund has estimated a need for US\$ 114–154 million to fund co-payment of ACTs, and up to an additional US\$ 26 million for critical supporting interventions. In recognizing the importance of ensuring access to both affordable diagnostic testing and treatment for malaria, and the role of the private sector in providing this access, the Global Fund will assess how to incorporate diagnostic testing in the co-payment system.



**Figure 3.3** Example options for closing funding gaps



funds. The *World Malaria Report 2011* reviewed options for cost savings and raising revenue. Potential options are summarized in **Figure 3.3**.

In many settings ITNs and other vector control interventions account for the majority of malaria programme expenditure. ITNs have a limited lifespan and need to be replaced every 2 to 3 years; as 2010 was the year in which the procurement of ITNs peaked, funding is urgently needed to replace ITNs in 2013. As well as overall levels of funding, the timing of funding is also critical.

Experience has repeatedly shown that weakening of malaria control efforts leads to resurgences in malaria (12), 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.

### 3.5 Distribution of available funding

**Figure 3.4** shows domestic and external disbursements in 2006–2010 according to: (i) WHO Region; (ii) size of population at high risk of malaria; (iii) GNI per capita; and (iv) estimated malaria mortality rates.

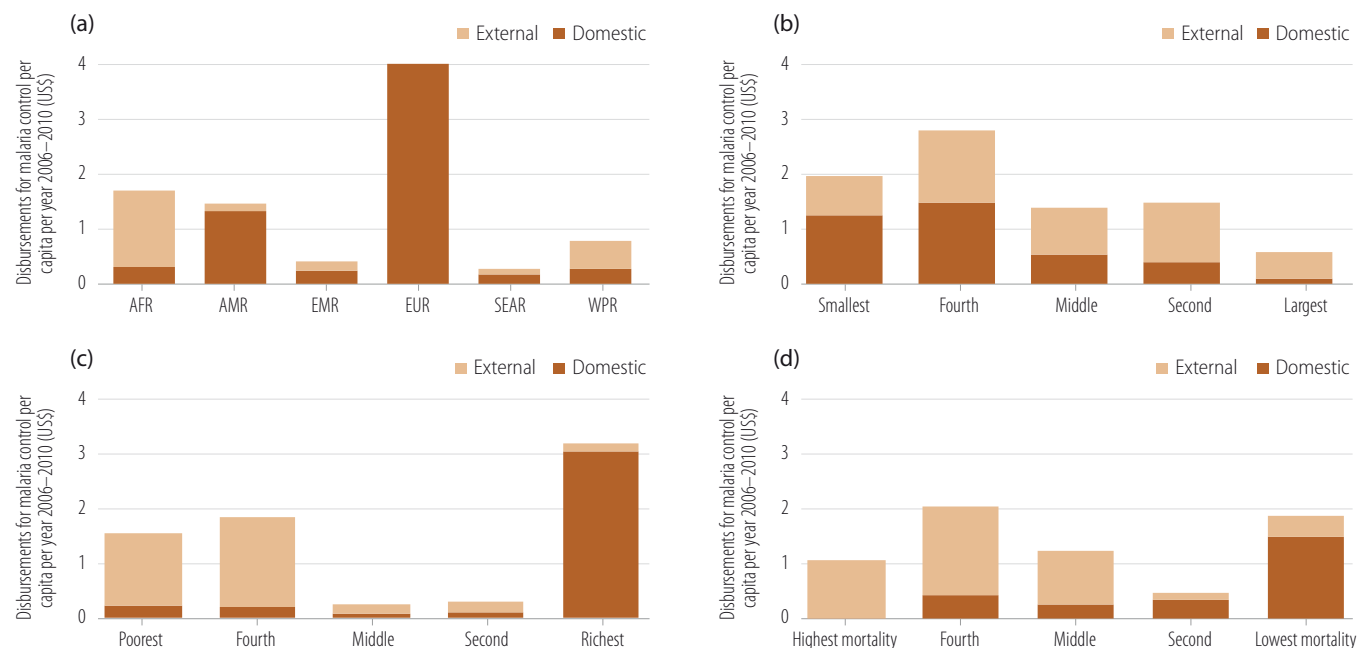
Domestic funding per capita for malaria in 2006–2010 is highest in the European Region and the Region of the Americas, while external funding is greatest in the African and Western Pacific Regions. Total disbursements for malaria control were lowest in the Eastern Mediterranean and South-East Asia Regions.

Countries with larger populations at high risk of malaria have lower levels of domestic malaria funding per capita than those with smaller populations at risk. Countries with the largest populations at risk also receive the lowest levels of international financing per capita and, as a consequence, have the least amounts per person at risk overall. Part of the reason for the apparent low levels of disbursements in large countries could be that populations at risk are estimated less precisely and are prone to over-estimation. In particular, if populations at risk are defined at a comparatively high administrative level (e.g. province), all of the population may be classified as being at high risk even if risk is confined to a limited part of the administrative area. Another factor in the lower level of international funds received by countries with larger populations at risk is affordability; the 20% of countries with the largest populations at risk account for 67% of the total population at risk of malaria and spend approximately US\$ 0.60 per capita per year. If spending on malaria control in these countries were to increase to the levels seen in the smallest countries (approximately US\$ 2.00 per capita) then total spending on malaria would increase to US\$ 3.9 billion per year, 70% higher than the US\$ 2.3 billion estimated expenditure in 2011.

Countries in the highest quintile of GNI per capita invest vastly more of their own money per capita on malaria control than countries in other quintiles. These wealthier countries have lower malaria burdens, accounting for just 1% of estimated cases in 2010 and 0.3% of deaths; they include 5 countries which spend more than US\$ 5.00 per capita per year (Azerbaijan, Costa Rica, Malaysia, South Africa, and Turkey). The high expenditures are partly related to the drive towards elimination of malaria in

**Figure 3.4** Domestic and external disbursements 2006–2010 according to: (a) WHO Region (b) size of population at risk of malaria (c) GNI per capita (d) estimated malaria mortality rates.

Data on disbursements are available only up to 2010 for most agencies (See Box 3.1).



some countries. International assistance is focused on countries in the lower two quintiles of GNI per capita.

Domestic financing is lowest in countries with the highest malaria mortality rates; these are usually countries with lower GNI per capita (Chapter 8, Section 8.4). International financing is targeted to countries with relatively high malaria mortality rates, but it appears that countries with the highest mortality rates receive less per capita than those in the middle and fourth quintiles.

### 3.6 Options for resource allocation

The observed gap between the funding available for malaria control and the amount required to achieve universal coverage of malaria interventions implies that choices need to be made (and have been made) about which countries or populations should benefit from malaria control and which should not. Clearly, there is little scope for reallocating domestic government funds for malaria control – the amount raised per capita in a country will depend on domestic government revenues and on the priority given to spending on malaria relative to other government programmes. For international funding the choice of countries that should benefit will be influenced by the ability of domestic governments to pay for malaria control, commitments made by other donors, and the impact achievable, which is influenced by the epidemiological setting and the capacity of endemic countries to utilize funds. Each choice will have consequences in terms of cases averted and lives saved. It is possible to illustrate the consequences of different choices by comparing two models of international resource allocation:

1. Allocation of available funding according to the size of population at risk (*equal access model*). A justification for this model is that in many malaria programmes the majority of international funding is spent on malaria prevention (ITN and

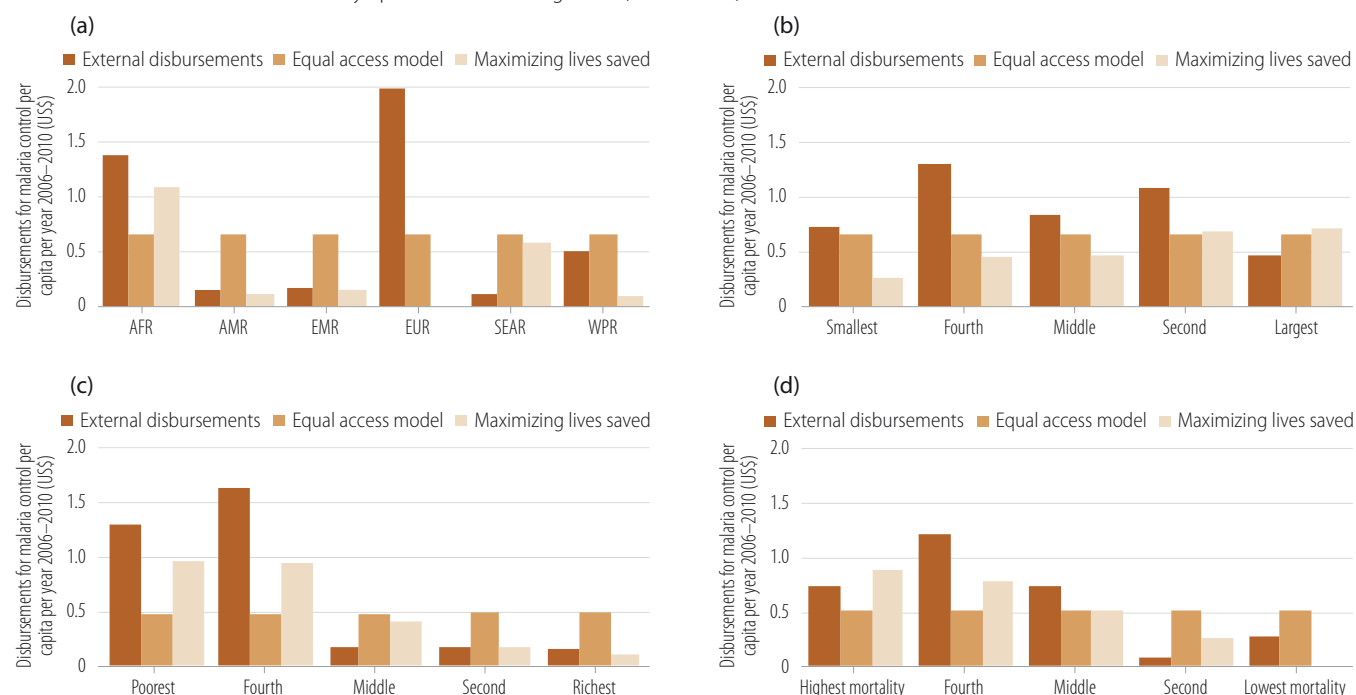
IRS programmes) (13). Achievement of universal coverage of malaria interventions would largely follow this pattern of resource allocation since a main driver of costs is malaria prevention which depends on the size of the population at risk.. Two features of this model are that: (i) the allocation of funds is not influenced by a country's wealth or malaria mortality rates, but funds are allocated simply in proportion to the resources required to achieve universal access to malaria interventions; and (ii) each person at risk is given equal opportunity to receive malaria interventions.

2. Allocation of funding according to malaria mortality rates estimated in each country (*maximizing lives saved model*). A justification for this model is that when malaria interventions, such as ITNs, are deployed in areas with high mortality rates they are likely to have greater impact in terms of averting cases and saving lives than if deployed in lower risk areas. In this model funds are first allocated to the country where malaria mortality rates are highest (this is also where the benefit per unit of investment is likely to be greatest or where the cost of saving a life is lowest). After disbursing sufficient funds to achieve universal coverage of interventions in that country, funds are allocated to the country with the second highest mortality rate (and second lowest cost per life saved). This pattern is repeated until all funding for that year has been exhausted.

With the *equal access* model it can be seen that funds would flow equally to each Region or grouping of countries and population sub-group according to the size of population at risk. With the *maximizing lives saved* model, funds would flow preferentially to the African and South-East Asia Regions, and resources would be prioritized to poorer countries and countries with larger populations at risk and higher malaria mortality rates. A feature of the *maximizing lives saved* model is that as funds become

**Figure 3.5** Comparison of historical external disbursement patterns with two models of resource allocation by: (a) WHO Region (b) size of population at risk of malaria (c) GNI per capita (d) estimated malaria mortality rates.

Data on disbursements are available only up to 2010 for most agencies (See Box 3.1).



more constrained, a greater proportion of funds go to countries with the highest mortality rates (which are also generally the poorest). In contrast, in the *equal access* model the proportion of funds allocated to a country remains constant irrespective of the total budget envelope.

Historical funding patterns have prioritized the African Region, providing fewer funds to the South-East Asia Region and countries with larger populations at risk than in either of the two models outlined above (Figure 3.5). A comparison over time indicates that international disbursements have been increasingly targeted to the African Region and to countries with the highest malaria mortality rates and lowest GNI per capita (Figure 3.6). The proportion of funds received by countries with

the largest populations at risk has decreased (although the absolute value of these funds increased from US\$ 32 million in 2001 to US\$ 800 million in 2010).

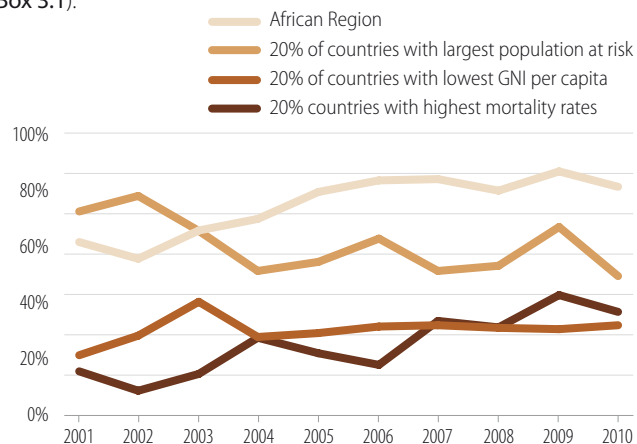
### 3.7 Conclusions

International disbursements to malaria-endemic countries increased every year from less than US\$ 100 million in 2000 to US\$ 1.71 billion in 2010, and were estimated to be US\$ 1.66 billion in 2011 and US\$ 1.84 billion in 2012. The leveling off in the rate of increase in funds available for malaria control has been primarily due to lower levels of disbursements from the Global Fund in 2010 and 2011 compared to 2009 and 2010. In 2011 the Global Fund announced the cancellation of Round 11 of Grant Awards. A Transitional Funding Mechanism was established to ensure continuity of programmes in countries due for grant renewal in Round 11 but the mechanism does not allow for further scale-up of programmes.

Reported data suggest that domestic financing for malaria has increased in all WHO Regions during 2005–2011 except in the European Region. The Region of the Americas and the African Region report the greatest expenditure on malaria control. Total domestic spending in 2011 was estimated to be US\$ 625 million. Global resource requirements for malaria control were estimated in the 2008 Global Malaria Action Plan (GMAP) to exceed US\$ 5.1 billion per year between 2011 and 2020. Combining both domestic and international funds, the resources available for malaria control globally were estimated to be US\$ 2.3 billion in 2011, leaving a funding gap of US\$ 2.8 billion. Projections of available domestic and international resources indicate that total funding for malaria control will remain at less than US\$ 2.7

**Figure 3.6** Change over time in allocation of international funds for malaria control.

Data on disbursements are available only up to 2010 for most agencies (See Box 3.1).



Source: See Box 3.1.

billion between 2013 and 2015, substantially below the amount required to achieve universal access to malaria interventions.

A review of historical funding patterns indicates that international funding for malaria control has been targeted to countries with lower GNI per capita and higher mortality rates, particularly those in Africa. Domestic funding for malaria per person at risk is highest in the European Region and the Region of the Americas and lowest in the South-East Asia Region. Countries in the highest quintile of GNI per capita invest much more money per capita in malaria control than countries in other quintiles. These wealthier countries have lower malaria burdens, accounting for just 1% of estimated cases in 2010 and 0.3% of deaths; their higher expenditures are partly related to the drive towards elimination of malaria in some countries. Countries with the largest populations at risk of malaria – and the highest malaria mortality rates – have the lowest levels of domestic malaria funding per capita.

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# Vector control for malaria

**This chapter: (i) quantifies the need for malaria vector control, (ii) reviews adoption of national policies for malaria vector control, (iii) reviews progress towards the goal of universal ITN/LLIN access and utilization; and (iv) reviews monitoring and management of insecticide resistance in malaria vectors.**

## 4.1 Need for vector control

WHO recommends that in areas targeted for malaria vector control, all persons at risk should be protected by ITNs or IRS. The choice of ITNs or IRS depends on a number of entomological, epidemiological, and operational factors including seasonality of transmission, vector survival and behavior, and insecticide susceptibility of anopheline vectors. Malaria-endemic countries which report to WHO classify their populations as being at high risk (annual parasite index of >1/1000) or at low risk (API <1/1000) for malaria. Areas of high malaria risk are considered most in need of vector control interventions. The need is most obvious for sub-Saharan Africa, where the characteristics of the predominant malaria vectors and the homogeneity of malaria risk indicate that almost all 780 million persons at risk would benefit from vector control with ITNs or IRS. To protect all 780 million persons at risk of malaria in sub-Saharan Africa, approximately 150 million ITNs would be needed each year (assuming that they are LLINs, that a typical LLIN lifespan is 3 years, and that 1 LLIN is distributed per 1.8 persons). If the average LLIN lifespan is actually less than 3 years, as suggested by some data, then true replacement needs could be greater. Increased coverage with IRS could decrease these estimated LLIN requirements.

In malaria-endemic areas outside Africa, due to the heterogeneity of malaria transmission, estimating the population at risk of malaria is more challenging and estimating vector control needs, in particular the needs for ITNs, has proven difficult.

Among the 2.6 billion persons at risk of malaria outside Africa, 568 million are considered by NMCPs to be at high risk and may therefore benefit from vector control measures. Nearly half (273 million) of the high risk population outside Africa resides in India. Given the heterogeneity of malaria transmission in most malaria-endemic areas outside Africa, these numbers may be overestimates, as high malaria rates measured in one area may not be applicable to the entire administrative region. As malaria risk is defined at more precise levels through improvements in surveillance, the estimated needs for vector control outside Africa may also become clearer.

## 4.2 ITN/LLIN policy and implementation

### 4.2.1 Policy adoption and ITN/LLIN distribution

Adoption and implementation of policies for ITN/LLIN programmes by WHO Regions is shown in **Table 4.1** and adoption of policies by country is shown in **Annex 3A**.

A total of 89 countries distribute ITNs free of charge, including 39 of 43 countries with ongoing *P. falciparum* transmission in the African Region. In 78 countries, ITNs are distributed to all age groups, and in 67 of those, ITNs are delivered to all age groups through mass campaigns. Of 40 countries in the African Region which distribute ITNs free of charge, 33 distribute them through antenatal clinics, reflecting policies where the effects of malaria in pregnancy are a particular concern. Twenty-seven countries distribute ITNs through EPI clinics.

The Alliance for Malaria Prevention has collated information on the number of LLINs delivered by the 7 WHOPES-approved manufacturers which supply nearly all LLINs for public sector distribution in Africa (While nearly all ITNs distributed in Africa are LLINs, this chapter refers to all treated nets as ITNs). The

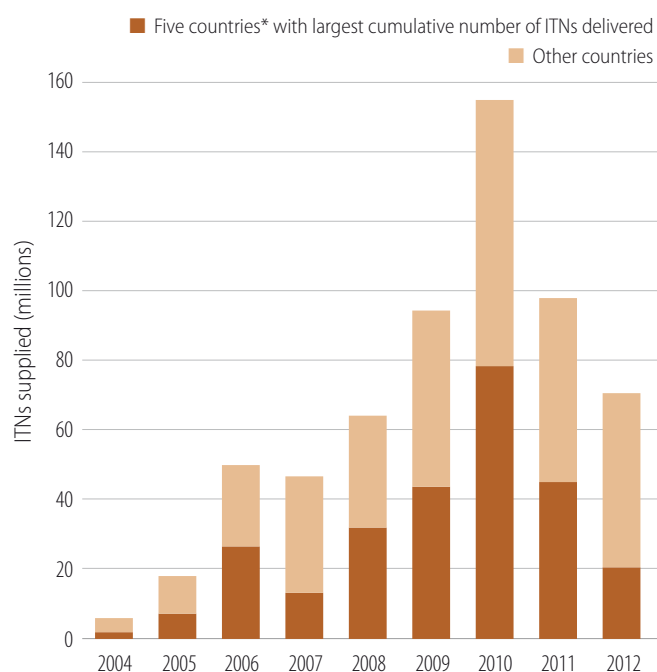
**Table 4.1** Adoption of Policies for ITN Programmes by WHO Region, 2011

Policy	AFR	AMR	EMR	EUR	SEAR	WPR	Grand Total
ITNs/ LLINs are distributed free of charge	39	17	9	4	10	10	89
ITNs/ LLINs are sold at subsidized prices	19	1	1		1	2	24
ITNs/ LLINs are distributed to all age groups	32	17	7	3	10	9	78
ITNs/ LLINs distributed through mass campaigns to all age groups	32	15	5		7	8	67
ITNs/ LLINs are distributed through antenatal clinics	33	4	3		4	5	49
ITNs/ LLINs are distributed through EPI clinics	27		1		1		29
<b>Number of countries/areas with ongoing malaria transmission</b>	<b>44</b>	<b>21</b>	<b>9</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>99</b>
<b>Number of countries/areas with ongoing <i>P. falciparum</i> transmission</b>	<b>43</b>	<b>18</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>88</b>

Source: NMCP reports.

number of nets delivered by manufacturers increased dramatically from 6 million in 2004 to 145 million in 2010 (Figure 4.1); however, the numbers delivered in 2011 (92 million) and projected to be delivered by the end of 2012 (66 million) have decreased from the 2010 peak. From 2009 to 2011 approximately 326 million nets were delivered to countries by manufacturers, well below the 450 million required for each person at risk to have access to a treated net in their household during

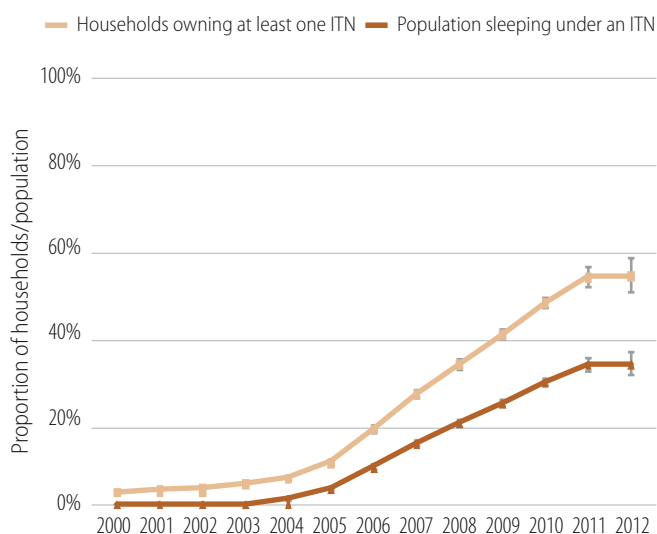
**Figure 4.1** Number of ITNs delivered by manufacturers to countries in sub-Saharan Africa, 2004–2012



\* Democratic Republic of the Congo, Ethiopia, Kenya, Nigeria, United Republic of Tanzania

Source: Alliance for Malaria Prevention. Data for the first three quarters of 2012 have been multiplied by 4/3 to provide an annual estimate.

**Figure 4.2** Estimated trend in proportion of households with at least one ITN and proportion of the population sleeping under an ITN in sub-Saharan Africa, 2000–2012.



Proportion of population sleeping under an ITN derived from relationship with household ownership of at least one ITN analyzed by linear regression in 48 household surveys 2001–2011,  $y = 0.67x - 0.03$ .

Source: ITN coverage model from the Institute for Health Metrics and Evaluation, which takes into account ITNs supplied by manufacturers, ITNs delivered by NMCPs and household survey results (1). Includes Djibouti, Somalia and Sudan which are in the WHO Eastern Mediterranean Region.

the 3-year time period. Moreover, the number of ITNs supplied in 2012 is less than those distributed in 2009, indicating that the number of nets procured may not be sufficient to replace those distributed 3 years earlier. Through gap analysis supported by RBM<sup>1</sup>, country programmes reported that well over 100 million LLINs were financed by donors in 2012, suggesting that the lower number delivered in 2012 may have been due in part to a decrease in funding disbursements.

NMCPs in the African Region report using mass campaigns as the main ITN distribution channel, accounting for 78% of nets distributed, followed by antenatal care clinics (14%), immunization clinics (6%) and other channels (2%).

Outside Africa, NMCP reports indicate that 54 million ITNs were distributed during 2009–2011, with 6 countries accounting for 70% of the total (India 18.4 million, Indonesia 6.5 million, Afghanistan 4.6 million, Myanmar 3.6 million, Philippines 3.0 million, China 2.2 million). Approximately 81% of ITNs outside Africa were reportedly distributed through mass campaigns, while 6% were distributed through immunization clinics, 1% through antenatal clinics and 12% through other channels.

#### 4.2.2 Trend in ITN ownership and utilization

The extent of coverage of populations at risk of malaria with ITNs can be best measured through household surveys. However, household surveys are not conducted frequently enough to provide annual estimates of ITN coverage. To obtain more up-to-date estimates of ITN coverage, it is possible to combine information from previous household surveys with data provided by manufacturers on the number of ITNs delivered to countries, and data from NMCPs on the number of ITNs distributed within countries (1). Estimates modeled in this way for the World Malaria Report, produced in collaboration with the Institute for Health Metrics and Evaluation, show that the proportion of households in sub-Saharan Africa owning at least one ITN increased dramatically from 3% in 2000 to 53% in 2011, and remained at 53% (range 50%–58% in 2012 (Figure 4.2)). The rate of increase in the estimated proportion of households owning at least one ITN has slowed recently, related to the decreased number of ITNs delivered to countries in the last two years. With typical attrition of ITNs due to loss, physical degradation and inadequate replacement, the proportion of households owning at least one ITN may decrease next year and beyond.

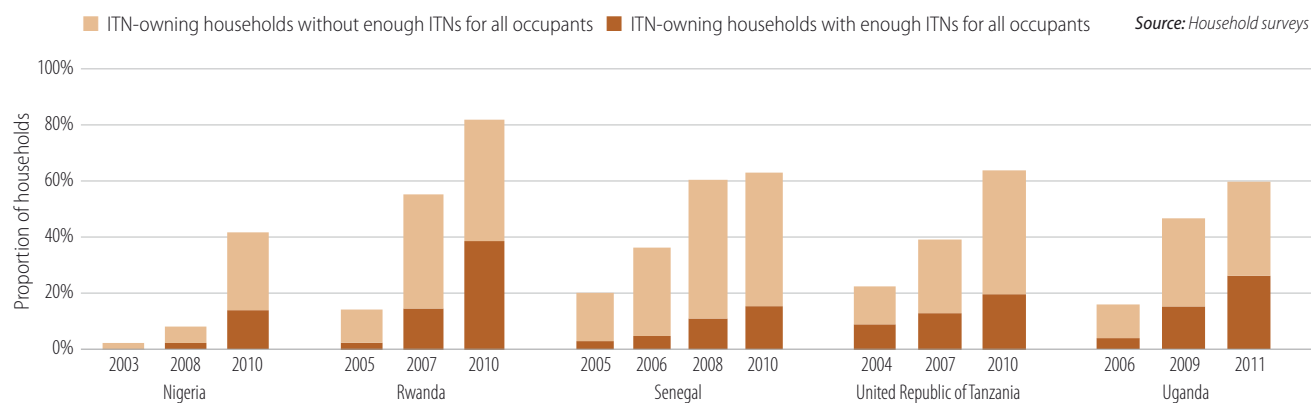
The proportion of the population sleeping under an ITN over time in sub-Saharan Africa can be derived from household ownership of at least one ITN in the model by comparing the relationship between these two measures within individual household surveys<sup>2</sup>. The estimated proportion of the population that sleep under an ITN, although lower than the proportion owning at least one ITN, has also increased since 2000, reaching 33% in 2012.

Trends in ownership of ITNs and use of ITNs, and progress towards recommended universal coverage of all populations at risk, can be illustrated by considering countries with multiple household surveys conducted over time. Among 5 countries with at least 3 household surveys since 2003 (Figure 4.3), the proportion

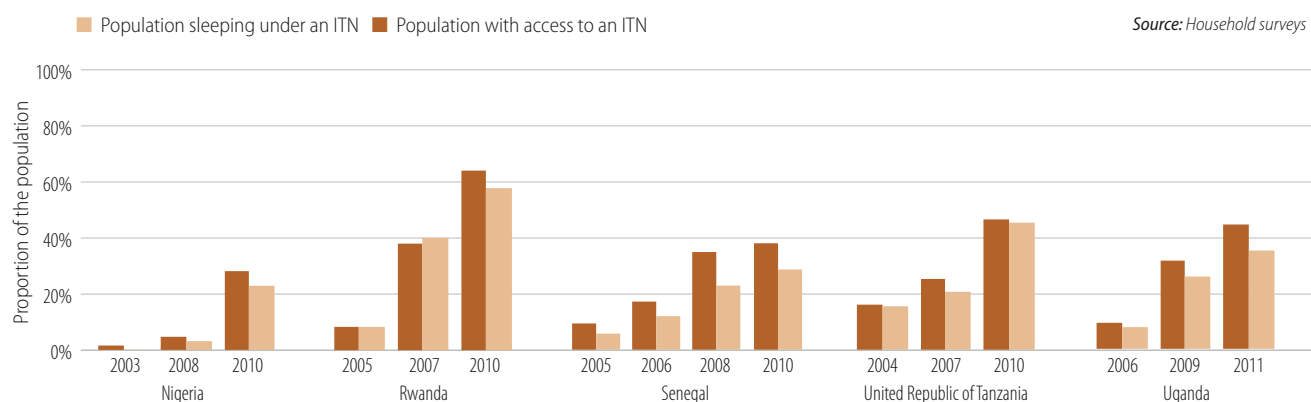
1. <http://www.rbm.who.int/mechanisms/hwg.html>

2. In 48 household surveys conducted in Africa 2003–2011, regression line  $y = 0.67x - 0.03$ .

**Figure 4.3** Proportion of ITN-owning households with and without enough ITNs for all occupants, among countries with at least three household surveys, 2003–2011



**Figure 4.4** Proportion of the population with access to an ITN and proportion sleeping under an ITN in household, among countries with three or more surveys, 2003–2011



of households owning at least one ITN increased substantially during 2003–2011, from 5%–22% in the initial survey in each country to 42%–82% in surveys during 2010–2011. The proportion of households in these countries with enough ITNs for all household members also increased during this period, reaching 14%–39% across countries in the most recent surveys, below the 100% required for universal access for the entire population. Further, the majority of households with an ITN only have a single net, which is not enough to cover all occupants.

As ownership of ITNs by households and the proportion of households with enough ITNs for all members have risen, so has the proportion of the population with access to an ITN and use of these ITNs (Figure 4.4). The proportion of the population with access to an ITN in the household<sup>3</sup> ranged from 2%–18% in initial surveys to 28–64% in the most recent surveys. Similarly, the proportion of the population sleeping under an ITN in these countries increased from 1%–16% to 23–58%.

By comparing the proportion of the population with access to an ITN and the proportion sleeping under an ITN, one may see that use of nets by persons with access to them is consistently high across countries and survey years. In the most recent surveys in these 5 countries, the proportion of the population using an ITN among those with access to an ITN ranges from 76%–97%. In surveys from 17 sub-Saharan African countries conducted during 2009–2011, the median proportion of the population using an ITN among the population with access to

one was 91% (IQR 82%–98%). However, this includes households using nets beyond their assumed capacity of two persons per net and those households not using nets to full capacity. For example, in 21% of Rwandan households surveyed in 2010, a greater proportion of the population slept under an ITN than the proportion which had access to one, while in the remaining 79% of households approximately 71% of persons with access to an ITN slept under one. People use nets that are available at high rates, however, more work needs to be done to ensure that all persons with nets available to them use their nets to full capacity. Information on the uptake of ITNs according to a range of background variables is shown in Box 4.1.

## 4.3 IRS policy adoption and implementation

### 4.3.1 IRS policy adoption

Adoption and implementation of policies for IRS programmes by WHO Region are shown in Table 4.2 and adoption of policies by country is shown in Annex 3A. IRS is recommended for control of malaria in 80 countries, 38 of which are in Africa. IRS is used for control of epidemics in 42 countries and in combination with ITNs in 58 countries, 30 of which are in Africa. A total of 77 countries reported that monitoring of insecticide resistance is undertaken, which is less than the number of countries implementing IRS. Resistance monitoring should be undertaken in all countries where insecticide-based vector control measures are implemented.

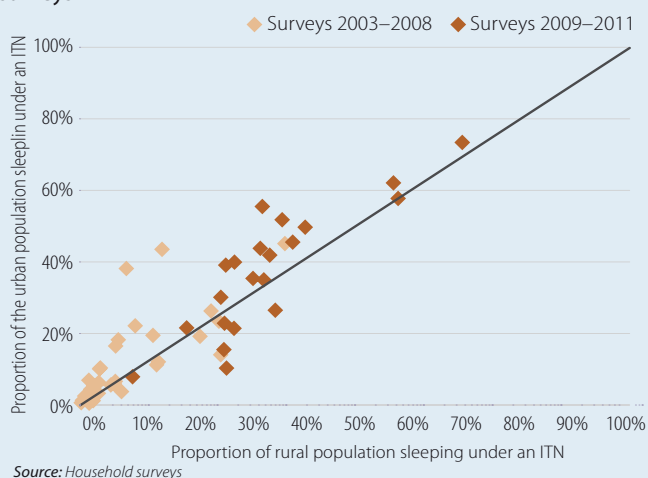
3. Assuming 2 persons per ITN and the number of persons with access to an ITN cannot be greater than the number of persons sleeping in the household.

## Box 4.1 Disparities in persons protected by ITNs

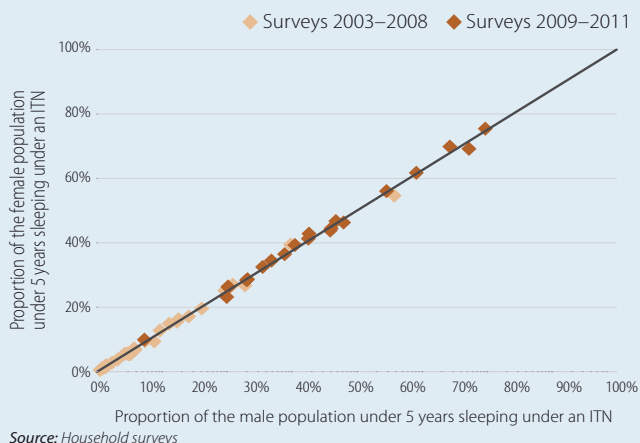
Equity in access to and use of ITNs among different population groups will be attained if the goal of universal access is achieved. When access to an ITN falls short of universal it is informative to examine which population groups benefit from the intervention and which do not, in order to assess whether the intervention is reaching those most in need. Through analysis of household survey data, it is possible to examine access to, and use, of ITNs according to urban and rural setting, socioeconomic status, sex and age. Data were examined from 50 household surveys conducted during 2003–2011. As use of ITNs is correlated with access and can be examined across all factors of interest, analysis is presented for ITN use.

In most surveys since 2003, the proportion of the population sleeping under an ITN was higher in urban than in rural areas (Figure Box 4.1a). The difference is less in more recent surveys, where the overall proportion of the population sleeping under an ITN was higher. In most of the countries surveyed, a higher proportion of urban than rural households had enough ITNs for all members, and consequently a higher proportion of persons in urban households slept under an ITN the previous night.

**Figure Box 4.1a** Proportion of the population sleeping under an ITN, by urban and rural areas and by older and more recent surveys



**Figure Box 4.1c** Proportion of the population under age 5 years sleeping under an ITN, by sex and by older and more recent surveys



The proportion of the population with access to an ITN and sleeping under an ITN also varies according to socioeconomic status in the countries surveyed, and does not appear to have become more equitable as the overall proportion sleeping under an ITN has increased (Figure Box 4.1b). At lower levels of overall ITN ownership, more countries had higher ITN use in the highest wealth quintile than in the lowest wealth quintile.

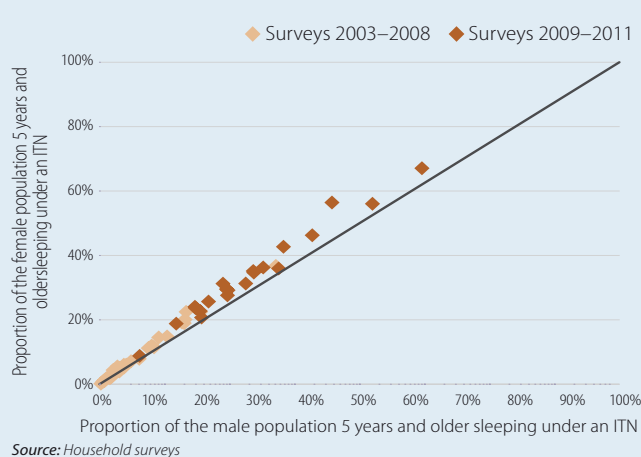
A similar proportion of males and females reported having slept under an ITN in all surveys. For children under 5 years of age, ITN use is remarkably similar among males and females (Figure Box 4.1c), while for those older than 5 years, a slightly higher proportion of females report sleeping under an ITN (Figure Box 4.1d), a difference that does not change substantially as overall ITN use increases. The higher proportion of female adults may be related to greater use of ITNs by pregnant women.

A lower proportion of older children, aged 5–19 years, slept under an ITN than younger children and adults (2) both in earlier surveys (Figure Box 4.1e) and those conducted more recently (Figure Box 4.1f). Even at high levels of use overall, the ratio of ITN use in older children

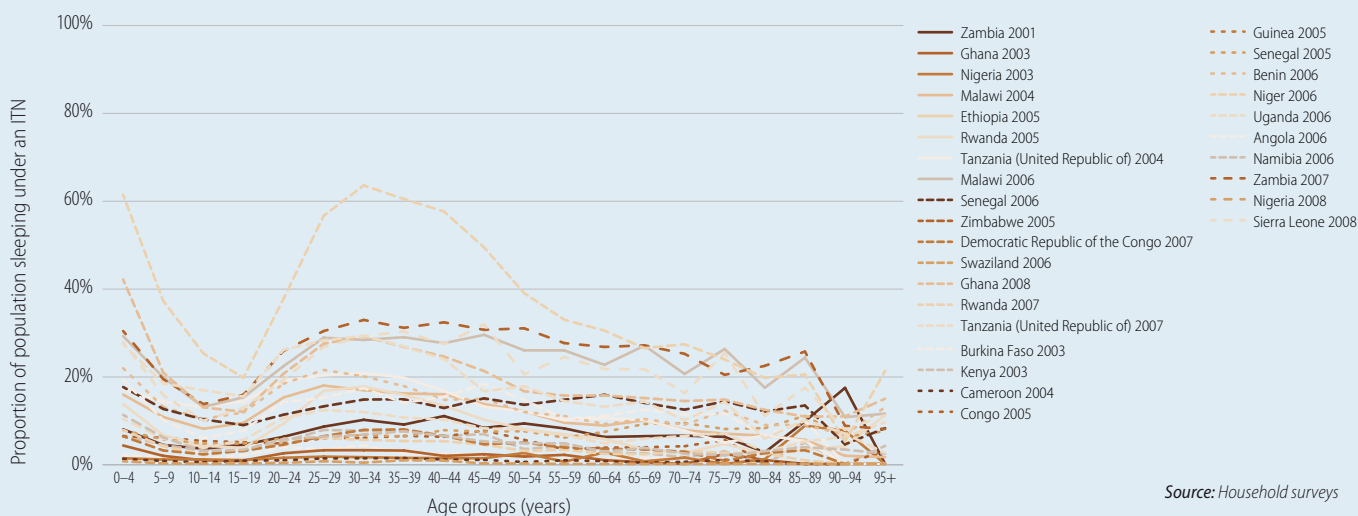
**Figure Box 4.1b** Proportion of the population sleeping under an ITN, by poorest and wealthiest quintiles and by older and more recent surveys



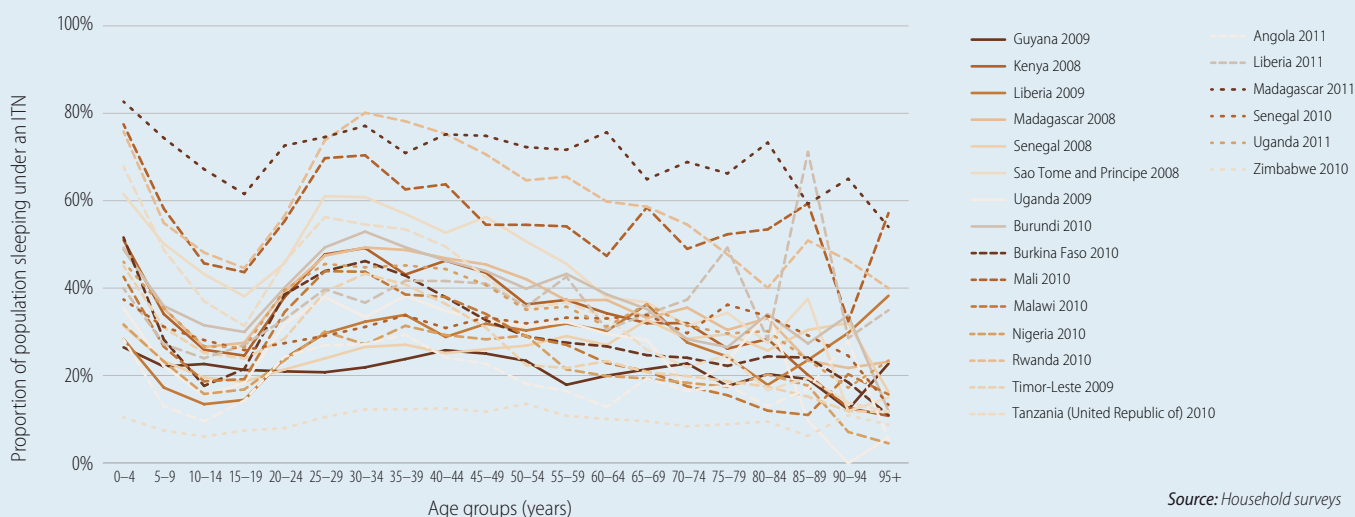
**Figure Box 4.1d** Proportion of the population age 5 years and older sleeping under an ITN, by sex and by older and more recent surveys



**Figure Box 4.1e** Proportion of the population sleeping under an ITN, by five year age groups, 2003–2008



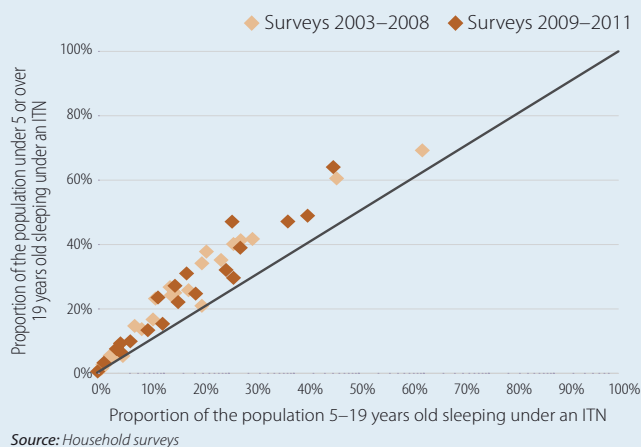
**Figure Box 4.1f** Proportion of the population sleeping under an ITN, by five year age groups, 2009–2011



compared with other age groups has not increased over time (Figure Box 4.1g). Older children can be an important potential reservoir of infection, especially in areas where transmission has been reduced from high levels by interventions (3). Increasing the proportion protected by ITNs in this group by ensuring universal access may make an important contribution to further reduction of transmission in these areas.

In summary, the proportion of the population sleeping under an ITN has been higher among urban than rural and in wealthier than poorer populations; ITN use among older children has been lower than among younger children and adults. There is little sex difference in ITN use although a higher proportion of females  $\geq 5$  years of age sleep under an ITN.

**Figure Box 4.1g** Proportion of 5-19 year olds compared to other age groups sleeping under an ITN, by older and more recent surveys





**Table 4.2** Adoption of policies for IRS programmes by WHO Region, 2011

Policy	AFR	AMR	EMR	EUR	SEAR	WPR	Grand Total
IRS is recommended by malaria control programme	38	17	6	5	8	6	80
IRS is used for the prevention and control of epidemics	19	9	3		4	7	42
IRS and ITNs used together for malaria control in at least some areas	30	14	3		5	6	58
DDT is used for IRS	10	2			1		13
Insecticide resistance monitoring is undertaken	34	11	8	5	9	10	77
<b>Number of countries/areas with ongoing malaria transmission</b>	<b>44</b>	<b>21</b>	<b>9</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>99</b>
<b>Number of countries/areas with ongoing <i>P. falciparum</i> transmission</b>	<b>43</b>	<b>18</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>88</b>

Source: NMCP reports.

### 4.3.2 IRS coverage achieved

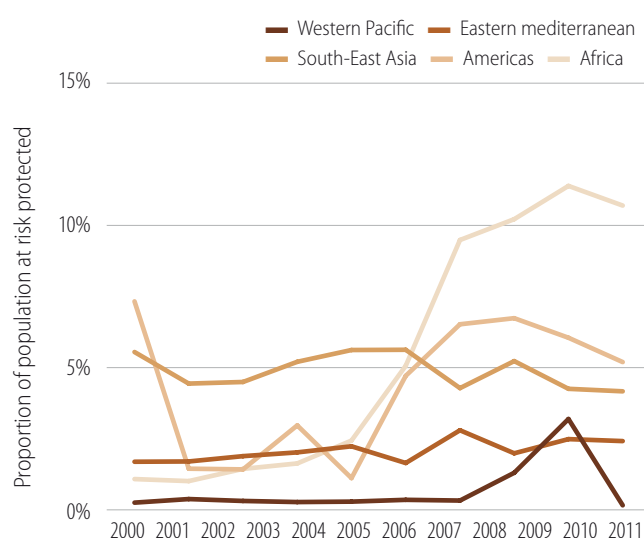
National programmes reported that 153 million people were protected by IRS in 2011, representing 5% of the global population at risk. The proportion of the population protected by IRS increased substantially in the African Region during 2006–2008, and the increased coverage was then maintained above 10% during 2009–2011; in 2011, 77 million people, or 11% of the population at risk, were protected (Figure 4.5). The coverage of IRS programmes was expanded in the Americas during the same time period, protecting 5% of the population at risk in 2011. The proportion of the population protected by IRS increased more recently in the Western Pacific Region, largely due to an increase in the numbers protected by IRS in China, where 24 million people were protected in 2010. IRS coverage by national programmes in the Eastern Mediterranean and South-East Asia Regions has varied little during the last 10 years, with the proportion of the populations at risk protected in these Regions at 2% and 4% respectively in 2011. As several countries in the European Region move towards elimination of malaria, IRS programmes are focused on much smaller populations at risk than in other Regions and the proportion of the population at risk protected by IRS is substantially higher, reaching 65% in 2011 (not shown in figure).

Information on the insecticides used for IRS was provided by 24 of 79 malaria-endemic countries which reported the use of IRS. Pyrethroids were the primary agents used, as reported by 18 of the 24 countries, while carbamates were used by 3 countries and 3 of these 24 countries used DDT<sup>4</sup>.

The proportion of the population protected by IRS reported by NMCPs can be combined with the estimated proportion of the population with access to an ITN derived from household surveys, and from manufacturer and national programme reports (see section 4.2.2) to estimate the proportion of the population at risk in each country protected by vector control interventions. In countries employing both ITNs and IRS, the extent to which the populations targeted for these interventions overlap is difficult to quantify but it is likely to be small in most countries. An upper limit for a combined coverage estimate can be obtained by assuming there is no overlap in the populations protected by IRS or by ITNs, so that the combined coverage

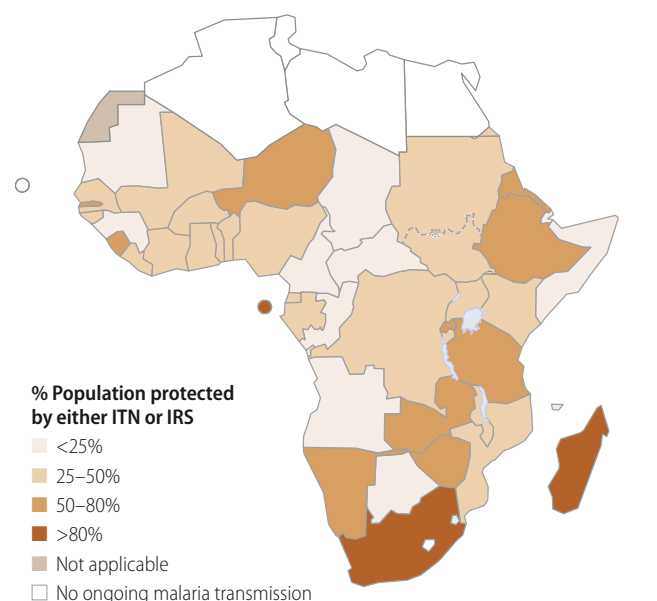
4. Of 99 countries with ongoing malaria transmission, 13 reported having adopted a policy of using DDT for IRS (see table 4.2).

**Figure 4.5** Proportion of population at malaria risk protected by IRS by WHO Region, 2002–2011



Source: NMCP reports

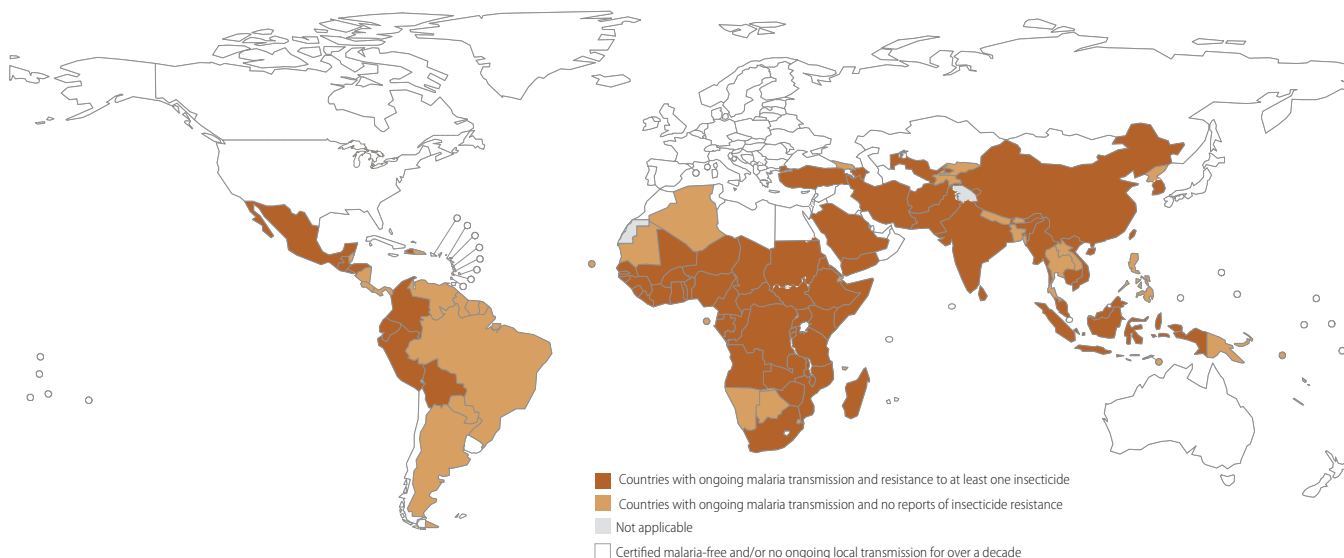
**Figure 4.6** Proportion of population at malaria risk protected by ITNs or IRS, sub-Saharan Africa, 2011



Note: estimates are as of June 30 2011.

Source: ITN coverage model from the Institute for Health Metrics and Evaluation, which takes into account ITNs supplied by manufacturers, ITNs delivered by NMCPs and household survey results (1). Proportion population sleeping under an ITN derived from relationship with household ownership of at least one ITN analyzed by linear regression in 48 household surveys 2001–2011,  $y = 0.67x - 0.03$ . Proportion population protected by IRS from NMCP reports. Map production: Global Malaria Programme (GMP) World Health Organization

**Figure 4.7** Countries with ongoing malaria transmission where insecticide resistance has been identified in at least one of their major vectors



Source: Adapted from, *Global Plan for Insecticide Resistance Management in malaria vectors*, WHO, Geneva, 2012. From WHO regional entomologists in WHO Regional Offices and literature review by the Global Malaria Programme. Map production: Global Malaria Programme (GMP) World Health Organization  
Includes countries with confirmed susceptibility to all insecticides used and countries where susceptibility testing is not currently conducted or results are unknown. The map provides no indication of how widespread resistance is within a country, therefore, a single report of resistance would be sufficient to mark a country as having resistance

for a particular country is obtained by adding the proportion protected by IRS and that protected by ITNs. (A lower limit can be obtained by assuming that there is complete overlap in the population protected by IRS and that protected by ITNs, and therefore, the combined coverage would be equal to the higher of the 2 population proportions protected by ITNs or IRS.<sup>5</sup>)

For Africa, the maximum estimated coverage of vector control interventions varies among countries (Figure 4.6). In 13 countries, more than half of the population was protected by vector control measures including more than 80% of the population in Madagascar and South Africa. In Mozambique, Namibia, Sao Tome and Principe, South Africa, Zambia, and Zimbabwe, more than half of the estimated population protected by vector control was covered by IRS.

#### 4.4 Larval source management strategies

WHO recommends that in a few specific settings and circumstances, the core vector control interventions of IRS and ITNs may be complemented by other methods, such as mosquito larval source management. Anti-larval measures are appropriate and advisable only in a minority of settings, where mosquito breeding sites are few, fixed, and findable (i.e. easy to identify, map and treat).<sup>6</sup>

Reports received from national programmes indicate that 27 malaria-endemic countries worldwide use larval control in certain specific foci of malaria transmission, including 9 countries

in the African Region, 5 in the Region of the Americas, 3 in the Eastern Mediterranean Region, 6 in the European Region, 2 each in the South-East Asia and Western Pacific Regions. Various larval control strategies were reported, and many countries engaged in more than one type of larval control activity. In 2011, 9 countries reported activities involving habitat manipulation (temporary changes to vector habitats) and 9 reported some form of habitat modification (long-lasting physical transformations to reduce vector larval habitats). Larval control through chemical larviciding was reported by 16 countries, while 13 reported biological larviciding activities. Reports from endemic countries give an indication of the range of larval control methods employed, although the scale of efforts are not quantified and the impact on individual country malaria burden is not easily measured.

#### 4.5 The Global Plan for Insecticide Resistance Monitoring in malaria vectors

Vector control through ITNs and IRS is a core component of malaria control programmes today, and the success of these interventions is dependent upon the continued effectiveness of the insecticides used. Currently, insecticides used for IRS come from only 4 classes: pyrethroids (the most commonly used class), organochlorines (of which DDT is the only compound in use), organophosphates, and carbamates; all WHO-recommended LLINs use pyrethroids. As malaria vector control, and consequently the success of global malaria control, is heavily reliant on a single class of insecticide, the pyrethroids, increasing resistance of malaria vectors to pyrethroids and to other insecticides jeopardizes global malaria control efforts. Recognizing the threat posed by insecticide resistance, in 2010 WHO initiated a consultation process on technical strategies to preserve the effectiveness of insecticides used for malaria control.

5. This approach may underestimate the coverage since, if only a small proportion of households with ITNs have enough for all occupants, IRS would offer protection for those who do not have access to a net in their household.

6. [http://www.who.int/malaria/publications/atoz/larviciding\\_position\\_statement/en/](http://www.who.int/malaria/publications/atoz/larviciding_position_statement/en/)

The product of the consultative process, *The Global Plan for Insecticide Resistance Management in malaria vectors* (GPIRM), was released by WHO in May 2012. It summarizes the current status of insecticide resistance, the potential effect of resistance on the burden of malaria, the available approaches to managing resistance, and outlines a global strategy and action plan for insecticide resistance management for the global malaria community.

To inform the GPIRM, during 2011–2012 the WHO regional entomologists in WHO Regional Offices collected information on insecticide resistance monitoring activities by WHO Member States. Insecticide resistance in malaria vectors is widespread, and affects all currently used insecticides; resistance to at least one insecticide in one malaria vector in one study site has been identified in 64 countries worldwide (Figure 4.7). Most of these reports concerned resistance to pyrethroids. The extent of resistance within the countries is unknown – however, if resistance to pyrethroids were to reach a level at which they became ineffective in all areas, in Africa, an estimated 26 million malaria cases and 120 000 malaria deaths averted by current vector control efforts would instead occur. Strategies to manage insecticide resistance described in the GPIRM include rotations of insecticides used in IRS, use of vector control interventions in combination, and mosaic spraying.

## 4.6 Conclusions

**Access to ITNs is increasing but programmes are still far from universal coverage targets.**

Tremendous progress had been made in the distribution of ITNs, especially in Africa, where it is estimated that more than half of all households in malaria-endemic areas had at least one ITN in 2012. Malaria control programmes are, however, far from achieving universal coverage targets for the availability of ITNs, since most households do not have enough ITNs for all household members and only an estimated 33% of the population slept under an ITN in their home.

Where nets are available they are used at high levels and high use of available nets is maintained as overall coverage improves. In the most recent household surveys, approximately 91% of persons with access to a net in their household slept under it the night before. Current efforts to encourage the use of nets should be maintained and efforts to increase the number of available nets within households should be strengthened.

Progress towards achieving universal coverage is hindered by decreased distribution of ITNs in the last 2 years. In 2010, approximately 145 million ITNs were distributed by manufacturers to countries in Africa, which is close to the estimated number required each year to maintain universal coverage (assuming each net lasts 3 years and protects 2 persons); in 2011 and 2012 the number of ITNs distributed to countries was well below that level, at 92 and 66 million respectively. Attaining universal coverage with vector control measures will be a monumental achievement; maintaining universal coverage will be essential to ensure that the benefits of that achievement are sustained. National programmes, domestic and international financiers of malaria control, and other partners in the malaria community should work to ensure a sufficient ongoing supply of ITNs to achieve and maintain universal coverage.

### Equity in distribution and use of ITNs

Distribution of ITNs by national programmes has resulted in slightly greater availability and use of ITNs in urban over rural households, of wealthier over the poorer households, and among young children and adults over older children. There is little difference in ITN use between sexes although a higher proportion of females  $\geq 5$  years of age sleep under an ITN. These differences may be a consequence of the logistical challenges of distributing ITNs to the more remote rural populations and continued targeting of ITNs to particular population groups such as children and pregnant women. Country programmes should ensure that nets are made available to, and used by, all age groups equally.

### IRS coverage in Africa may have reached a plateau

After a substantial increase in the proportion of the population protected by IRS in Africa during 2006–2009, IRS coverage has remained at about 11% of the population at risk the past 3 years. The reasons for the lack of increase in IRS implementation are not clear. IRS is a powerful vector control tool, offers certain advantages over ITNs, not least by offering more flexibility in insecticide choice, and has been used as the predominant vector control method in a number of countries. However, for most programmes implementing IRS, it is relatively more expensive per person protected per year than ITNs (4, 5), which may preclude its use on a larger scale than has currently been achieved.

### Monitoring and management of insecticide resistance

The effectiveness of both IRS and ITNs is threatened by the development of insecticide resistance. Monitoring and management of insecticide resistance for malaria control is set out in the recently released GPIRM. More could be done to manage resistance by more active strategies using existing tools. Addressing insecticide resistance will benefit greatly from the development of new insecticides, especially those appropriate for insecticide-treated nets, and from vector control and other interventions to reduce transmission that do not rely on insecticides.

## References

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# Preventive chemotherapy for malaria

**This chapter: (i) quantifies the need for malaria preventive chemotherapies, (ii) reviews the adoption of policies and implementation of programmes for intermittent preventive treatment of malaria in pregnancy and in infants, and of seasonal malaria chemoprevention in children, and (iii) reviews progress in the development of a malaria vaccine.**

## 5.1 Need for malaria preventive chemotherapy

WHO currently recommends three strategies for the use of anti-malarial agents for the prevention of malaria, targeting specific groups at high risk of *P. falciparum* malaria, predominantly in sub-Saharan African countries:

(i) in areas of moderate-to-high malaria transmission in sub-Saharan Africa, intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine (SP) is recommended for all pregnant women at each scheduled antenatal care visit;

(ii) the co-administration of intermittent preventive treatment in infants (IPTi) with sulfadoxine-pyrimethamine (SP-IPTi) together with the second and third diphtheria-pertussis-tetanus (DPT) and measles vaccination of infants, through routine Expanded Programme on Immunization (EPI) services in countries in sub-Saharan Africa, in areas with moderate-to-high malaria transmission<sup>1</sup> and where parasite resistance to SP is not high<sup>2</sup>;

(iii) seasonal malaria chemoprevention (SMC) with amodiaquine plus sulfadoxine-pyrimethamine (AQ+SP) for children aged 3–59 months is recommended in areas of highly seasonal malaria transmission across the Sahel subregion in Africa.

High risk groups targeted for these strategies represent important fractions of populations in malaria-endemic countries. Among the approximately 780 million persons at risk of malaria in endemic countries in sub-Saharan Africa in 2011, an estimated 32 million women who become pregnant each year (7) could benefit from IPTp, a large proportion of the approximately 28 million infants born each year<sup>3</sup> could benefit from IPTi, and an estimated 25 million children aged 3–59 months living in the Sahel subregion could benefit from SMC (2). A large proportion of the groups targeted for two of the WHO recommended preventive malaria treatments, IPTp and IPTi, have access to malaria preventive services through their attendance at health facilities to participate in other well-functioning preventive health programmes. In more than half of countries in sub-Saharan Africa the proportion of pregnant women

making at least one visit to an antenatal clinic (ANC), where IPTp is most often delivered, is at least 90% (3) and approximately 71% of infants in sub-Saharan African countries complete a full schedule of DPT vaccination at immunization clinics (4), where IPTi is recommended to be delivered. WHO recommends that, if possible, SMC should be integrated into existing community-based programmes. However, a single deployment strategy for SMC has not yet been devised, and therefore the extent to which the targeted population could be reached through different existing service delivery platforms is uncertain.

The estimated burden of malaria is high in groups targeted for preventive treatments. Some of the disease burden may not be immediately recognized as attributable to malaria. For example, low birth weight arising from malaria in pregnancy, which commonly occurs without symptoms of malaria, is estimated to result in as many as 100 000 infant deaths each year in sub-Saharan Africa (5). More directly attributable to malaria, approximately 108 000 deaths in children with malaria under 5 years of age occurred in 2010 in areas of the Sahel targeted for SMC (2). Thus important reductions in infant and childhood mortality could be achieved through expanded implementation of IPTp, IPTi and SMC.

## 5.2 Malaria chemoprevention policies and implementation

### 5.2.1 Intermittent preventive treatment of pregnant women

During 2012, the WHO Malaria Policy Advisory Committee (MPAC) convened an Evidence Review Group (ERG) on IPTp to review current evidence on IPTp and develop an interim policy statement on IPTp. The revised policy statement, endorsed by the MPAC and issued by WHO in October 2012, affirms that in areas of stable (moderate- to- high) malaria transmission, IPTp with SP is recommended for all pregnant women at each scheduled antenatal care visit. The previous IPTp policy stated that pregnant women in areas of stable malaria transmission should receive at least 2 doses of SP and was not sufficiently clear on the timing and number of SP doses recommended. Information on IPTp policy adoption and implementation described in this chapter reflects experience with the previous IPTp policy. The evidence review also noted that IPTp with SP remains effective in preventing the adverse consequences on maternal and fetal outcomes even in areas where a high proportion of *Plasmodium falciparum* parasites carry quintuple mutations associated with *in vivo* therapeutic failures to SP and therefore, IPTp with SP should still be administered to women in such areas. Furthermore, the ERG found no evidence of a threshold level of malaria transmission below which IPTp-SP is no longer cost effective.

1. Annual entomological inoculation rates >10

2. Defined as a prevalence of the pfdhps 540 mutation of <50%

3. Projected using crude birth rates of endemic countries



**Table 5.1** Adoption of Policies for Intermittent Preventive Treatment for Pregnant Women (IPTp), 2011

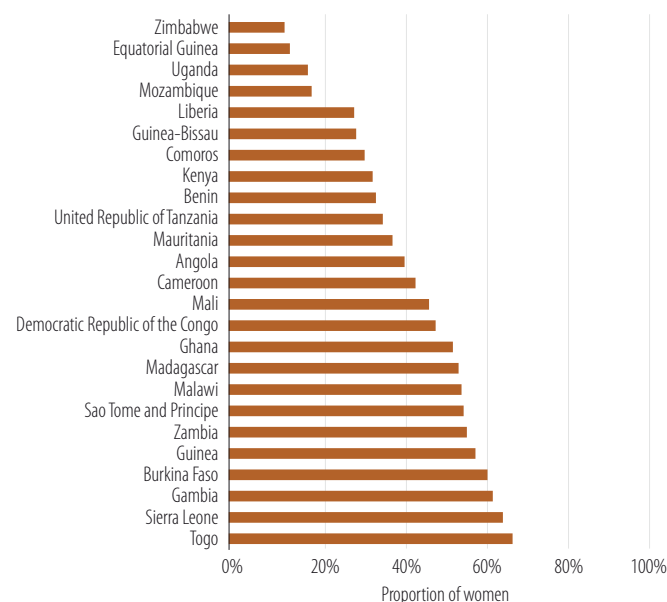
Policy	AFR	AMR	EMR	EUR	SEAR	WPR	Grand Total
IPTp used to prevent malaria during pregnancy	34	N/A	2	N/A	N/A	1	37
<b>Number of countries/areas with ongoing transmission</b>	<b>44</b>	<b>21</b>	<b>9</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>99</b>
<b>Number of endemic countries/areas with ongoing transmission of <i>P. falciparum</i></b>	<b>43</b>	<b>18</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>88</b>

The countries which had adopted IPTp with SP as national policy by the end of 2011 include 36 high-burden countries in sub-Saharan Africa spanning the African and Eastern Mediterranean WHO Regions. Although the WHO policy focuses on Africa, IPTp has also been adopted and implemented in Papua New Guinea in the Western Pacific Region (Table 5.1).

Consistent data on both the second dose of IPTp (numerator) and the number of women who had attended antenatal care (ANC) at least once (denominator) were available for 25 of the 36 NMCPs which had IPTp as national policy in 2011; data were available for 10 countries for each of the last 5 years. Approximately half of women attending antenatal clinics in 2011 (44%, inter-quartile range 30%–57%) received a second dose of SP for IPTp in the reporting countries (Figure 5.1). Although some low IPTp coverage rates for 2 doses may be attributable to the fact that some pregnant women only make a single ANC visit, the low rates of IPTp coverage suggest that a large number of opportunities are missed for delivering recommended preventive treatment during antenatal care. For countries which consistently reported data on the second dose of IPTp and ANC attendance, no consistent trend over time was seen across countries in the proportion of women receiving IPTp (Figure 5.2). It is unclear how much variation in the proportion receiving IPTp is due to changes in programme performance in delivering IPTp and how much may be due to variation in completeness and quality of reporting.

Information on the proportion of all pregnant women receiving the second dose of IPTp can be derived from household surveys. Data were available on IPTp for pregnant women from 60 surveys in 38 countries between 2003 and 2011. Overall during

**Figure 5.1** Proportion of women attending antenatal care receiving the second dose of IPTp, 2011



Source: NMCP reports

2009–2011, the weighted average of the proportion of pregnant women who received 2 doses of IPTp across 16 surveyed countries was low, at 22%, primarily due to low coverage rates in large countries such as Nigeria and the Democratic Republic of the Congo. Information on the uptake of IPTp according to a range of background variables is shown in Box 5.1.

### 5.2.2 Intermittent preventive treatment of infants

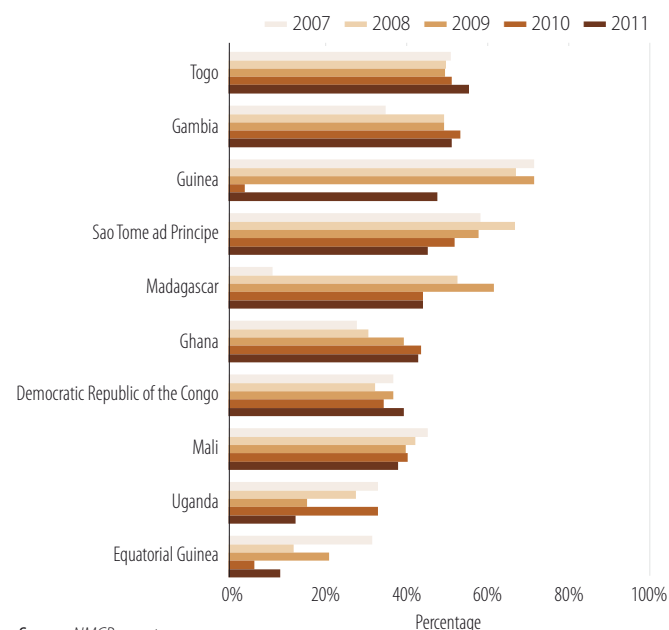
Intermittent preventive treatment of infants with SP (IPTi) is the administration of a therapeutic dose of SP delivered through immunization services at defined intervals corresponding to routine vaccination schedules – usually at 10 weeks, 14 weeks, and approximately 9 months of age – to those at risk of malaria. WHO recommends IPTi in countries with moderate-to-high malaria transmission, and with low levels of parasite resistance to SP. So far only Burkina Faso has adopted IPTi as national policy since it was recommended by WHO in 2009; however, the IPTi implementation guidelines were published<sup>4</sup> in September 2011, and several countries are developing plans for its adoption and implementation.

### 5.2.3 Seasonal malaria chemoprevention

Seasonal malaria chemoprevention (SMC), previously termed intermittent preventive treatment in children, is defined as the intermittent administration of full treatment courses of an effective

4. Intermittent preventive treatment for infants using sulfadoxine-pyrimethamine (SP-IPTi) for malaria control in Africa: Implementation field guide available at: [whqlibdoc.who.int/hq/2011/WHO\\_IVB\\_11.07\\_eng.pdf](http://whqlibdoc.who.int/hq/2011/WHO_IVB_11.07_eng.pdf)

**Figure 5.2** Proportion of women attending antenatal care receiving a second dose of IPTp, by country and year, 2007–2011



Source: NMCP reports

tive antimalarial medicine during the malaria season to prevent malarial illness. The objective of SMC is to maintain therapeutic anti-malarial drug concentrations in the blood throughout the period of greatest malarial risk. SMC has been studied most frequently in areas with seasonal malaria transmission where the main burden of malaria is in children, rather than in infants, and the main risk of clinical malaria is restricted to a few months each year.

WHO convened the Technical Expert Group (TEG) on Preventive Chemotherapy in May 2011 to review the current evidence on the efficacy, safety and feasibility of large-scale implementation of SMC; the TEG recommended that SMC be adopted as policy in targeted areas. The report of this consultation was presented to the MPAC in January 2012. The MPAC endorsed the TEG recommendation and advised WHO to promote SMC in the control of malaria in targeted areas (in the Sahel subregion of Africa). In accordance with this advice, WHO formulated a policy recommendation which was released in March 2012.

According to this new WHO policy, SMC is recommended for use in areas of highly seasonal malaria transmission across the Sahel subregion in Africa. In areas where both drugs retain sufficient antimalarial efficacy, a complete treatment course of amodiaquine plus sulfadoxine-pyrimethamine (AQ+SP) should be given to children aged between 3 and 59 months at monthly intervals, beginning at the start of the transmission season, to a maximum of 4 doses during the malaria transmission season. SMC with AQ+SP is not currently recommended for countries in southern and eastern Africa, even though there are some locations in those regions where the transmission pattern would suggest suitability. This is because of the high level of *P. falciparum* resistance to AQ and/or SP, and the absence of adequate efficacy and safety data for other potential anti-malarial regimens for use in SMC.

Given that the the policy recommendation was made only recently, no countries have yet adopted SMC; however several countries involved in evaluating SMC have plans to expand SMC activities beyond their study populations. An implementation manual for SMC, *Seasonal malaria chemoprevention with sulfadoxine-pyrimethamine plus amodiaquine in children, a field guide*, developed by WHO, was issued in December 2012. (6)

## 5.3 New tools for malaria prevention

### Malaria vaccine development

An effective vaccine against malaria has long been envisaged as a potentially valuable addition to the available tools for malaria control. Research towards the development of malaria vaccines has been pursued in this technically complex field since the 1970s. As yet there are no licensed malaria vaccines. A number of candidate vaccines are being evaluated in clinical trials, with one candidate vaccine currently being assessed in Phase 3 clinical trials and approximately 20 others in Phase 1 or Phase 2 clinical trials.

#### Vaccine candidate RTS,S/AS01

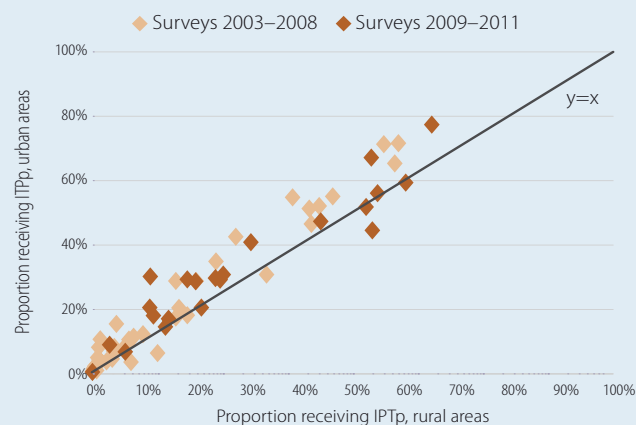
The RTS,S/AS01 vaccine targets *P. falciparum*. It comprises a fusion protein of a malaria antigen with hepatitis B surface antigen and includes a new potent adjuvant. Now in Phase 3 clinical trials, the vaccine is being developed in a partnership between GlaxoSmithKline (GSK) and PATH Malaria Vaccine Initiative (MVI), with funds provided by the Bill & Melinda Gates Foundation to MVI. The vaccine manufacturer's clinical development plan for this vaccine is focusing on African infants and young children resident in malaria-endemic countries.

### Box 5.1 Disparities in the use of IPTp

Household surveys enable an analysis to be made of differences in the use of IPTp according to rural/urban residence and wealth quintile. In most surveyed countries, a higher proportion of women in urban areas received 2 doses of IPTp than women in rural areas (Figure Box 5.1a). Differences between urban and rural areas in the uptake of IPTp appeared to be smaller in more recent years, during which

there was also higher overall coverage. Similarly, when examining IPTp coverage by wealth quintile, a higher proportion of women in the highest wealth quintile received 2 doses of IPTp than those in the lowest wealth quintile, though disparities in IPTp by wealth did not change in more recent surveys (Figure Box 5.1b).

**Figure Box 5.1a** Proportion of all pregnant women receiving a second dose of IPTp, by urban and rural area, 2003–2011



Source: Household surveys

**Figure Box 5.1b** Proportion of pregnant women receiving the second dose of IPTp, by lowest and highest wealth quintile, 2003–2011



Source: Household surveys

The full Phase 3 trial results will become available to WHO in late 2014 and will include 30 months' safety and efficacy data from groups aged 6–14 weeks and 5–17 months, together with data on an 18-month booster dose and site-specific efficacy data. The WHO Joint Technical Expert Group on Malaria Vaccines, set up in April 2009 (jointly by the Global Malaria Programme and Department of Immunization, Vaccines & Biologicals), has advised that, in the light of the published results to date, a policy recommendation could be considered once the full trial results become available. The timelines of the Phase 3 trial may allow a policy recommendation in 2015, subject to vaccine performance, in which case this vaccine could then be assessed for potential addition to the current WHO recommended malaria preventive measures.

Preliminary Phase 3 trial results published in November 2012 (7) do not change the timing of a possible WHO policy recommendation for RTS,S/AS01 in 2015, which as noted above, will be based on the full results from the completed Phase 3 trial in late 2014. For malaria vaccines, the Joint Technical Expert Group on malaria vaccines will draft proposed policy recommendations for review by the Strategic Advisory Group of Experts on Immunization and the MPAC in 2015. RTS,S/AS01 will be evaluated as a possible addition to, and not a replacement for, existing preventive, diagnostic and treatment measures.

#### *Other malaria vaccine candidates in development*

Several other scientifically promising vaccine candidates are currently being explored, but their development is at least 5–10 years behind that of RTS,S/AOS1. Details are provided in the rainbow tables<sup>5</sup>, WHO's comprehensive annually updated spreadsheets of global malaria vaccine project activity.

In the longer term WHO is committed to working with malaria vaccine stakeholders towards the strategic goal set out in the malaria vaccine technology roadmap. The strategic goal, as defined in 2006, is now being re-examined in a consultative process with the likely outcome that the revised goal(s) will include both protection against malaria morbidity and impact against malaria transmission. *P. vivax* will also be included for the first time in the malaria vaccine roadmap.

## 5.4 Conclusions

### **Burden of malaria in pregnancy and IPTp implementation**

Although the burden of malaria during pregnancy is substantial, and the benefit of IPTp in reducing it has been well established, implementation of IPTp has lagged when compared to that of other malaria control interventions. Analysis of data reported by country programmes and data available through household surveys shows relatively high levels of ANC attendance (88%, IQR 68%–95%) but much lower proportions of women attending ANC receiving IPTp (44%, IQR 30%–57%). These findings suggest that there are missed opportunities to deliver preventive therapy and that efforts to overcome barriers to implementation are best focused at the level of antenatal service delivery. Simplified guidelines for administration of IPTp following the revised IPTp policy may help overcome

these barriers. Though the recent evidence review concluded that SP remains effective for IPTp in areas where it is no longer effective as a therapeutic agent, further recommendations are pending on the best approach to malaria in pregnancy in light of increasing SP resistance and changes in malaria burden.

### **Disparities in the delivery of IPTp**

IPTp is recommended for all pregnant women in areas of moderate-to-high malaria transmission. In available household surveys, the proportion of pregnant women receiving the second dose of IPTp was higher in urban than in rural areas, and in the highest wealth quintile compared with the lowest wealth quintile. This may be due to better access to antenatal services in urban areas, although in several more recent surveys, the difference in receipt of IPTp between pregnant women in urban and rural areas was negligible. Further investigation is needed to understand why there are greater differences between urban and rural areas, or between wealth quintiles, in some countries than in others and how the approach for a more equitable scale-up of IPTp can be replicated in other countries.

### **Implementation of IPTi and SMC:**

The studies on which the WHO policy recommendation for IPTi is based showed that in areas of moderate-to-high transmission of malaria, IPTi delivered through EPI services provides protection in the first year of life against clinical malaria and anaemia, as well as reductions in hospital admissions for infants with malaria parasitaemia and admissions for all causes. The slow uptake of IPTi and its implementation highlight the challenges to implementation of new control strategies, even where an established system for delivery of preventive services, such as EPI, exists. Uptake of IPTi may have been slowed in part due to lack of implementation guidance at the time the policy recommendation was made and may accelerate now that guidance is available. This lesson will be useful in devising a strategy for implementing the recently recommended policy on SMC, particularly as no single existing preventive service has been identified in which to implement it. These considerations may also be relevant for implementation of malaria vaccines in the future.

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5. Malaria Vaccine Project Spreadsheets: [www.who.int/vaccine\\_research/links/Rainbow/en/index.html](http://www.who.int/vaccine_research/links/Rainbow/en/index.html)

# Diagnostic testing and treatment of malaria

**This chapter:** (i) quantifies needs for malaria diagnostic testing and treatment, (ii) reviews the extent to which national programmes have adopted policies for universal diagnostic testing of suspected malaria cases and trends in the availability and utilization of parasitological testing, (iii) reviews the adoption of policies and implementation of programmes to expand access to, and utilization of, effective treatment for malaria, (iv) reviews the progress made in withdrawing oral artemisinin-based monotherapies from the market, (v) reviews the current status of drug efficacy monitoring and the latest trends in antimalarial drug resistance; and (vi) reviews efforts to contain artemisinin resistance.

## 6.1 Needs for diagnostic testing and treatment

WHO recommends that all persons of all ages in all epidemiological settings with suspected malaria should receive a parasitological confirmation of diagnosis by either microscopy or rapid diagnostic test (RDT), and that uncomplicated *P. falciparum* malaria should be treated with an ACT (1). WHO guidance for quantifying, at the national programme level, diagnostic needs using malaria surveillance data<sup>1</sup> and treatment needs based on malaria morbidity<sup>2</sup> can be used to assess the scale of global and regional diagnostic and treatment needs that follow from this policy recommendation.

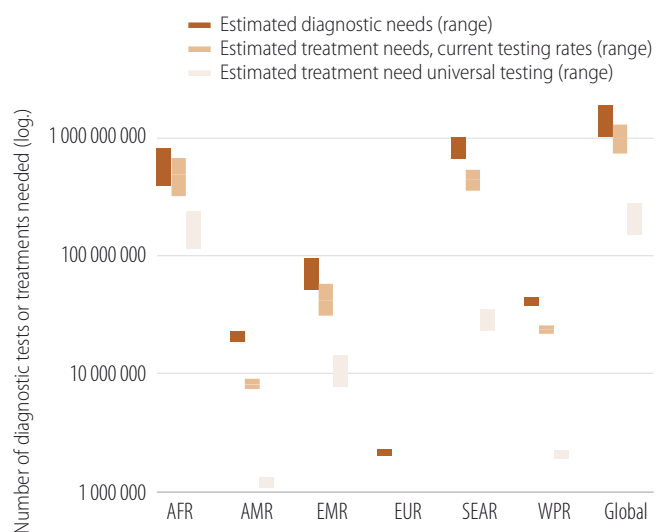
To estimate diagnostic needs by WHO Region, the number of malaria cases obtained from malaria burden estimates<sup>3</sup> and malaria diagnostic test positivity rates derived from national programme data can be used to calculate the total number of suspected malaria cases that would require a malaria diagnostic test. For this analysis, malaria test positivity rates are assumed to be the same among suspected malaria cases in the public and private sectors, and one half this rate among persons who do not seek treatment.

Malaria treatment needs depend in part on the extent to which malaria diagnostic testing is employed. If diagnostic testing were universally applied, the number of malaria cases from malaria burden estimates could be taken as the number of cases requiring treatment. However, at current levels of diagnostic testing, it is necessary to examine the proportion of patients

with suspected malaria who receive a diagnostic test and have confirmed malaria, and the proportion treated for malaria without diagnostic testing (2) Another factor to be taken into account is the proportion of patients with suspected malaria presenting for care at public and at private health facilities, as the proportion receiving a diagnostic test differs by health sector and by Region. In this analysis, in order to estimate total treatment needs, the proportion of persons who report not seeking treatment for fever are apportioned to public and private treatment according to the proportions among those who do seek care. The proportion tested at public facilities can be calculated from national programme data. Data on the extent of diagnostic testing of suspected malaria cases in the private sector are more limited, but can be derived from household surveys. In household surveys conducted by ACTwatch during 2008-2010 in 6 African countries (3), the proportion of suspected malaria cases tested in the private sector was approximately one third of that tested in the public sector.

Taking these factors into account, the estimated number of suspected malaria cases which require diagnostic testing is large and varies by WHO Region, from as many as 1 billion in the South-East Asia Region to just over one million in the European Region (Figure 6.1). Treatment needs based on current levels

**Figure 6.1** Estimated malaria diagnostic and treatment needs, by WHO Region, 2010



\* Estimated treatment needs for current and universal testing rates not shown for European Region, as below 1,000,000

Source: World Malaria Report 2011, NMCP reports

Diagnostic needs=suspected malaria cases, derived from estimated confirmed cases and programme reported test positivity rates; Treatment needs current testing rates = confirmed + presumed cases, derived from rproportion care-seeking by health sector, proportion suspected cases tested, by health sector, reported test positivity rates; Treatment needs, universal testing = estimated confirmed cases, 2010 (World Malaria Report 2011); Treatment needs encompasses treatment for all Plasmodium species

1. Universal access to malaria diagnostic testing, WHO 2011: <http://www.who.int/malaria/publications/atoz/9789241502092/en/index.html>
2. Good procurement practices for artemisinin-based antimalarial medicines, WHO, 2010: <http://apps.who.int/medicinedocs/en/m/abstract/Js17072e/>
3. World Malaria Report, 2011. [http://www.who.int/malaria/world\\_malaria\\_report\\_2011/en/](http://www.who.int/malaria/world_malaria_report_2011/en/)

of diagnostic testing also vary by Region, and are greatest in the African and South-East Asia Regions. If all suspected cases were tested, and only confirmed malaria cases treated with anti-malarial medicines, the need for malaria treatment would be dramatically reduced. This is true for all regions, including Africa, where diagnostic testing of suspected cases is lower than in other Regions, as well as for the South-East Asia Region, where a large proportion of patients seek care in the private sector, with estimated testing rates lower than in the public sector.

The levels of diagnostic or treatment needs presented here are intended to illustrate the differences among malaria-endemic regions and the potential effect of implementing universal diagnostic testing, and should not be interpreted as absolute needs for programme procurement purposes. Confidence limits around these calculated diagnostic and treatment needs are large, based on the limits of the malaria burden estimates from which they are derived, and other data inputs into the calculation carry their own uncertainty. The diagnostic needs for the African Region, for example, may underestimate true diagnostic needs, as the test positivity rates derived from reported national programme data are higher than those derived from published studies (4).

For full implementation of a universal diagnostic testing policy for suspected malaria, delivery of care by trained health-care providers is increasingly important. In data from 104 countries

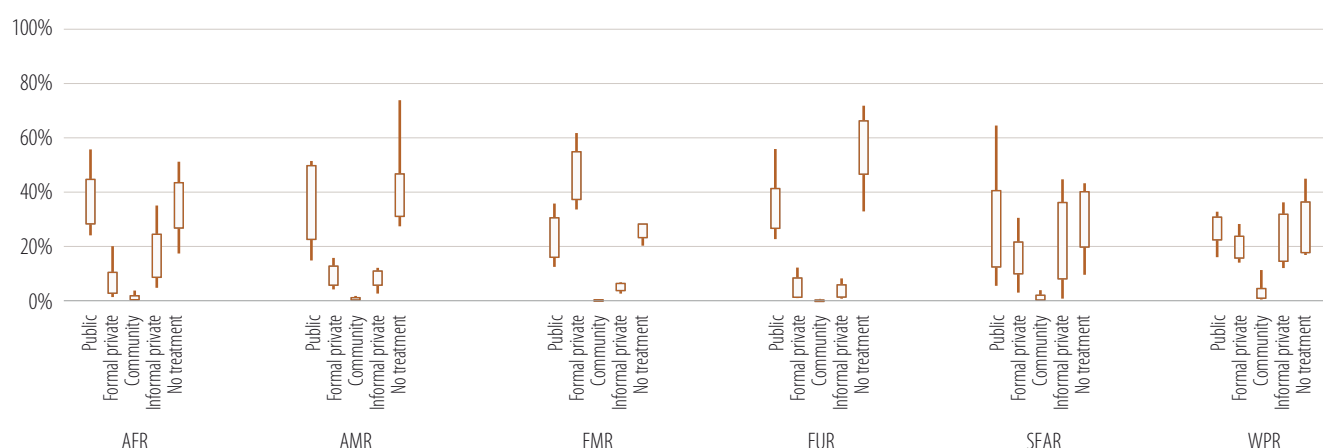
surveys conducted from 1990 to 2011, the majority from countries in the African Region, the proportion of children receiving care at different places varied widely (Figure 6.2). Comparison of the inter-quartile range by health sector suggests that more children received care at public health facilities than at private facilities in the African, American, and European Regions, while a relatively small proportion overall received care from community health workers.

## 6.2 Diagnostic testing for malaria

### 6.2.1 Policy adoption

National adoption and implementation of policies for parasitological confirmation of diagnosis of malaria by WHO Region are shown in Table 6.1 and by country in Annex 3A. In 2011, 41 of 44 with ongoing malaria transmission countries in the African Region reported having adopted a policy of parasitological diagnosis for all age groups, an increase of 4 countries since 2010; in other Regions a policy of universal diagnostic testing was adopted in 46 of 55 countries with ongoing malaria transmission. Malaria diagnosis is provided free of charge in the public sector in 84 countries across all Regions. A total of 26 African countries are now deploying RDTs at the community level, as are 23 countries in other Regions, 6 more countries than in 2010.

**Figure 6.2** Proportion of children presenting for treatment of fever by health sector, by WHO Region



Source: Household surveys, 104 worldwide, 2000–2011 (AFR-59, AMR-18, EMR-3, EUR-6, SEAR-12)

Public health sector includes government and non-profit facilities; Formal private sector includes private clinics and providers; Community sector is community health workers; Informal private sector includes pharmacies, shops and traditional providers.

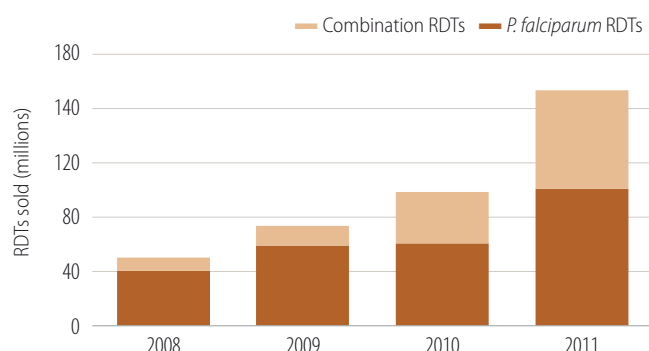
The top and bottom of the lines are the 90th and 10th percentile, the box represents the limits of the 25th to 75th percentile or interquartile range.

**Table 6.1** Adoption of Policies for Malaria Diagnosis by WHO Region, 2011

Policy	AFR	AMR	EMR	EUR	SEAR	WPR	Grand Total
Patients of all ages should undergo diagnostic test	41	20	5	5	8	8	87
Only patients >5 years old undergo diagnostic test	1		1				2
RDTs used at community level	26	8	3		7	5	49
Malaria diagnosis is free of charge in the public sector	33	18	9	5	10	9	84
<b>Number of countries/areas with ongoing malaria transmission</b>	<b>44</b>	<b>21</b>	<b>9</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>99</b>
<b>Number of countries/areas with ongoing <i>P. falciparum</i> transmission</b>	<b>43</b>	<b>18</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>88</b>

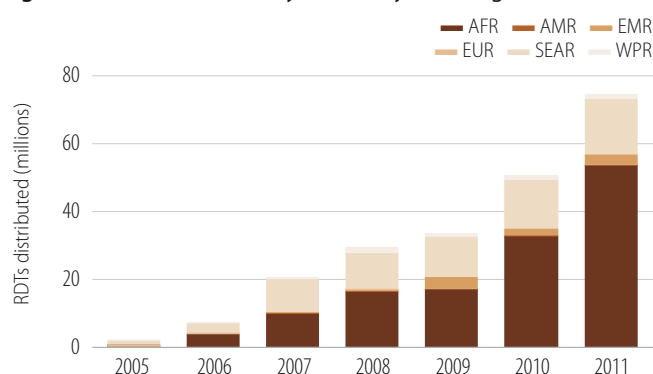


**Figure 6.3** RDT sales to public and private sectors, 2008–2011



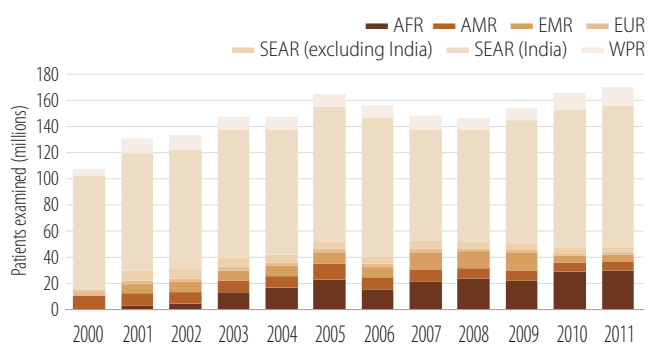
Source: Data provided by 36 manufacturers eligible for the WHO Malaria RDT Product Testing Programme.

**Figure 6.4** RDTs distributed by NMCPs, by WHO Region, 2005–2011



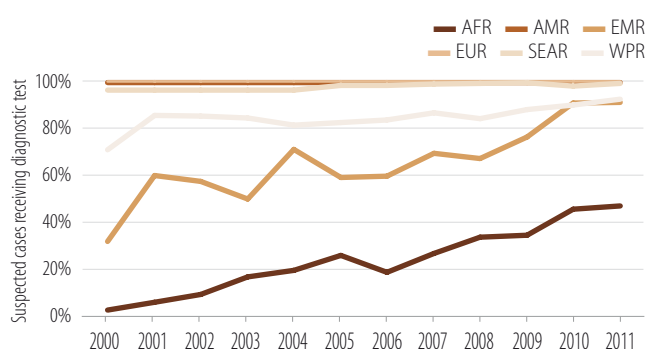
Source: NMCP reports. RDTs distributed in Europe and Americas are a very small fraction of the number distributed in other WHO Regions.

**Figure 6.5** Number of patients examined by microscopy, by WHO Region, 2000–2011



Source: NMCP reports

**Figure 6.6** Proportion of suspected malaria cases attending public health facilities that receive a diagnostic test, 2000–2011



Source: NMCP reports

## 6.2.2 RDTs procured and distributed and microscopic examinations undertaken

### RDTs procured

Since 2011, many manufacturers participating in the WHO Malaria RDT Product Testing Programme have supplied data on RDT sales to public and private sectors in malaria-endemic Regions (Figure 6.3). The volume of sales has increased dramatically over the last 4 years, for both *P. falciparum*-only tests and combination tests that can detect more than one species, reaching a total of 155 million in 2011. Results of product quality testing undertaken by WHO, FIND, TDR, and CDC show an improvement in test quality and proportionally more high quality RDTs being procured over time (5).

### RDTs distributed

The reported number of RDTs delivered by NMCPs provides information on where RDTs procured from manufacturers are deployed in the public sector; the number has increased rapidly from less than 200 000 in 2005 to more than 74 million in 2011 (Figure 6.4). Most of the RDTs delivered (72%) were used in the African Region, followed by the South-East Asia Region (22%) and Eastern Mediterranean Region (4%). Although these totals are for the public sector only and underestimate the total quantity of RDTs distributed (only 32 of the 44 endemic countries in Africa reported these data in 2011), the same upward trend is seen as for RDT sales, with most growth occurring in the African Region.

### Microscopic examinations undertaken

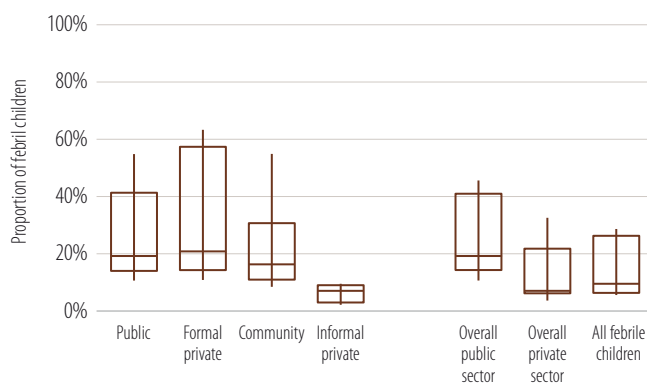
The number of patients tested by microscopic examination increased to a peak of 171 million in 2011 (Figure 6.5). The global total is dominated by India, which accounted for over 108 million slide examinations in 2011, an increase of 2 million slides since 2010. Increases in the number of patients examined by microscopy were also reported in the African, Eastern Mediterranean, and Western Pacific Regions. The number of patients examined by microscopy remains relatively low in the African Region, although it has increased over the last 4 years.

## 6.2.3 Parasitological testing in the public sector, private sector and in the community

### Parasitological testing in the public sector

The proportion of reported suspected cases receiving a parasitological test is highest in the American and European Regions followed by South-East Asia and Western Pacific, Eastern Mediterranean and African Regions (Figure 6.6), Box 6.1. The value for the South-East Asia Region is heavily influenced by India, where the proportion of suspected cases receiving a diagnostic test is very high; without India, the proportion drops from 99% to 55%. The testing rate in the Eastern Mediterranean Region rose to 80% in 2010, while in the African Region it rose from 20% in 2005 to 47% in 2011. The pace of increase in these two regions appears to have slowed over the past year. Globally the proportion of suspected cases receiving a diagnostic test increased from 68% in 2005 to 77% in 2011. Much of the increase in testing in the African Region is from an increase in use of RDTs, which accounted for 40% of all tested cases in 2011. The reported testing rate may overestimate the true extent of diagnostic testing in the public sector, since countries with higher testing rates have a greater propensity to report, and therefore countries with lower testing rates are underrepresented in the overall rate.

**Figure 6.7** Proportion of febrile children who had a blood test, by place of care in 9 African countries, 2010–2011



**Source:** Household surveys, 2010–2011, from 9 African countries (Burkina Faso, Burundi, Liberia, Madagascar, Nigeria, Rwanda, Senegal, Uganda, Zimbabwe). Public health sector includes government and non-profit facilities; Formal private sector includes private clinics and providers; Community sector is community health workers; Informal private sector includes pharmacies, shops and traditional providers. The top and bottom of the lines are the 90th and 10th percentile, the box represents the limits of the 25th to 75th percentile or interquartile range, and the horizontal line through the box the median value.

### Parasitological testing in the private sector

Data reported by ministries of health on the number of RDTs distributed and patients examined by microscopy or RDTs generally cover the public sector only. However, approximately 40% of patients with suspected malaria worldwide seek treatment in the private sector, which includes regulated health facilities, pharmacies and other retail outlets (2). Information on the extent of parasitological testing in the private sector is limited but some may be derived from household surveys. The private sector includes a range of facilities, both formal, such as private health-care providers, and informal providers, such as shops. In 9 household surveys conducted in Africa during 2010 and 2011, information on testing was available to compare testing in different health sectors. Comparison of the range of testing rates in different sectors suggests that the proportion of children <5 years of age who received a diagnostic test for suspected malaria was similar in public facilities and in the formal private sector, and lower in the community and the informal private sector (Figure 6.7). Because more children present for care at public facilities, where testing is relatively more likely, and in the informal private sector, where testing is rates are lower, overall

### Box 6.1 Implementing T3: Test Treat Track

Three programmes were designated as the “Malaria Champions” during the commemoration of *Malaria in the Americas Day 2012*, hosted by the Pan American Health Organization. All three have made substantial progress in implementing T3: *Test Treat Track*.

The State of Acre in Brazil is home to the malaria-endemic municipalities of Cruzeiro do Sul, Rodrigues Alves, and Mâncio Lima which contribute almost 95% of malaria cases in the state.

The State Health Department of Acre has developed and expanded programmes for the early diagnosis and treatment of malaria including the use of rapid diagnostic tests in areas that are difficult to access. It evaluates the services provided through systematic supervision of diagnostic stations and expansion of units for quality control of diagnosis. Surveillance data has been used to stratify endemic areas and produce a monthly epidemiological bulletin. The programme is recognized for: its strong commitment and leadership; being responsive to populations in areas affected by malaria; the innovative use of school programmes; the involvement of the community; strong health promotion efforts; the judicious use of surveillance information in programme implementation; and sustained and strong impact in reducing malaria statewide. Among the major advances achieved is early diagnosis and timely treatment, with 80% of cases treated within 48 hours after the onset of symptoms and 99% of cases treated within 24 hours after diagnosis. In 2011 Acre recorded 22 958 cases compared to 93 864 cases in 2006, a reduction of 76 %.

The Malaria Control Programme of Ecuador has strengthened various aspects of the national programme’s capacity to diagnose, treat, and track malaria cases. The programme has expanded coverage of diagnostic testing through rapid tests and thick smears and implemented current therapeutic regimens. It also promotes improvement in quality management of the network for microscopic diagnosis through supervision and periodic external evaluation of microscopists at the provin-

cial and national levels. Action is guided by a national epidemiological surveillance system for malaria (SIVEMAE) which includes data collection, analysis, and interpretation at local level, and the issuing of periodic reports of the epidemiological situation. It has engaged civil society, demonstrated leadership, taken steps towards elimination of local transmission in areas where it is deemed feasible, and implemented innovative efforts such as 100% screening of pregnant women in areas at risk and combinations of vector management methods. In 2011, 32% of positive cases were followed up and, of these, 94% were found to be treated according to national standards. Malaria incidence has declined steadily in the country since 2001 and during the past two years, it was further reduced by 70%.

The National Malaria Eradication service (SENEPA) of the Ministry of Public Health and Welfare in Paraguay is responsible for malaria control efforts at national, regional and local levels. The service is geographically decentralized into 18 zones and 40 sectors. There is a laboratory for the diagnosis of malaria in most areas, totaling 20 at the central level; 7 areas have entomology laboratories. The main strategy for malaria control focuses on intensive surveillance through a national network of 4868 community-based volunteers, coordinating with the evaluation assistants from local reporting units. The network enables timely actions to deal with cases as they occur. Prompt and free access to good quality malaria diagnosis and treatment is accomplished through the Primary Health Care (APS) service and the Family Health Unit (USF) which were formed in 2008. All cases are microscopically confirmed, radically treated, recorded and reported nationally through a database and a geographic information system. Cases of malaria have declined from 2778 in 2002 to 91 cases in 2009, with only 27 in 2010 (18 indigenous and 9 imported cases), and just 10 in the year 2011 (1 indigenous case). This represents a reduction of 99% compared to 2002. There has been no mortality due to malaria in Paraguay since 1989.

a higher proportion of children are tested in the public sector than in the private sector. The low proportion of all children tested includes those who do not present for care.

### Malaria diagnostics in the community

A total of 46 countries reported deployment of RDTs at the community level and 12 million patients were tested in 2011, including 10 million tested with RDTs in India. However, patients tested with RDTs in the community represent a relatively small proportion (6%) of the reported total number of patients who received a parasitological test. Information on the utilization of malaria diagnostic testing in relation to a range of background variables is shown in **Box 6.2**.

## 6.3 Treatment of malaria

### 6.3.1 Policy adoption

By the end of 2011, ACTs had been adopted as national policy for first-line treatment in 79 of 88 countries where *P. falciparum* is endemic; chloroquine is still used in some countries in the Region of the Americas where it remains efficacious. By mid-2011, 70 countries were deploying ACTs in their general health services, with varying levels of coverage.<sup>4</sup> The adoption

4. Information on adoption of the WHO policy on ACTs and their deployment (i) country adoption of ACTs: the WHO/GMP Antimalarial Drug Policies Database ([http://www.who.int/malaria/am\\_drug\\_policies\\_by\\_region\\_afro/en/index.html](http://www.who.int/malaria/am_drug_policies_by_region_afro/en/index.html)); and (ii) country deployment of ACTs to general health services: compiled by the GMP Supply Chain Management Unit on the basis of reports from WHO regional and country offices.

of policies for the treatment of malaria is summarized by WHO Region in **Table 6.2** and by country in **Annex 3B**.

### 6.3.2 Quantity of ACTs procured and distributed

#### ACTs procured

From reports of manufacturers and the Affordable Medicines Facility-malaria (AMFm) initiative collected by WHO, the number of ACT treatment courses delivered by manufacturers to the public and private sectors increased greatly from 11 million in 2005 to 76 million in 2006, and reached 278 million in 2011<sup>5</sup> (**Figure 6.8**). Artemether-lumefantrine (AL) accounted for the largest volume of ACTs delivered (77%) in 2011. The second ACT in terms of volumes delivered was artesunate + amodiaquine, which increased from fewer than 1 million treatment courses in 2007 to 63 million in 2011. The proportion of fixed-dose combination ACTs (with the 2 active pharmaceutical ingredients combined in the same tablet), which are preferred because of improved patient adherence to the recommended regimen, has been increasing and in 2011 accounted for 96% of all ACT deliveries.

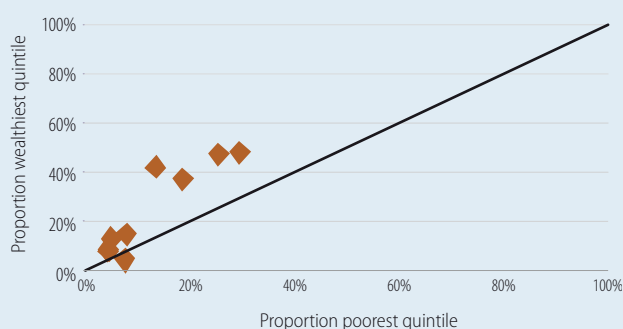
In 2011, the largest proportion of AL (37%) was procured for patients with a body weight >35 kg and the second largest

5. Data provided by 8 manufacturers eligible for procurement from WHO/UNICEF and AMFm reports. ACT public sector deliveries monitored 2005–2011; public and private sector deliveries through AMFm monitored 2010–2011, in 2010 by AMFm reports and in 2011 by reports of manufacturers. ACT deliveries through non-AMFm commercial channels are not monitored, but are estimated to be a small fraction (approx. 5–10%) compared to public sector sales.

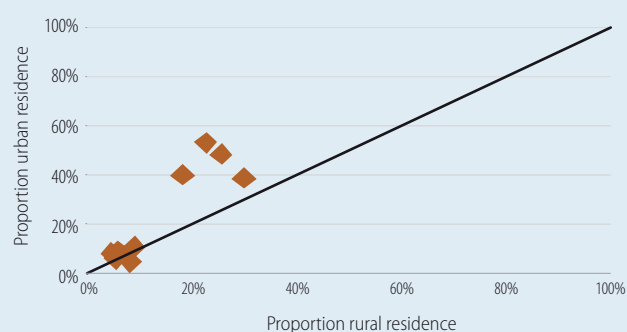
### Box 6.2 Disparities in diagnostic testing for malaria

From 9 African countries (Burkina Faso, Burundi, Liberia, Madagascar, Nigeria, Rwanda, Senegal, Uganda, Zimbabwe) household surveys conducted in Africa during 2010–2011, the extent to which diagnostic testing for malaria is affected by residence, wealth, or gender can also be assessed. In countries where the overall proportion of suspected cases tested for malaria is greater than 10%, febrile children who received care in urban areas were more likely to have a diagnostic test than children in rural areas (**Figure Box 6.1a**), and febrile children from wealthier households who received care were more likely to be tested (**Figure Box 6.1b**). Male and female children were equally likely to be given a diagnostic test for malaria (**Figure Box 6.1c**).

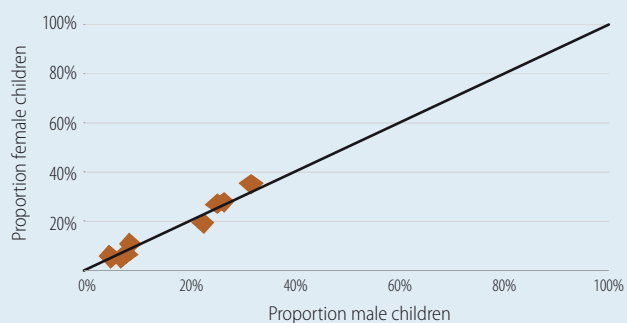
**Figure Box 6.1b** Proportion of febrile children who had a blood test, by poorest and wealthiest quintiles, 2010–2011



**Figure Box 6.1a** Proportion of febrile children who had a blood test, by rural and urban residence, 2010–2011



**Figure Box 6.1c** Proportion of febrile children who had a blood test, by sex, 2010–2011



**Table 6.2** Adoption of Policies for Malaria Treatment, by WHO Region, 2011

Policy	AFR	AMR	EMR	EUR	SEAR	WPR	Grand Total
ACT is used for treatment of <i>P. falciparum</i>	43	8	9		9	9	79
ACT is free of charge for all age groups in public sector	33	13	7		8	8	69
ACT is free of charge only for under 5 years old in the public sector	9						9
ACT is delivered at community level	26	7	4		3	4	44
Pre-referral treatment with quinine/artemether IM/artesunate suppositories	31	5	6		6	6	58
<b>Number of countries/areas with ongoing malaria transmission</b>	<b>44</b>	<b>21</b>	<b>9</b>	<b>5</b>	<b>10</b>	<b>10</b>	<b>99</b>
<b>Number of countries/areas with ongoing <i>P. falciparum</i> transmission</b>	<b>43</b>	<b>18</b>	<b>9</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>88</b>

(28%) for young children weighing <15 kg, followed by doses for children weighing 25–34 kg and the smallest proportion was supplied for patients with a body weight of 15–24 kg. Compared with previous years, an increased amount of AL was procured for young children weighing <15 kg than for older children and adults weighing >35 kg<sup>6</sup> (Figure 6.9).

The increase in ACTs delivered in 2011 was due in large part to medicines procured through the AMFm initiative (Figure 6.10). Although AMFm accounted for a substantial portion (27%) of public sector deliveries in 2011, the total amount of ACTs procured for the public sector decreased in 2011 compared to 2010. Tracking of global ACT availability and national programme ACT needs by the Interagency ACT Supply Task Force is increasingly important to ensure an adequate supply of medicines as programmes scale up ACTs (Box 6.3).

### ACTs distributed by national programmes

The number of ACTs distributed by NMCPs provides information on where ACTs procured from manufacturers are deployed in the public sector. The number distributed appears to have increased between 2007 and 2011, however reporting by countries is incomplete, and the totals do not match those delivered by manufacturers (Figure 6.11). The majority of ACTs distributed by NMCPs are in Africa, which accounted for 135 of 139 million treatments reportedly distributed by NMCPs worldwide in 2011.

### 6.3.3 Utilization of appropriate antimalarial medicines to treat febrile children in the public sector, private sector, and in the community

It has been difficult to track the extent to which patients with confirmed malaria (by RDT or microscopy) received antimalarial medicines because information on diagnostic testing has

### Box 6.3 Interagency ACT Supply Task Force

The InterAgency Supply Task Force (Task Force) was established in September 2011 to monitor the supply and demand constraints for ACTs, mainly reflected in increasing manufacturer lead time and rising cost of artemisinin. The Task Force, which is coordinated by WHO (GMP) and includes resource persons from the ALMA, CHAI, Global Fund, PMI, UNDP and UNICEF, was requested to monitor ACT stock levels to identify countries at risk of stock-out and recommend corresponding corrective actions.

Its activities have focused on:

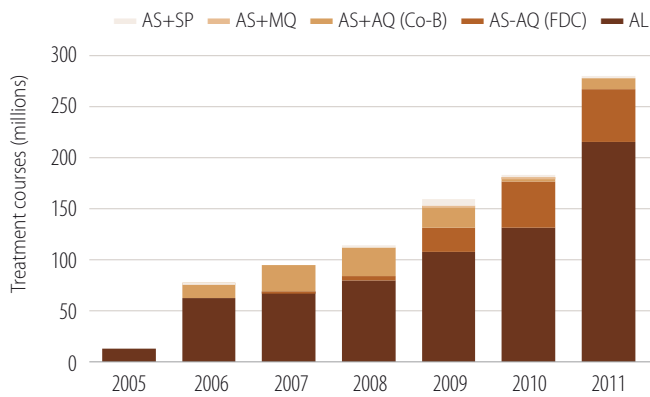
- Quarterly data collection on in-country stock levels, past consumption, projected requirements and orders pipelines;
- Development of a database to compile and analyse data provided by countries and manufacturers, based on simple metrics to identify risks of stock-out within defined time periods;
- Preparation of stock-out risk assessment reports for validation by the country;
- Interventions for risk mitigation in case of country-confirmed supply problems.

Task Force interventions included discussions to release delayed donor funding, mobilizing new funding, expediting deliveries with manufacturers, splitting deliveries to address temporary shortfalls,

liaising with regulators and facilitating the intra-country and intra-region movement of surplus stocks. The Task Force observed that lack of funding, delays in disbursement and suboptimal in-country planning and supply management substantially impact ACT procurement and distribution. In addition, many countries have weak management information systems with limited information as to consumption of medicines and diagnostic tests and difficulties with quantification and forecasting.

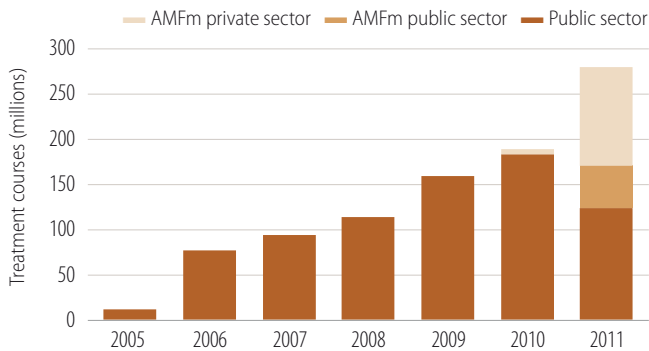
Despite multiple interventions by the Task Force, countries continue to experience stock-outs due to systematic shortcomings. The Task Force therefore in November 2012 proposed a number of changes for the future: (i) integration of the data collection function into the newly created WHO/RBM Situation Room, effective from January 2013, with referrals to the Task Force for required interventions; (ii) development of a user-friendly online web-based monitoring tool for stock levels which all countries can use at their discretion, to improve stock monitoring; and (iii) improvement of communication with countries highlighting applied interventions and the range of assistance the Task Force offers. Simultaneously, the Task Force aims to strengthen collaboration with other groups, particularly the RBM Procurement and Supply Management (PSM) Working Group, to address the root causes of stock-outs.

**Figure 6.8** ACT deliveries to the public and private sector, 2005–2011



AL= Artemether-lumefantrine, AQ=Amodiaquine, AS=Artesunate, MQ = Mefloquine, SP = Sulfadoxine-pyrimethamine, Co-B =co-blistered pack, FDC=fixed dose combination  
**Source:** Data provided by 8 manufacturers eligible for procurement from WHO/UNICEF and AMFm reports. ACT public sector deliveries monitored 2005–2011; public and private sector deliveries through AMFm monitored 2010–2011, in 2010 by AMFm reports and in 2011 by reports of manufacturers. ACT deliveries through non-AMFm commercial channels are not monitored, but are estimated to be a small fraction (approx. 5–10%) compared to public sector sales.

**Figure 6.10** ACT deliveries, by health sector and initiative status, 2005–2011



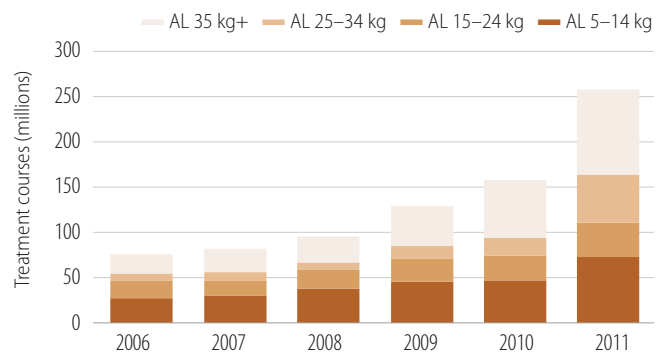
**Source:** Data provided by 8 manufacturers eligible for procurement from WHO/UNICEF and AMFm reports (as of 30 August 2012). ACT public sector deliveries monitored 2005–2011; public and private sector deliveries through AMFm monitored 2010–2011, in 2010 by AMFm reports and in 2011 by reports of manufacturers. ACT deliveries through non-AMFm commercial channels are not monitored, but are estimated to be a small fraction (approx. 5–10%) compared to public sector sales.

not generally been included in household surveys. In the few recent surveys which included questions on diagnostic testing, the validity of survey responses regarding test results and treatments given is uncertain. Similarly, while routine information systems usually include data on diagnostic confirmation, they rarely track treatments given to patients diagnosed with malaria. The development of routine systems that track febrile patients, testing, results, and treatments given, would enable better tracking of antimalarial utilization. However, such systems seldom exist, especially in Africa, and comprehensive information on the relationship between diagnostic test results and treatments given is therefore lacking.

#### Utilization of appropriate antimalarial medicines, national programme reports

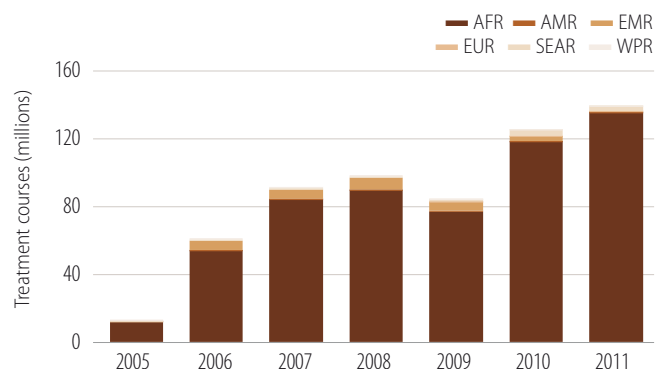
On the basis of the available data from national programmes on the number of ACT treatments distributed and the estimated number of *P. falciparum* cases at public facilities, it is possible to calculate the proportion of malaria cases from public facilities which would potentially be treated with ACTs. In 2011, the proportion of presumed and confirmed *P. falciparum* cases

**Figure 6.9** Artemether-lumefantrine deliveries to the public and private sector, by weight-based treatment course, 2006–2011



**Source:** Data provided by 4 companies prequalified by WHO and AMFm reports. ACT private deliveries monitored 2005–2011; public and private sector deliveries through AMFm monitored 2010–2011, in 2010 by AMFm reports and in 2011 by reports of manufacturers. ACT deliveries through non-AMFm commercial channels are not monitored, but are estimated to be a small fraction (approx. 5–10%) compared to public sector sales.

**Figure 6.11** Number of ACT treatment courses distributed by NMCPs, by WHO Region, 2005–2011



**Source:** NMCP report

potentially treated by distributed ACTs varied by Region. In the Region of the Americas, the Eastern Mediterranean Region, European Region, and the Western Pacific Region, essentially all *P. falciparum* cases in public facilities could potentially be treated with distributed ACTs, whereas in the South-East Asia Region approximately 73%, and in the African Region, 55% could potentially be treated. In the African Region, 9 countries distribute enough ACTs to potentially treat 100% of *P. falciparum* cases seen in public facilities. Because the African Region accounts for nearly 90% of all *P. falciparum* cases globally, approximately half of all *P. falciparum* cases could potentially be treated with distributed ACTs. (Figure 6.12).

#### Utilization of appropriate antimalarial medicines, household surveys

From household survey data it is possible to examine the proportion of febrile children receiving antimalarial treatments who were given an ACT in different health sectors. In surveys conducted in 12 African countries during 2010–2011 which included information on the type of malaria treatment, the proportion of children receiving ACTs among those who



received any antimalarial varied widely (Figure 6.13). Comparing the interquartile range of proportions among different places of care, a greater proportion of children presenting at public facilities and in the formal private sector received ACTs than in the informal private sector. Because a higher proportion of children present at public facilities, where they are more likely to receive an ACT as the antimalarial, and in the informal private sector, where they are less likely to receive ACTs, the overall proportion of children in the public sector who receive ACT as the antimalarial is higher than in the private sector.

It is not possible to determine from these data what proportion of the children had confirmed malaria; however, the results suggest that ensuring access to ACTs remains a challenge in both public and private settings. Children treated in the community still represent a small fraction of all treated patients, although these numbers may be underestimated in many reporting systems. Expanding malaria diagnostic testing and treatment to the community level would further improve access to appropriate antimalarial therapy. Information on the utilization of malaria diagnostic testing according to a range of background variables is shown in Box 6.4.

### 6.3.4 Scaling up diagnostics and reducing treatment needs

Despite recent expansion of malaria diagnostic testing, as evidenced by increase in sales of RDTs and of RDTs distributed by country programmes, and in the proportion of suspected

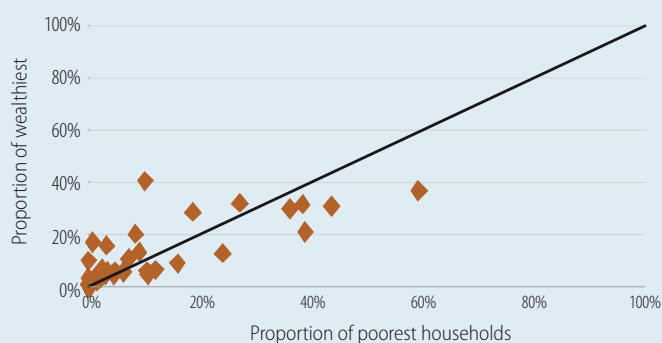
malaria cases tested at public facilities, many patients with suspected malaria still do not receive a parasitological test. In the African Region during 2006–2011, the total number of tests (microscopy + RDTs) conducted in the public sector was less than half the number of ACTs distributed by NMCPs during the year (Figure 6.14), indicating that many patients receive ACTs without confirmatory diagnosis. Considering that test positivity rates in most areas in Africa are less than 50%, the ratio of diagnostic tests to ACTs should be  $\geq 2$ . The data indicate that the scale-up of RDTs remains far from complete. Shortfalls in the availability of diagnostic testing can be attributed at least in part to the relatively recent policy change and the expected lag time in securing funds, subsequent procurement of RDTs, and training of health workers

The increasing use of RDTs has accounted for most of the increase in malaria diagnostic tests carried out in recent years and provides the most feasible means of rapidly expanding diagnostic testing, especially in peripheral health facilities and at the community level in remote rural areas. The introduction of RDTs can significantly reduce the need for ACTs and consequently, expenditures on antimalarial drugs (6). While overall cost-savings will depend on the intensity of malaria transmission and other factors, RDTs are cost-effective compared to presumptive treatment, in part due to improved patient outcomes for non-malarial febrile illness (7). Promotion of testing starts at the level of programme planning, budgeting and procurement. Country programmes and their supporting donors should aim to procure

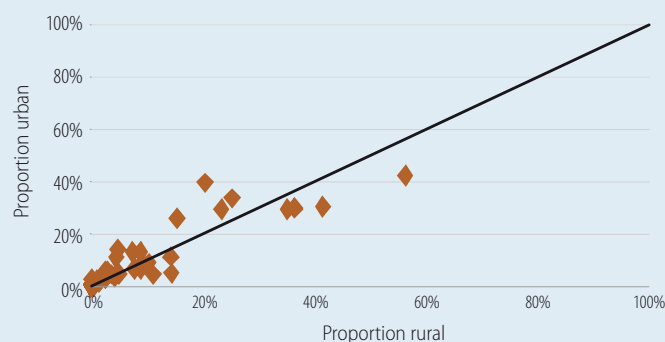
## Box 6.4 Disparities in ACT utilization

Household surveys from 12 countries in Africa (Angola, Burkina Faso, Burundi, Liberia, Madagascar, Malawi, Nigeria, Rwanda, Senegal, Uganda, United Republic of Tanzania, Zimbabwe) conducted during 2010–2011 enable assessment of the extent to which utilization of ACT is affected by residence, wealth, or gender. The proportion of febrile children in urban areas given any antimalarial medicine who received an ACT compared to those in rural areas varies across surveyed countries (Figure Box 6.3a). Similarly, the proportion of febrile children residing in wealthier households given any antimalarial who received an ACT compared to those residing in poorer households also varies (Figure Box 6.3b). Male and female febrile children were equally likely to receive an ACT (Figure Box 6.3c).

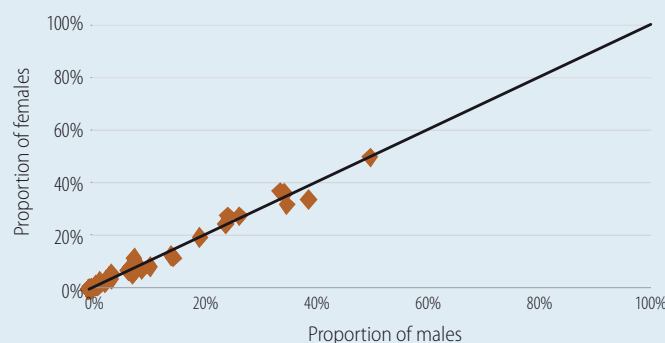
**Figure Box 6.3b** Proportion of ACTs among antimalarial treatments given to febrile children, by household wealth quintile, 2006–2011



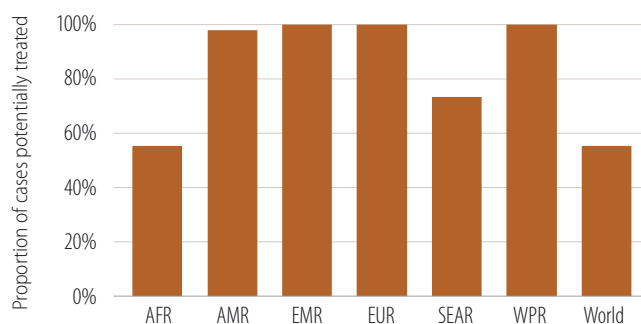
**Figure Box 6.3a** Proportion of ACTs among antimalarial treatments given to febrile children, by urban or rural residence, 2006–2011



**Figure Box 6.3c** Proportion of ACTs among antimalarial treatments given to febrile children, by sex, 2006–2011

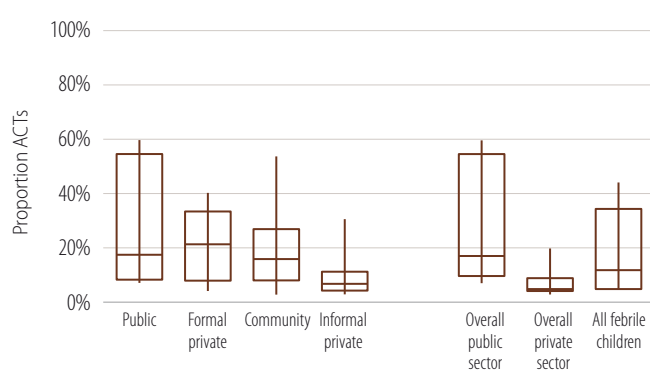


**Figure 6.12** Proportion of confirmed *P. falciparum* cases potentially treated with distributed ACTs, by WHO Region, 2011



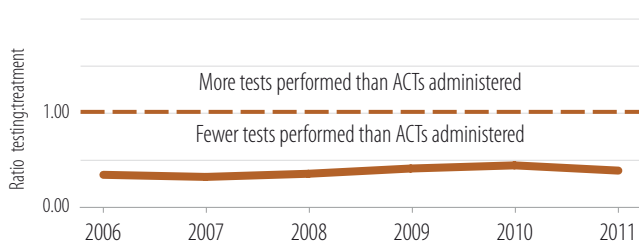
Source: NMCP reports

**Figure 6.13** Proportion of ACTs among antimalarial treatments given to febrile children, by health sector, selected countries with household surveys, 2010-2011

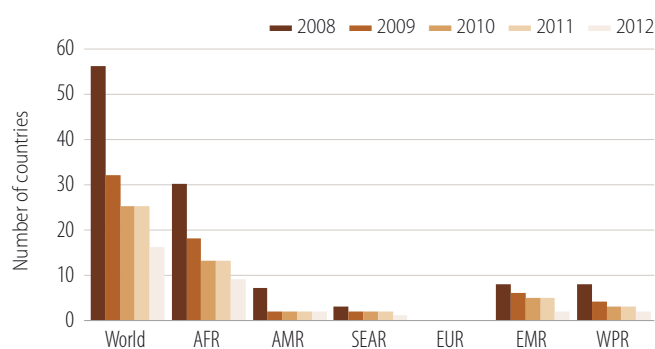


Source: Household surveys, 2010-2011, 12 African countries (Angola, Burkina Faso, Burundi, Liberia, Madagascar, Malawi, Nigeria, Rwanda, Senegal, Uganda, United Republic of Tanzania, Zimbabwe) Public health sector includes government and non-profit facilities; Formal private sector includes private clinics and providers; Community sector is community health workers; Informal private sector includes pharmacies, shops and traditional providers. The top and bottom of the lines are the 90th and 10th percentile, the box represents the limits of the 25th to 75th percentile or interquartile range, and the horizontal line through the box the median value.

**Figure 6.14** Ratio of RDT and microscopy performed to ACTs distributed, African Region, 2006-2011



**Figure 6.15** Number of countries allowing marketing of oral artemisinin-based monotherapies, by WHO Region, 2008-2012



Source: [http://www.who.int/malaria/monotherapy\\_NDRAs.pdf](http://www.who.int/malaria/monotherapy_NDRAs.pdf)

an appropriate number of RDTs and ACTs based on local data according to procurement guidance described in WHO documents. If the projected number of ACTs required exceeds the estimated number of RDTs required, the calculations should be carefully reviewed, as the ratio of all diagnostic tests to ACTs should exceed 2 in most malaria-endemic settings.

## 6.4 Antimalarial drug resistance

### 6.4.1 Policy adoption: withdrawal of oral artemisinin-based monotherapy medicines

The use of oral artemisinin-based monotherapies threatens the long-term usefulness of ACTs by fostering the emergence and/or spread of resistance to artemisinin. To contain this risk and to ensure high cure rates for *P. falciparum* malaria, WHO recommends the withdrawal of oral artemisinin-based monotherapies from the market and their replacement by ACTs, as endorsed by the World Health Assembly in 2007.<sup>7</sup> WHO also calls upon manufacturers to cease the marketing of oral artemisinin-based monotherapies.

To track adherence to this recommendation, WHO compiles data on the marketing of oral artemisinin-based monotherapies by manufacturers and on the regulatory action taken by malaria-endemic countries; these data are posted on the Global Malaria Program Website.<sup>8</sup> At the time the WHA resolution was adopted in 2007, 55 countries worldwide, including 30 in Africa, allowed the marketing of oral artemisinin-based monotherapies. By December 2012, 16 countries were still allowing the marketing of these products, including 9 in the African Region, and as of November 2012, 28 pharmaceutical companies were manufacturing these products, down from 38 one year previously. Most of the countries still allowing the marketing of monotherapies are in the African Region (Figure 6.15), while most of the manufacturers are located in India. Although weak regulation of pharmaceutical markets in many malaria-endemic countries presents a challenge, steady progress has been made in phasing out oral artemisinin-based monotherapy. Greater collaboration and involvement of national regulatory authorities is required to ensure complete withdrawal of oral artemisinin-based monotherapies from all countries.

### 6.4.2 Drug efficacy monitoring

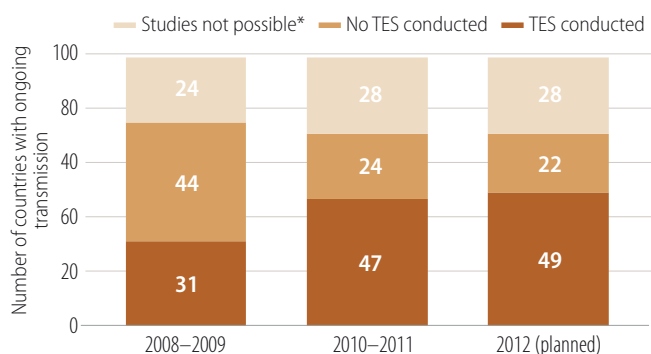
#### Status of drug efficacy monitoring

Therapeutic efficacy studies remain the gold standard for guiding drug policy; the standard WHO protocol was updated in 2009 (8). WHO compiles the results of efficacy tests conducted by national programmes and research institutes in the WHO Global Database on Antimalarial Drug Efficacy. The database currently contains over 4000 studies carried out

7. The full text of the WHA resolution (WHA 60.18) can be found at [http://apps.who.int/gb/ebwha/pdf\\_files/WHA60/A60\\_R18-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA60/A60_R18-en.pdf).

8. Information is available on the internet via the following links:  
Manufacturing companies: [http://www.who.int/malaria/monotherapy\\_manufacturers.pdf](http://www.who.int/malaria/monotherapy_manufacturers.pdf)  
National Regulatory Authorities: [http://www.who.int/malaria/monotherapy\\_NDRAs.pdf](http://www.who.int/malaria/monotherapy_NDRAs.pdf)

**Figure 6.16** Status of therapeutic efficacy monitoring in countries with ongoing malaria transmission, 2008-2012



\*Therapeutic Efficacy Studies (TES) are impractical in countries with low malaria transmission or transmission of *P. vivax* only.

Source: WHO Global Malaria Program database on antimalarial therapeutic efficacy monitoring by country, November, 2012

between 1996 and 2011 and it formed the basis of the *Global report on antimalarial drug efficacy and drug resistance: 2000–2010* (9). Experience with previous antimalarial treatments shows that significant levels of resistance can develop within a short time, and therefore WHO recommends that the efficacy of first- and second-line antimalarial treatments should be monitored at least once every 2 years.

In 2010–2011, studies of first- or second-line antimalarial treatments were completed in 47 of 71 countries where *P. falciparum* efficacy studies were possible,<sup>9</sup> an increase from 31 countries which conducted studies during 2008–2009 (Figure 6.16). However 24 countries did not conduct studies during 2010–2011 and were therefore not in compliance with the WHO recommendation on antimalarial drug efficacy monitoring. Studies are planned in 49 countries during 2012, including 29 countries in Africa.

#### Status of artemisinin resistance in *P. falciparum*<sup>10</sup>

Routine monitoring of the therapeutic efficacy of ACTs is essential for timely changes to treatment policy and can help to detect early changes in *P. falciparum* sensitivity to artemisinins. WHO currently recommends changing antimalarial treatment policy when the treatment failure rate in a 28 or 42 day follow-up study (depending on the medicine) exceeds 10%. The proportion of patients who are parasitaemic on day 3 of treatment is currently the best widely available indicator used in routine monitoring to measure *P. falciparum* sensitivity to artemisinins. The working definition of suspected resistance to artemisinins is defined as an increase in parasite clearance time, as evidenced by 10% or more cases with parasites detectable on day 3 of treatment with an ACT; confirmed resistance is defined as treatment failure after treatment with an oral artemisinin-based monotherapy with adequate antimalarial blood concentration, as evidenced by the persistence of parasites for 7 days, or the presence of parasites

9. In certain countries (28 with ongoing malaria transmission in 2012), efficacy studies are impractical because of low malaria incidence, or because they are endemic for *P. vivax* only

10. Status of artemisinin resistance as of April, 2012: [http://www.who.int/malaria/diagnosis\\_treatment/resistance/updateartemisininresistanceapr2012/en/index.html](http://www.who.int/malaria/diagnosis_treatment/resistance/updateartemisininresistanceapr2012/en/index.html)

on day 3 and recrudescence within 28 or 42 days (depending on the drug).

In recent years, *P. falciparum* resistance to artemisinins has been detected in 4 countries in the Greater Mekong subregion: Cambodia, Myanmar, Thailand, and Viet Nam (Figure 6.17). Despite these changes in parasite sensitivity to artemisinins, ACTs have generally remained clinically and parasitologically efficacious so long as the partner drug remains efficacious. In Pailin province, Cambodia, resistance to artemisinin and to several partner drugs in commonly used ACTs has been confirmed. Resistance to piperazine is under investigation after a study in 2010 found 27% treatment failure with dihydroartemisinin-piperazine. Due to the high failure rate of ACTs in Pailin, a consensus meeting – held in November 2011 in Cambodia – recommended the use of atovaquone-proguanil delivered as directly observed therapy for Pailin province; stringent follow-up of all treated patients was also recommended to detect any emergence of atovaquone resistance. To date, there have been no reports of delayed parasite clearance during routine therapeutic efficacy studies conducted in Africa.

#### Chloroquine resistance in *P. vivax* malaria

Chloroquine remains the drug of choice in areas where this drug remains effective. Treatment failure on or before day 28 and/or prophylactic failures have been observed in 23 countries: Afghanistan, Bolivia (Plurinational State of), Brazil, Cambodia, China, Colombia, Ethiopia, Guyana, India, Indonesia, Madagascar, Malaysia, Myanmar, Pakistan, Papua New Guinea, Peru, the Republic of Korea, Solomon Islands, Sri Lanka, Thailand, Turkey, Vanuatu and Viet Nam. However, confirmation of true chloroquine resistance requires additional drug concentration studies and for this reason it is not entirely clear to what extent chloroquine-resistant *P. vivax* has spread. Among the countries with *P. vivax* treatment or prophylactic failure listed above, at least 1 case of chloroquine-resistant vivax malaria has been confirmed in each of 10 countries: Bolivia (the Plurinational State of), Brazil, Ethiopia, Indonesia, Malaysia, Myanmar, Solomon Islands, Thailand, Papua New Guinea, and Peru. ACTs are now recommended for the treatment of chloroquine-resistant *P. vivax*, particularly where ACTs have been adopted as the first-line treatment for *P. falciparum*.

#### 6.4.3 Containment of artemisinin resistance

In accordance with the *Global Plan for Artemisinin Resistance Containment* (GPARC) (10), in areas with evidence of artemisinin resistance, an immediate, multifaceted response should be launched with the goal of containing and, if feasible, eliminating the resistant parasites. Containment efforts are underway in all areas with suspected or confirmed artemisinin resistance in the 4 affected countries of Cambodia, Myanmar, Thailand, and Viet Nam. In higher transmission areas, efforts focus on limiting the risk of spread by lowering the malaria burden through intensified malaria control, by increasing access to diagnosis and appropriate treatment, and by scaling up provision of health-care services to migrant and mobile populations. Containment programmes in lower transmission areas seek to achieve an accelerated elimination of *P. falciparum* parasites. These efforts have been effective in lowering the burden of falciparum

**Figure 6.17** Sites where suspected or confirmed artemisinin resistance has been detected in therapeutic efficacy studies, Mekong subregion, 2007–2012



**Map production:** Global Malaria Program (GMP), World Health Organization Global Malaria Program (GMP), World Health Organization; **Source of data:** WHO Global Database on Antimalarial Drug Efficacy, as of November, 2012

malaria, but need to be strengthened and expanded if efforts at containment, and ultimately elimination, are to be successful. Implementing all WHO recommendations requires considerable financial resources, long term political commitment, and stronger cross-border cooperation. Following recommendations made during a joint assessment by international development partners and WHO of the response to artemisinin resistance in the Greater Mekong subregion<sup>11</sup>, WHO and international partners are formulating an emergency response plan for artemisinin resistance in the greater Mekong subregion. The emergency plan will provide further guidance for field implementation of the containment efforts outlined in the GPARC, and is to be released in early, 2013.

It is not known whether new foci of artemisinin resistance represent the spread of existing *P. falciparum* resistant strains or the de novo emergence of resistance, in part because molecular markers of artemisinin resistance are not yet available. However, the possibility exists that artemisinin resistance will spread to or develop independently in other parts of the world. The spread of artemisinin resistance is difficult to predict based on previous patterns of resistance as malaria control interventions have been significantly scaled up during the past decade. There is an urgent need for further research on artemisinin resistance, including the identification of molecular markers and better in vitro sensitivity tests.

11. Joint Assessment report of the Response to Artemisinin Resistance in the Greater Mekong subregion (<http://malaria2012conference.com/cms/wp-content/uploads/2012/10/Joint-Assessment-of-the-Response-to-Artemisinin-Resistance.pdf>) – conducted November 2011 to February 2012 in partnership with the World Health Organization, UK Department for International Development and the US Agency for International Development. Sponsored by the Australian Agency for International Development and the Bill and Melinda Gates Foundation (<http://malaria2012conference.com/cms/wp-content/uploads/2012/10/Joint-Assessment-of-the-Response-to-Artemisinin-Resistance.pdf>).

## 6.5 Conclusions

### Implementation of parasitological testing

There have been significant increases in the availability and use of parasitological testing in the last few years, particularly in the African Region where the proportion of reported suspected cases receiving a parasitological test in the public sector increased from 20% in 2005 to 47% in 2011; however, progress has slowed during the past year. Most of the increase is attributable to an increase in use of RDTs. The limited information available indicates that testing in the private sector and in the community is lower than in the public sector and overall testing rates are well below the target to test all suspected malaria cases. Further funding and technical support are required to assist countries to achieve universal diagnostic testing of suspected malaria in the public sector, private sector and in the community. Promotion of malaria diagnostic testing needs to begin during planning, budgeting and procurement. Considering that in most malaria-endemic areas, malaria diagnosis will be confirmed in less than half of patients tested, programmes should aim to obtain at least as many RDTs as ACT treatment courses until such time as surveillance data allow for more precise procurement estimation.

### Access to treatment

Information from manufacturers and from country programmes indicates that the number of ACTs procured has increased dramatically since 2005. It is difficult to track the extent to which patients with confirmed malaria (by RDT or microscopy) receive antimalarial medicines because diagnostic test results are not usually linked to the treatment given to patients, in either household surveys or routine information systems. A limited number of recent household surveys suggest that febrile patients attending public health facilities are more likely to receive an ACT than those attending private facilities; in countries surveyed most recently, the proportion has increased in both public and private sectors. In some countries the proportion of febrile patients who receive ACTs remains low, which implies that a proportion of febrile patients with malaria do not receive appropriate treatment. At the same time, given low rates of testing among patients treated for malaria, a substantial proportion of those who do receive ACTs do not have malaria. Consequently, both under and over treatment with ACT continues. The development of routine systems that track febrile patients, diagnostic testing, test results, and treatments administered, would enable better tracking of antimalarial utilization. As routine system development may take time, national programmes may consider other sources of testing and treatment information, such as health facility-based surveys.

### Equity in testing and treatment:

A higher proportion of febrile children who are residents of urban areas and those from wealthier households receive diagnostic testing for malaria than children from rural areas and poorer households; these differences are more pronounced at moderate overall rates of testing than when testing rates are lowest. Differences in diagnostic testing rates between male and female children are small. The proportion of febrile children receiving an ACT for antimalarial treatment by residence and household wealth varies across surveyed countries; there is little

difference by gender. Ensuring availability of diagnostic testing and appropriate antimalarial therapy for all those in need is a priority for country programmes. The new “T3: Test. Treat. Track” initiative aims to support malaria-endemic countries in these efforts (see **Chapters 2 and 7**).

### Combating drug resistance

The recent spread of resistance to antimalarial medicines has led to an intensification of efforts to prohibit the marketing of oral artemisinin-based monotherapies and to expand antimalarial drug efficacy monitoring. In the last year, 9 more countries have withdrawn marketing authorization of oral artemisinin-based monotherapies, but 16 countries have not done so. The number of countries conducting therapeutic efficacy studies for antimalarials has increased, in particular in the African Region, where the reliance on ACTs is high. Despite the observed changes in parasite sensitivity to artemisinins, ACTs remain efficacious in curing patients provided the partner drug is still efficacious. In Pailin province, Cambodia, resistance to both components of multiple ACTs has been found, and special provisions for directly observed therapy using a non-artemisinin-based combination (atovaquone-proguanil) have been put in place. Containment efforts in the Mekong subregion have shown that the incidence of falciparum malaria can be decreased, a key component of the overall containment plan to halt the spread of resistant parasites. Greater use of diagnostic tests to better target appropriate antimalarial treatment will contribute to this effort.

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# Malaria surveillance

**This chapter examines: (i) the extent to which malaria surveillance systems are able to detect malaria cases, (ii) how well surveillance systems can assess trends over time and provide information on geographical differences in malaria incidence.**

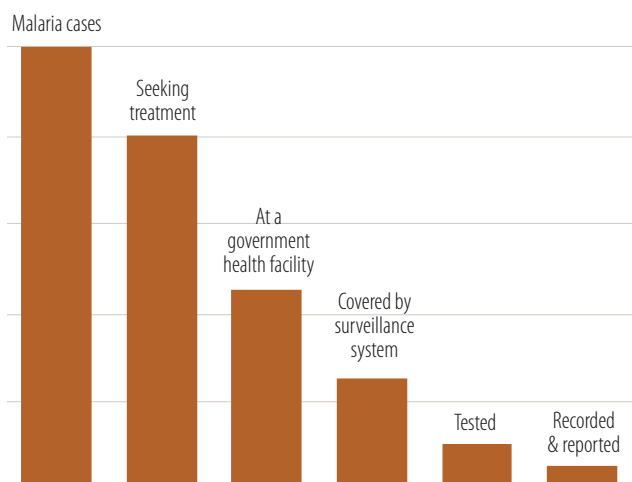
## 7.1 Bottlenecks in case detection

All malaria-endemic countries have systems to record and report malaria cases and deaths. The extent to which these systems provide reliable information on trends and distribution of malaria varies widely across countries and WHO Regions. In 2010 WHO estimated that there were 220 million malaria cases worldwide (Chapter 8, Box 8.1), and received reports of 23 million confirmed cases from endemic countries, representing a case detection rate of 10% globally.

The ability of surveillance systems to detect cases is influenced by: (i) the extent to which malaria patients seek treatment; (ii) whether or not patients use health facilities covered by a country's surveillance system; (iii) the proportion of patients who receive a reliable diagnostic test; and (iv) the completeness of recording and reporting (Figure 7.1).

**Figure 7.1 Bottlenecks in case detection**

For a malaria case to be captured by a surveillance system several conditions must be met: (i) the patient seeks treatment; (ii) the patient seeks treatment at a health facility or provider covered by a surveillance system – usually a government run health facility; (iii) the patient receives a diagnostic test of high quality; and (iv) the diagnostic test result is recorded and reported through the information or surveillance system. The proportion of cases that meet these conditions decreases progressively as each condition is considered. Cases that fulfil all conditions may represent only a small fraction of the true number of malaria cases in a country, as illustrated in this hypothetical figure.



For countries in the elimination phase, a further potential constraint may be encountered – the extent to which malaria infections become symptomatic. While asymptomatic cases occur in all programme phases, generally they do not constitute a public health priority in countries with high burdens of clinical cases. They are nevertheless important for countries aiming for elimination, as asymptomatic cases can lead to continuing transmission.

### 7.1.1 The proportion of malaria patients who seek treatment

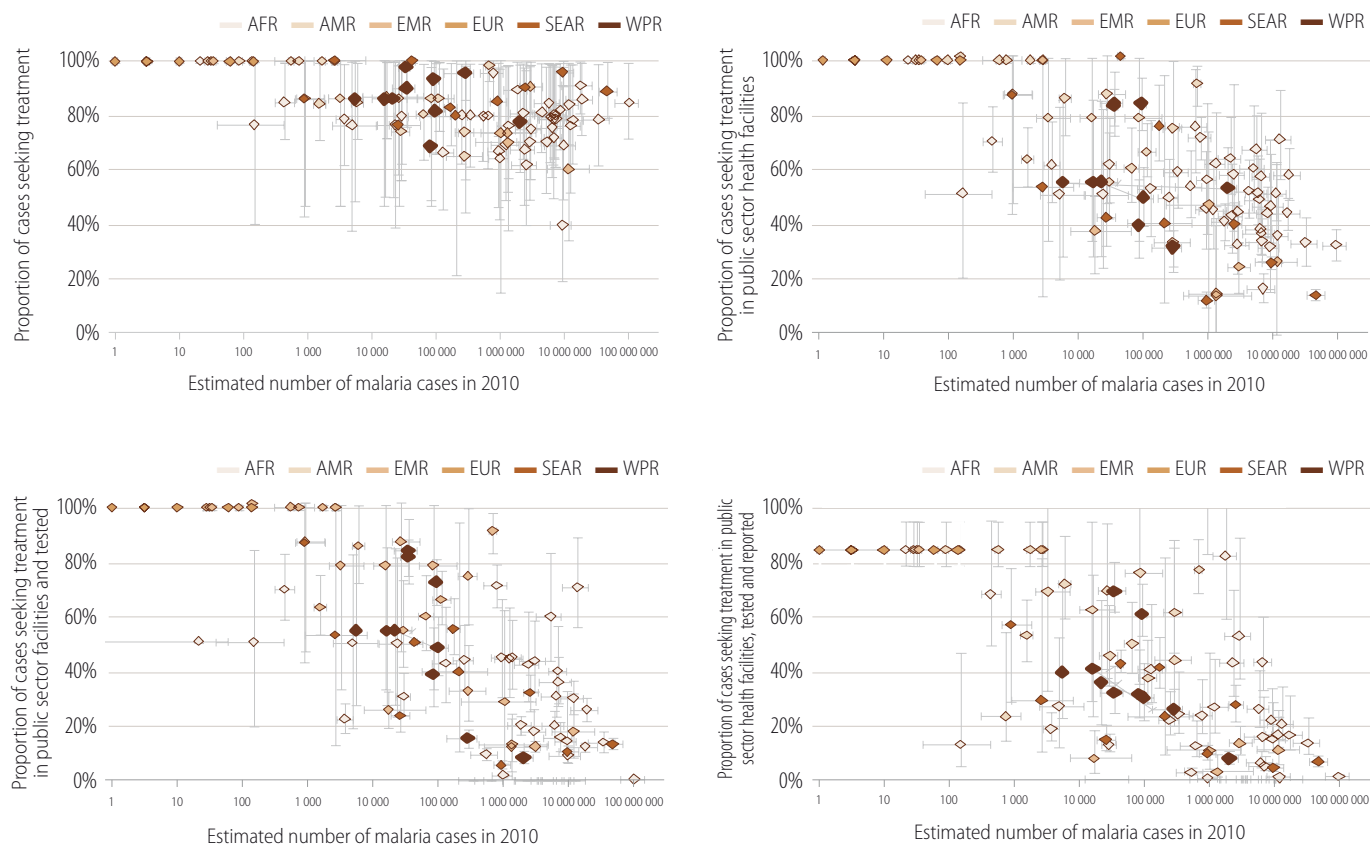
Information on where malaria patients seek treatment can be derived from household surveys which ask care-givers whether or not children under 5 years with fever in the previous two weeks were taken for treatment and, if so, where (e.g. government health facility, private clinic, pharmacy, shop, traditional healer). Although most household surveys do not record where adults with fevers seek treatment, some evidence suggests that treatment-seeking patterns are similar across all age groups (1,2). A drawback of household surveys is that in most settings, the majority of fever cases recorded would not have been caused by malaria, and adjustment of proportions is needed by taking into account the likelihood that fevers are caused by malaria in the local setting (2). When such an adjustment is made it is found that the proportion of malaria patients who seek treatment, whether in the public or private sector, is generally more than 60% (Figure 7.2a). A higher proportion of patients appear to seek treatment in countries in the WHO Regions of the Americas, South-East Asia and Western Pacific than in the African Region. It is assumed that almost 100% of patients in countries in the elimination phase, which includes all affected countries in the European Region, seek treatment.

### 7.1.2 Proportion of malaria patients treated in public sector health facilities

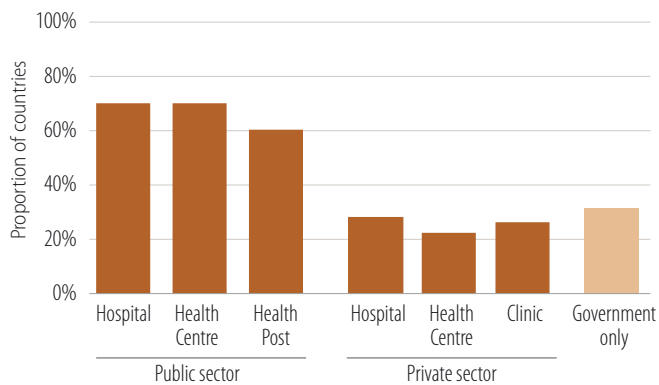
The surveillance systems of most countries focus on government-run public health facilities; indeed 44% of countries receive information only from government health facilities (Figure 7.3). A small proportion of national surveillance systems do not include government-run hospitals. This is possibly because hospitals are administered separately from health centres and health posts, which are often considered to be part of the primary health-care network. On the other hand, a small proportion of countries do not include health centres and only obtain reports from hospitals (secondary and tertiary health-care facilities). Most national surveillance systems include health posts but almost 20% do not. In many countries relatively few malaria patients appear to be treated at health posts; the majority access care through health centres and hospitals (Figure 7.4).

**Figure 7.2** Proportion of malaria cases captured by a surveillance system in relation to total number of cases estimated to occur in a country.

Public sector includes cases in the private sector that are reported through the public sector.



**Figure 7.3** Types of health facility covered by malaria surveillance systems



Source: NMCP data.

Less than 40% of countries receive information from private sector health facilities. Even for those countries which receive reports from the private sector, the reports generally cover only a small proportion of all private sector health facilities. Thus most surveillance systems essentially capture only cases seen at public sector health facilities.

There is great variation across WHO Regions in the extent to which malaria patients seek treatment in public sector health facilities (Figure 7.2b). The European Region and the Americas have the highest proportions of patients seeking treatment in public sector health facilities. However, for most countries, the proportion is less than 60% – with countries in the Eastern

Mediterranean, South-East Asia and Western Pacific Regions having proportions similar to, or lower than, most countries in the African Region. The data also show that the proportion of patients seeking treatment in the public sector is lower in countries with the greatest number of malaria cases.

### 7.1.3 Proportion of malaria patients treated in public sector health facilities who receive a diagnostic test

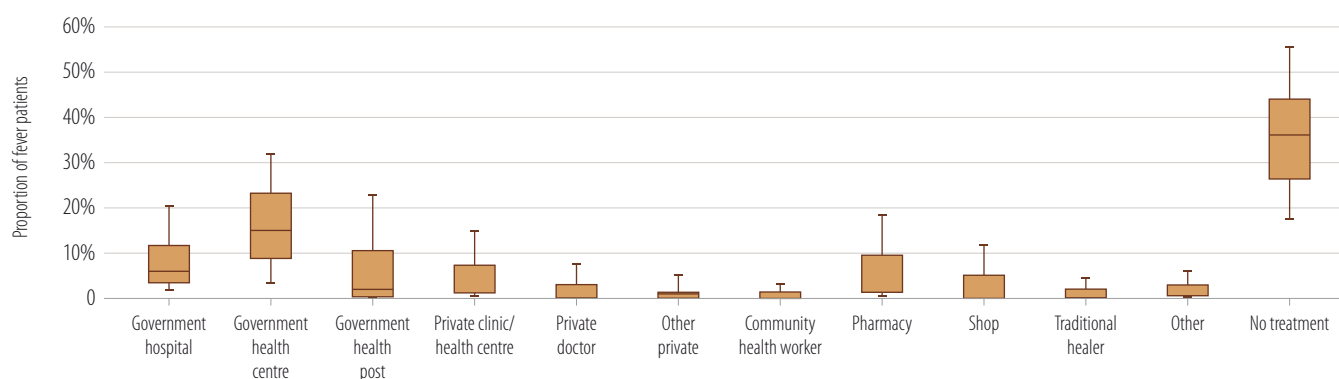
The proportion of malaria patients treated and tested in public sector health facilities is less than 20% in 30 of 99 countries with ongoing malaria transmission (Figure 7.2c); these 30 countries accounted for 78% of estimated cases globally in 2010. The proportion of malaria patients seeking treatment in public sector health facilities and receiving a diagnostic test is estimated to be 27% globally. The proportion is higher in the European Region and the Americas. The proportion tested is zero for several countries in the African Region which undertake limited or no testing, or do not include the results of testing in their reporting systems.

### 7.1.4 Proportion of malaria patients treated in public sector health facilities, tested and reported

Not all health facilities submit complete reports on malaria patients to the national control programme. In assessing the completeness of reporting within a surveillance system it is useful to consider: (i) the extent to which individual patients are registered when they attend health facilities and diagnostic test results recorded; (ii) the extent to which registered cases and/or diagnostic test results are transcribed onto a monthly report: (iii)

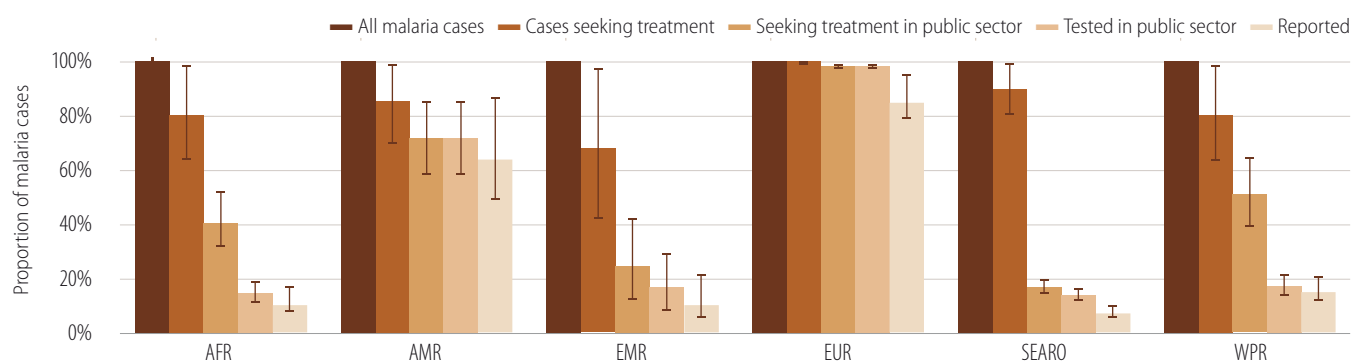
**Figure 7.4 Treatment source used for treatment of fever cases**

The box-plots summarize, for all household surveys available since 2000, where fever cases in children under 5 years of age were treated. The middle box shows the 25% and 75% percentiles and the end lines the 10% and 90% percentiles. The median is the horizontal line through the middle box.



**Figure 7.5 Bottlenecks in case detection, by WHO Region.**

Public sector includes cases in the private sector that are reported through the public sector.



Source: NMCP data, WHO estimates.

the proportion of health facilities submitting monthly reports to the NMCP or ministry of health; and (iv) the size of health facility failing to report – a missing report from a hospital is likely to have more impact on the data than a missing report from a health post. In practice such information is not readily available for most malaria-endemic countries, and an assessment of reporting completeness is confined to assessing the proportion of health facilities that submit monthly reports to the NMCP. While this indicator has limitations, it is nevertheless instructive to incorporate it in an assessment of case detection rates.

The proportion of malaria cases seeking treatment in public sector health facilities, tested and reported (the “case detection rate”), is less than 20% in 37 of the 99 countries with ongoing malaria transmission (Figure 7.2d). These 37 countries account for 189 million cases of malaria or 86% of the estimated global total. It is evident that case detection rates are lower in countries with higher numbers of cases. In other words, measured by this criterion, surveillance systems are weakest where the malaria burden is highest.

### 7.1.5 Bottlenecks in case detection, by WHO Region

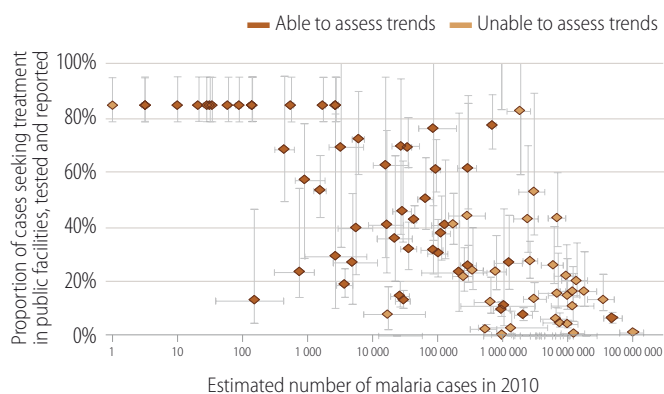
Figure 7.5 shows the percentage of malaria patients who seek treatment in facilities covered by surveillance systems, and who receive a diagnostic test, and are reported. The bottlenecks in case detection vary by WHO Region. In the African Region a large problem lies in the small proportion of patients attending public health facilities who receive a diagnostic test. In the Americas, small gaps appear at different stages of case detec-

tion. In the Eastern Mediterranean Region, a relatively small proportion of patients seek treatment – and generally not in the public sector. In the European Region, only very small gaps are assumed to occur in case detection. In the South-East Asia Region, the largest obstacle in case detection is the fact that a large proportion of patients seek treatment in the private sector, and these cases are not captured by existing surveillance systems. In the Western Pacific Region, the main constraint is the low proportion of patients attending public health facilities who receive a diagnostic test. The Regional patterns are sometimes dominated by individual countries with the highest number of cases – for instance a large proportion of patients in India seek treatment in the private sector, and in Papua New Guinea only a small proportion of suspected cases receive a diagnostic test.

## 7.2 Objectives of surveillance systems in different phases of malaria control

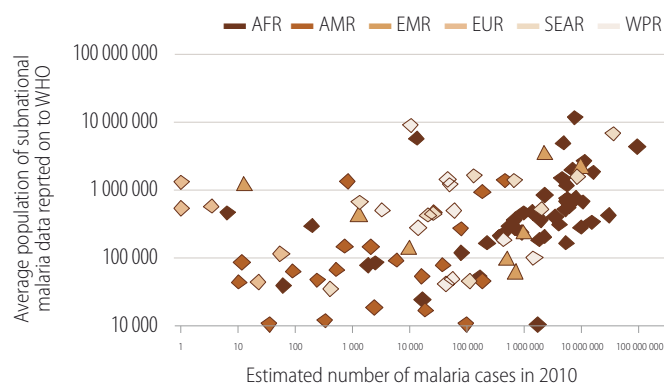
While the proportion of cases detected by surveillance systems globally is currently low, this does not necessarily imply that surveillance systems are unable to serve important functions at country level. In April 2012, WHO issued two manuals on malaria surveillance: *Disease surveillance for malaria control* (3), and *Disease surveillance for malaria elimination* (4). These manuals describe the objectives of surveillance systems at different stages of malaria control.

**Figure 7.6** Proportion of malaria cases captured by surveillance systems, in relation to total estimated number of cases and whether trends over time can be assessed



Source: NMCP data, WHO estimates.

**Figure 7.7** Average size of geographical unit for which incidence data are available in relation to total estimated number of cases in a country



Source: NMCP data, WHO estimates.

### 7.2.1 Objectives of surveillance systems in the control phase

For programmes in the control phase, the principal objectives of a surveillance system are to reduce incidence and mortality rates as rapidly as possible by:

- identifying areas or population groups most affected by malaria
- identifying trends in cases and deaths (e.g. epidemics, or the absence of a decrease in the number of cases despite widespread implementation of interventions) that require additional intervention
- assessing the impact of control measures to identify effective measures and those which are less effective or ineffective.

With this information, programmes in the control phase can direct resources to the populations most in need and respond to unusual trends. For these functions it is not necessary for a surveillance system to detect all cases. However, case detection efforts need to be reasonably uniform across the country if a system is to identify geographical differences in malaria incidence. Similarly a consistent sample is needed over time in order to assess trends in malaria incidence.

### 7.2.2 Objectives of surveillance systems in the elimination phase

The objective of a malaria surveillance system in the elimination phase is to stop local transmission by detecting all malaria infections, whether symptomatic or not, and ensuring that they are radically cured sufficiently early so that they do not generate secondary cases. In practice, this is accomplished in two stages:

- All areas or foci with local transmission of malaria are identified using reports of confirmed malaria cases from public and private sector health facilities. Pro-active case detection may be undertaken for populations which are not adequately served by fixed health facilities or in which faster reductions in transmission are sought. Each malaria case is then investigated (reactive case detection) to determine whether infection was locally acquired or imported, and if imported, from where.

- The characteristics of transmission in a focus are documented by conducting a focus investigation. Control and surveillance activities are then intensified in the focus.

Thus the principal goals of a surveillance system in the elimination phase are: (i) to detect all malaria cases, and (ii) to undertake case investigation to determine whether infection was acquired locally or imported.

The data submitted by endemic countries to WHO do not allow a complete assessment of the extent to which surveillance systems are able to meet their objectives. However, it is instructive to examine, for each country, the consistency of case detection efforts over time and geographically, in order to assess whether or not programmes can reliably assess trends or differences in incidence rates by geographical location.

### 7.2.3 Ability of surveillance systems to assess trends

Every year, WHO reviews the malaria data submitted by the ministries of health of all endemic countries to determine whether there have been changes in the total numbers of cases. In doing so, a strategy is used to minimize the influence of the use of private sector health facilities, lack of diagnostic testing and incompleteness of reporting. This includes focusing on confirmed cases only (or in the case of high-burden countries in the African Region, admissions for malaria), monitoring the number of diagnostic tests carried out, assessing reporting completion rates, monitoring trends in proportionate morbidity (such as test positivity rate and percentage of admissions and deaths due to malaria) and examining the consistency of trends between different indicators (**Regional Profiles, Section R2**). In following this strategy an assessment is made of whether or not case reporting is sufficiently consistent from year to year to be able to draw conclusions about trends in disease incidence. In 2011, reporting was considered to be sufficiently consistent in 58 of the 99 countries with ongoing transmission to make a reliable judgment about malaria trends (**Figure 7.6**). Although these countries comprise the majority of malaria-endemic countries, they account for just 15% of the estimated total number of cases

worldwide. In the remaining 41 countries, in which most of the malaria burden is present, it is not possible to make an assessment of malaria trends using the data submitted to WHO.

#### 7.2.4 Ability of surveillance systems to identify populations at greatest risk

The ability of a surveillance system to identify locations in which the incidence of malaria is highest depends partly on how far national programme managers are able to disaggregate data subnationally. The smaller the geographical unit with available data, the better able the manager is to identify populations with the highest incidence and to target interventions to populations most in need. In general, the smaller the number of malaria cases then the smaller is the geographical unit for which data are available, or the greater the ability of a surveillance system to define which populations are at highest risk (**Figure 7.7**). Such a relationship is influenced by two factors: (i) many countries with lower numbers of malaria cases also have smaller populations, and there is a limit to the possible size of population in subnational geographical units in small countries – the size of a subnational unit cannot exceed the total population size; and (ii) the relationship is based on data submitted to WHO, whereas data available within countries may be disaggregated to smaller population sizes. Nonetheless, the relationship suggests that countries with the highest numbers of malaria cases are less able to define precisely the geographical areas/populations at greatest risk of malaria.

### 7.3 Conclusions

Malaria surveillance systems detect only 10% of cases estimated to occur globally. Case detection rates are lowest in countries with the highest numbers of malaria cases.

There are four main bottlenecks in case detection: (i) the extent to which malaria patients seek treatment in the public sector; (ii) whether or not patients use health facilities covered by a country's surveillance system; (iii) the proportion of patients who receive a diagnostic test; and (iv) the completeness of recording and reporting including the extent to which laboratory findings are linked to case reporting. The relative importance of these factors varies by WHO Region. In the African and Western Pacific Regions the main constraint is the small proportion of patients attending public health facilities who receive a diagnostic test. In the South-East Asia the most important issue is in the high proportion of patients who seek treatment in the private sector. The regional patterns are sometimes dominated by individual countries with the greatest number of cases.

A principal reason for low rates of case detection in countries with the highest numbers of cases is the use of private health facilities by a large proportion of patients, these facilities are usually not covered by a ministry of health surveillance system. This pattern of care-seeking presents challenges not only for establishing surveillance systems but also for ensuring universal access to diagnostic testing and appropriate treatment.

Surveillance systems do not need to detect all cases in order to achieve their objectives in the control phase, which is to assess trends over time and/or identify geographical differences in

malaria incidence. However, case detection efforts need to be reasonably uniform over time and geographically, and countries with the highest numbers of cases appear to be least able to assess temporal or geographical variation in incidence. In 41 countries around the world, which account for 85% of estimated cases, it is not possible to make a reliable assessment of malaria trends due to incompleteness or inconsistency of reporting over time.

Thus surveillance systems appear to be weakest where the malaria burden is greatest. Improvement of malaria surveillance in these settings is an urgently required.

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# Changes in malaria incidence and mortality

This chapter reviews (i) trends in reported malaria cases for 58 countries which have reported consistently between 2000 and 2011, and (ii) for countries with low numbers of cases, summarizes their progress towards elimination; it then presents (iv) analysis of the global distribution of the estimated numbers of cases and deaths for 99 endemic countries in 2010, and (v) trends in estimated malaria cases and deaths for 99 endemic countries from 2000 to 2010.

## 8.1 Introduction

For individual countries the reported number of confirmed malaria cases can be used as a core indicator for tracking progress towards the WHA and RBM targets for 2015 – to reduce malaria cases by 75% from 2000 levels – if cases are reported consistently over time. The first part of this chapter reviews data on reported malaria cases between 2000 and 2011 for the 99 countries and areas with ongoing malaria transmission, 58 of which have submitted data that are sufficiently complete and consistent to draw inferences about trends. It then considers progress towards elimination for countries with low numbers of cases.

Surveillance systems do not capture all malaria cases occurring in a country, and surveillance data are not sufficiently reliable to assess trends in some countries (Chapter 7). It is therefore necessary to use estimates of the total number of cases or deaths occurring in countries to make inferences about trends in malaria cases and deaths at regional and global level. The methods for producing estimates either (i) adjust the number of reported cases to take into account the proportion of cases that are not captured by a surveillance system, or (ii) for countries with insufficient surveillance data, produce estimates using a modeled relationship between malaria transmission, case incidence or mortality and intervention coverage (1). While helping to make numbers more comparable between countries, and filling gaps where data are missing, the estimates rely on relationships between variables that are uncertain, and draw upon data that may have been imprecisely measured, or measured in previous years and projected forward. Thus estimates of the number of malaria cases or deaths are accompanied by a large degree of uncertainty, and inferences concerning trends are less certain than those made directly from good quality surveillance data. Nevertheless, the estimates can provide useful insight into the distribution of malaria across countries and trends over time. The second part of this chapter analyses the global distribution of the estimated numbers of cases and deaths in 2010 and trends in estimates of malaria cases and deaths from 2000 to 2010. The numbers were published at regional level in the *World Malaria Report 2011* (2). They have been updated after a process

of country consultation. Updated results are shown in Table 8.2 and Annex 6A which also shows country level estimates.

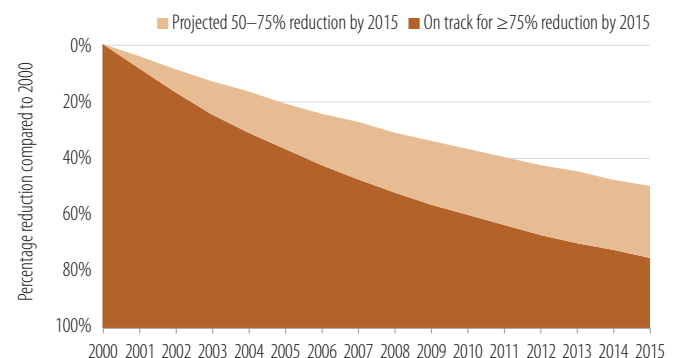
## 8.2 Changes in disease incidence at country level, 2000–2011

A description of the strategy used to analyse trends, and a summary of results for individual countries is provided in the *Regional Profiles* (Section R2). For most countries the reported number of confirmed malaria cases is used as a core indicator for tracking progress towards WHA and RBM targets. For many high-burden countries in the WHO African Region, where case confirmation remains variable and often inadequate, it is not possible to assess trends in confirmed cases (Chapter 5). Therefore attempts are made to evaluate trends in the reported numbers of malaria admissions (inpatient cases) and deaths; although the diagnosis of admitted patients is not always confirmed with a diagnostic test the predictive value of diagnosis undertaken for an admitted patient is considered to be higher than for outpatient diagnosis based only on clinical signs and symptoms.

The analysis strategy aims to exclude data-related factors, such as incomplete reporting or changes in diagnostic practice, as explanations for a change in the reported incidence of disease. However, even if trends in health facility data appear to be real, and not an artifact of data reporting, they may not reflect changes in the entire community. They are nevertheless the best information available on which to assess progress. The conclusion that trends inferred from health facility data reflect changes in the community has more weight if: (i) the changes in disease incidence are large; (ii) coverage with public health services is high; and (iii) interventions that promote a reduction in cases,

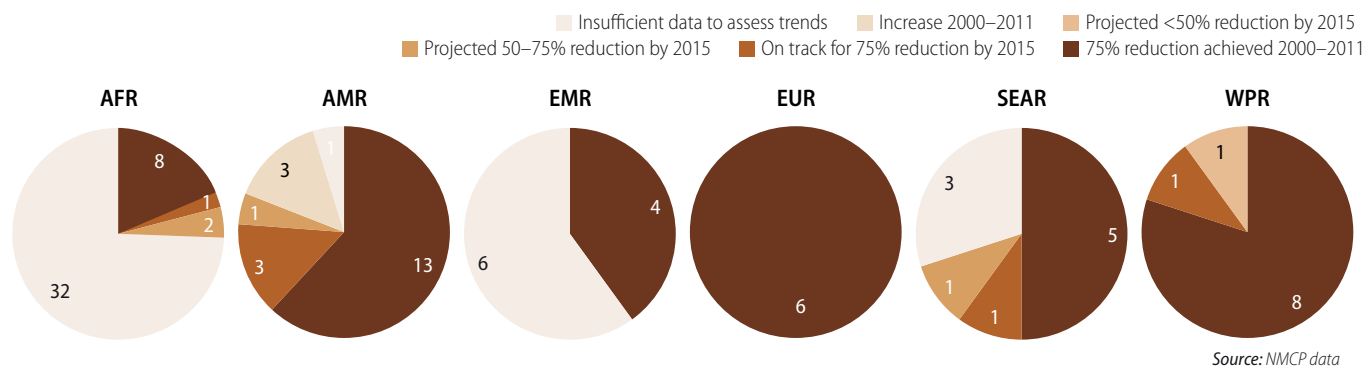
**Figure 8.1** Decreases necessary in order to achieve a 75% reduction in malaria case incidence from 2000 levels by 2015

For countries to achieve this target they need to have reduced the incidence of malaria by 64% between 2000 and 2011, assuming a constant compounded reduction of 8.83% per year between 2000 and 2015.



**Figure 8.2 Decreases in reported malaria case incidence rates 2000–2011, by WHO Region**

The number of countries in each category is shown in each pie slice.



such as use of ITNs, are delivered throughout the community and not restricted to health facilities.

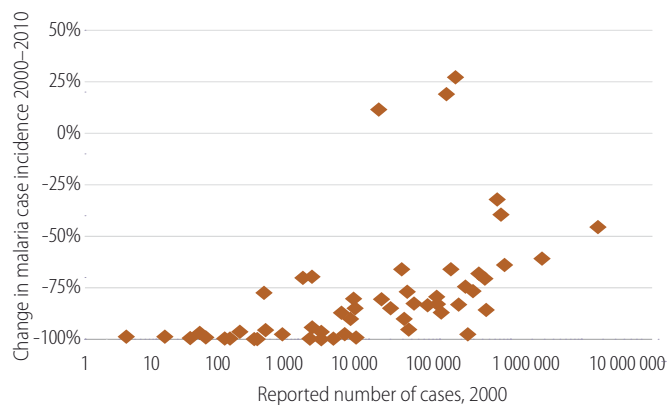
In considering progress towards WHA and RBM targets it is preferable to examine changes in malaria case incidence rather than absolute numbers, in order to take into account the expected rise in the number of cases due to population growth over a long period of time. A 75% reduction in malaria case incidence 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. Countries which reduced malaria incidence rates by 40%–64% between 2000 and 2011 are on track to achieve reductions in malaria case incidence of 50%–75% in 2015 (Figure 8.1). A summary of progress by WHO Region is provided in Figure 8.2, the Regional Profiles (Table R.1) and the following text.

In the **African Region**, of 43 countries with ongoing malaria transmission 8 countries (Algeria, Botswana, Cape Verde, Namibia, Rwanda, Sao Tome and Principe, South Africa and Swaziland) and the island of Zanzibar, (United Republic of Tanzania), have achieved reductions in malaria case incidence or malaria admission rates of 75% or more. In addition Eritrea is on track to achieve reductions in malaria admission rates of 75% or more by 2015, while 2 countries are projected to achieve reductions in malaria admission rates of 50%–75% by 2015 (Madagascar and Zambia). After falling substantially between 2004 and 2008, malaria admissions in Ethiopia have increased; the increase may be related to improved access to health facilities as the number of hospitals increased from about 120 in 2005 to more than 195 hospitals in 2010. In the remaining countries it was not possible to make a reliable assessment to malaria trends owing to incompleteness or inconsistency in reported data.

In the **Region of the Americas**, reductions in incidence of  $\geq 75\%$  in microscopically confirmed malaria cases were reported in 13 countries between 2000 and 2011 (Argentina, Belize, Bolivia (Plurinational State of), Costa Rica, Ecuador, El Salvador, French Guiana, (France), Guatemala, Honduras, Mexico, Nicaragua, Paraguay and Suriname). A further 3 countries recorded reductions of more than 64% and are therefore on track to achieve reductions of 75% by 2015 (Colombia, Panama and Peru) while Brazil is projected to achieve reductions of 50%–75%. Increases in numbers of cases between 2000 and 2011 were reported by 3 countries (the Dominican Republic, Guyana, and Venezuela (Bolivarian Republic of)), although the Dominican Republic had

**Figure 8.3 Percentage change in reported case incidence versus reported cases in 2000**

Countries reporting a smaller number of cases in 2000 achieved larger rates of decrease in malaria incidence. There are a few outliers from this general pattern, in particular 3 countries in the Region of the Americas which have recorded an increase in malaria case incidence since 2000.



registered decreases since 2005. In Haiti, malaria cases increased to over 80 000 in 2010 following the earthquake in January of the same year and then fell to 32 000 cases in 2011; it is unclear whether this reflects a real rise in incidence, or is a consequence of increased availability of resources for case detection during the emergency response.

In the **Eastern Mediterranean Region**, 4 of the 10 countries with ongoing transmission have attained a decrease of more than 75% in case incidence rates in 2011 compared to 2000 (Afghanistan, Iran (Islamic Republic of), Iraq, and Saudi Arabia). The number of microscopically confirmed cases has fluctuated from year to year in the other 6 countries (Djibouti, Pakistan, Somalia, South Sudan<sup>1</sup>, Sudan, Yemen) and it is not possible to deduce whether malaria case incidence is increasing, decreasing or is constant.

In the **European Region**, all malaria-affected countries have achieved reductions in case incidence of more than 75%

1. South Sudan became a separate State on 9 July 2011 and a Member State of WHO on 27 September 2011. South Sudan and Sudan have distinct epidemiological profiles comprising low transmission and high transmission areas respectively. For this reason data up to June 2011 from the high transmission areas of Sudan (9 southern states which correspond to South Sudan) and low transmission areas (15 northern states which correspond to contemporary Sudan) are reported separately.

between 2000 and 2011. Only 69 indigenous cases were reported in 2011, of which 65 were in Tajikistan, the others in Azerbaijan and Turkey. The Region as a whole appears to be on track to achieve elimination of malaria by 2015 as planned, if countries address the remaining challenges and prevent the reintroduction of malaria transmission, in particular responding effectively to outbreaks recently reported in Greece and Turkey.

In the **South-East Asia Region**, 5 countries have registered decreases in the incidence of microscopically confirmed malaria incidence rates of 75% or more between 2000 and 2011 (Bhutan, the Democratic People's Republic of Korea, Nepal, Sri Lanka and Thailand). Bangladesh is on track to achieve a 75% reduction by 2015, 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 and Timor-Leste owing to incon-

sistency of reporting over time. In Myanmar and Timor-Leste this is partly due to a change in diagnostic practice, with large increases in the use of RDTs since 2007.

In the **Western Pacific Region**, decreases of more than 75% in the incidence of microscopically confirmed cases between 2000 and 2011 have been reported in 8 of the 10 endemic countries (Cambodia, China, Lao People's Democratic Republic, Philippines, Republic of Korea, Solomon Islands, Vanuatu and Viet Nam). Malaysia is on track to achieve a 75% reduction by 2015. Papua New Guinea is projected to achieve a reduction in case incidence of less than 50% by 2015, if rates of reduction observed between 2000 and 2011 continue; however, results of household surveys in 2009 and 2011 suggest that recent expansion in the availability of ITNs has led to reductions in parasite prevalence (see **Box 8.1**).

### Box 8.1 Reduction in malaria prevalence following widespread distribution of ITNs in Papua New Guinea

Papua New Guinea has one of the highest burdens of malaria outside Africa. In 2012 the population was estimated to be about 7 million people, located in 22 000 villages spread across some of the most challenging landscapes found in any country of the world. The use of ITNs for malaria control has a long tradition in Papua New Guinea, where some of the first studies on the efficacy of treated nets were carried out.

In 2009 the country received an award of US\$ 102 million from the Global Fund. The Rotarians Against Malaria (RAM) were allocated the task of coordinating the distribution of ITNs purchased with Global Fund financing. RAM carries out this function through teams of 6–8 people who work with provincial and district health authorities to plan the distribution of ITNs. RAM arranges all logistics and funds for the work to be carried out. The RAM teams then work with provincial health staff and other partners locally to implement the programme. Papua New Guinea is an extremely difficult environment in which to distribute mosquito nets. In many parts of the country the road infrastructure is poor, resulting in the need to use a combination of road transport, aircraft, boats, helicopters, and often many days of trekking to reach many of the villages. This results in very complicated and expensive distribution.

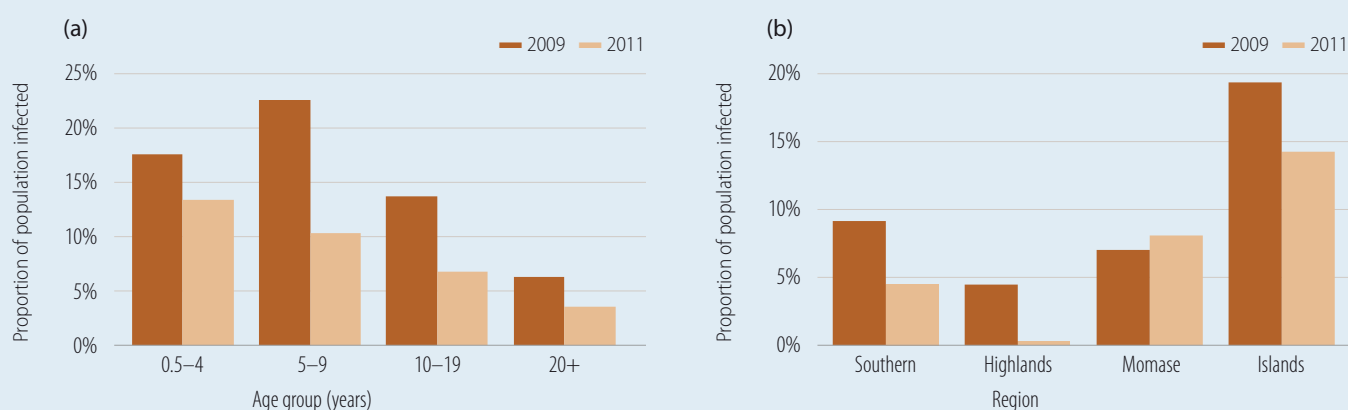
Between 2009 and 2011 RAM coordinated the distribution of over 2.5 million nets to all households in 18 provinces and another 400 000 LLINs to vulnerable groups, particularly pregnant women to

whom nets were provided through antenatal services. The distribution of nets to vulnerable groups was implemented in collaboration with provincial health services (both government and church health services), supported by the private sector and NGOs in some places. RAM was able to attain a consistently high coverage of nets because:

- As an NGO, it had flexibility to move funds and respond quickly to numerous technical difficulties in the field, which is particularly important in a country such as Papua New Guinea where infrastructure and reliability of services are very poor.
- Being the sole organization to coordinate all LLIN distributions in the country it was able to develop a consistency of approach to the distribution of nets in all areas.
- As an organization specializing in one activity (LLIN distribution) it could focus on quality of delivery and more detailed reporting (RAM can report on the distribution of nets by each village in the country), through its dedicated and motivated staff.

An evaluation undertaken by the Papua New Guinea Institute of Medical Research indicated that the proportion of the population sleeping under an ITN increased from 32% in 2009 to 59% in 2011. Parasite prevalence dropped from 18.2% to 6.7% between 2009 and 2011. Reductions were seen in all regions and age groups but were most marked in the Highlands Region and in children aged 5–9 years. People using an ITN were less likely to be parasitaemic than those not using an ITN.

**Figure Box 8.1** Change in parasite prevalence following nationwide distribution of ITNs (a) by age group (b) by region



Among countries where the data permit an assessment of trends it is apparent that rates of decrease have been higher in countries with smaller numbers of cases in 2000 (Figure 8.3).

Of 33 countries with less than 10 000 reported cases in 2000, 30 (91%) registered decreases in malaria case incidence rates of more than 75% by 2011 compared to 8 of 19 countries (42%) with more than 10 000 cases. There are a few outliers from the general pattern, in particular 3 countries in the Region of the Americas which recorded increases in malaria case incidence (Dominican Republic, Guyana and Venezuela (Bolivarian Republic of)).

The 50 countries that are on track to reduce malaria case incidence rates by 75% by 2015 account for only 7 million (3%) of the total estimated cases of 223 million in 2000. Only 1 country with more than 1 million estimated cases in 2000, Afghanistan, is projected to achieve a reduction in malaria case incidence of 75% or more. While this is partly because progress has been faster in countries with lower numbers of cases, it is also influenced by the poorer quality of surveillance data submitted by countries with larger estimated numbers of cases. Because countries with higher numbers of cases are less likely to submit sufficiently consistent data for assessing trends (Section 7.1.4) it is necessary to draw inferences about trends in these countries using estimated numbers of cases rather than surveillance data (Section 8.5).

## 8.3 Progress towards elimination

The criteria used to classify countries according to their stage of malaria control were updated in 2012 in order to facilitate tracking of progress over time. The updated criteria are based on an evaluation of 3 main components: the malaria epidemiological situation, case management practices, and the state of the surveillance system (see Section R4 for the updated criteria). The evaluation concentrates on the situation in districts of the country reporting the highest API values. The status of malaria-endemic countries in 2012 is summarized below.

In the **African Region**, Cape Verde (with a total of 36 confirmed cases reported in 2011, of which 18 were locally acquired) has been in the pre-elimination phase since 2010, and Algeria (with 191 confirmed cases reported in 2011, including only 4 local cases) has been in the elimination phase since 2007 when WHO published the first country classification. Algeria implements active case detection, case investigation, a QA system for diagnosis guided by the national reference laboratory, and a radical treatment policy for *P. vivax* and gametocytocidal treatment for *P. falciparum*. Tamanrasset, the Algerian province with the highest incidence (116 confirmed cases in 2011), reported just over 1 malaria case per 1000 inhabitants, pointing to the importance of trans-Saharan migration as a source of infection in this sparsely populated desert area. The relatively high CFR of 9% in Cape Verde (4 deaths among 36 reported malaria cases in 2011) underscores the need to maintain early diagnostic testing and inpatient treatment capacity when progressing towards elimination.

In 2011, Namibia reported 1860 confirmed malaria cases among 61 861 persons tested, giving an SPR of 3% at the national level. Based on this relatively low reported malaria burden, Namibia may progress towards the elimination phase in the coming

years. At subnational level, the SPR ranged in 2011 from 0.4% in Kavango to 11.6% in Omusati, with ABER of 1.5% and 0.4% respectively, reflecting low diagnostic activity. In line with these findings, the 2011 Malaria Programme Review raised concerns about malaria treatment without prior diagnostic testing, the quality of diagnostic testing, and the need for improvement of the surveillance system to allow location and tracking of cases. The country is therefore still classified by WHO as being in the control phase.

Other African nations with relatively low reported malaria incidences include Swaziland (171 confirmed cases and 405 presumed to be malaria) and Botswana (432 confirmed cases), where malaria risk is geographically limited and seasonal. It is expected that these countries will continue their progress towards elimination, although they do not yet meet the case management and surveillance criteria for the pre-elimination phase. Mauritania also reports relatively few cases (2721 confirmed cases), but has a high SPR of 30% among febrile patients and is therefore classified as being in the control phase.

In the **Eastern Mediterranean Region**, Oman had achieved interruption of transmission in 2004–2006, but has been battling small outbreaks since 2009 involving both *P. falciparum* and *P. vivax*. The country reported 1532 cases in 2011, of which 13 were locally acquired. Oman is applying a prevention of reintroduction strategy, with general health services vigilant for the occurrence of any new cases, and case investigation followed by outbreak response as needed. In the Region, 3 other countries are also in the prevention of reintroduction phase: Egypt, Iraq, which has not reported indigenous malaria since 2009, and the Syrian Arab Republic which reported zero local cases in 2011. Iran (Islamic Republic of) and Saudi Arabia have been in the elimination phase since 2010 and 2008 respectively.

In the **European Region**, Azerbaijan, Tajikistan and Turkey have been in the elimination phase since 2007, 2005 and 2008 respectively. These countries reported a total of only 69 indigenous cases in 2011 (65 in Tajikistan), all due to *P. vivax*. The SPR and API in the most affected districts of these 3 countries are near zero, QA is carried out by the national reference laboratory and there is 100% radical treatment of *P. vivax*. Kyrgyzstan and Uzbekistan have been in the elimination phase since 2008. Georgia is in the prevention of reintroduction phase: the country has reported zero indigenous cases in 2010, followed by one locally acquired case in 2011. The Russian Federation reported zero local transmission in 2009 and 2011, with only 1 introduced case in 2010, and is once again considered malaria-free (and is on the Supplementary list). The year 2010 marked the start of renewed local *P. vivax* transmission in Greece subsequent to importation of parasites, and if this outbreak is not stopped by 2013, the country will once again be considered endemic (Greece is on the Supplementary list).

In the **Region of the Americas**, Argentina, El Salvador, Mexico and Paraguay remain in the pre-elimination phase. In addition, Ecuador and Costa Rica have moved from the control phase to the pre-elimination phase. The outbreaks in the Bahamas and Jamaica have been controlled, with no local transmission reported since 2009 in Jamaica and since 2011 in the Bahamas. Jamaica is on the *Official Register* of areas where malaria eradi-



**Table 8.1.** Classification of countries by stage of elimination, as of December 2012.

Region	Pre-elimination	Elimination	Prevention of re-introduction	Recently certified as malaria free
African	Cape Verde	Algeria		
Region of the Americas	Argentina Costa Rica Ecuador El Salvador Mexico Paraguay			
Eastern Mediterranean		Iran (Islamic Republic of) Saudi Arabia	Egypt Iraq Oman Syrian Arab Republic	Morocco - 2010 United Arab Emirates – 2007
European		Azerbaijan Kyrgyzstan Tajikistan Turkey Uzbekistan	Georgia	Armenia - 2011 Turkmenistan – 2010
South-East Asia	Bhutan Democratic People's Republic of Korea	Sri Lanka		
Western Pacific	Malaysia	Republic of Korea		

Source: NMCP data

cation has been achieved and Bahamas was added to the Supplementary list in 2012.

In the **South-East Asia Region**, Sri Lanka had been in the pre-elimination phase since 2007 and progressed to the elimination phase in 2011. It reported 124 locally-acquired malaria cases in 2011 (including 3 *P. falciparum*), down from 632 local cases in 2010. Intense case detection efforts have been pursued in 2010–2011, reflected in an average ABER of 25.4% for these 2 years in the most affected district Mulattivu, where an API of 0.8 was measured. Regional laboratories and the national reference laboratory carry out QA for microscopy. Radical treatment for *P. vivax* malaria was introduced in 2006 and ACTs for gametocytocidal treatment of *P. falciparum* in 2008. A 24-hour case reporting policy using SMS was introduced in 2009.

Bhutan has also made remarkable progress since its Malaria Programme Review in 2010, and moved into the pre-elimination phase this year. Malaria is a notifiable disease in Bhutan, with malaria cases reported by the districts to the central level Vector-borne Disease Control Programme on a weekly basis. A total of 228 malaria cases were detected in 2011, confirmed mainly by microscopy; a QA system for microscopy is in place. In the most endemic district of Sarpang where there is perennial transmission, the API averaged 4.7 during 2010–2011, with an average ABER of 44.3%. Case management and surveillance systems for malaria elimination are being set up.

The Democratic People's Republic of Korea (DPR Korea) has been in the pre-elimination phase since 2007. The continuing high number of malaria cases and transmission foci reported on the Korean Peninsula, with a combined total of 17 598 cases in 145 foci in 2011 in DPR Korea and the Republic of Korea (which is in the elimination phase) is a serious concern for the long-term viability of the elimination strategy.

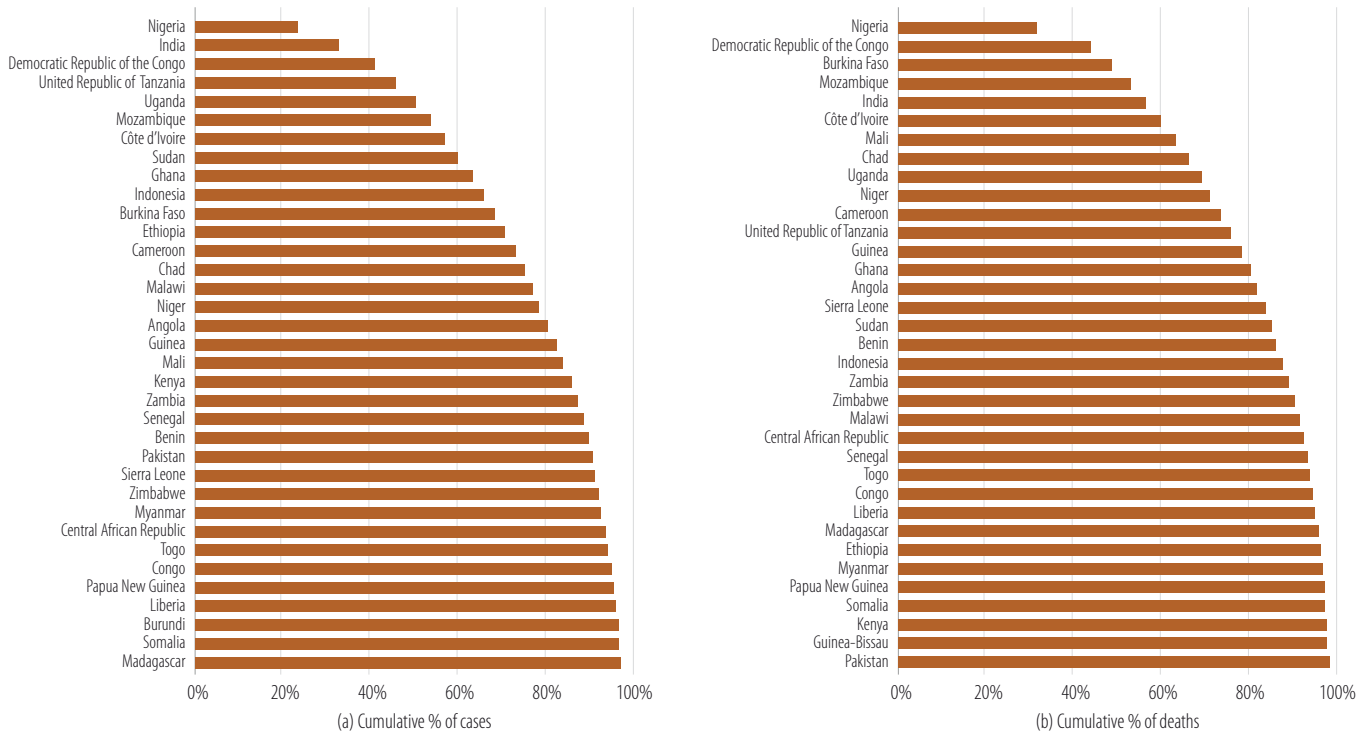
Lastly, India, Nepal and Thailand could potentially move towards the pre-elimination phase by continuing their progress, assuring that all malaria cases are laboratory confirmed and including the private sector in the health reporting system

In the **Western Pacific Region**, Malaysia continues to meet the pre-elimination criteria regarding case management and surveillance system. Malaria transmission is geographically very limited. The highest endemic districts are found in Sarawak (Marudi district, population 90 100, average API 13.34 and ABER 15% in 2010–2011; Belaga, (population 30 300, API 7.2), and in Sabah (Tongod, population 32 000, API 6.7). With a total of 5306 malaria cases from 3134 transmission foci (villages) reported in 2011, the achievement of malaria elimination in Malaysia remains an enormous task.

The Philippines is progressing with subnational elimination at the provincial level, and has declared 22 of its 80 provinces malaria-free. The national SPR is 4.6%, but provincial SPRs reached up to 49% in Maguindanao (Mindanao). The highest APIs in 2010 were in the islands Palawan (10.3) and Tawi-Tawi (5.2). The Philippines is progressively meeting the pre-elimination criteria regarding case management and surveillance system: all suspected malaria cases are confirmed by microscopy and there is a QA system for malaria microscopy (the Research Institute for Tropical Medicine is the reference laboratory); there is a national policy for radical treatment; and there is a malaria surveillance system. However, the worst affected malaria-endemic areas of the Philippines are still in the control phase, and thus the country is classified as control phase.

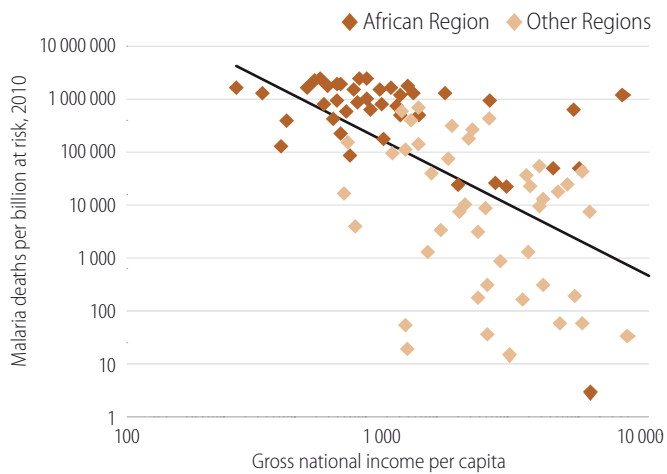
China is successfully aiming for subnational elimination in Hainan, which is reflected in the average ABER of 11.3% in the province over the period 2010–2011, and an API of 0.002 (with only 7 reported cases in 2011). In Yunnan, the province with the greatest malaria burden, 1321 cases were detected in 2011 (API 0.03, ABER 1.2%). The highest API for the period 2010–2011 was

**Figure 8.4** Cumulative proportion of the global estimated cases and deaths accounted for by the countries with the highest number of (a) cases and (b) deaths



Source: WHO estimates

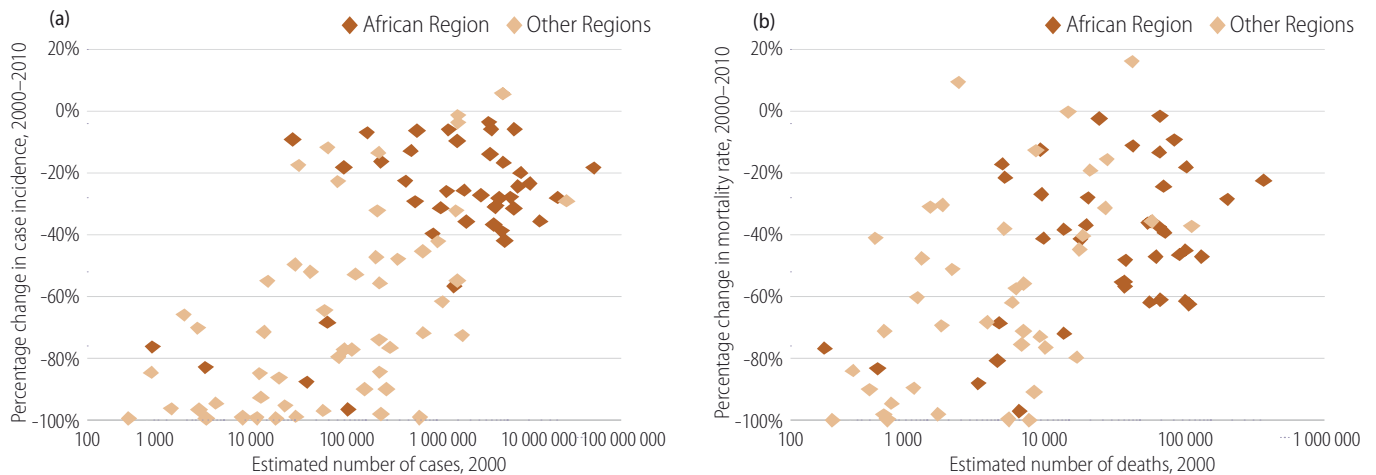
**Figure 8.5** Relation between gross national income and malaria mortality rates



**Figure 8.6** Relation between proportion of country's population living in poverty and malaria mortality rates



**Figure 8.7** Relations between (a) change in estimated number of cases between 2000 and 2010 versus estimated cases in 2000 (b) change in estimated number of deaths between 2000 and 2010 versus estimated deaths in 2000.



**Table 8.2** WHO estimates of the number of malaria cases and deaths in 2010

Region	Estimated cases ('000s)				Estimated deaths			
	Estimate	Lower	Upper	% falciparum	Estimate	Lower	Upper	% <5
African	174 000	110 000	242 000	98%	596 000	429 000	772 000	91%
Region of the Americas	1 100	900	1 300	35%	1 100	700	1 800	29%
Eastern Mediterranean	10 400	6 400	16 600	83%	15 300	7 200	23 500	70%
European	0.2	0.2	0.2	–	0	0	0	–
South-East Asia	32 000	25 900	41 900	53%	43 000	31 100	60 300	32%
Western Pacific	1 700	1 300	2 100	79%	4 000	2 400	6 100	41%
<b>World</b>	<b>219 000</b>	<b>154 000</b>	<b>289 000</b>	<b>90%</b>	<b>660 000</b>	<b>490 000</b>	<b>836 000</b>	<b>86%</b>

Source: WHO estimates

reported in Xizang (API 0.44, ABER 0.6%). Programmatically, the country has not yet met the surveillance and treatment criteria for the nationwide pre-elimination phase and therefore remains classified as being in the control phase.

Table 8.1 shows the current classification of endemic countries by programme phase, and the movement between phases over 2010–2011. Altogether, 23 countries were in the pre-elimination, and elimination and prevention of reintroduction phases in 2012.

## 8.4 Distribution of the total estimated malaria cases and deaths in 2010

Because cases reported through surveillance systems represent only a fraction of the total number of cases occurring in a country, and the fraction is smaller in countries with the highest number of cases (see Chapter 7), it is not possible to draw inferences about regional or global trends in malaria incidence by simply aggregating the reported number of cases across countries (regional totals are disproportionately influenced by trends in countries with a lower number of cases as they report a higher

fraction of all cases). Therefore WHO makes estimates of the total number of cases and deaths occurring in each country which allows the aggregation of numbers of cases and deaths across countries and provides a measure of the full magnitude of the malaria burden by WHO Region and globally. Despite the wide uncertainty intervals associated with estimates of the number of malaria cases and deaths, the estimates can provide some insight into the distribution of malaria and trends over time. The *World Malaria Report 2011* summarized the estimates at regional and global level. The estimates have been subject to some modification after a process of country consultation. Updated results are shown in Table 8.2 and Annex 6A which also shows country level estimates (see also Box 8.2). This section reviews the distribution of cases and deaths estimated for 2010 at country level.

More than 80% of malaria deaths occur in just 14 countries and 80% of cases occur in 17 countries (Figure 8.4), indicating that international targets for reducing cases and deaths will not be attained unless considerable progress can be made in these countries. Owing to wide uncertainty intervals surrounding individual country estimates, the composition of the country grouping that comprises 80% of the global burden is also subject

### Box 8.2 Estimated number of malaria cases and deaths in 2010, by WHO Region

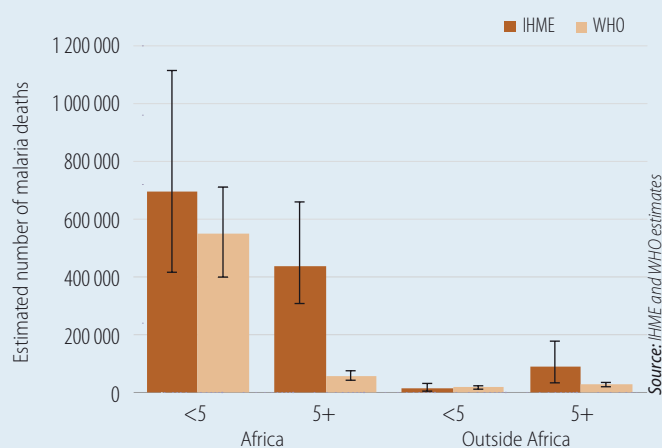
Estimates by WHO Region of the number of cases and deaths from malaria from 2000 to 2010 were published in the *World Malaria Report 2011* (1). The estimated numbers of cases and deaths are summarized by WHO Region for 2010 in Table 8.2 and by country in Annex 6A. The vast majority of estimated cases (80%) and deaths (91%) occur in sub-Saharan Africa and the vast majority of deaths (86%) occur in children <5 years of age.

Estimates differing from those calculated by WHO in 2011 (1) have been published this year (2). Wide uncertainty ranges accompany both sets of estimates, and with one exception – for deaths in people older than 5 years in Africa – these ranges overlap, so that in most settings the estimates cannot be regarded as significantly different (Figure Box 8.1).

Finding a large number of malaria deaths in people older than 5 years in Africa, relative to those younger than 5 years, is unexpected in stable endemic areas, since partial immunity to malaria generally develops at an early age and protects most older children and adults against severe disease and death. In Africa, much lower adult-to-child death ratios have been found when the cases had been confirmed microscopically (3). Moreover, the proportion of malaria deaths occurring over 50 years of age has been observed to be considerably

smaller in a wide range of settings (4). Verbal autopsy, which was used to assign cause of death in children in Africa in both sets of estimates for children, and for all ages in the IHME estimates is an imprecise estimator of malaria mortality since it cannot distinguish severe malaria from other severe febrile illnesses.

**Figure Box 8.2** Estimates of number of malaria deaths in 2010, by age group and geographical region (1,2).

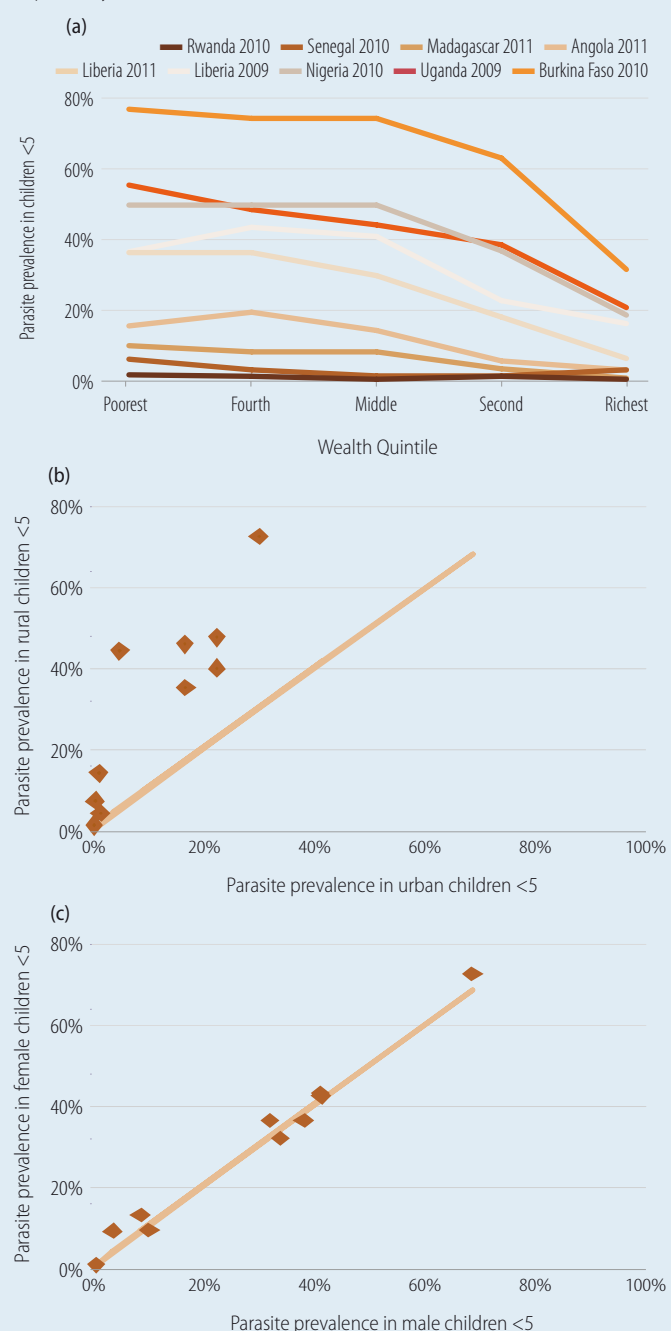


### Box 8.3 Disparities in prevalence of malaria infections in some African countries

Parasite prevalence rates in children <5 years of age are highest in poorer populations and rural areas (Figure Box 8.3 a,b). Poorer populations are more prone to infection because they are more likely to live in rural areas, in housing that offers little protection against mosquitoes, and they are generally less likely to have access to ITNs or IRS (Chapter 4). They are also less likely to use health facilities which can offer effective diagnostic testing and treatment (Chapter 5). There is little difference in parasite prevalence rates between sexes in children <5 years of age (Figure Box 8.3c).

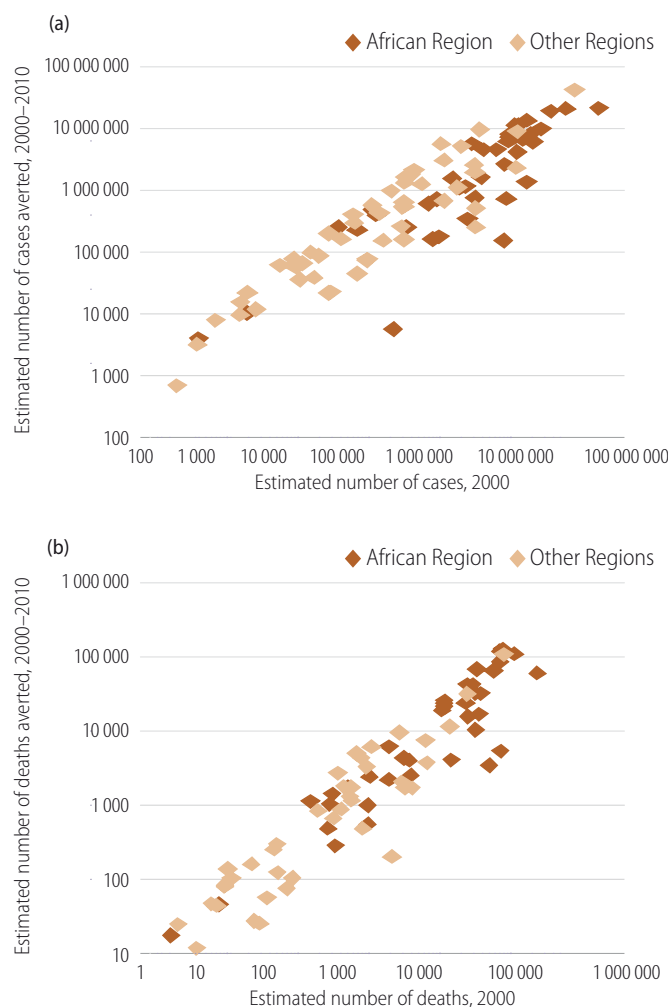
**Figure Box 8.3. Parasite prevalence in children <5 years of age according to (a) wealth quintile (b) rural or urban residence and (c) sex**

In (b) and (c) the diagonal line signifies where parasite prevalence rates are equal between urban and rural, and between male and female populations respectively.



Source: Households surveys (DHS, MIS)

**Figure 8.8 Estimated numbers of (a) cases averted in 2000–2011 versus cases in 2000 and (b) number of deaths averted in 2000–2011 versus deaths in 2000**



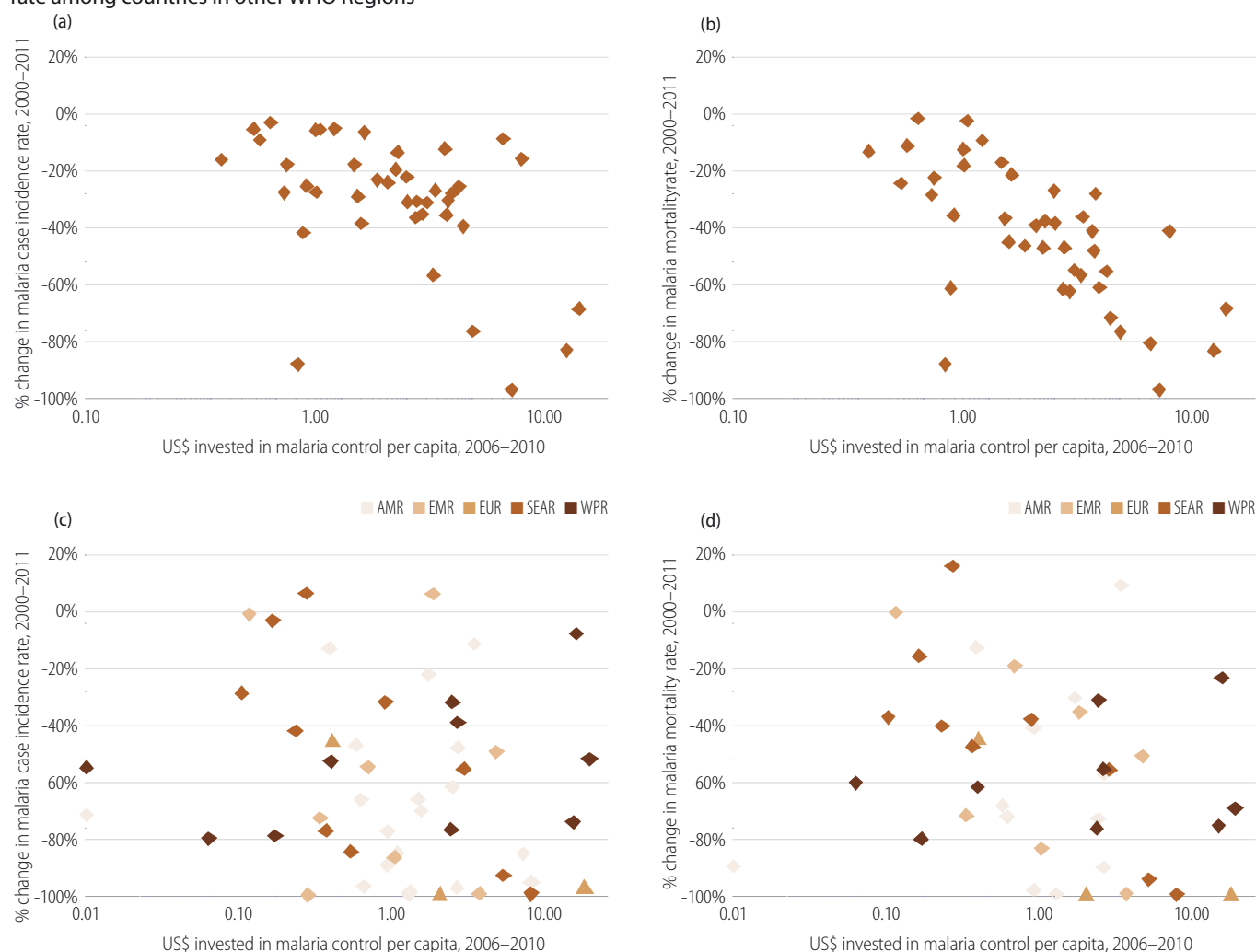
to some uncertainty. Nevertheless, the global burden is clearly dominated by countries in sub-Saharan Africa: the Democratic Republic of the Congo (DR Congo) and Nigeria together account for >40% of the global total of estimated malaria deaths.

Malaria remains inextricably linked with poverty. Malaria mortality rates are highest in countries with lower gross national income (GNI) per capita (Figure 8.5). Countries with higher proportions of their population living in poverty (on less than US\$ 1.25 per person per day) have higher death rates from malaria (Figure 8.6). Within countries the prevalence of malaria infections in children <5 years of age is highest in poorer populations and rural areas (Box 8.3).

## 8.5 Cases and deaths averted, 2001–2010

As reported in the *World Malaria Report 2011*, estimated incidence rates decreased by 17% globally between 2000 and 2010, and mortality rates by 26% (33% in the WHO African Region). An estimate of the number of cases averted and lives saved between 2001 and 2010 can be made by calculating the

**Figure 8.9** Change in malaria case incidence rate and mortality rate in relation to per capita investments in malaria control: (a) change in malaria case incidence rate among countries in the WHO African Region; (b) change in malaria mortality rate among countries in the WHO African Region; (c) change in malaria case incidence rate among countries in other WHO Regions; (d) change in malaria mortality rate among countries in other WHO Regions



number of cases and deaths that would have occurred if incidence and mortality rates remained at 2000 levels throughout the decade (i.e. there was no progress). The calculated number of cases and deaths can be compared with the number of cases estimated for each year presented in the *World Malaria Report 2011*. Such an analysis indicates that 274 million fewer cases and 1.1 million fewer malaria deaths occurred between 2001 and 2011 globally than would have occurred had incidence and mortality rates remained unchanged since 2000 (Table 8.2). The majority of cases averted (66%) and lives saved (88%) are in the African Region.

From the numbers of malaria cases reported through surveillance systems, it appears that progress has been most rapid in countries with lower initial burdens of malaria. A similar pattern is observed in estimated incidence and mortality rates; larger percentage decreases in cases incidence and mortality rates are seen in countries with the lowest estimated malaria burdens in 2000 (Figure 8.7). However, while progress in reducing incidence and mortality rates has been faster in countries with smaller estimated numbers of malaria cases and deaths, this does not imply a lack of impact in higher burden countries: overall more cases and deaths have been averted 2001–2011 in

countries with the highest estimated initial number of cases and deaths (Figure 8.8)<sup>2</sup>.

Not all of the malaria cases and deaths averted can be attributed to malaria control programmes. Some progress is likely to be related to increased urbanization and overall economic development, which lead to improvements in housing and nutrition. In assessing the impact of malaria interventions, it is of interest to examine changes in estimated malaria case incidence or mortality in relation to financial investments made in malaria control.

In the African Region, there is a strong association between per capita expenditures on malaria control and estimated decreases in malaria case incidence and mortality rates between 2000 and 2010 (Figure 8.9a). The association is stronger for mortality rates than for incidence rates (Figure 8.9b). A clear relationship between investments and reductions in incidence and mortality rates is not evident outside Africa, except possibly in the South-East Asia Region (Figure 8.9c,d).

2. 52% of cases and 58% of deaths averted are in the 10 countries which had the highest estimated malaria burdens in 2000



The stronger associations in Africa may be because information on malaria expenditures concerned the period 2006–2010 in which there was a rapid expansion in ITN and IRS programmes and a consequent reduction in incidence and mortality rates. Outside Africa, much of the decline in morbidity and mortality rates was achieved before this period. In addition, the estimated numbers of cases and deaths in Africa are derived from a model which relies on changes in intervention coverage to predict changes in case incidence and mortality rates. Such a model is not affected by natural variation in malaria levels that occur from year to year owing to climatic and other factors. In contrast, estimates for countries outside Africa are derived from reported cases, which do vary according to climatic and other factors.

## 8.6 Conclusions

Of 99 countries and areas with ongoing malaria transmission in 2011, 58 submitted sufficiently complete and consistent data on malaria cases between 2000 and 2011 to enable an assessment of trends to be made. Based on the reported data, 50 countries are on track to meet WHA and RBM targets: to reduce malaria case incidence by 75% by 2015 including 8 countries and 1 area of the African Region. Of these 50 countries, 44 had already attained a 75% reduction in case incidence by 2011 and 6 countries are projected to achieve reductions of 50%–75% by 2015. Malaria case incidence has increased in 3 countries of the Region of the Americas.

Progress in reducing case incidence has been faster in countries with lower initial numbers of cases. The 50 countries that are on track to reach the 2015 target, as measured through surveillance systems, accounted for only 7 million (3%) of the global total of 223 million estimated cases in 2000. This is partly due to faster progress in countries with fewer cases, but it is also heavily influenced by the poorer quality of surveillance data submitted by countries with a larger estimated number of cases. Improved surveillance and evaluation in countries with higher malaria burdens is essential for the impact of malaria investments to be properly assessed.

Of 99 countries with ongoing transmission in 2012, 11 are classified as being in the pre-elimination phase of malaria control, and 10 countries are classified as being in the elimination phase. A further 5 countries were classified as being in the prevention of introduction phase.

Because countries with higher numbers of cases are less likely to submit sufficiently consistent data, it is necessary to draw inferences about the distribution of malaria and trends in some countries using estimates of numbers of cases. The estimated numbers of malaria cases and deaths are accompanied by a large degree of uncertainty but can provide insight into the distribution of malaria across countries and trends over time.

More than 80% of estimated malaria deaths occur in just 14 countries and 80% of estimated cases occur in 17 countries, with Democratic Republic of the Congo and Nigeria together accounting for >40% of the estimated global deaths. International targets for reduction of cases and deaths will not be attained unless substantial progress can be made in these countries.

Malaria is strongly associated with poverty. Malaria mortality rates are highest in countries with a lower GNI per capita. Countries with higher proportions of their population living in poverty (less than US\$ 1.25 per person per day) have higher mortality rates from malaria. Within countries parasite prevalence rates in children are highest in poorer populations and rural areas. There is little difference in parasite prevalence rates by sex in children <5 years of age.

While progress in reducing malaria case incidence and mortality rates has been faster in countries with lower numbers of cases and deaths, the vast majority of *numbers* of cases and deaths averted between 2000 and 2011 have been in countries which had the highest malaria burdens in 2000. If the malaria incidence and mortality rates in 2000 had remained unchanged over the decade, 274 million more cases and 1.1 million deaths would have occurred between 2001 and 2010. The majority of cases averted (52%) and lives saved (58%) are in the 10 countries which had the highest estimated malaria burdens in 2000.

The relation between investments in malaria control and changes in estimated numbers of cases and deaths is not clear except in the African Region, where there is a strong association between per capita investments in malaria control in 2006–2010 and a fall in estimated malaria mortality rates between 2000 and 2011.

There remain many inherent uncertainties in any approach to producing estimates of malaria case incidence and mortality, and on analyses based on the estimates. The global malaria community needs to increase its efforts to support malaria-endemic countries in improving diagnostic testing, surveillance, vital registration, and routine health information systems, so that accurate information on malaria morbidity and mortality can be obtained.

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# Regional profiles

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## African Region



### Central Africa

Algeria	Liberia
Benin	Mali
Burkina Faso	Mauritania
Cape Verde	Niger
Côte d'Ivoire	Nigeria
Gambia	Sao Tome & Principe
Ghana	Senegal
Guinea	Sierra Leone
Guinea-Bissau	Togo

### West Africa

Angola	Congo
Burundi	Democratic Republic of the Congo
Cameroon	Equatorial Guinea
Central African Republic	Gabon
Chad	

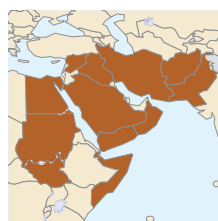
### East Africa and high transmission areas in Southern Africa

Comoros	Rwanda
Eritrea	Uganda
Ethiopia	United Republic of Tanzania (Mainland)
Kenya	United Republic of Tanzania (Zanzibar)
Madagascar	Zambia
Malawi	
Mozambique	

### Low transmission Southern African Countries

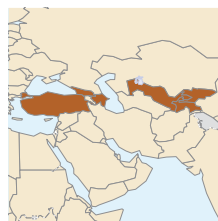
Botswana	Swaziland
Namibia	Zimbabwe
South Africa	

## Eastern Mediterranean Region



Afghanistan	Saudi Arabia
Djibouti	Somalia
Iran (Islamic Republic of)	South Sudan
Iraq	Sudan
Pakistan	Yemen

## European Region



Azerbaijan	Tajikistan
Georgia	Turkey
Kyrgyzstan	Uzbekistan

## South-East Asia Region



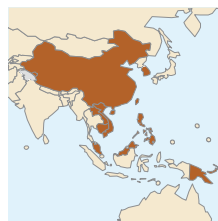
Bangladesh	Myanmar
Bhutan	Nepal
Democratic People's Republic of Korea	Sri Lanka
India	Thailand
Indonesia	Timor-Leste

## Region of the Americas



Argentina	Guyana
Belize	Haiti
Bolivia, (Plurinational State of)	Honduras
Brazil	Mexico
Colombia	Nicaragua
Costa Rica	Panama
Dominican Republic	Paraguay
Ecuador	Peru
El Salvador	Suriname
French Guiana, France	Venezuela, (Bolivarian Republic of)
Guatemala	

## Western Pacific Region



Cambodia	Philippines
China	Republic of Korea
Lao People's Democratic Republic	Solomon Islands
Malaysia	Vanuatu
Papua New Guinea	Viet Nam

This section describes (i) the graphs used in the Regional Profiles, (ii) the strategy to assess trends in malaria case incidence, (iii) the criteria used to classify countries as being in the control, pre-elimination, elimination or prevention of reintroduction phase, (iv) the epidemiology of malaria in each Region, and (vi) summarizes trends in malaria case incidence and their link to malaria programme implementation.

## R.1 Graphs used in Regional Profiles

The following graphs are shown for each WHO Region:

**Figure A. Percentage of cases due to *P. falciparum*:** percentage of confirmed cases in which *P. falciparum* or a mixed infection was detected.

**Figure B. Population at risk:** The population at high risk for malaria is that living in areas where the incidence is more than 1 per 1000 per year (defined at the second or lower administrative level). The population at low risk for malaria is that living in areas with less than 1 case of malaria per 1000 per year (see country profile methods).

**Figure C. Annual blood examination rate (ABER):** number of slide examinations or RDT tests carried out each year in relation to the population at risk for malaria, expressed as a percentage (see country profile methods).

**Figures D–H. Change in number of reported cases:** Trends in the numbers of reported cases: Figure D shows the percentage change in the incidence of reported confirmed cases between 2000 and 2011 (decrease, downward bars; increase, upward bars). For countries in the African Region percentage reductions are in rate of hospital admissions (except for Algeria, Cape Verde, Sao Tome and Principe, and 5 countries in low transmission south-east Africa, where confirmed cases are used). Figures E and F show the numbers of cases (or admissions) for each country between 2000 and 2011, dividing countries between those that are on track to achieve a >75% decrease in case incidence by 2015 (E) or <75% (F) reduction in malaria incidence. Figures G and H present trends in malaria case incidence for each country between 2000 and 2011, again dividing countries

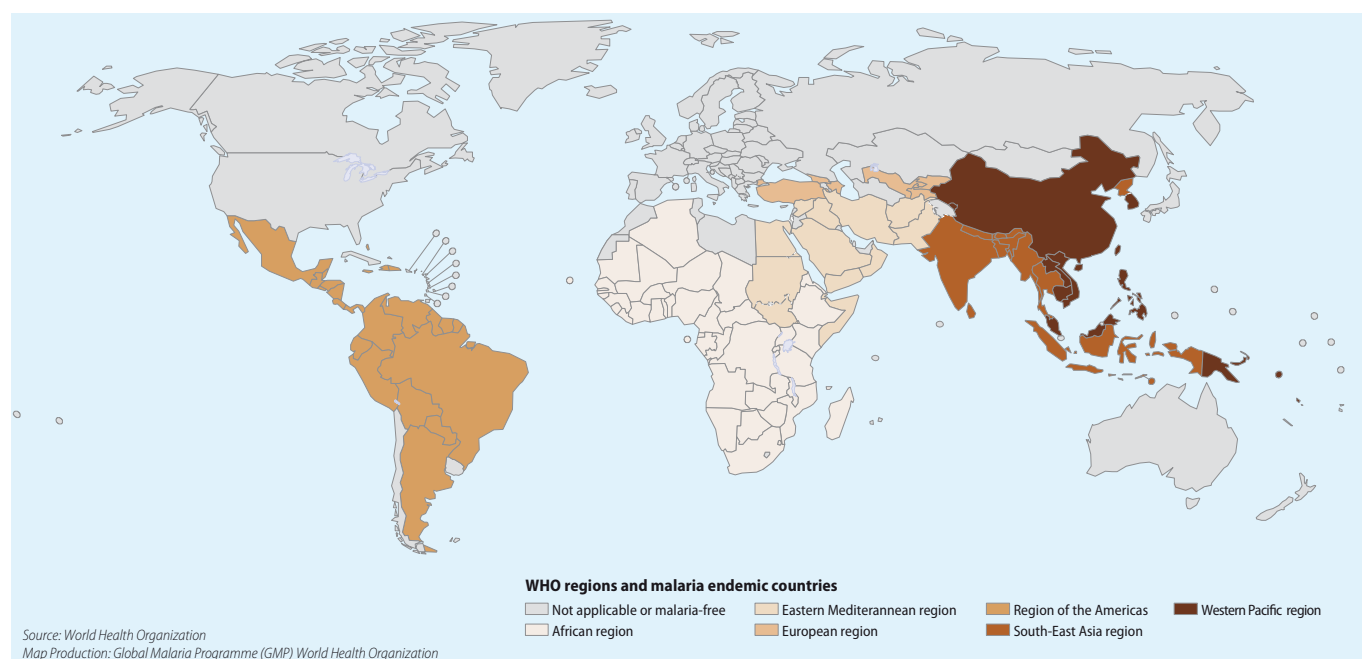
between those that are on track to achieve a ≥75% decrease in case incidence by 2015 (E) or <75% (F) reduction in malaria incidence. The vertical axes in Figures G and H are on a logarithmic scale. Countries with an increase in malaria case incidence or for which reported data are not sufficiently consistent to make an inference about trends, are presented in the graphs for the countries with reductions of <75% (F and H).

**Figure I. IRS and ITNs delivered:** The vertical bars shows the proportion of the population at risk for malaria potentially covered by preventive programmes with IRS and ITNs. It is assumed that each ITN delivered can cover on average 1.8 people, that conventional nets are re-treated regularly, and that no nets are replaced before 3 years.

**Figure J. Cases potentially treated with antimalarial drugs:** Few countries have information systems that record treatments given to individual patients. It is therefore necessary to use aggregate information on numbers of treatment courses delivered to public health facilities and relate these to the number of patients attending health facilities. The number of treatment courses available is shown as a percentage of confirmed plus presumed malaria cases reported (correcting for reporting completeness in the public sector). The bars for any antimalarial treatment show the number of all treatment courses supplied in relation to all malaria cases, including those due to *P. falciparum*. The bars for ACT show the number of ACT treatment courses in relation to the number of *P. falciparum* cases reported in the public sector. In many countries in sub-Saharan Africa patients with clinically diagnosed malaria do not receive a diagnostic test but are presumed to have *P. falciparum*.

## R.2 Assessing trends in the incidence of malaria

The reported numbers of malaria cases and deaths are used as core indicators for tracking the progress of malaria control programmes (the working definition of a case of malaria is considered to be “fever with parasites” (1)). The main sources



of information on these indicators are the disease surveillance systems operated by ministries of health. Data from such systems have 3 strengths: (i) case reports are recorded continuously over time and can thus reflect changes in the implementation of interventions or other factors, (ii) routine case and death reports are often available for all geographical units of a country, and (iii) they reflect the burden that malaria places on the health system. Changes in the numbers of cases and deaths reported by countries do not, however, necessarily reflect changes in the incidence of disease in the general population, because: (i) not all health facilities report each month, and so variations in case numbers may reflect fluctuations in the number of health facilities reporting rather than a change in underlying disease incidence; (ii) routine reporting systems often do not include patients attending private clinics or morbidity treated at home, so disease trends in health facilities may not reflect trends in the entire community; and (iii) not all malaria cases reported are confirmed by microscopy or RDT, so that some of the cases reported as malaria may be other febrile illnesses (1,2). When reviewing data supplied by ministries of health in malaria-endemic countries, the following strategy was used to minimize the influence of these sources of error and bias:

- Focusing on confirmed cases (by microscopy or RDT) to ensure that malaria, and not other febrile illnesses, are tracked. For high-burden countries in the WHO African Region, where little case confirmation is undertaken, the numbers of malaria admissions (inpatient cases) and deaths are reviewed because the predictive value of diagnosis undertaken for an admitted patient is considered to be higher than outpatient diagnosis based only on clinical signs and symptoms. In such countries, the analysis may be heavily influenced by trends in severe malaria rather than trends in all cases.
- Monitoring the number of laboratory tests undertaken. It is useful to measure the ABER, which is the number of parasitological tests (by microscopy or RDT) undertaken per 100 people at risk per year, to ensure that potential differences in diagnostic effort or completeness of reporting are taken into account. To discern decreases in malaria incidence, the ABER should ideally remain constant or be increased.<sup>1</sup> In countries progressively reducing their malaria endemicity, the population at risk also reduces, becoming limited to foci where malaria transmission is present, or where there is potentially a high risk due to receptivity. In addition, it is useful to monitor the percentage of suspected malaria cases that were examined with a parasite-based test. When reviewing the number of malaria admissions and deaths, the health facility reporting rate (the proportion of health facilities that report) should remain constant and should be high, i.e. > 80%.
- Monitoring trends in the malaria (slide or RDT) positivity rate (SPR). This rate should be less severely distorted by variations in the ABER than trends in the number of confirmed cases.

1. Some authorities recommend that the ABER should exceed 10% to ensure that all febrile cases are examined; however, the observed rate depends partly on how the population at risk is estimated, and trends may still be valid if the rate is <10%. Some authorities have noted that 10% may not be sufficient to detect all febrile cases. It is noteworthy that the ABER in the Solomon Islands, a highly endemic country, exceeds 60%, with a slide positivity rate of 25%, achieved solely through passive case detection.

- Monitoring malaria admissions and deaths. For high-burden African countries, when the number of malaria admissions or deaths is being reviewed, it is also informative to examine the percentage of admissions or deaths due to malaria of total inpatient cases and deaths respectively, as this proportion is less sensitive to variation in reporting rates than the number of malaria admissions or deaths.
- Monitoring the number of cases detected in the surveillance system in relation to the total number of cases estimated to occur in a country (see chapter 7). Trends derived from countries with high case detection rates are more likely to reflect trends in the broader community. When examining trends in the number of deaths, it is useful to compare the total number of deaths occurring in health facilities with the total number of deaths estimated to occur in the country.
- Examining the consistency of trends. Unusual variation in the number of cases or deaths that cannot be explained by climate or other factors, or inconsistency between trends in cases and in deaths, can suggest deficiencies in reporting systems.
- Monitoring changes in the proportion of cases due to *P. falciparum* or the proportion of cases occurring in children <5 years of age. While decreases in the incidence of *P. falciparum* malaria may precede decreases in *P. vivax* malaria, and there may be a gradual shift in the proportion of cases occurring in children <5 years, unusual fluctuations in these proportions may point to changes in health facility reporting or to errors in recording.

The aim of these procedures is to rule out data-related factors, such as incomplete reporting, or changes in diagnostic practice, as explanations for a change in the incidence of disease and to ensure that trends in health facility data reflect changes in the wider community. The results of the analysis are shown in **Table R.1**. The conclusion that trends inferred from health facility data reflect changes in the community has more weight if (i) the changes in disease incidence are large (ii) coverage with public health services is high and (iii) interventions promoting change, such as use of ITNs, are delivered throughout the community and not restricted to health facilities.

### R.3 Establishing a link between malaria disease trends and control activities

In establishing a causal link between malaria disease trends and control activities, one should consider what the disease trends would have been without application of the control activities and then assess whether the decrease in malaria observed is greater than that expected without control activities. A realistic view of what would have happened without control activities (i.e. counterfactual) cannot be established from the data currently available; however, it can be expected that, without a change in control activities, the malaria incidence might fluctuate in response to short-term climate variations but would otherwise show little change, as improved living conditions, environmental degradation or long-term climate change have only gradual effects (although there may be local exceptions). Thus, a plausible link with control efforts can be established if the disease incidence decreases at the same time as control activities increase, if the magnitude of the decrease in malaria

**Table R.1** Summary of trends in reported malaria incidence 2000–2011

Region	On track for >75% decrease in incidence 2000–2015	50%–75% decrease in incidence projected 2000–2015	<50% decrease in incidence projected 2000–2015	Increase in incidence 2000–2011	Insufficiently consistent data to assess trends
Africa	<b>Algeria</b> <b>Botswana</b> <b>Cape Verde</b> <b>Namibia</b> <b>Rwanda</b> <b>Sao Tome and Principe</b> <b>South Africa</b> <b>Swaziland</b> Eritrea	Madagascar Zambia			Angola Guinea Benin Guinea-Bissau Burkina Faso+ Kenya* Burundi+ Liberia+ Cameroon Malawi Central African Republic Mali Mauritania Mozambique Chad Niger Comoros Nigeria Congo Senegal Côte d'Ivoire Sierra Leone+ Democratic Republic of the Congo+ Uganda+ Equatorial Guinea United Republic of Tanzania (Mainland)* Ethiopia Gabon Zimbabwe+ Gambia Ghana
Americas	<b>Argentina</b> <b>Belize</b> <b>Bolivia</b> <b>(Plurinational State of)</b> <b>Costa Rica</b> <b>Ecuador</b> <b>El Salvador</b> <b>French Guiana, France</b>	<b>Guatemala</b> <b>Honduras</b> <b>Mexico</b> <b>Nicaragua</b> <b>Paraguay</b> <b>Suriname</b> Colombia Panama Peru	Brazil	Dominican Republic Guyana Venezuela (Bolivarian Republic of)	
Eastern Mediterranean	<b>Afghanistan</b> <b>Iran (Islamic Republic of)</b>	<b>Iraq</b> <b>Saudi Arabia</b>			Djibouti South Sudan Pakistan* Sudan* Somalia Yemen*
Europe	<b>Azerbaijan</b> <b>Georgia</b> <b>Kyrgyzstan</b>	<b>Tajikistan</b> <b>Turkey</b> <b>Uzbekistan</b>			
South-East Asia	<b>Bhutan</b> <b>Democratic People's Republic of Korea</b>	<b>Nepal</b> <b>Sri Lanka</b> <b>Thailand</b> Bangladesh	India		Indonesia Myanmar+ Timor-Leste+
Western Pacific	<b>Cambodia</b> <b>China</b> <b>Lao People's Democratic Republic</b> <b>Philippines</b> <b>Republic of Korea</b>	<b>Solomon Islands</b> <b>Vanuatu</b> <b>Viet Nam</b> Malaysia		Papua New Guinea	

Source: NMCP data

Countries in bold achieved 75% decrease in case incidence by 2011

\* Progress in reducing cases has been reported sub-nationally where interventions have been intensified.

+ Country has recently expanded diagnostic testing, so assessment of trends is difficult.



**Table R.2** Criteria for classifying countries according to malaria programme phase

	Pre-elimination	Elimination	Prevention of reintroduction
<b>Malaria situation in areas with most intense transmission</b>			(1) Recently endemic country with zero local transmission for at least three years; or (2) Country on the Register or Supplementary list that has ongoing local transmission*
Test positivity rate	< 5% among suspected malaria patients (PCD) throughout the year		
API in the district with the highest number of cases/1000 population/year (ACD and PCD)**, averaged over the last two years	<5 (less than 5 cases / 1000 population)	<1 (less than 1 case / 1000 population)	
Total number of reported malaria cases nationwide		A manageable number, e.g. <1000 cases nationwide (local & imported)	
<b>Case management</b>			Imported malaria. Maintain capacity to detect malaria infection and manage clinical disease
All cases detected in the private sector are microscopically confirmed	National policy being rolled out	Yes	Yes
All cases detected in the public sector are microscopically confirmed	National policy being rolled out	Yes	Yes
Nationwide microscopy quality assurance system covers public and private sector	Initiated	Yes	Yes
Radical treatment with primaquine for <i>P. vivax</i>	National policy being updated	National policy fully implemented	Yes
Treatment with ACT plus single dose primaquine for <i>P. falciparum</i>	National policy being updated	National policy fully implemented	Yes
<b>Surveillance</b>			Vigilance by the general health services
Malaria is a notifiable disease nationwide (<24–48 hrs)	Laws and systems being put in place	Yes	Yes
Centralized register on cases, foci and vectors	Initiated	Yes	Yes
Malaria elimination database	Initiated	Yes	Certification process (optional)
Active case detection in groups at high risk or with poor access to services ("pro-active" case detection)	Initiated	Yes	In residual and cleared-up foci; among high risk population groups
Case and foci investigation & classification (including "reactive" case detection and entomological investigation)	Initiated	Yes	Yes

\* Ongoing local transmission = 2 consecutive years of local *P. falciparum* malaria transmission; or 3 consecutive years of local *P. vivax* malaria transmission in the same locality or otherwise epidemiologically linked.

\*\* The API has to be evaluated against the diagnostic activity in the risk area (measured as the ABER). Low values of ABER in a district raise the possibility that more cases would be found with improved diagnostic efforts.

**Table R3** Countries that have been certified by WHO as malaria-free or added to the supplementary list of countries where malaria never existed or disappeared without specific measures

Region	Country/territory	Year added to the official register*	Year added to the supplementary list**
<b>African</b>	Lesotho		2012
	Mauritius	1973	
	Seychelles		2012
<b>Eastern Mediterranean</b>	Bahrain		2012
	Jordan		2012
	Kuwait		1963
	Lebanon		2012
	Libya		2012
	Morocco	2010	
	Qatar		2012
	Tunisia		2012
	United Arab Emirates	2007	

Region	Country/territory	Year added to the official register*	Year added to the supplementary list**
European	Albania		2012
	Andorra		2012
	Armenia	2011	
	Austria		1963
	Belarus		2012
	Belgium		1963
	Bosnia and Herzegovina	1973	
	Bulgaria	1965	
	Croatia	1973	
	Cyprus	1967	
	Czech Republic		1963
	Denmark		1963
	Estonia		2012
	Finland		1963
	France (with exception of French Guiana and the island Mayotte)		2012
	France, <i>Réunion</i>	1979	
	Germany		1964
	Greece		2012
	Hungary	1964	
	Iceland		1963
	Ireland		1963
	Israel		2012
	Italy	1970	
	Kazakhstan		2012
	Latvia		2012
	Lithuania		2012
	Luxembourg		2012
	Malta		1963
	Monaco		1963
	Montenegro	1973	
	Netherlands	1970	
	Norway		1963
	Poland	1967	
	Portugal	1973	
	Republic of Moldova		2012
	Romania	1967	
	Russian Federation		2012
	San Marino		1963
	Serbia	1973	
	Slovakia		1963
Slovenia	1973		
Spain	1964		
Sweden		1963	
Switzerland		1963	
The former Yugoslav Republic of Macedonia	1973		
Turkmenistan	2010		
Ukraine		2012	
United Kingdom		1963	
Region of the Americas	Antigua and Barbuda		2012
	Bahamas		2012
	Barbados		1968
	Canada		1965
	Chile		1968
	Cuba	1973	
	Dominica	1966	
	Grenada	1962	
	Jamaica	1966	
	Saint Kitts and Nevis		2012
Region of the Americas	Saint Lucia	1962	
	Saint Vincent and the Grenadines		2012
	Trinidad and Tobago	1965	
	United States of America	1970	

Region	Country/territory	Year added to the official register*	Year added to the supplementary list**
	Uruguay		2012
	Venezuela (Bolivarian Republic of, northern part)	1961	
Western Pacific	Australia	1981	
	Brunei Darussalam	1987	
	China, Taiwan	1965	
	Cook Islands		1963
	Fiji		1963
	Japan		2012
	Kiribati		2012
	Marshall Islands		1963
	Micronesia,(Federated States of)		1963
	Mongolia		1963
	Nauru		1963
	New Zealand		1963
	Niue		1963
	Palau		1963
	Samoa		1963
	Singapore	1982	
	Tonga		1963
Tuvalu		2012	
South-East Asian	Maldives		2012

\*WHO Official Register of areas where malaria elimination has been achieved

\*\*Supplementary list indicates countries where malaria never existed or disappeared without specific measures

incidence is consistent with the magnitude of the increase in control activities (a 50% decrease in the number of cases is unlikely to occur if malaria control activities cover only 10% of the population at risk) and if the decreases in malaria incidence cannot readily be explained by other factors.

## R.4 Classification of countries according to malaria programme phase

In February 2012, the Malaria Policy Advisory Committee (MPAC) discussed the classification of countries according to their malaria programme phase and the milestones on the path to malaria elimination (3). It noted that the format of the classification criteria as used in previous editions of the *World Malaria Report* (4,5,6,7) did not facilitate tracking over time. This discussion led to the development of updated classification criteria supported by indicators to make the process of classification as transparent as possible. The updated WHO country classification criteria are based on an evaluation of 3 main components: the malaria situation, case management practices, and the surveillance system as shown in **Table R.2**.<sup>2</sup> The evaluation concentrates on the situation in those districts of the country reporting the highest API.

Also as a result of the MPAC discussions, the list of countries that are officially recognized as being malaria-free has been expanded to include all countries that (1) never had malaria transmission, or (2) have been malaria-free for well over a decade. In consultation with the WHO Regional Offices, 31 malaria-free

countries have therefore been added to the "Supplementary list"<sup>3</sup> see **Table R.3**. The Supplementary list complements the list of countries that have been certified by WHO as malaria-free ("The Register")<sup>4</sup> (6). All the countries and areas on these two lists have been without local malaria transmission for significant periods of time, even though some may suffer renewed outbreaks of local transmission subsequent to importation of parasites from abroad (including, as of 2011, Greece). Countries included in the Supplementary list do not need to request (and are not eligible for) certification of their malaria-free status.

The northern part of Venezuela (Bolivarian Republic of) is the only subnational administrative level immediately adjacent to endemic areas that has ever been certified by WHO as malaria-free, and was the first area so certified by the Pan American Health Organization (PAHO) in 1961. The other WHO certification exercises concerned entire nations, in addition to the islands of Taiwan (China, 1965) and La Réunion (France, 1979). Since 1980, WHO certification has only taken place at national level. As of 2011, elimination at subnational level, usually in the form of a "malaria-free initiative" is a declared goal in several control-phase countries, including China, Indonesia, the Philippines, Solomon Islands, Sudan, Vanuatu, and Yemen. In the Philippines, the Ministry of Health is providing subnational certification of achievement of malaria elimination at provincial level.

## R.5 Regional profiles

2. Other components such as (1) the stated programme goal; (2) vector control and malaria prevention practices; and (3) health systems and financing are also important for tracking progress towards elimination, however they are less specific and therefore not included as classification criteria.

3. The Supplementary list was started in the 1960s during the Global Malaria Eradication Programme (1955–1972) to indicate countries where malaria never existed or disappeared without specific measures.

4. The WHO Official Register of areas where malaria eradication has been achieved.

# West Africa

Of the 17 countries in this subregion, 2 reduced malaria case incidence rates by  $\geq 75\%$  between 2000 and 2011 (Algeria and Cape Verde). In the other countries, evidence of change in malaria case incidence is scant owing to inconsistent reporting over time despite a marked scale-up of key interventions.

This subregion is generally characterised by a high intensity of malaria transmission and cases are almost exclusively due to *P. falciparum* (Figures A, B). However, transmission intensity is lower in Cape Verde and Algeria and these countries are in the pre-elimination and elimination phase respectively. All other countries are in the control phase.

Only 2 countries (Algeria and Cape Verde) have consistent records of diagnostic testing since 2000, and in these countries, the incidence rate of confirmed indigenous malaria cases decreased by  $\geq 75\%$  between 2000 and 2011 (Figures D, E, F). Algeria reported only 4 local cases and 187 imported cases in 2011. In Cape Verde the number of indigenous cases decreased by 72% between 2000 and 2011; numbers have fluctuated with fewer than 100 cases per year with no further decreases since the beginning of the decade.

For all other 15 countries in this subregion, attempts to evaluate malaria trends are based on time series of hospital admissions and deaths (Figures D, F, H) because of inadequate historical data on parasitologically confirmed cases. Senegal had reported a reduction in admissions of 40% between 2000 and 2009 but has failed to report data since then owing to labour disputes within the health service (Figures D, F, H). Mali did not report on admissions for malaria between 2000 and 2011. For most countries that reported, the numbers of admitted malaria cases and malaria deaths have been rising (Figures D, F, H). These striking upward trends are likely to be due to improved reporting or access to health services, as the total number of admissions and deaths from all causes has also been rising. As a result, routinely collected data from most of the countries in this subregion do not enable trends to be assessed.

## Country in the pre-elimination phase

Cape Verde

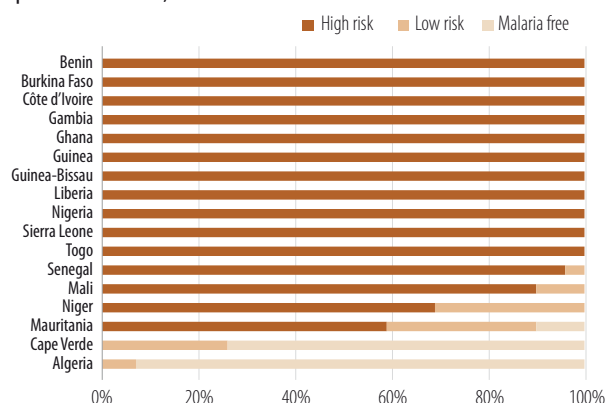
## Country in the elimination phase

Algeria

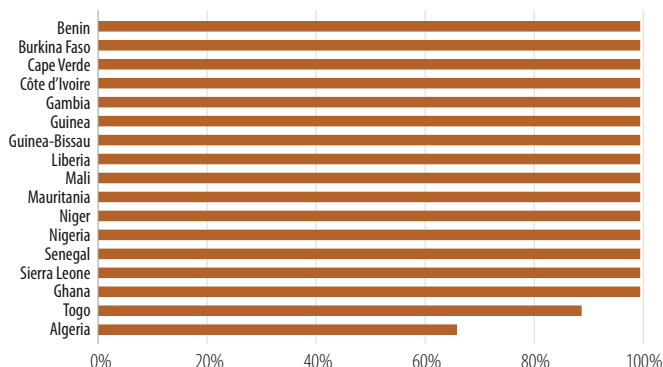
The number of ITNs reported as delivered between 2009 and 2011 could potentially have protected more than half of the populations at risk in Benin, Burkina Faso, Côte d'Ivoire, Gambia, Liberia, Mali, Mauritania, Senegal, Sierra Leone and Togo (Figure I). The countries with the highest populations at risk (Ghana, Niger and Nigeria) had a lower estimated ITN coverage in 2011 than in previous years. Most of the countries reported delivering sufficient ACTs to treat all patients attending public health facilities but the quantities supplied in Mauritania were inadequate (Figure J). Cape Verde, Senegal and Guinea-Bissau did not report on ACT deliveries.

A few research studies have documented successes in some countries of this subregion. In Niger, child mortality decreased from 226 in 1998 to 126 in 2009; ITNs were estimated to contribute to 25% of the reduction (8). In Benin, a reduction in malaria transmission was reported after implementation of IRS with bendiocarb in 4 districts (9). A study in 8 villages in Burkina Faso (10) found a reduction in parasite prevalence from 64% to 46% associated with an increase in ITN use from 0% to 73%. Many more special studies of this kind are needed to gain a full understanding of the effects of malaria control in the African subregions.

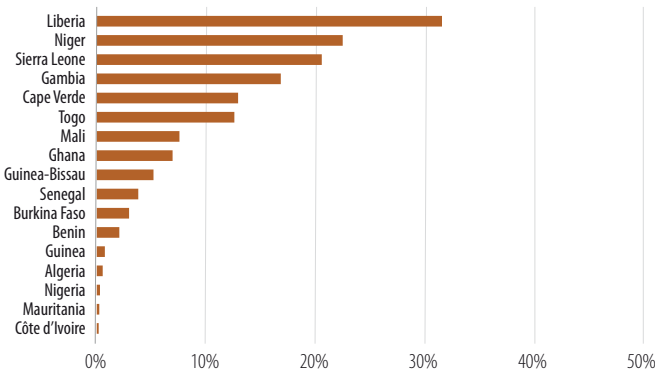
A – Population at risk, 2011



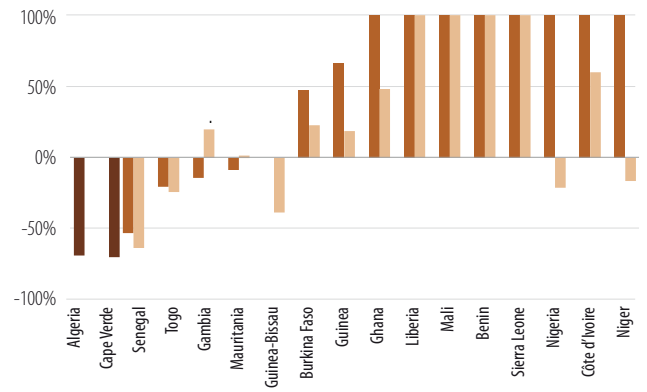
B – Percentage of cases due to *P. falciparum*, 2007–2011



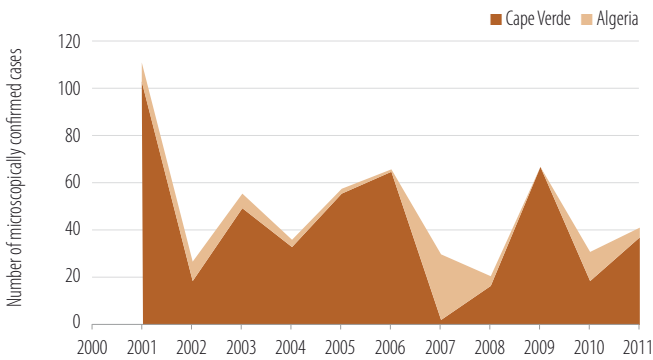
C – Annual blood examination rate, 2007–2011



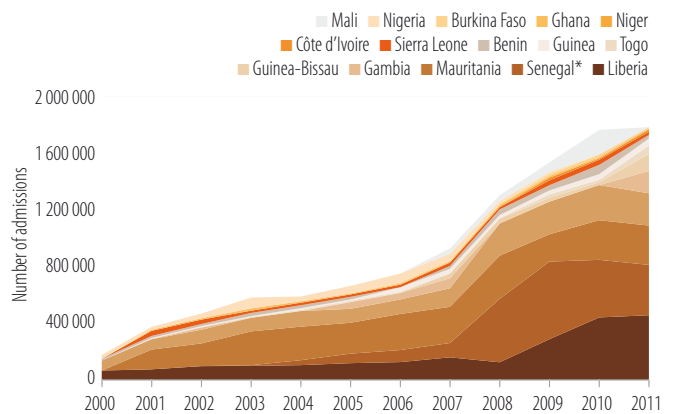
D – Percentage change in case incidence or admissions and death rates, 2000–2011



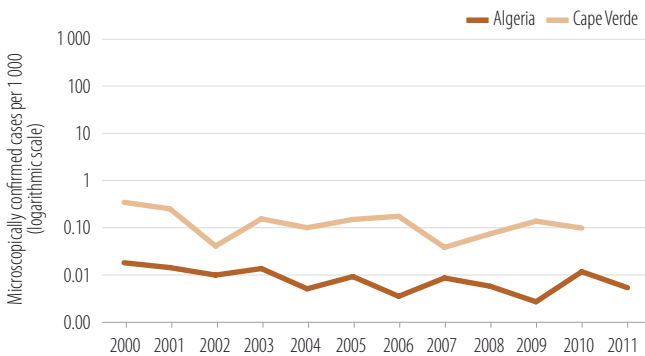
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



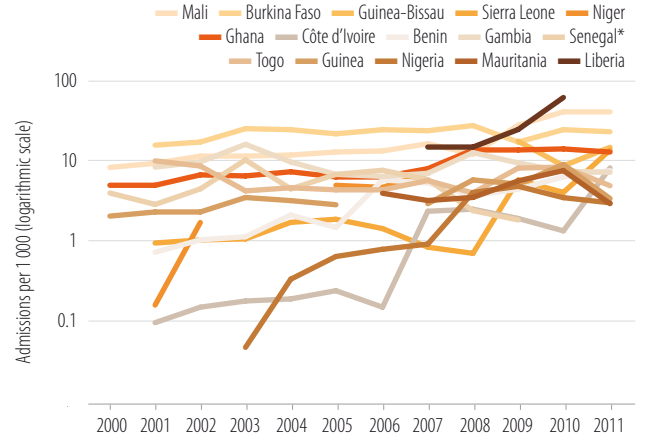
F – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess trends



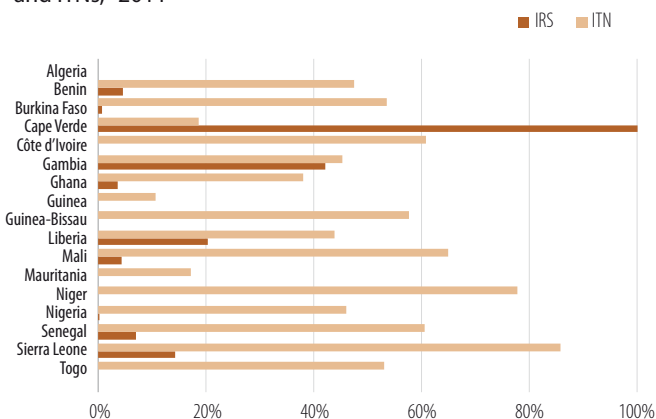
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



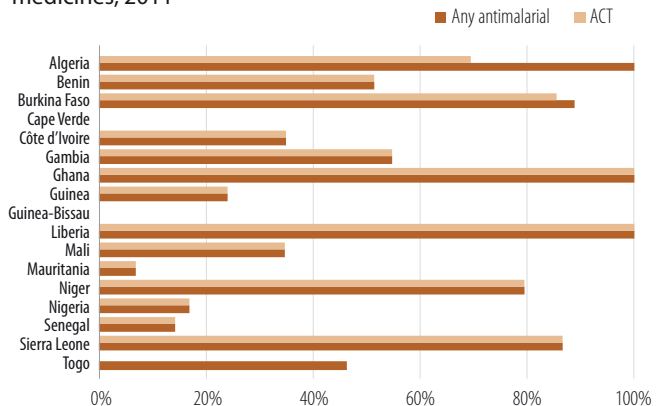
H – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011





# Central Africa

**Of the 10 countries in this subregion, one country has reduced malaria case incidence rates by  $\geq 75\%$  between 2000 and 2011 (Sao Tome and Principe). Incompleteness or inconsistency of reporting malaria cases, admissions and deaths restricts the possibility of drawing reliable conclusions about malaria trends elsewhere in this subregion.**

Malaria endemicity in all the countries of this subregion is characterised by moderate to high transmission, exclusively caused by *P. falciparum* (Figures A, B). All countries are in the control phase.

In Sao Tome and Principe, the number of confirmed malaria cases fell by 87% between 2000 and 2011 and the number of malaria admissions by 84% (Figures D, E, G). Recent years have seen a higher number of cases and admissions; the number of cases reported in 2011 (6400) is the highest since 2005 and the number of malaria admissions is the highest since 2006. Nonetheless the country had achieved a reduction in malaria case incidence of  $>75\%$  by 2011.

Due to low rates of diagnostic testing, the data used to assess trends in other countries in this subregion are the numbers of malaria admissions to hospitals and health centres. In most countries the reported numbers of malaria admissions and deaths were stable or rising (Figures D, F, H). Angola reported slight decreases in malaria admissions and deaths since 2007. The increase in the number and rate of admissions for some countries since 2007 may be due to improved reporting and/or better access to health services, since, with the exception of the Central African Republic, the total number of admissions for all causes reported has increased (and the proportion of admissions due to malaria has been constant or decreasing). Gabon did not report any data for 2011.

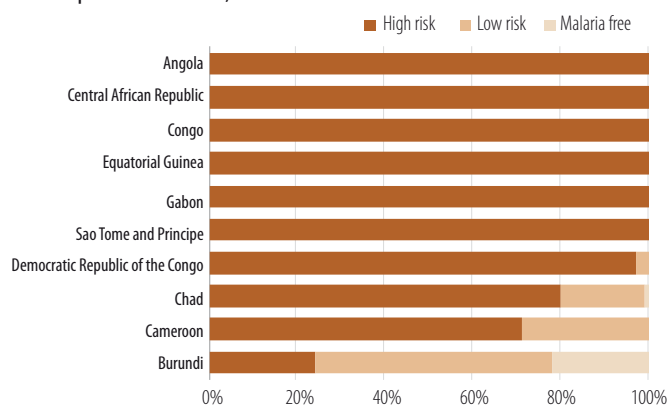
Evidence of change in malaria incidence or mortality rates from peer-reviewed publications is scanty in this subregion. A study in the Island of Bioko in Equatorial Guinea found a decrease in parasite prevalence in children between 2004 and 2011, and a shift in the age of peak prevalence from 8 year-olds to 12 year-

olds in this period, after the combined implementation of ITNs and IRS (17). However, such selective studies do not allow general conclusions to be drawn about trends in malaria throughout the subregion.

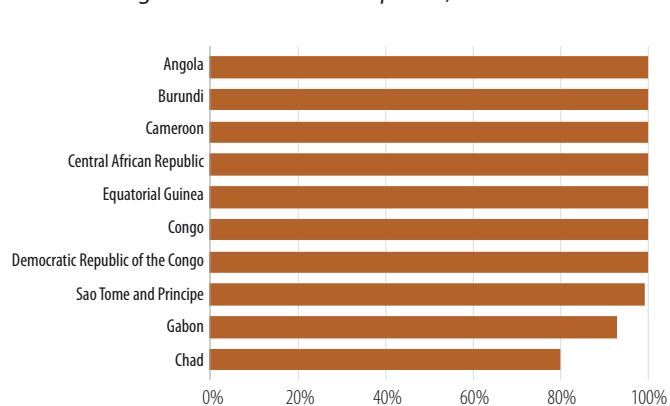
The strongest association between interventions and their impact on malaria morbidity and mortality is seen in Sao Tome and Principe (Figures C, E, G, I, J). Reported coverage with IRS or ITNs and diagnostic testing is high: ABER exceeds 60%, far greater than in other countries in this subregion. However, the recent increase in malaria admissions despite maintaining high coverage of the interventions requires further investigation. Burundi and Cameroon reported a high ( $>70\%$ ) percentage of the population potentially covered by ITNs delivered in 2011 but did not report a decrease in admissions and deaths. Angola, Central African Republic, Chad and the Democratic Republic of the Congo reported moderate (around 30%–60%) coverage with ITNs (Figure I). The Democratic Republic of the Congo, Equatorial Guinea and Gabon reported little evidence of intensified vector control. Half of the countries in the subregion, (Angola, Burundi, Cameroon, and Democratic Republic of the Congo) reported delivery of sufficient ACTs to treat all presumed and confirmed cases of malaria attending public health facilities (Figure J).

In summary, only one country in this subregion, Sao Tome and Principe, was able to reliably document changes in the incidence of malaria. Nearly half of the countries had made only slow progress in delivering interventions, both vector control and ACTs. Even in the countries that have scaled up both ITNs and ACTs (Angola, Burundi, Cameroon and Democratic Republic of the Congo), it has not been possible to evaluate the impact of these efforts because the quality of routinely collected data is generally poor, the parasitological confirmation rate is low, and there are few alternative sources of information such as population-based surveys or specific studies of the impact of interventions. Following substantial investments in malaria control in this subregion, the need for improved surveillance and evaluation is critical.

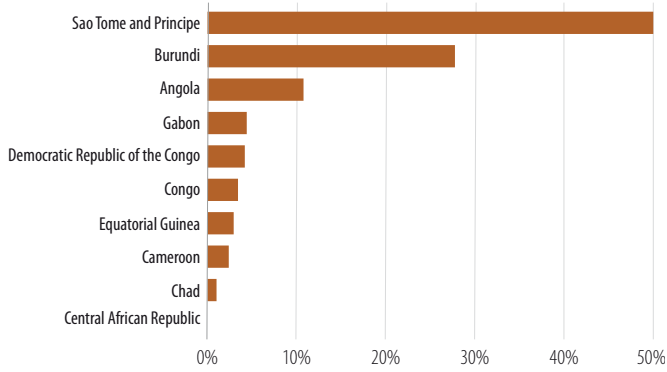
A – Population at risk, 2011



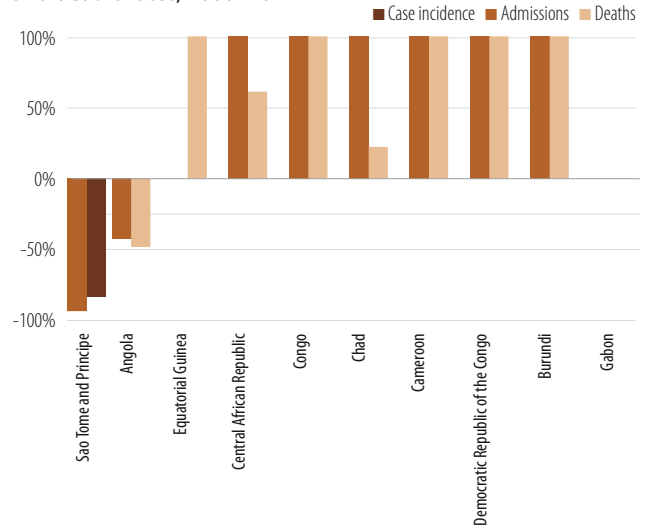
B – Percentage of cases due to *P. falciparum*, 2007–2011



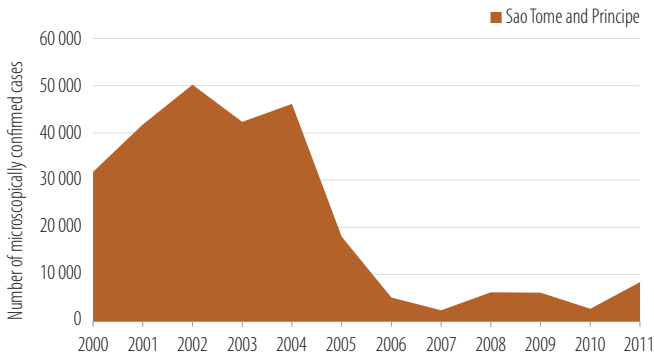
C – Annual blood examination rate, 2007–2011



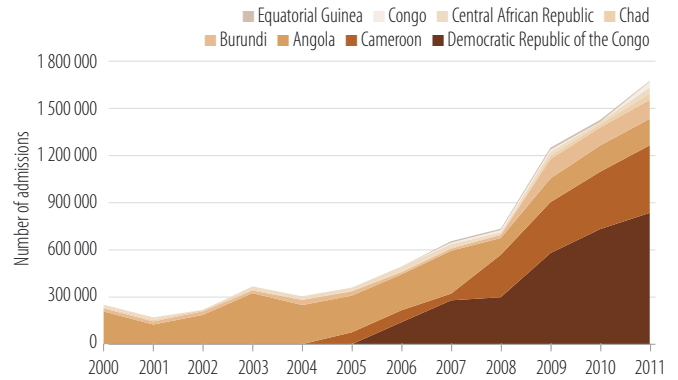
D – Percentage change in case incidence or admissions and deaths rates, 2000–2011



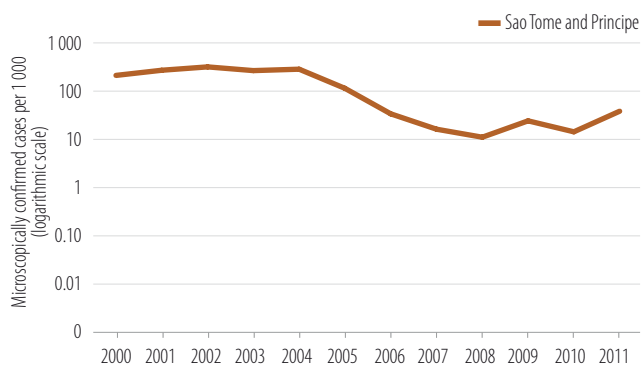
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



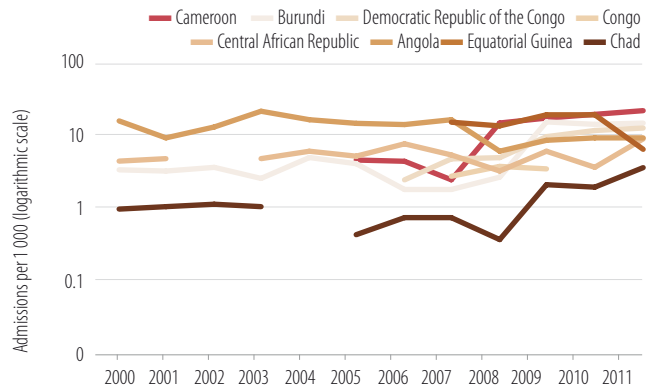
F – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess trends



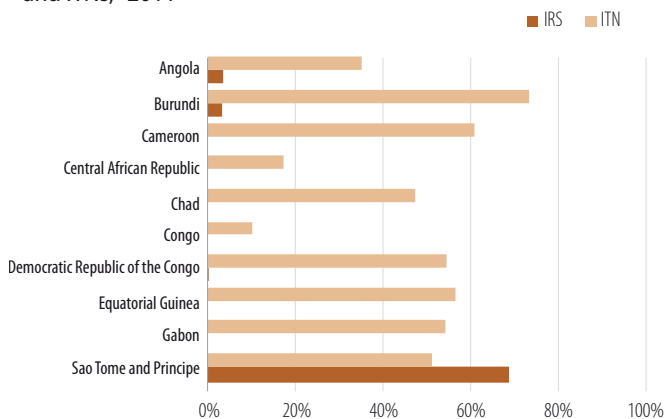
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



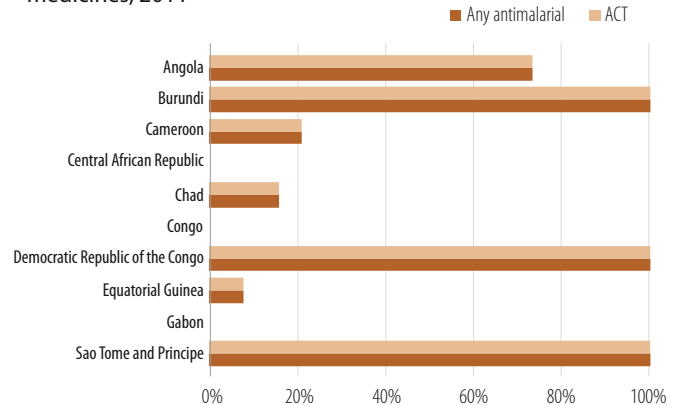
H – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# East and southern Africa

(excluding low transmission countries in southern Africa)

Of the 11 countries in this subregion, Rwanda reduced malaria admission rates by  $\geq 75\%$  between 2000 and 2011. Eritrea is on track to reduce admission rates by 75% by 2015 and 2 countries are projected to reduce admission rates by 50%–75% (Madagascar and Zambia). In the remaining 7 countries it was not possible to make a reliable assessment of malaria trends owing to changes in health service accessibility or inconsistency of reporting over time. However, amongst these 7, the island of Zanzibar (United Republic of Tanzania) reduced malaria admission rates by  $\geq 75\%$  between 2000 and 2011.

All countries in this subregion are in the control phase. The majority of the inhabitants are exposed to a high risk of malaria (Figure A), although more than 25% of the population of Ethiopia and Kenya live in malaria-free areas. In most countries, cases of malaria are predominantly due to *P. falciparum* (Figure B), with the exception of Eritrea and Ethiopia where the proportions of cases due to *P. vivax* are 50% and 37% respectively.

Access to diagnostic testing has been low and inconsistent in the subregion except in Rwanda and Eritrea. In recent years almost all the countries have expanded diagnostic testing with RDTs and microscopy, resulting in increase in the number of confirmed cases in most settings. Given the change in diagnostic practice it is necessary to use numbers of malaria admissions to examine changes in malaria incidence over time.

Between 2000 and 2011 the number of malaria admissions to hospitals and health centres decreased by  $>75\%$  in Rwanda and the island of Zanzibar (United Republic of Tanzania), by 50%–75% in Eritrea (Figures D, E, G), and by 25%–50% in Madagascar and Zambia (Figures D, F, H). Rwanda has reversed the increases in cases and admissions observed in 2009 and consolidated its progress by reporting the lowest ever recorded numbers of confirmed cases, malaria admissions and deaths in 2011. The number of admissions reported in Zanzibar (United Republic of Tanzania) increased in 2011 compared to 2010, but was still the second lowest reported since 2000. The declines in malaria admissions and deaths seen in nationally aggregated hospital data are consistent with published studies of data from health facilities in Rwanda and Zanzibar (United Republic of Tanzania) (12,13).

Malaria admission rates, taking into account population growth, decreased by  $\geq 75\%$  in Rwanda and Zanzibar (United Republic of Tanzania) (Figures D, E, G). Eritrea is on track to achieve a 75% reduc-

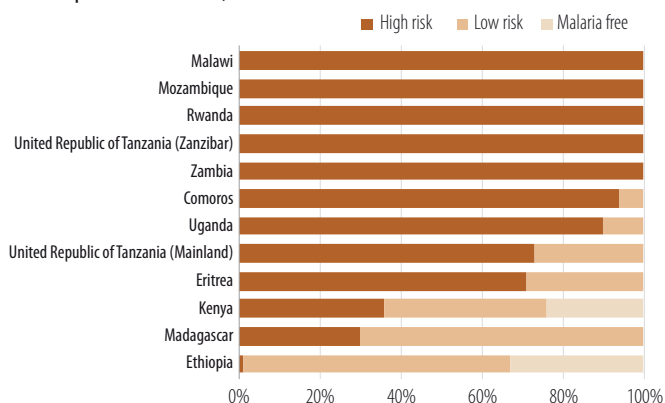
tion in malaria admission rates by 2015 (Figures D, E, G) whereas Madagascar and Zambia are projected to achieve reductions in malaria admission rates of 50% by 2015 (Figures D, F, H). The number of national aggregated admissions in Ethiopia has increased every year since 2008, and in 2011 was the second highest on record since 2000; the increase may be related to improved access to health facilities as the number of hospitals increased from about 120 in 2005 to more than 195 hospitals in 2010. A preliminary result of a WHO-led impact assessment using retrospective surveillance data in 39 hospitals below 2000m of elevation in Ethiopia shows that malaria admissions decreased by 43% between 2001–2011.

Data on admissions were too incomplete or inconsistently reported to make an assessment of trends in Comoros, Kenya, Malawi, Mozambique, Uganda, and the United Republic of Tanzania (Mainland) (Figures D, F, H). Trends in hospital deaths were similar to the trends in hospitalized cases as would be expected (Figure D).

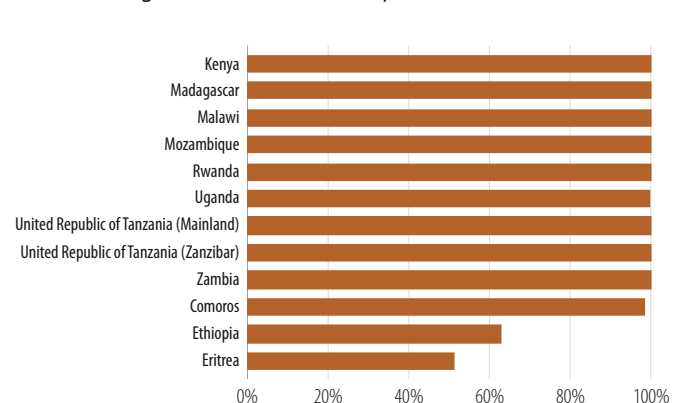
ITNs are the principal method of vector control in this subregion but the use of IRS is expanding in Ethiopia, Madagascar, Mozambique, and Zambia. In 7 countries (Comoros, Ethiopia, Kenya, Madagascar, Rwanda, United Republic of Tanzania, and Zambia) enough ITNs were distributed to cover  $>60\%$  of the population at risk (Figure I). In Rwanda and Zambia a relatively high coverage of vector control might explain why cases declined substantially between 2000 and 2011. But this association has not yet been observed in the Comoros or in mainland Tanzania (Figures D, F, H, I). In-depth investigations are needed to explain these inconsistencies. The proportion of the population potentially protected by ITNs decreased in 2011 in Zanzibar (United Republic of Tanzania) compared to 2009 and 2010 but IRS coverage was maintained at high levels. Most countries reported distributing sufficient ACTs to treat patients attending public health facilities, but Eritrea, Kenya and Rwanda did not report on ACT deliveries in 2011 (Figure J).

In summary, in 2011, Eritrea, Madagascar, Rwanda and Zambia, and the island of Zanzibar (United Republic of Tanzania) are on track to achieve a 75% reduction in malaria admission rates by 2015, and similar trends are seen in malaria death rates. In all these countries, there was high potential coverage ( $>60\%$ ) of either ITNs or IRS and good access to ACTs. In the remaining countries that are scaling-up interventions, the impact of interventions on malaria morbidity and mortality remains to be confirmed.

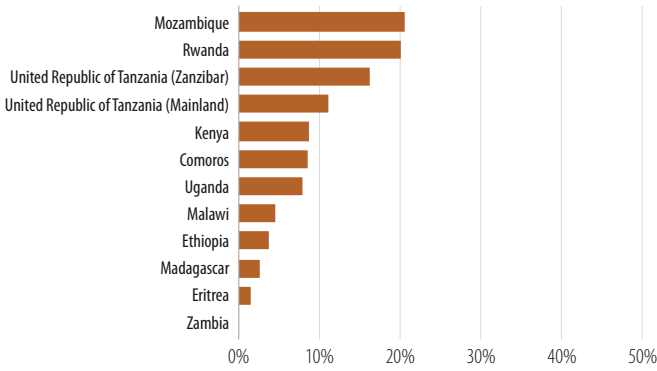
A – Population at risk, 2011



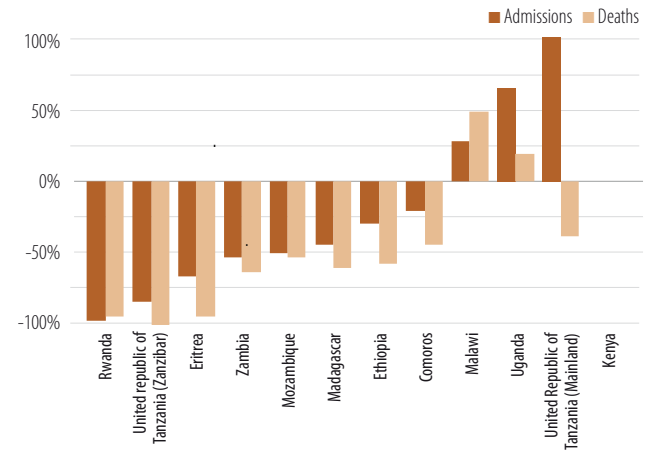
B – Percentage of cases due to *P. falciparum*, 2007–2011



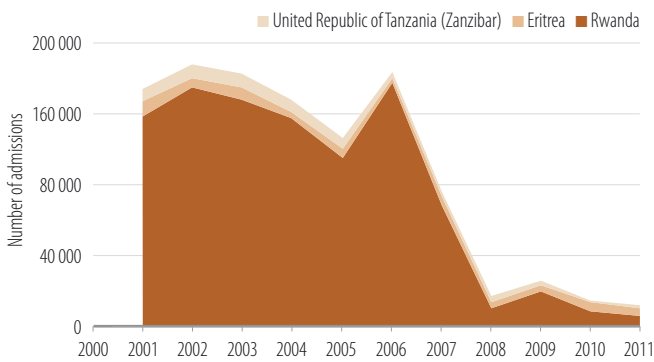
C – Annual blood examination rate, 2007–2011



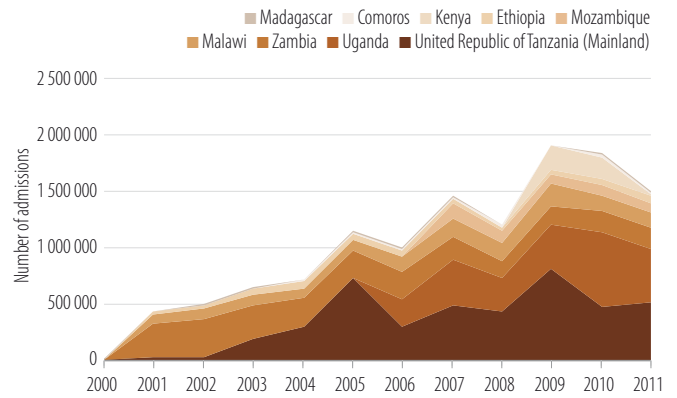
D – Percentage change in admission and death rates, 2000–2011



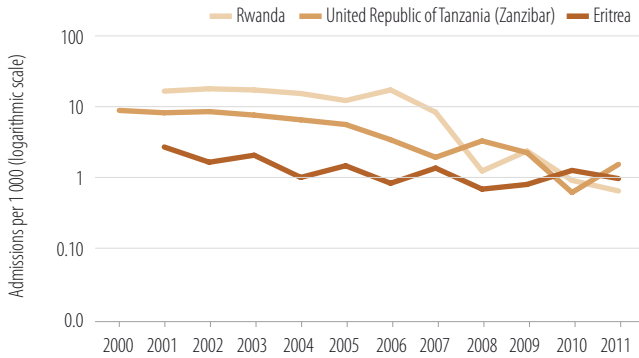
E – Countries projected to achieve ≥75% decrease in admission rates by 2015



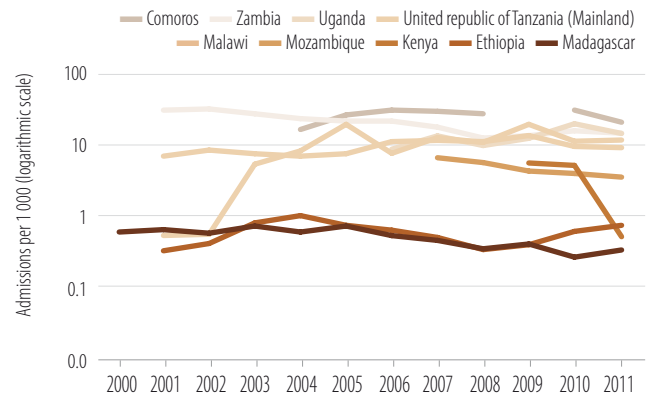
F – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess trends



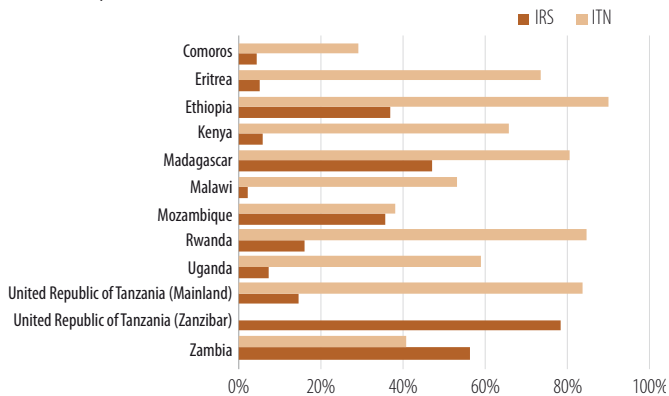
G – Countries projected to achieve >75% decrease in admission rates by 2015



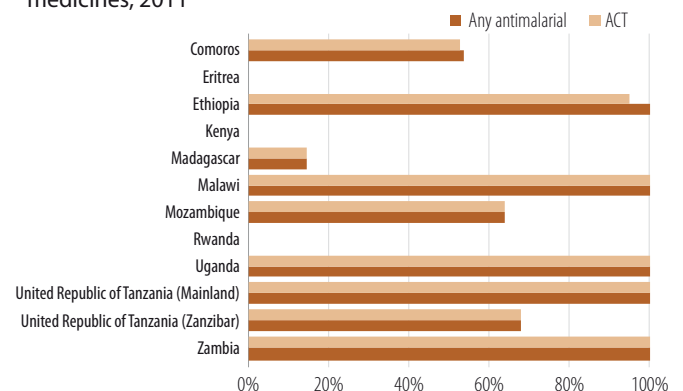
H – Countries projected to achieve <75% decrease in admission rates by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# Low transmission southern African countries

**Of the 5 countries in this subregion, 4 have recorded decreases in malaria case incidence of  $\geq 75\%$  between 2000 and 2011 (Botswana, Namibia, South Africa and Swaziland). It is not possible to assess trends in Zimbabwe owing to inconsistent reporting and a change in diagnostic practice.**

All countries in this subregion have low levels of malaria transmission, but are still in the control phase. Approximately 20% of the populations in these countries are at some degree of malaria risk while substantial proportions live in areas that are free of malaria (Figure A). Malaria transmission is highly seasonal, and during the transmission season parts of the population of all these countries, with the exception of Swaziland, are temporarily at high risk. Almost all malaria cases in the 5 countries are caused by *P. falciparum* (Figure B).

Diagnosis by microscopy has been widely used in the subregion since 2000. The use of RDTs has substantially increased in Botswana, Namibia, South Africa and Zimbabwe in recent years. Trend analyses were based on microscopically confirmed cases in order to examine trends over a longer period of time. Botswana, Namibia, South Africa and Swaziland reported decreases in microscopically confirmed malaria cases, and in case incidence rates, of  $\geq 75\%$  during 2000–2011, albeit with some fluctuations from year-to-year (Figures D, E, G).

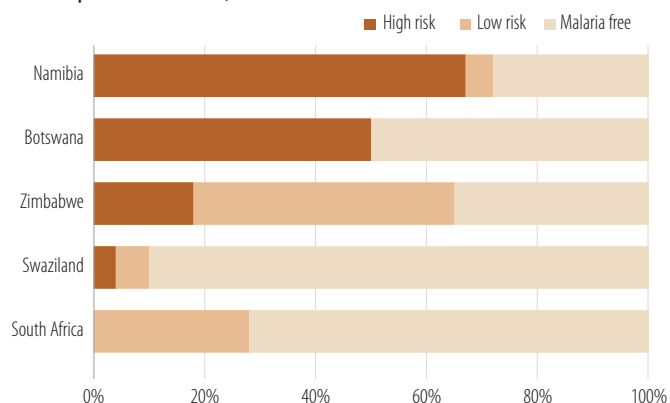
Case reports from Zimbabwe have been inconsistent over the past decade, with no data reported for years 2000–2003 and the reported number of confirmed cases varying between a minimum of 16 000 and a maximum of 320 000 between 2008 and 2011 (Figure D, F, H). Since 2008, Zimbabwe has increasingly shifted its diagnostic services from microscopy to RDTs. Given the changes in diagnostic practice, and inconsistencies in data reported, it is not possible to make an assessment of trends

in cases in Zimbabwe. All 5 countries, including Zimbabwe, reported a decrease in malaria deaths by  $>70\%$  in the decade.

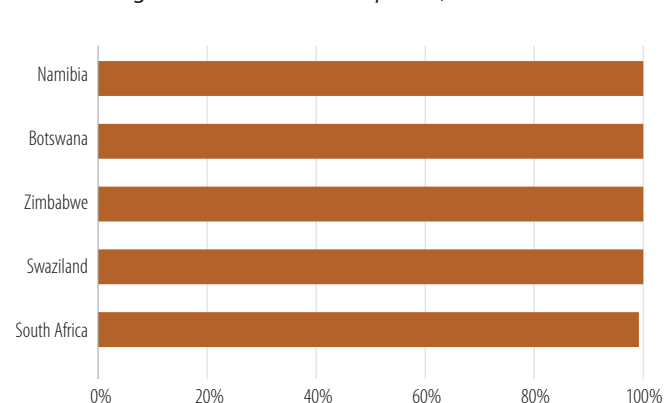
In South Africa, IRS is the primary vector control measure and nearly all of the population at risk was protected in 2011 (Figure I). Malaria transmission has been halted in most of the country, but occurs in north-eastern border regions adjacent to Mozambique and Swaziland. Swaziland reported distributing sufficient ITNs between 2009 and 2011 to cover  $>60\%$  of its population at risk. In Zimbabwe, sufficient ITNs were distributed to cover 52% of the population at risk, while 52% were protected by IRS. Both Botswana and Namibia reported reductions in IRS and ITN coverage in 2011 compared to previous years. All countries reported delivering sufficient ACTs to treat patients attending public health facilities, apart from South Africa which did not submit data in 2011 (Figure J).

The 5 countries in this subregion are signatories to Malaria Elimination 8 (E8) in southern Africa, launched in March 2009. The initiative centres on the 4 countries that aim to achieve elimination by 2020, namely Botswana, Namibia, South Africa and Swaziland (E4), but also includes Zimbabwe and the neighbouring countries: Angola, Mozambique and Zambia.

A – Population at risk, 2011

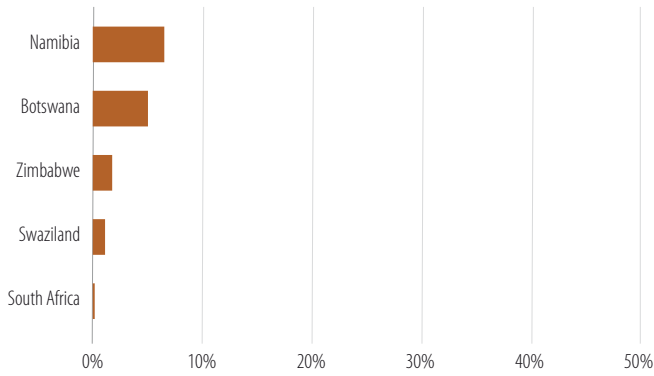


B – Percentage of cases due to *P. falciparum*, 2007–2011

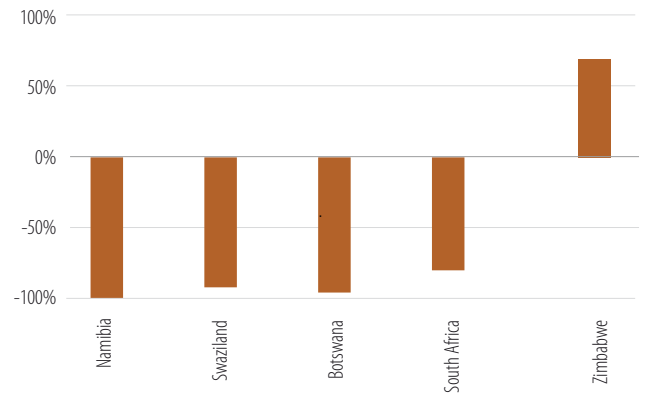




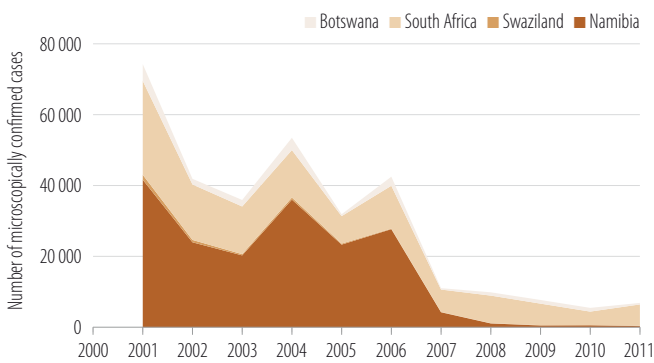
C – Annual blood examination rate, 2007–2011



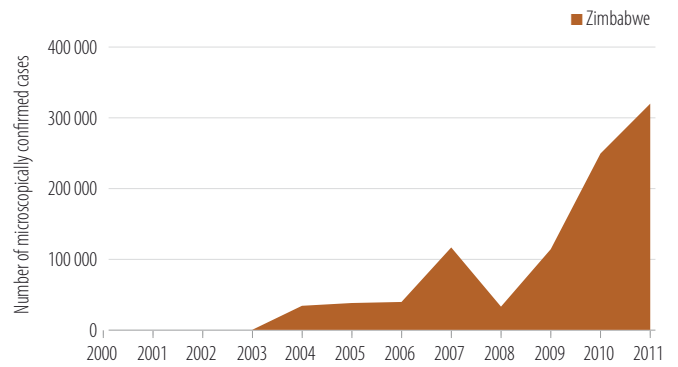
D – Percentage change in case incidence, 2000–2011



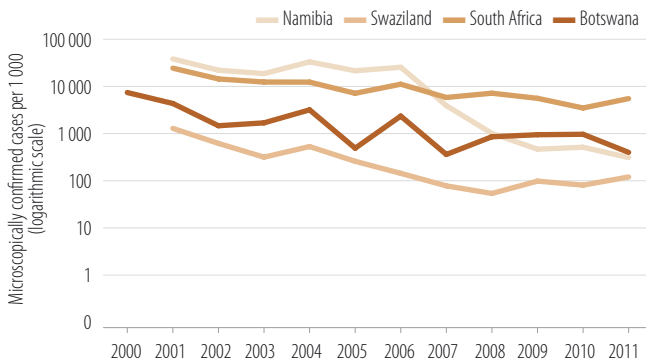
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



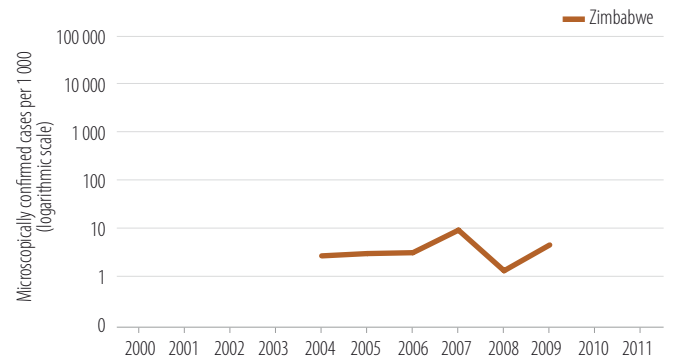
F – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



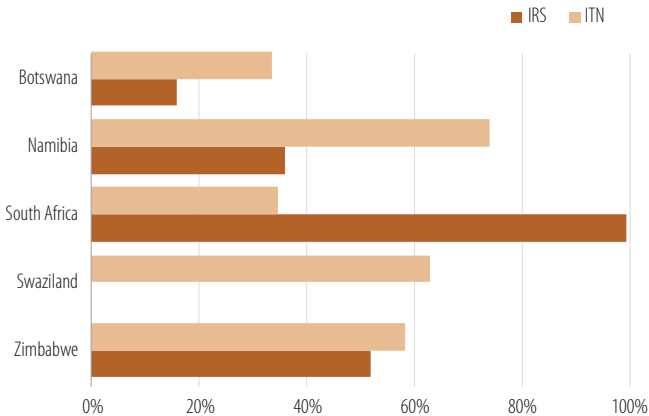
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



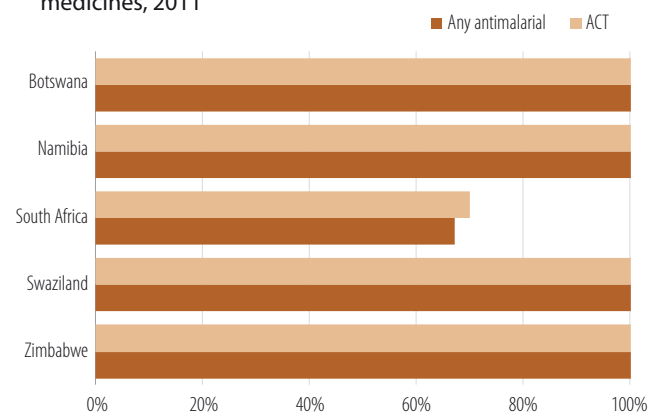
H – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# Region of the Americas

Of the 21 malaria-endemic countries in the Region of the Americas, 13 had achieved a reduction in malaria incidence rates of  $\geq 75\%$  between 2000 and 2011. Another 3 countries are on track to achieve a reduction of 75% by 2015 and one country is projected to reduce incidence rates by 50%–75%. Increases in the number of microscopically confirmed cases were observed in 3 countries. It was not possible to assess trends in Haiti owing to inconsistencies in reporting over time.

About 30% of the population of the 21 countries with ongoing transmission is at some degree of risk (Figure A) and about 8% of the population is at high risk. Argentina, Costa Rica, Ecuador, El Salvador, Mexico and Paraguay are in the pre-elimination phase. The 15 other endemic countries are all in the control phase. In 2011, less than 60% of cases in most countries in the Region were caused by *P. falciparum*, but in the Dominican Republic and Haiti they are almost exclusively due to *P. falciparum* (Figure B). The proportion of cases due to *P. falciparum* fell by 20% or more in Ecuador, French Guiana, (France) and Suriname between 2000 and 2011. Smaller but consistent decreases in the proportion of cases due to *P. falciparum* were also seen in Brazil, Colombia and Peru.

The number of microscopically confirmed cases in the Region decreased from 1.18 million in 2000 to 490 000 in 2011 (a decrease of 58%). Brazil and Colombia accounted for 68% of the cases in 2011. Reductions in the number of microscopically confirmed cases, and in case incidence rates, of more than 75% were recorded in 13 countries between 2000 and 2011 (Argentina, Belize, Bolivia (Plurinational State of), Costa Rica, Ecuador, El Salvador, French Guiana, France, Guatemala, Honduras, Mexico, Nicaragua, Paraguay and Suriname) while 3 countries are on track to achieve a reduction of 75% before 2015 (Colombia, Panama and Peru) (Figures D, E, G), and Brazil is projected to reduce incidence rates by 50%–75% (Figures D, F, H). It should be noted that several countries had considerable fluctuations in numbers of cases despite large decreases over the decade. Panama experienced a 5-fold increase in confirmed cases during 2001–2004. Similarly, Costa Rica experienced a

## Countries in the pre-elimination phase

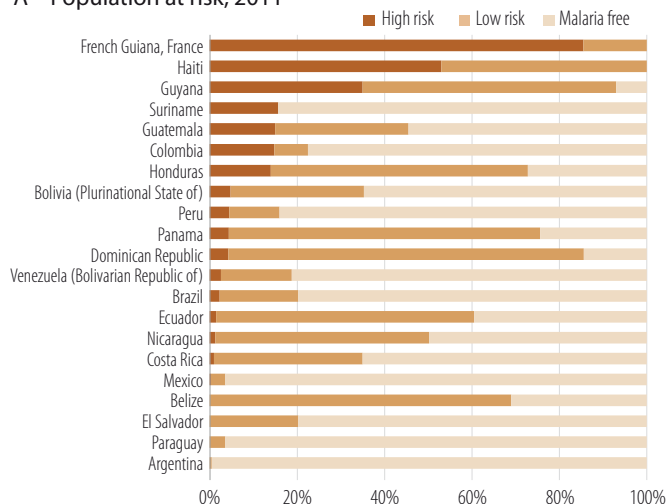
Argentina	El Salvador
Costa Rica	Mexico
Ecuador	Paraguay

3-fold increase during 2005–2006 (more than 3000 cases) but this fell to only 17 cases in 2011. Bolivia (Plurinational State of) and Colombia reported upturns during 2009–2010 but in 2011 numbers of cases dropped to the lowest levels ever reported in those countries.

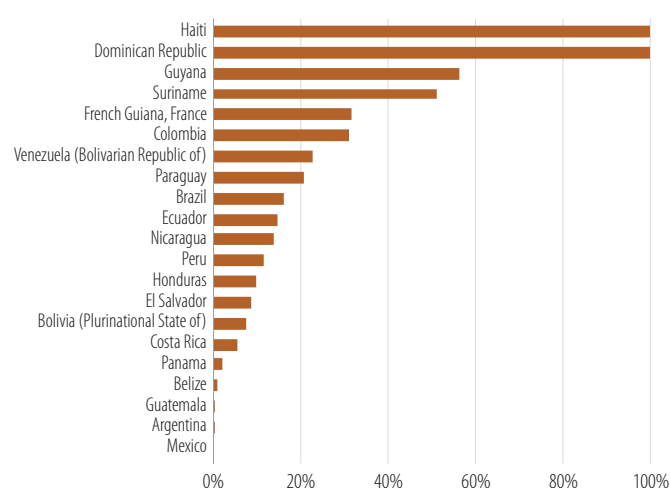
The Dominican Republic, Guyana, and Venezuela, (Bolivarian Republic of) reported increases in case numbers between 2000 and 2011 (Figures D, F, H). In Haiti, malaria cases increased from 17 000 in 2000 to 84 000 in 2010 following the earthquake in January of the same year and then fell to 32 000 cases in 2011; it is unclear whether the peak observed in 2010 reflects a real rise in incidence, or is a consequence of increased availability of resources for case detection during the emergency response. In Guyana, the number of cases decreased to less than 14 000 during 2007–2009 but increased to almost 23 000 in 2010 and to more than 29 000 in 2011.

The link between decreases in malaria cases and implementation of vector control is not always clear-cut. In 5 countries (Costa Rica, Dominican Republic, Ecuador, Nicaragua and Venezuela, (Bolivarian Republic of)), coverage of high risk populations with either ITNs or IRS exceeded 50% (Figure I) and but only in 3 of these countries (Costa Rica, Ecuador and, Nicaragua) have malaria cases decreased by  $>50\%$ . Reports on the availability of ACTs were complete for only 3 of the 8 countries which have resistance to chloroquine and which therefore use ACTs. Brazil, Colombia and Guyana reported adequate availability of ACTs for the treatment of *P. falciparum* malaria in the public sector (Figure J). From the available information therefore, the association between prevention (IRS, ITN) or treatment (antimalarial drugs) and malaria trends across the endemic countries in the Region of the Americas is inconsistent and requires further in-depth evaluation.

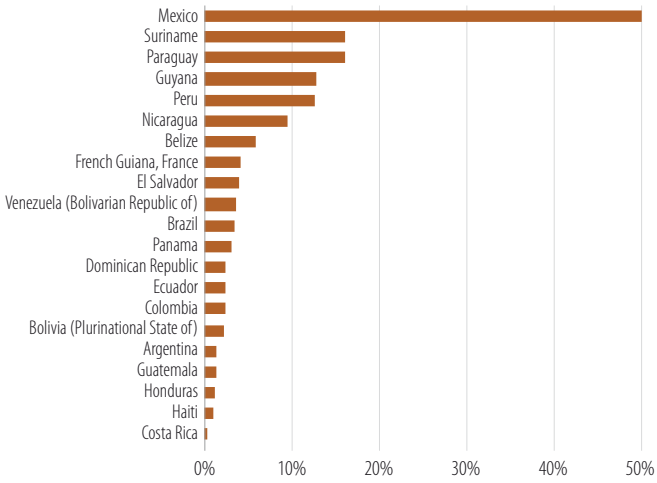
A – Population at risk, 2011



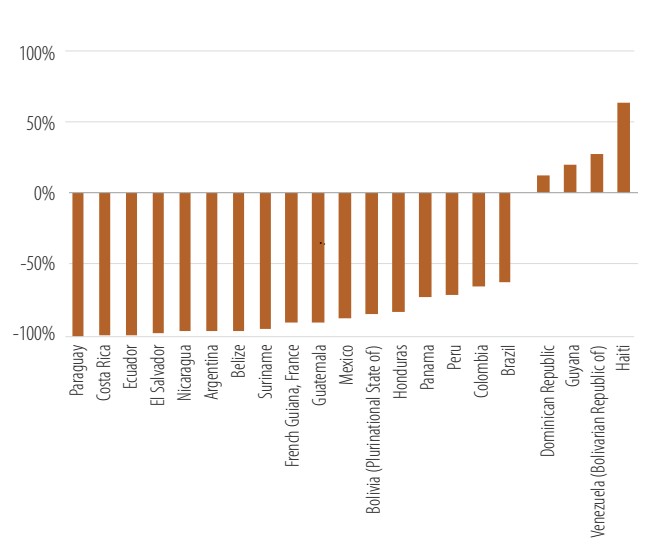
B – Percentage of cases due to *P. falciparum*, 2007–2011



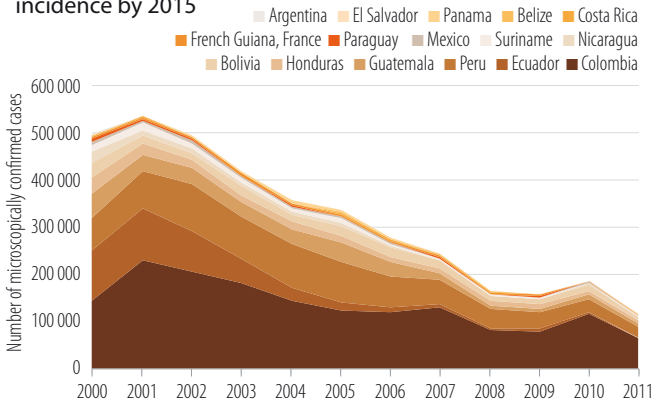
C – Annual blood examination rate, 2007–2011



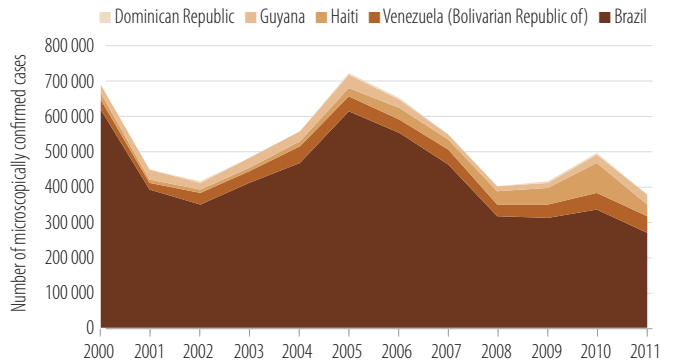
D – Percentage change in case incidence, 2000–2011



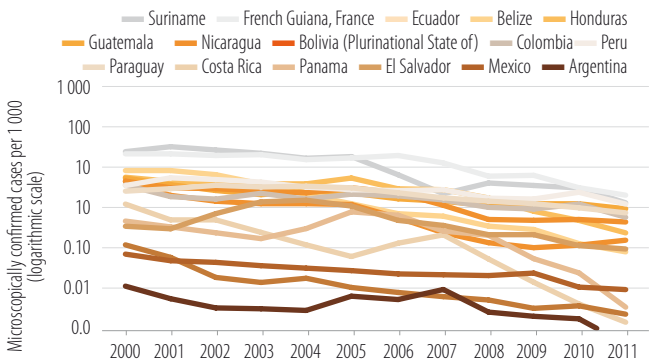
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



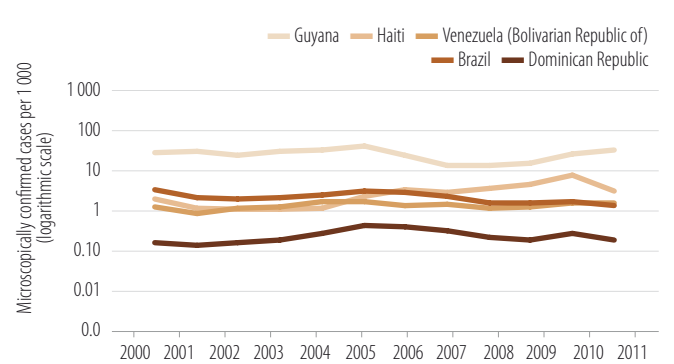
F – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



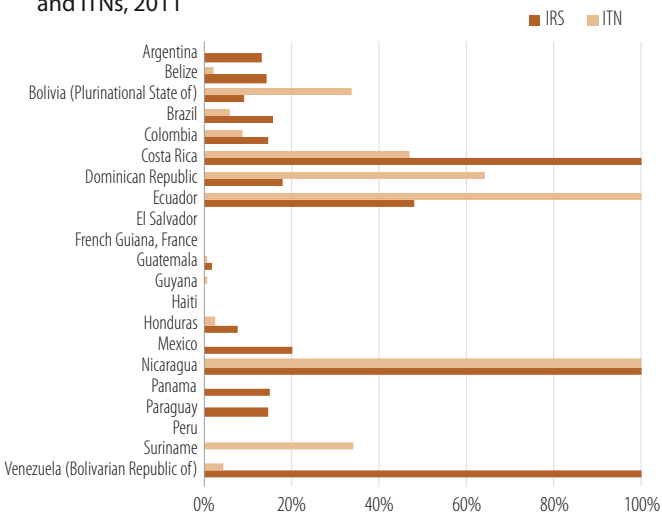
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



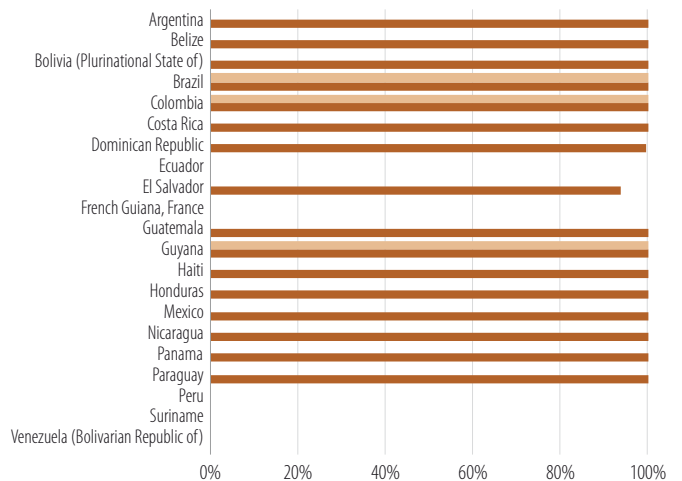
H – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# Eastern Mediterranean Region

Of the 10 countries with ongoing transmission in the Eastern Mediterranean Region, 4 have attained a decrease of  $\geq 75\%$  in microscopically confirmed cases and in case incidence rates in 2011 compared to 2000. The number of microscopically confirmed cases has fluctuated from year to year in the other 6 countries and it is difficult to assess trends owing to inconsistent reporting.

In September 2011, South Sudan became a new WHO member state, increasing the number of member states in the Eastern Mediterranean Region to 23. Approximately 55% of the population in the Region is at some risk of malaria and about 20% of the population is at high risk (Figure A). Malaria endemicity varies considerably: 7 countries still have areas of high malaria transmission (Afghanistan, Djibouti, Pakistan, Somalia, South Sudan, Sudan and Yemen) (Figure A); malaria transmission is geographically limited in 2 countries (the Islamic Republic of Iran, and Saudi Arabia) whereas Iraq has not reported locally acquired cases since 2009. *P. falciparum* is the dominant malaria species in Djibouti, Saudi Arabia, Somalia, South Sudan, Sudan and Yemen, while the majority of cases in Afghanistan, Iran, and Pakistan are due to *P. vivax* (Figure B).

Afghanistan, Iran (Islamic Republic of), Iraq, and Saudi Arabia achieved a decrease in malaria cases and case incidence rates of  $\geq 75\%$  between 2000 and 2011 (Figures D, E, G). The decline in case numbers in Saudi Arabia and Iran (Islamic Republic of) has been aided by the high coverage of IRS, by the use of ITNs (Figure I) and by the consistent availability of antimalarial drugs free of charge (Figure J). Following a steep decline in case numbers, Iraq was able to report zero locally-acquired cases for the first time in 2009 and continued to have zero locally-acquired cases in 2010 and 2011; all 11 reported cases in 2011 were imported. In 2011, Saudi Arabia reported 69 locally-acquired cases and 2719 imported cases; Iran (Islamic Republic of) recorded 1710 locally-acquired cases and 1529 imported cases. Afghanistan,

## Countries in the elimination phase

Iran (Islamic Republic of)      Saudi Arabia

## Countries in the prevention of re-introduction phase

Iraq      Syrian Arab Republic  
Oman

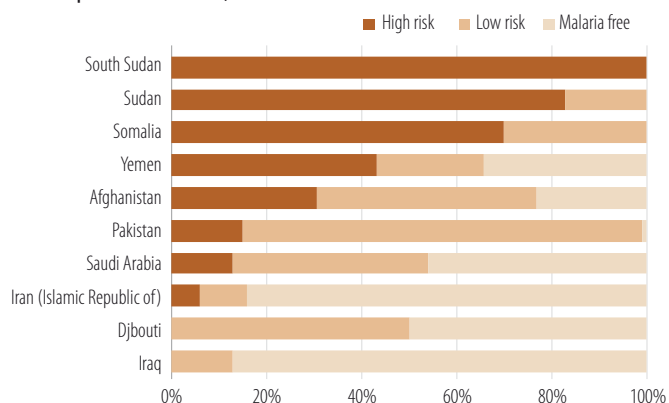
## Countries certified malaria free

Morocco, 2010      United Arab Emirates, 2007

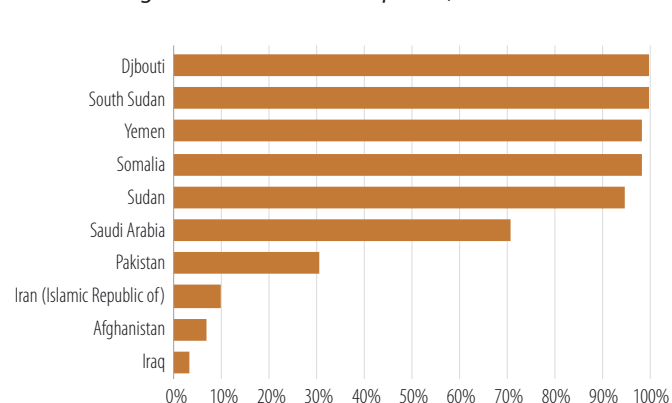
having achieved a decline from about 415 000 cases in 2002 to 86 000 cases in 2006, continues to report an average of 77 000 cases every year against a background of increasing availability of health services. The availability of ITNs has greatly increased, with more than 4.5 million delivered between 2009 and 2011, sufficient to cover approximately 80% of the population at high risk (Figure I). Availability of antimalarial medicines including ACT in the public sector in 2011 was reported as adequate in Iraq and Yemen (Figure J).

In Yemen the number of microscopically confirmed cases has fluctuated from year to year showing no clear trend (Figures D, F, H). In Djibouti, Pakistan, Somalia, South Sudan and Sudan it is not possible to make an assessment of trends owing to inconsistent reporting of microscopically confirmed cases. Pakistan did not submit a report to WHO in 2011 and Djibouti did not report on parasitologically confirmed cases. South Sudan delivered enough ITNs to cover nearly all the population at risk in 2011 (Figure I). Somalia, Sudan and Yemen reported delivering sufficient ITNs, or undertaking IRS, to protect  $<50\%$  of the population at high risk of malaria in 2011. A more detailed appraisal of malaria epidemiology and trends in disease and their link to the coverage of interventions is needed in these 6 countries.

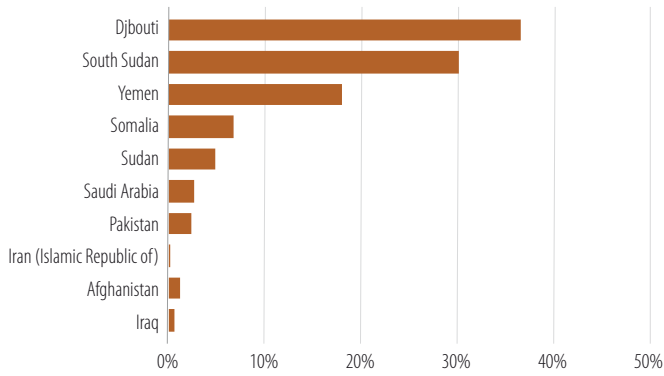
A – Population at risk, 2011



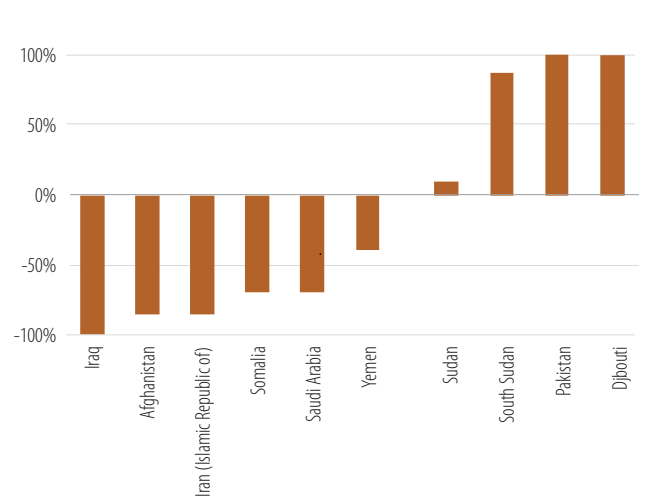
B – Percentage of cases due to *P. falciparum*, 2007–2011



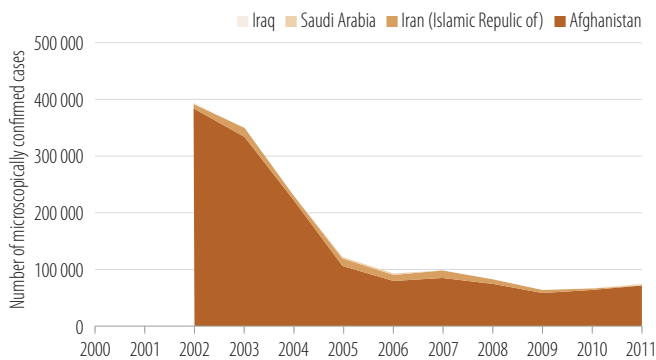
C – Annual blood examination rate, 2007–2011



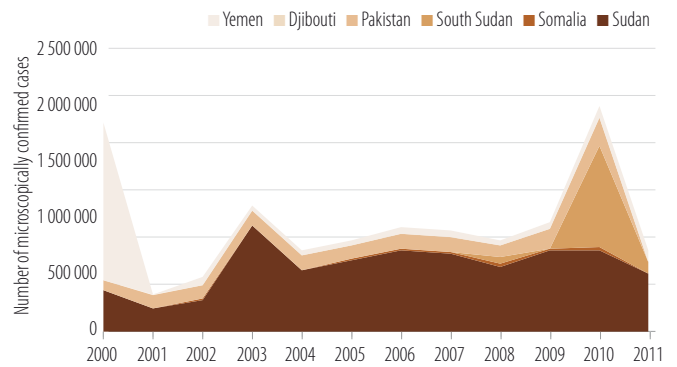
D – Percentage change in case incidence, 2000–2011



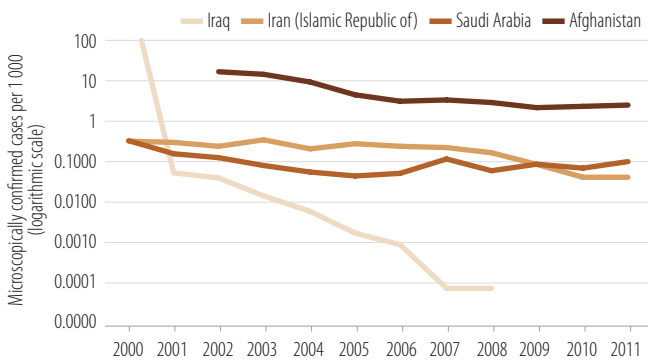
E – Countries projected to achieve  $\geq 75\%$  decrease in case incidence by 2015



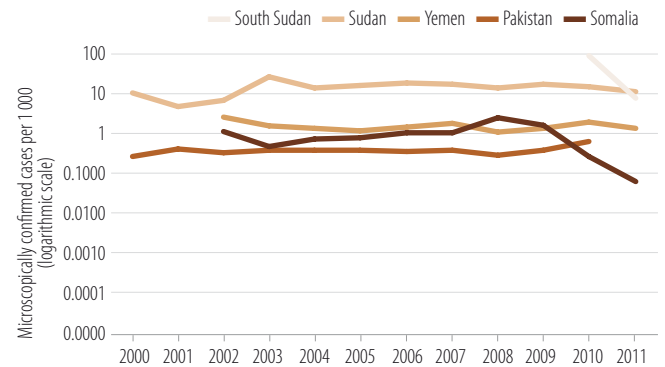
F – Countries projected to achieve  $< 75\%$  decrease in case incidence by 2015 or with insufficient data to assess trends



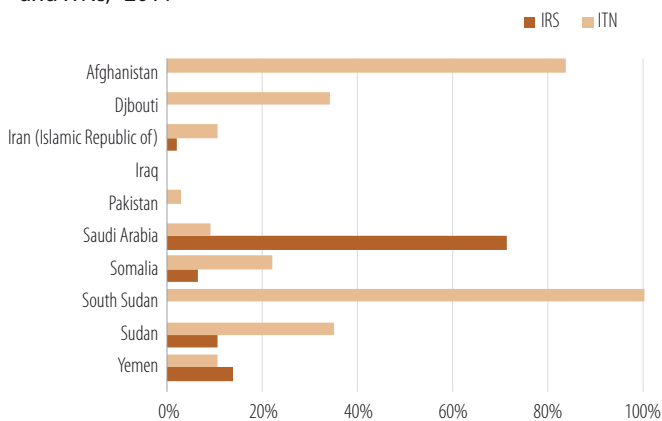
G – Countries projected to achieve  $\geq 75\%$  decrease in case incidence by 2015



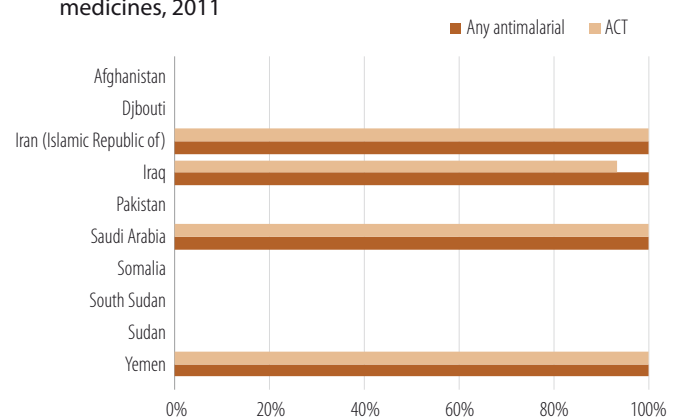
H – Countries projected to achieve  $< 75\%$  decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011





# European Region

All malaria-affected countries in the European Region have achieved reductions in case incidence of  $\geq 75\%$  between 2000 and 2011. The Region has a real possibility of becoming the first to achieve the complete elimination of malaria and aims to do so by 2015 in line with the ambitions of the 2005 Tashkent Declaration (14), which was endorsed by 9 malaria-affected countries. However, despite the achievements made to date, the Region faces challenges due to reintroduction of malaria from neighbouring countries or through population migration from more distant countries.

The total number of reported malaria cases in the European Region decreased from 33 365 in 9 countries in 2000 to just 226 in 5 countries in 2011. Only 69 of the 226 malaria cases were indigenous; these were reported from Tajikistan and Azerbaijan. No locally-acquired *P. falciparum* cases have been reported since 2008; the last case was reported from Tajikistan. All other *P. falciparum* malaria cases found in the Region in 2011 were imported (Figure B, see also Section 6.8).

Figures D and E show how case incidence has fallen in 6 countries. Kyrgyzstan suffered a large outbreak in 2002 but had zero locally-acquired cases in 2011 (Figure E). Between 2001 and 2005, Turkey reported around half of all cases in the Region, but it had zero cases in 2011 (Figure E). Uzbekistan reported zero indigenous cases in 2009, 3 *P. vivax* cases in 2010, and again zero indigenous cases in 2011. Georgia reported zero indigenous cases for the first time in 2010 and continued to have zero cases in 2011. Turkmenistan and Armenia were certified malaria-free by the Director-General of WHO, in October 2010 and September 2011 respectively.

Although malaria was not increasing in any country of the Region in 2011 (Figure F) a localized malaria outbreak occurred in 2012 in one village in Mardin province in Turkey where 208 *P. vivax* cases were recorded. The reasons for the outbreak have not been fully elucidated but it appears to be linked to truck drivers returning from endemic countries.

Greece, which has remained malaria-free since 1974, reported 3 locally acquired *P. vivax* cases in 2010 and 40 in 2011,, originating primarily from migrant workers from Pakistan. Most of

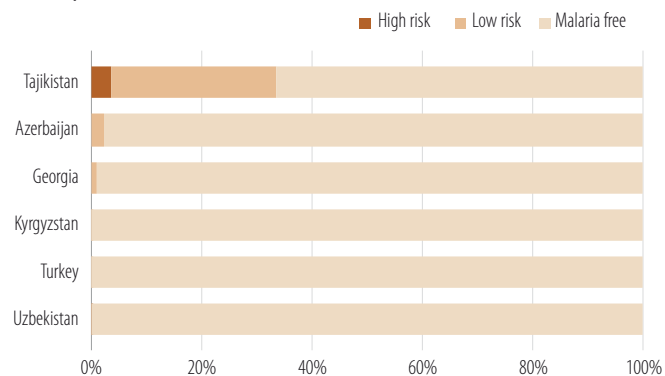
<b>Countries in the elimination phase</b>	
Azerbaijan	Turkey
Kyrgyzstan	Uzbekistan
Tajikistan	
<b>Countries in the prevention of re-introduction phase</b>	
Georgia	
<b>Countries certified malaria free</b>	
Armenia, 2011	Turkmenistan, 2010

the 40 cases were clustered in the prefecture of Lakonia in the south of mainland Greece. In 2011, 11 local cases were reported of which 7 were again in Lakonia, posing a risk of re-establishment of malaria in the country. The Ministry of Health is making concerted efforts to contain the outbreak. Linked to the outbreak in Greece, 7 cases were imported to Albania in 2012.

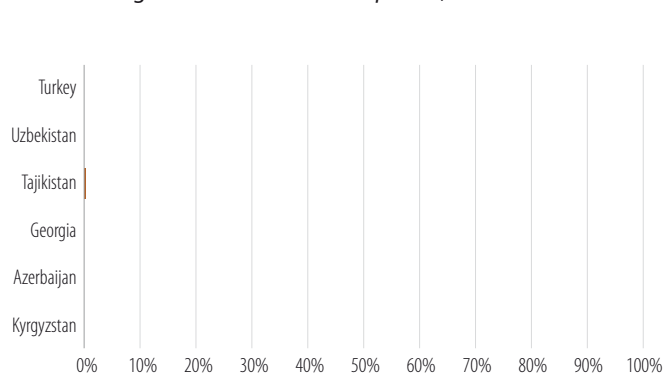
IRS is the primary vector control measure in the Region, where each country aims for complete coverage of all remaining active and any new foci of malaria (Figure I). ITNs were used as a supplementary intervention with IRS in Tajikistan and Uzbekistan (Figure G).

Intensive diagnostic testing efforts being made in Armenia, Azerbaijan, Kyrgyzstan, Tajikistan, Turkey, and Uzbekistan are reflected in high ABER values in 2011 (Figure C). All suspected cases in the Region are examined microscopically, and all cases are investigated to determine whether infection is due to local transmission or has been imported. Antimalarial supplies are maintained to ensure radical treatment of all local and imported confirmed cases (Figure J). Countries pay particular attention to the risk of malaria spreading among countries in the Region, and between the European and Eastern Mediterranean Regions.

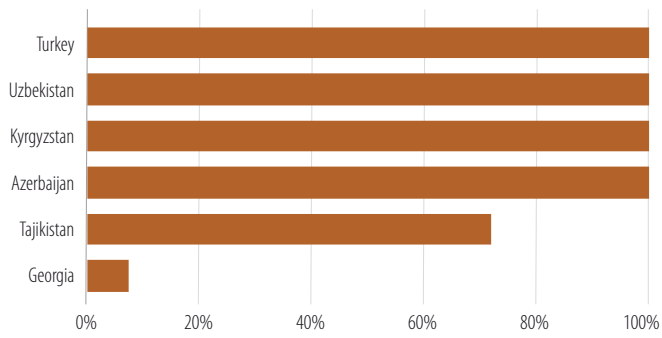
A – Population at risk, 2011



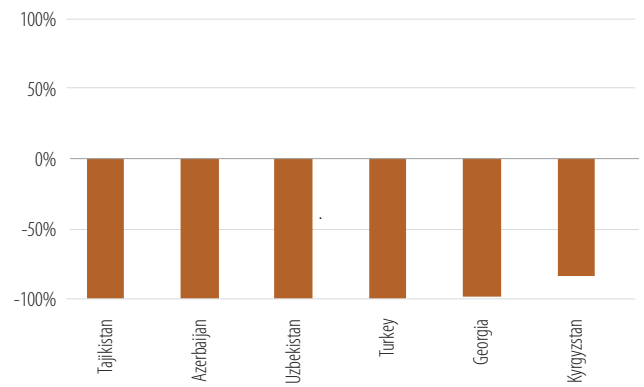
B – Percentage of cases due to *P. falciparum*, 2007–2011



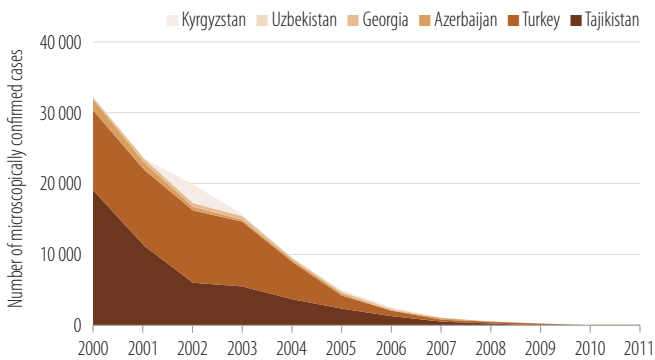
C – Annual blood examination rate, 2007–2011



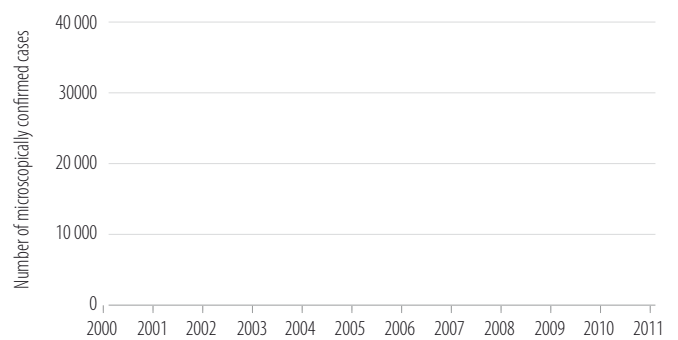
D – Percentage change in case incidence, 2000–2011



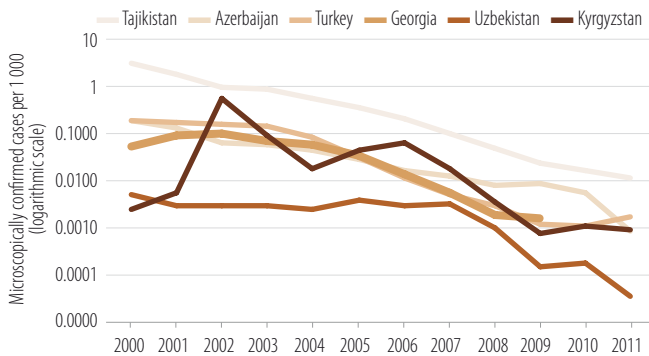
E – Countries projected to achieve  $\geq 75\%$  decrease in case incidence by 2015



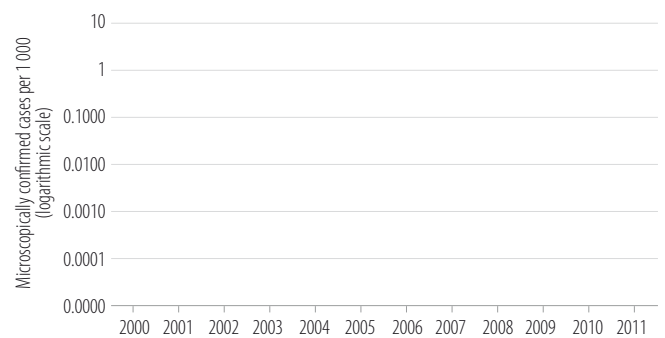
F – Countries projected to achieve  $< 75\%$  decrease in case incidence by 2015 or with insufficient data to assess trends



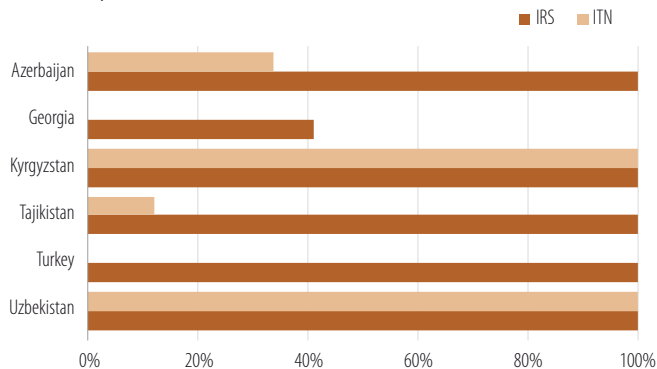
G – Countries projected to achieve  $\geq 75\%$  decrease in case incidence by 2015



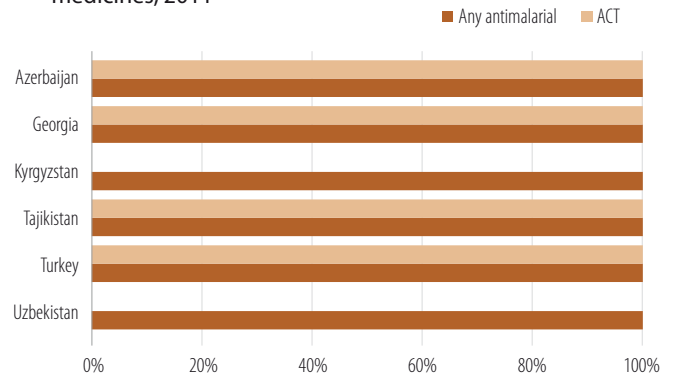
H – Countries projected to achieve  $< 75\%$  decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# South-East Asia Region

Of the 10 malaria-endemic countries in the South-East Asia Region, 5 reported decreases in malaria cases and incidence rates of  $\geq 75\%$  between 2000 and 2011, and another (Bangladesh) is on track to achieve a decrease in malaria case incidence of 75% by 2015. India, the country with the highest number of cases in the Region, is projected to achieve decreases of 50%–75% in malaria case incidence by 2015.

In South-East Asia Region approximately 70% of the population of 1.8 billion people is at some risk for malaria, with 26% at high risk: 460 million people inhabit areas with a reported incidence of  $>1$  case per 1000 population per year (Figure A). The majority of confirmed cases in the Region are due to *P. falciparum*, although the proportion varies greatly among countries (Figure B). Malaria is predominantly due to *P. falciparum* in Bangladesh, Myanmar and Timor-Leste, mostly to *P. vivax* in Nepal and Sri Lanka, and exclusively due to *P. vivax* in the Democratic People's Republic of Korea (DPR Korea). In Sri Lanka, the percentage of cases due *P. falciparum* has fallen from 29% in 2000 to 4% in 2011.

In 2011, 2.15 million parasitologically confirmed malaria cases were reported, with 3 countries accounting for 95% of confirmed cases: India (61%), Myanmar (22%) and Indonesia (12%). Both cases and deaths are substantially underreported (see Section 7.9), but these proportions are indicative of the geographical distribution of malaria in the Region.

Bhutan, DPR Korea, Nepal, Sri Lanka and Thailand reported decreases in the number and incidence rate of microscopically confirmed cases of  $\geq 75\%$  since 2000. Bangladesh recorded a decrease of 69% in malaria case incidence between 2000 and 2011 and is therefore on track to achieve a decrease of 75% by 2015 (Figures D, E, G). India has reported a slow but steady decline in case numbers of 36%, and case incidence of 45%, between 2000 and 2010 (Figures D, F, H), while continuing to examine more than 100 million blood slides each year (Figure C). The number of reported malaria deaths fell by  $>75\%$  in Bangladesh, Bhutan, Sri Lanka and Thailand between 2000 and 2011 (Annex 6D). The number of reported deaths in DPR Korea and Nepal is too small to make an assessment of trends. A decrease of 16% was observed in India.

## Countries in pre-elimination phase

Bhutan Democratic People's Republic of Korea

## Countries in the elimination phase

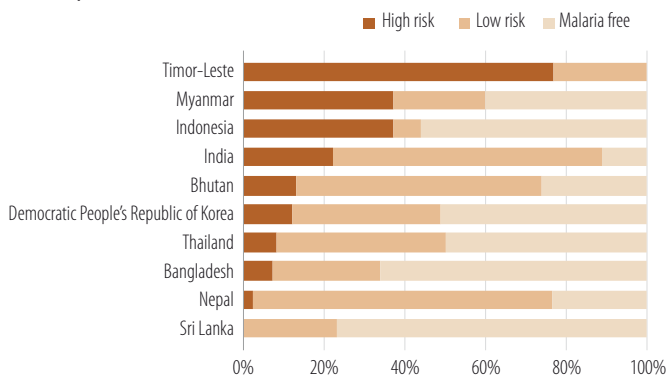
Sri Lanka

It was not possible to discern the direction of trends in Indonesia, Myanmar and Timor-Leste owing to inconsistency of reporting over time (Figures F, H). In Myanmar and Timor-Leste this is partly due to a change in diagnostic practice with large increases in the use of RDTs since 2007. Reported deaths in Myanmar have decreased since 2000 by 79% but this is largely due to a change in reporting practices as only confirmed malaria deaths have been reported since 2007. In Timor-Leste, reported malaria deaths decreased by 75% between 2007 and 2011, thus progress in reducing malaria may be wider in the South-East Asia Region than suggested by an analysis of cases.

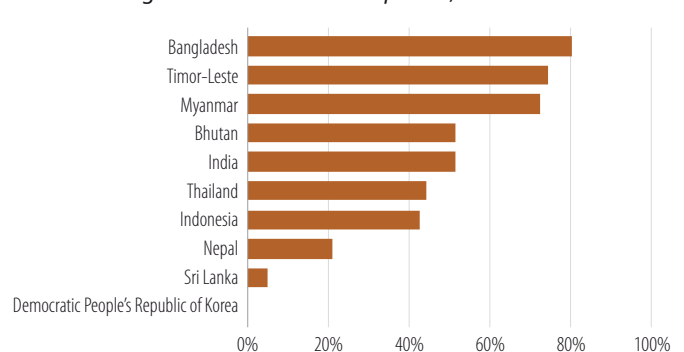
Of the 5 countries that reported a decrease of more than 75% in the incidence of confirmed malaria between 2000 and 2011 (Figure E), 4 countries (Bhutan, DPR Korea, Nepal and Sri Lanka) had distributed sufficient ITNs (both LLINs and conventional ITNs), or had undertaken sufficient IRS, to cover  $>80\%$  of the population at high risk. In Thailand 38% of the population at high risk was protected with either ITNs or IRS. All these countries reported having distributed adequate supplies of antimalarial medicines (Figure J) to treat all patients attending public sector health facilities.

Timor-Leste had distributed sufficient ITNs, or undertaken IRS, to cover  $>50\%$  of its population at high risk, but it is not yet possible to conclude that this has had an impact on trends in malaria cases. As in other Regions, further analyses are needed of the determinants of malaria trends in the South-East Asia Region, specifically the potential association with scale-up of vector control and treatment.

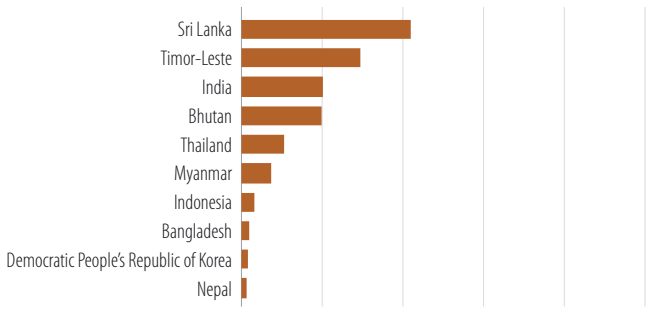
A – Population at risk, 2011



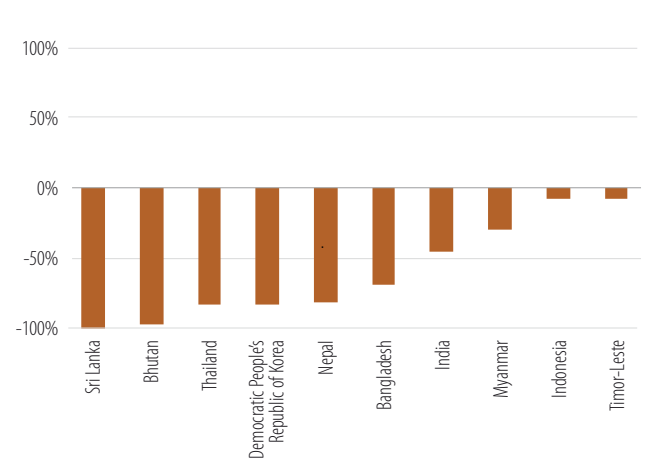
B – Percentage of cases due to *P. falciparum*, 2007–2011



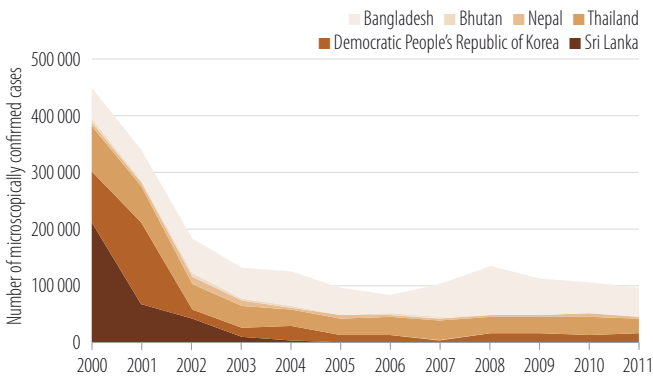
C – Annual blood examination rate, 2007–2011



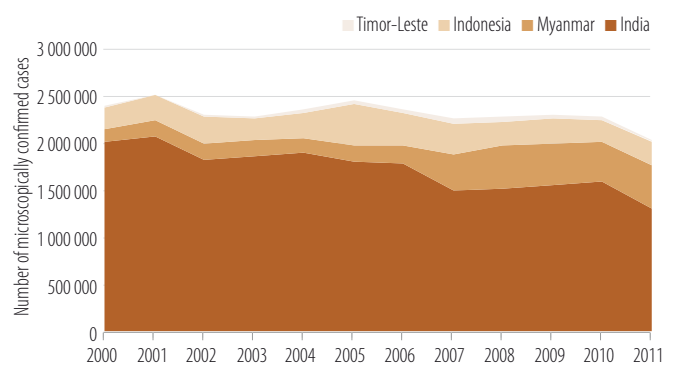
D – Percentage change in case incidence, 2000–2011



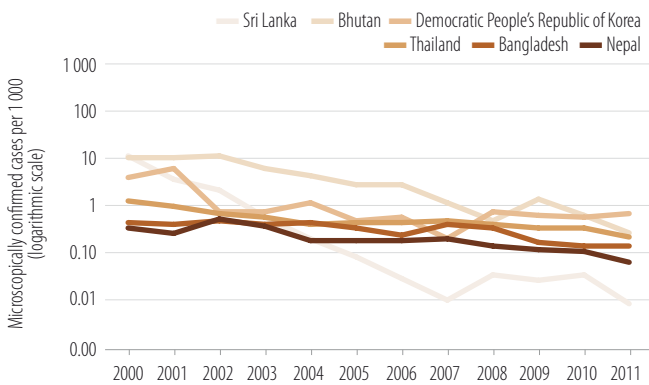
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



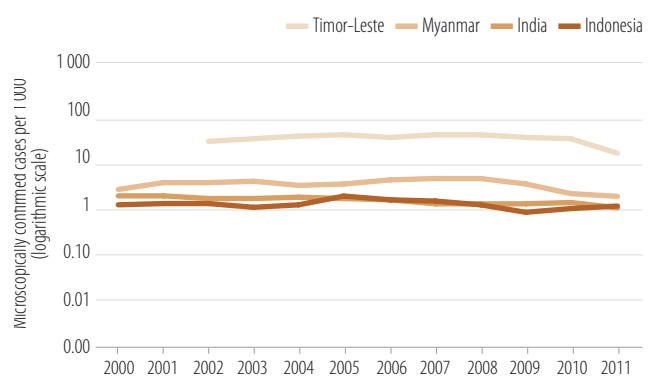
F – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



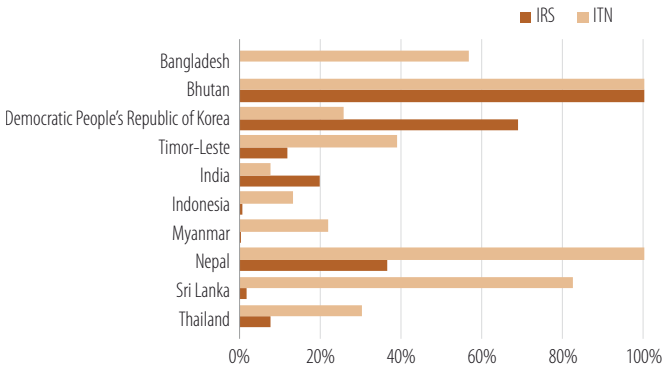
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



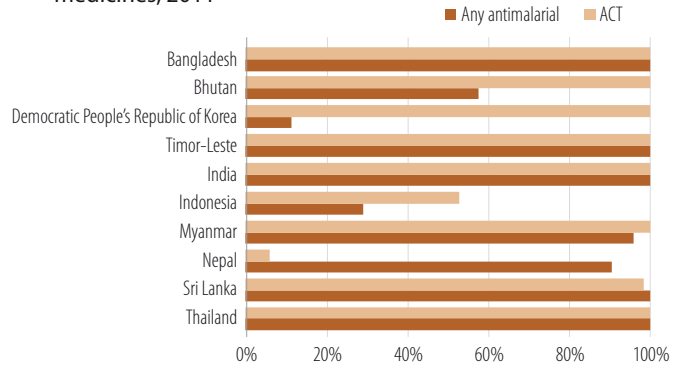
H – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



# Western Pacific Region

Of the 10 malaria-endemic countries in the Western Pacific Region, 8 reported decreases in malaria cases and incidence rates of  $\geq 75\%$  between 2000 and 2011, and Malaysia is on track to achieve a 75% decrease in case incidence rates by 2015. The reported incidence of microscopically confirmed malaria is projected to decrease by  $< 50\%$  by 2015 in Papua New Guinea, the country with the highest number of cases in the Region.

In the Region approximately 870 million are at some risk of malaria of whom 69 million (8%) people inhabit areas with a reported incidence of  $> 1$  case per 1000 population per year (Figure A). Malaria transmission is intense through most of Papua New Guinea, Solomon Islands and Vanuatu. Transmission is highly focal in the countries and areas of the Greater Mekong sub-region, including Cambodia, Yunnan province (China), Lao People's Democratic Republic and Viet Nam, where it is most intense in remote forested areas and where the disease disproportionately affects ethnic minorities and migrants. Malaria is also restricted in distribution in Malaysia, the Philippines and the Republic of Korea.

Most countries have transmission cycles of both *P. falciparum* and *P. vivax*, but transmission is entirely due to *P. vivax* in the Republic of Korea and in central areas of China (Figure B). The proportion of cases due to *P. falciparum* has decreased by more than 20% since 2000 in 3 countries of the Region (Cambodia, Malaysia and Philippines).

The total number of reported confirmed malaria cases in the Region decreased from 385 000 in 2000 to 221 000 in 2011 (42% decrease). In 2011, 3 countries accounted for approximately 75% of these cases: Papua New Guinea (37%), Cambodia, (26%) and Solomon Islands (12%). Decreases of  $\geq 75\%$  in the number of microscopically confirmed malaria cases between 2000 and 2011 have been recorded by 6 countries (Cambodia, China, Lao People's Democratic Republic, Philippines, Republic of Korea and Viet Nam), and 3 have recorded decreases of 50%–75% (Malaysia, Solomon Islands and Vanuatu) (Figures D, E, G). The number of reported malaria deaths decreased by more than 75% in Cambodia, Lao People's Democratic Republic, Philippines, and Viet Nam, and by 50%–75% in Malaysia, Solomon Islands and Vanuatu (Annex 6D). Papua New Guinea recorded a decrease in microscopically confirmed cases of  $< 25\%$  (Figures D, F, H).

Reported incidence rates, which take into account population growth since 2000, decreased by  $\geq 75\%$  in 8 countries between

## Country in pre-elimination phase

Malaysia

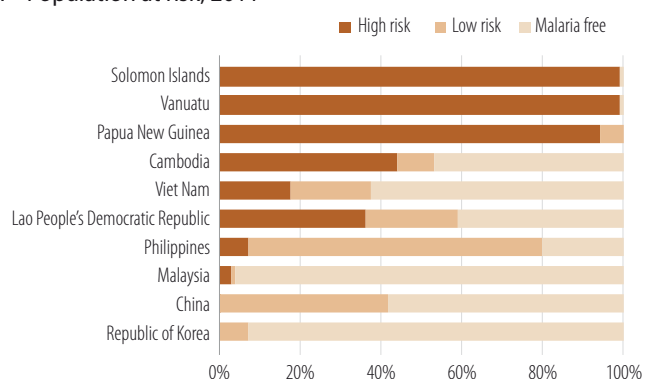
## Country in elimination phase

Republic of Korea

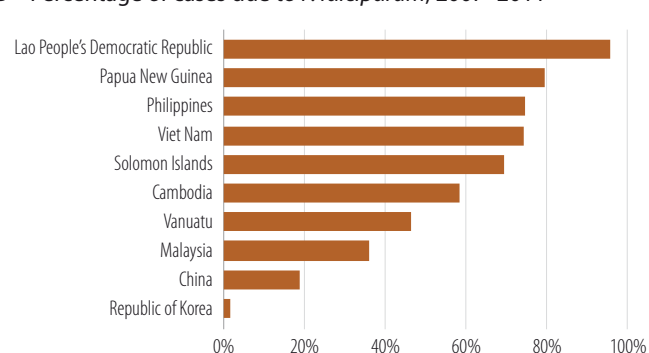
2000 and 2011 (Cambodia, China, Lao People's Democratic Republic, Philippines, Republic of Korea, Solomon Islands, Vanuatu and Viet Nam) (Figures D, G). Malaysia is on track to achieve a 75% decrease in case incidence by 2015. The reported incidence of microscopically confirmed malaria is projected to decrease by  $< 50\%$  in Papua New Guinea by 2015 if the rates of change observed between 2000 and 2011 are unchanged (Figures D, H). However, population-based surveys suggest a recent decrease in parasite prevalence from 18% to 6.8% between 2009 and 2011 associated with ITN use (see Box 8.1).

Malaria interventions are implemented widely in the Region, both vector control and enhanced diagnosis and treatment. However, the intensity of control varies among countries and the links between interventions and malaria trends in routinely collected data are imprecise. Of the 9 countries with large decreases in malaria, 5 (Cambodia, Malaysia, Philippines, Solomon Islands and Vanuatu) also reported a coverage of  $> 50\%$  with either ITNs or IRS in 2011 in populations living in areas at high risk (Figure I). Mosquito nets have been widely used in Viet Nam but a household survey (MICS 2006) found that only 19% of households owned an ITN. The proportion of households owning an ITN is also low in Cambodia (5% in DHS 2005); re-treatment of nets was practiced until 2009, but has been increasingly replaced by distribution of LLINs in recent years. The Republic of Korea reported almost no vector control activity in 2010. Papua New Guinea which, until 2011, had not recorded large decreases in confirmed malaria cases, had distributed sufficient ITNs to cover  $> 60\%$  of the population at high risk by 2011. Malaysia, Solomon Islands and Vanuatu have a high diagnostic examination rate (ABER) (Figure C) but the ABER in the other endemic countries is much lower. Antimalarial medicines were widely available in 9 of the 10 malaria-endemic countries in 2011 (Figure J). However, in 2011 inadequate supplies of ACTs were reported by Papua New Guinea, where *P. falciparum* constitutes a major public health problem.

A – Population at risk, 2011

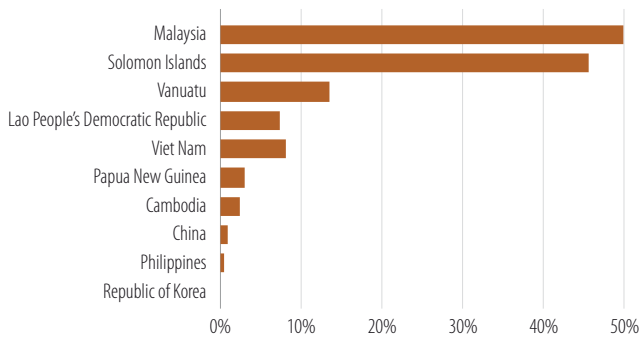


B – Percentage of cases due to *P. falciparum*, 2007–2011

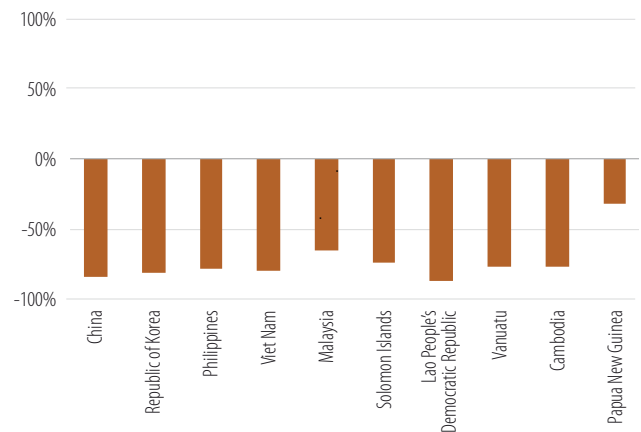




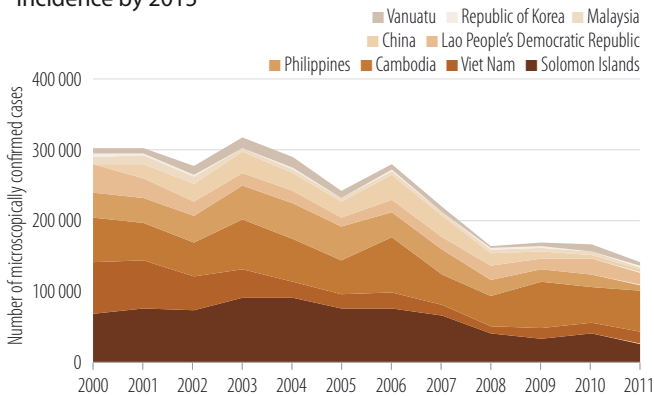
C – Annual blood examination rate, 2007–2011



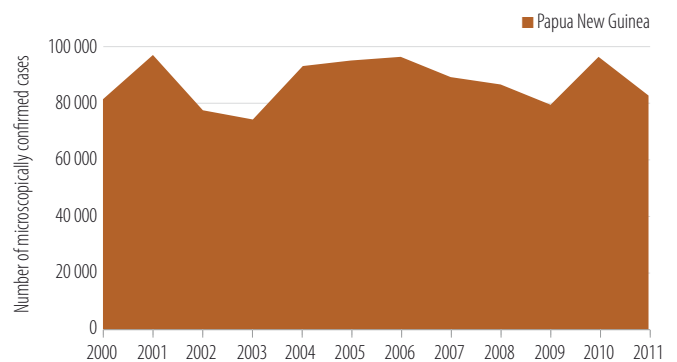
D – Percentage change in case incidence, 2000–2011



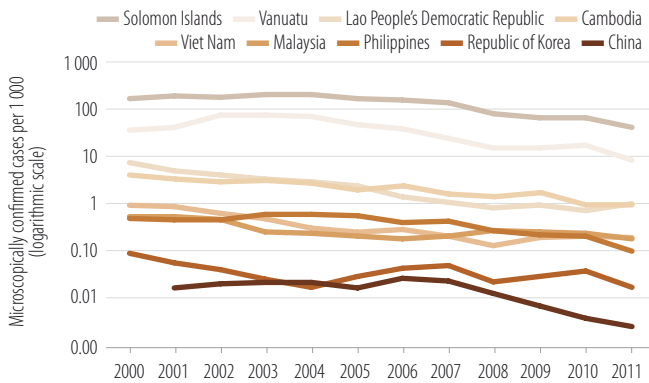
E – Countries projected to achieve ≥75% decrease in case incidence by 2015



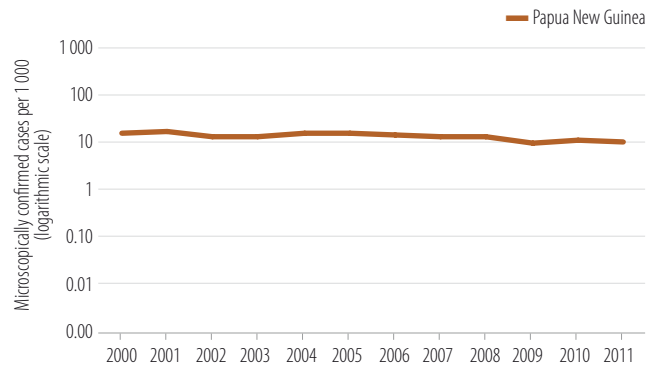
F – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



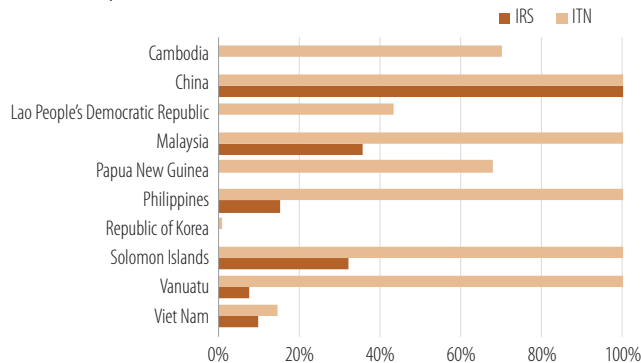
G – Countries projected to achieve ≥75% decrease in case incidence by 2015



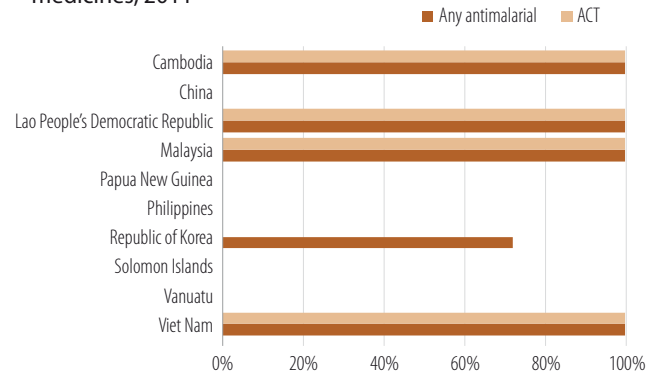
H – Countries projected to achieve <75% decrease in case incidence by 2015 or with insufficient data to assess trends



I – Percentage of high risk population protected with IRS and ITNs, 2011



J – Percentage of cases potentially treated with antimalarial medicines, 2011



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