World Malaria Report 2009

World Health Organization

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Foreword

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

The findings in the *2009 World Malaria Report* are cause for cautious optimism. While much remains to be done, the data presented here clearly suggest that the tremendous increase in funding for malaria control is resulting in the rapid scale up of today's control tools. This, in turn, is having a profound effect on health – especially the health of children in sub-Saharan Africa. In a nutshell, development aid for health is working.

The global momentum that has been built to tackle malaria is extraordinary. It has brought together the governments of malaria endemic countries, foundations, bilateral donors, multilateral organizations, private companies, nongovernmental and faith-based organizations, and civil society. In the process, it has sparked the creation of public-private partnerships that are speeding up the development of new tools to fight this terrible scourge.

This report demonstrates that funding has resulted in steady increases in the coverage with malaria control interventions, especially insecticide-treated mosquito nets. It also shows that where these interventions have been fully scaled up, the malaria burden falls dramatically. On recent visits to African countries, I have witnessed the empty beds in the malaria wards and heard what this means for doctors, nurses, and families. This is the human side of the statistics set out in the report. Although still limited, early data suggest that the impacts being observed in health facilities are being mirrored by population level declines in all-cause child mortality. This is the sort of good news we all need.

Yet there are potential threats to our fragile success. The most serious of these is the further spread of resistance to artemisinins, which has been identified in malaria parasites in Asia. Although the extent of the spread of this resistance is still being determined, we need to act quickly to mitigate the threat. The World Health Organization, with support from a variety of donors and partners, has taken a leading role in efforts to characterize and contain artemisinin resistance in South-East Asia. We know, right now, three of the things that we urgently need to do: 1) halt the manufacture, marketing and use of oral artemisinin monotherapies; 2) provide universal access to diagnostic testing for malaria; and 3) strengthen routine surveillance for malaria and regular monitoring of antimalarial drug efficacy.

We can save millions of lives over the coming years by scaling up the malaria control tools that we already have available. However, we know that the malaria parasite is a formidable opponent, and that if we are to ultimately eradicate malaria, we need new tools. The unprecedented recent spending on the research and development of these tools, including a vaccine against malaria, is a critical component of the long-term strategy against malaria. At the same time, we need to support operational research as an integral part of malaria programming so that we can learn as we implement and continuously refine our delivery strategies.

Ultimately, the power of malaria control interventions must be matched by the capacity to deliver those interventions to all who need them. If we fail to use these unprecedented global health resources to strengthen health systems, then we will have squandered a tremendous opportunity.

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Abbreviations

ACT	Artemisinin-based combination therapy
AIDS	Acquired immunodeficiency syndrome
API	Annual parasite incidence
DDT	Dichloro-diphenyl-trichloroethane
DHS	Demographic household survey
GBD	Global burden of diseases
GMP	Global Malaria Programme
HIV	Human immunodeficiency virus
IAEG	Inter-Agency and Expert Group on MDG Indicators
IRS	Indoor residual spraying
IPT	Intermittent preventive treatment
ITN	Insecticide-treated nets
LLIN	Long-lasting insecticidal nets
MDG	Millennium Development Goal
MERG	Monitoring and Evaluation Reference Group (for malaria)
MICS	Multiple indicator cluster survey
MIS	Malaria indicator survey
NMCP	National malaria control programme
RBM	Roll Back Malaria
RDT	Rapid diagnostic test
SPR	Slide positivity rate
SUFI	Scaling Up for Impact

Abbreviations of antimalarial medicines

AQ	Amodiaquine
AL	Artemether-lumefantrine
AM	Artemether
ART	Artemisinin
AS	Artesunate
CL	Clindamycine
CQ	Chloroquine
D	Doxycycline
DHA	Dihydroartemisinin
MQ	Mefloquine
NQ	Naphroquine
PG	Proguanil
PPQ	Piperaquine
PQ	Primaquine
PYR	Pyronaridine
QN	Quinine
SP	Sulfadoxine-pyrimethamine
T	Tetracycline
(d)	Days on treatment course

Abbreviations of WHO regions / offices

AFR	WHO African Region
AFRO	WHO Regional Office for Africa
AMR	WHO Region of the Americas
AMRO	WHO Regional Office for the Americas
PAHO	Pan-American Health Organization
EMR	WHO Eastern Mediterranean Region
EMRO	WHO Regional Office for the Eastern Mediterranean
EUR	WHO European Region
EURO	WHO Regional Office for Europe
SEAR	WHO South-East Asia Region
SEARO	WHO Regional Office for South-East Asia
WPR	WHO Western Pacific Region
WPRO	WHO Regional Office for the Western Pacific

Summary

The *2009 World Malaria Report* summarizes information received from 108 malaria endemic countries and other sources and updates the analysis presented in the *2008 Report*. It highlights progress made in meeting the World Health Assembly (WHA) targets for malaria to be achieved by 2010 and 2015, and new goals on malaria elimination contained in the Global Malaria Action Plan (2008):

- International funding commitments for malaria control have increased from around US$ 0.3 billion in 2003 to US$ 1.7 billion in 2009 due largely to the emergence of the Global Fund and greater commitments by the US President's Malaria Initiative, the World Bank and other agencies. This increase in funding is resulting in dramatic scale-up of malaria control interventions in many settings and measurable reductions in malaria burden.
- An increased percentage of African households (31%) are estimated to own at least one insecticide-treated net (ITN) in 2008 compared to 2006 (17%), and more children under 5 years of age used an ITN in 2008 (24%) compared to previous years, but the percentage of children using a net is still below the WHA target of 80%. These weighted averages are affected by low ITN ownership in several large African countries for which resources for scale-up are only now being made available. Household ITN ownership reached more than 50% in 13 high burden African countries.
- Use of artemisinin-based combination therapies (ACTs) has increased compared to 2006 but remains very low in most African countries; in 11 of 13 countries surveyed during 2007–2008, fewer than 15% of children under 5 years of age with fever had received an ACT, well below the WHA target of 80%.
- More than one-third of the 108 malarious countries (9 African countries and 29 outside of Africa) documented reductions in malaria cases of > 50% in 2008 compared to 2000. The number of cases fell least in countries with the highest incidence rates.
- Ten countries are implementing nationwide elimination programmes of which six entered the elimination phase in 2009. Eight countries are in the pre-elimination stage and a further nine countries have interrupted transmission and are in the phase of preventing reintroduction of malaria.

In countries that have achieved high coverage of their populations with bed nets and treatment programmes, recorded cases and deaths due to malaria have fallen by 50% suggesting that Millennium Development Goals (MDG) targets can be achieved if there is adequate coverage of key interventions. While these results were observed in some island settings (Sao Tome and Principe and Zanzibar, United Republic of Tanzania), they were also seen in countries on the African mainland, including Eritrea, Rwanda, and Zambia.

There is evidence from Sao Tome and Principe, Zanzibar and Zambia that large decreases in malaria cases and deaths have been mirrored by steep declines in all-cause deaths among children less than 5 years of age, suggesting that intensive efforts at malaria control could help many African countries to reach, by 2015, a two-thirds reduction in child mortality as set forth in the MDGs.

Parasite resistance to antimalarial medicines and mosquito resistance to insecticides are major threats to achieving global malaria control. Well conducted surveillance of drug efficacy in endemic countries with support from WHO has shown early evidence of resistance to artemisinins, and WHO is leading a major resistance containment effort. Continued use of artemisinin monotherapy is a major factor in parasite resistance; yet, despite WHO's call for a halt to their use, marketing of artemisinin monotherapies continues in many countries.

International disbursements to malaria-endemic countries (US$ 0.65 billion in 2007, the latest year for which data are available), still fall short of the US$ 5 billion required annually to ensure high coverage and maximal impact world wide. Approximately 80% of external funds were targeted to the WHO African Region. The South-East Asia Region received the least money per person at risk for malaria and saw the lowest increase in external financing between 2000 and 2007. High levels of external assistance are associated with increased procurement of commodities and decreases in malaria incidence.

However, external funds for malaria control are disproportionately concentrated on smaller countries with lower disease burdens. More attention needs to be given to ensuring success in large countries that account for most malaria cases and deaths, and protecting the gains that have been made. This will require not only adequate financial resources but also the strengthening of health systems capable of delivering vector control interventions, providing diagnostics for the parasitologic confirmation of malaria alongside treatment with ACTs, and the development of routine surveillance systems for malaria as well as for parasite resistance to antimalarial medicines and mosquito resistance to insecticides.

Key points

Background and context

With the target year 2010 in sight, malaria-endemic countries and the global community are attempting to achieve high coverage with effective interventions to attain both coverage and impact targets.

1. On World Malaria Day 2008, the United Nations Secretary General called for efforts to ensure universal coverage with malaria prevention and treatment programmes by the end of 2010.
2. The goal established by the Member States at the World Health Assembly and the Roll Back Malaria (RBM) Partnership is to reduce the numbers of malaria cases and deaths recorded in 2000 by 50% or more by the end of 2010 and by 75% or more by 2015.
3. In September 2008, RBM launched the Global Malaria Action Plan that defines the steps required to accelerate achievement of the Partnership's 2010 and 2015 targets for malaria control and elimination.

Policies and strategies for malaria control

To reach the 2010 and 2015 targets, countries must reach all persons at risk for malaria with an insecticide-treated net (ITN) or indoor residual spraying (IRS) and provide laboratory-based diagnosis for all suspected cases of malaria and effective treatment of all confirmed cases.

Treatment

4. Prompt parasitological confirmation by microscopy or with a rapid diagnostic test (RDT) is recommended for all patients with suspected malaria, before treatment is started. Confirmed cases of uncomplicated *Plasmodium falciparum* malaria should be treated with an artemisinin-based combination therapy (ACT) and *P. vivax* malaria 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 14 days of primaquine to prevent relapse.
5. Treatment solely on the basis of clinical suspicion should be considered only when a parasitological diagnosis is not accessible. In 2008, 20 of 45 malaria-endemic countries in the WHO African Region and 51 of 64 countries outside the African Region reported having a policy of parasitological testing of suspected malaria cases in persons of all ages, and 78 countries reported a policy of treatment with ACT for *P. falciparum* malaria.
6. WHO recommends that oral artemisinin-based monotherapies be withdrawn from the market and replaced with ACTs. Thirty-seven countries still allow use of oral artemisinin-based monotherapies; most are located in the African Region, followed by the Region of the Americas and the South-East Asia Region.
7. Parasite resistance has rendered previous antimalarial medicines ineffective in most parts of the world, threatening malaria control. The highly effective artemisinin derivatives and their partner drugs are vulnerable to the same risk. Resistance of *P. falciparum* to artemisinins has been observed at the Cambodia-Thailand border.

Prevention

8. In 2008, 23 countries in the African Region and 35 outside that Region had adopted the WHO recommendation to provide bednets for all age groups at risk for malaria, not just women and children; this represents an increase of 13 countries since 2007.
9. IRS with WHO-approved chemicals (including DDT) remains one of the main interventions for reducing and interrupting malaria transmission by vector control in all epidemiological settings. In 2008, 44 countries, including 19 in the African Region, reported implementing IRS.
10. Intermittent preventive treatment (IPTp) is recommended for pregnant women in areas of high transmission. Thirty-three countries in the African Region, 3 in the Eastern Mediterranean Region and 1 in Western Pacific Region had adopted an IPTp policy by 2009.

Progress in preventing malaria

Coverage with ITNs is increasing rapidly in some countries of Africa, household ITN ownership having risen to 31% in high-burden countries by the end of 2008.

11. Nearly 140 million long-lasting insecticidal nets (LLINs) were delivered to high-burden countries in the African Region in 2006–2008.
12. A model-based estimate showed that 31% of African households owned at least one ITN, and 24% of children under 5 years of age had used an ITN in 2008. Household ITN ownership reached ≥ 50% in 13 (37%) of 35 high-burden countries in the African Region by 2008. Surveys show that seven countries (Equatorial Guinea, Ethiopia [population living at < 2000 m], Gabon, Mali,

Sao Tome and Principe, Senegal and Zambia) had reached a household ITN ownership rate of ≥ 60% by 2007 or 2008.

13. The percentage of children < 5 years who had used an ITN the previous night, given household ownership of at least one ITN, was 51% (median; range, 14–68%) in six countries for which data were available in 2006–2007. As all six surveys were demographic and health surveys, which are usually conducted in the dry season; use in the wet season might be higher.

14. In two of four countries in the African Region in which repeated national surveys were carried out, household ITN ownership decreased by 13% and 37% within 24–36 months of mass distribution, suggesting that strong programmes for routine distribution of ITNs are needed. Routine monitoring of the durability of LLINs and of the longevity of the insecticide are needed in order to calculate the requirements for ITN maintenance.

Progress in the diagnosis and treatment of malaria

ACT procurement is improving, and the percentage of children with fever who are treated with an ACT is rising. Nevertheless, countries received only about 50% of the ACTs needed to treat malaria cases at health facilities in the public sector in 2008.

15. In 18 high-burden WHO African Region countries for which data were available, 22% of the reported suspected malaria cases were confirmed with a parasite-based test in 2008.

16. Access to treatment, especially ACTs, was generally poor in African countries. Less than 15% of children under 5 years of age received an ACT when they had fever in 11 of 13 African countries for which survey data were available in 2007–2008.

17. Nine household surveys in 2007–2008 showed that 20% of pregnant women received a second dose of ITP.

Impact of malaria control

Dramatic reductions in the numbers of childhood deaths from malaria and from all causes have been reported in some settings where high coverage has been reached with effective interventions.

18. Reductions of more than 50% in the numbers of reported malaria cases and deaths were observed in four high burden African countries (Eritrea, Rwanda, Sao Tome and Principe and Zambia) and one area (Zanzibar, United Republic of Tanzania). Reductions of > 50% were also observed in five low transmission African countries (Botswana, Cape Verde, Namibia, South Africa and Swaziland). In Sao Tome and Principe and Zanzibar (United Republic of Tanzania) reductions in the number of malaria cases and deaths were found within 2–3 years of widespread use of IRS, LLINs and ACTs. In Rwanda, a reduction was found with only LLINs and ACTs.

19. The numbers of inpatient deaths from all causes decreased by 53% in Sao Tome and Principe and 57% on the islands of Zanzibar (United Republic of Tanzania) after aggressive malaria control. In Zambia, child mortality rates from all causes fell by 35%, as measured both by the number of deaths recorded in health facilities and by < 5 mortality rates derived from the Demographic and Health Survey of 2007. These trends, if confirmed in non-island countries, suggest that intensive malaria control could help many African countries to reach, by 2015, a two-thirds reduction in child mortality, as set forth in the Millennium Development Goals.

20. In other WHO regions, the number of reported cases of confirmed malaria decreased by more than 50% in 29 of the 56 malaria-endemic countries between 2000 and 2008. The number of cases fell least in countries with the highest incidence rates, indicating that greater attention should be given to countries that account for most malaria cases and deaths outside Africa.

Eliminating malaria

In September 2008, the RBM Partnership set a target of eliminating malaria in eight to ten countries by 2015 and afterwards in all countries that were in the pre-elimination phase in 2008.

21. Eight countries are in the pre-elimination stage of malaria control in 2009; 10 countries are implementing elimination programmes nationwide (six having entered the elimination phase in 2009), and a further nine countries (Armenia, Bahamas, Egypt, Jamaica, Morocco, Oman, Russian Federation, Syrian Arab Republic and Turkmenistan) have interrupted transmission and are in the phase of preventing re-introduction of malaria.

Financing malaria control

The funds committed to malaria control from international sources have increased substantially, from approximately US$ 0.3 billion in 2003 to US$ 1.7 billion in 2009. The levels of domestic financing for malaria appear to have been maintained over this period.

22. Funds disbursed for malaria control increased from US$ 592 million in 2006 to US$ 652 million in 2007. Commitments for malaria control exceeded US$ 1 billion in 2008 and US$ 1.7 billion in 2009, suggesting that the funds continue to increase.

23. Of 108 malaria-endemic countries, 76 received external assistance for malaria control between 2000 and 2007. The highest per capita expenditure was seen in countries with smaller populations at risk.

24. Countries that received more than US$ 7 in external assistance per person at risk for malaria between 2000 and 2007 were more likely to report a reduction in the number of malaria cases than countries with a lower level of assistance.

Chapter 1.
Introduction

The renewed effort to control malaria worldwide and move towards elimination in some countries is founded on the latest generation of effective tools and methods for prevention and treatment. Increasing use of long-lasting insecticide nets (LLINs), artemisinin-based combination therapies (ACTs) and indoor residual spraying (IRS) of insecticide provides an unprecedented opportunity to control and, in selected countries, eliminate malaria.

To accelerate progress in malaria control, the 2005 World Health Assembly advanced the Roll Back Malaria (RBM) targets defined in 2000 by African Heads of State and set a coverage target of 80% or more for four key interventions: insecticide-treated nets (ITNs) for people at risk, appropriate antimalarial drugs for patients with probable or confirmed malaria, IRS for households at risk, and intermittent preventive treatment in pregnancy (in high-transmission areas) *(1)*. The Health Assembly specified that, as a result of these interventions, the numbers of malaria cases and deaths per capita should be reduced by 50% or more between 2000 and 2010, and by 75% or more between 2000 and 2015. These goals were affirmed in the Global Malaria Action Plan *(2)*.

Following a resolution of the Health Assembly to establish a World Malaria Day *(3)* as a yearly advocacy forum, international organizations, nongovernmental organizations, multilateral organizations and donors, private sector partners and research institutions commemorated the first World Malaria Day in 2008. The commemorations culminated in a call by the United Nations Secretary General for universal coverage with malaria control interventions.

Last year's *Report*, on the basis of data for 2006, showed that the increased political commitment from national governments and partners earlier in the decade had led to more financing and effective commodities to malaria-endemic countries. This was good news, as there were an estimated 880 000 deaths from malaria and about 250 million cases in 2006. The *2008 Report* also highlighted several success stories outside Africa, although the overall decrease in the number of confirmed cases was slow. In high-burden countries in Africa, relatively few successes were recorded. While progress in malaria control has been remarkable, a number of potential threats demand increased attention, including: resistance to insecticides and antimalarial medicines and lack of alternatives; insufficient funding to attain universal coverage; weak global and international purchasing and supply chains, which result in stock-outs of key commodities at national and health facility levels; and lack of monitoring and management information systems of effects in high-burden African countries.

Readers of this *Report* will want to know, in comparison to last year: have finances continued to grow, to enable scale up throughout Africa and globally? Have the commodities distributed by national governments ended up in households, benefitting children, women and other adults? Is the financing and the coverage by interventions having an effect?

This *Report* provides data for two additional years, 2007 and 2008. It describes the status of malaria control both outside as well as inside Africa. In addition, it describes the full chain, from financing and policies to number of commodities distributed, intervention coverage in households and, finally, impact. This third edition of the *World Malaria Report* covers progress in malaria control in five areas.

- **Chapter 2** addresses national policies and strategies on malaria control, established to reduce the burden of disease. It covers the adoption by countries of recommendations for malaria control, treatment and prevention promoted by WHO, with adjustments for their particular epidemiological settings.
- Progress in implementing treatment and control measures is compared to international targets for malaria control in **Chapter 3.** This chapter is based on data on the number of commodities distributed by ministries of health and those delivered by manufacturers and on survey data. The data were analysed to determine whether the commodities purchased, delivered and distributed ended up in households and at health facilities. The most recent surveys, 2006–2008, were analysed to see how successful national malaria programmes have been in reaching their intended targets, including universal coverage.
- **Chapter 4** summarizes the global burden of malaria, and reviews recent trends in the reported number of malaria cases and deaths. It also assesses the evidence for malaria control activities having an impact on malaria disease burden in each WHO Region.
- The status of elimination of malaria is described in **Chapter 5**, which presents progress in those countries that are preparing to enter the elimination phase (pre-elimination), those in the elimination phase and those that have eliminated malaria but are not yet certified by WHO (phase of prevention of reintroduction).
- **Chapter 6** summarizes trends in international and domestic financing for malaria and their relation to estimated resource requirements; how funds disbursed from external agencies have been allocated to different geographical regions, countries and programmes; and the relation between external financing, programme implementation and disease trends.

Profiles of 31 countries are then presented. Two or three countries with the highest malaria burdens were chosen from five of the six WHO Regions. The other profiles are those of the 20 countries with the highest burden in the African Region.

Following the profiles, annexes give data by country for malaria-related indicators.

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Chapter 2.
Policies, strategies and targets for malaria control

This chapter summarizes the policies, strategies and targets for malaria control recommended by WHO. It includes three sections: 1) diagnosis and treatment of malaria; 2) malaria prevention by mosquito control; and 3) goals, indicators and targets.

2.1 Diagnosis and treatment of malaria, including preventive treatment

The two main objectives of an antimalarial treatment policy are:

1. to reduce morbidity and mortality by *i)* ensuring rapid, complete cure of the infection and thus preventing the progression of uncomplicated malaria to severe, potentially fatal disease, *ii)* malaria-related anaemia and, during pregnancy, *iii)* the negative impact of malaria on the fetus; and
2. to curtail the transmission of malaria by reducing the parasite reservoir of infection and infectivity.

Current WHO recommendations for diagnosis and treatment are shown in **Box 2.1**. Since publication of the *World Malaria Report 2008*, WHO has made several modifications to its malaria policy recommendations *(1)*:

i) Prompt parasitological confirmation by microscopy or alternatively by rapid diagnostic tests (RDTs) is recommended for all patients with suspected malaria before treatment is started. Treatment solely on the basis of clinical suspicion should be considered only when a parasitological diagnosis is not accessible.

ii) A fifth ACT, dihydroartemisinin-piperaquine, has been added to the treatment options.

iii) A single dose of primaquine is recommended in addition to ACT as an anti-gametocyte medicine in treatment of *P. falciparum* malaria, particularly as a component of a pre-elimination or an elimination programme, provided the risks for haemolysis in glucose-6-phosphate dehydrogenase (G6PD)-deficient patients have been considered.

Furthermore, in light of evidence of resistance to artemisinins, WHO urges more strongly the continued routine monitoring of therapeutic efficacy of antimalarial medicines and halting the use all monotherapies for the treatment of uncomplicated malaria *(2)*.

BOX 2.1

WHO recommendations for diagnosis and treatment of malaria

- Prompt parasitologic confirmation by microscopy or alternatively by rapid diagnostic tests (RDTs) is recommended in all patients suspected of malaria before treatment is started. Treatment solely on the basis of clinical suspicion should only be considered when a parasitological diagnosis is not accessible.
- Uncomplicated *Plasmodium falciparum* malaria should be treated with an artemisinin-based combination therapy (ACT); vivax malaria should be treated with chloroquine where it is effective, or an appropriate ACT, in areas where *P. vivax* resistance to chorloquine has been documented. Both chloroquine and ACTs should be combined with primaquine for 14 days in the treatment of *P. vivax* malaria, for the prevention of relapses, subject to considering the risk of haemolysis in patients with G6PD-deficiency.
- Five ACTs are currently recommended for use: artemether-lumefantrine, artesunate-amodiaquine, artesunate-mefloquine, artesunate-sulfadoxine pyrimethamine, and dihydroartemisinin-piperaquine. The choice of the ACT should be based on the efficacy of the combination in the country or area of intended use.
- Artemisinin derivatives should not be used as monotherapies for the treatment of uncomplicated malaria as this will promote resistance to this critically important class of antimalarials.
- A single dose of primaquine to be added as an anti-gametocyte medicine to ACT treatment of *P. falciparum* malaria, particularly as a component of pre-elimination or elimination programme, is recommended provided the risk of haemolysis in G6PD-deficient patients is considered.
- Severe malaria should be treated with a parenteral artemisinin derivative or quinine to be followed by a complete course of an effective ACT as soon as the patient can take oral medications. When intravenous or intramuscular treatment is not feasible, e.g. in peripheral health posts, patients should receive pre-referral treatment with an artemisinin suppository and be transferred to a health facility capable of providing definitive treatment with parenteral antimalarial medicines.
- In settings with limited health facility access, diagnosis and treatment should be provided at community level through a programme of community case management (home-based management) of malaria.

2.2 Malaria prevention through mosquito control

2.2.1 Aims

Malaria vector control is intended to protect individuals against infective mosquito bites and, at the community level, to reduce the intensity of local malaria transmission. The two most powerful and most broadly applied interventions are insecticide-treated nets (ITN) and indoor residual spraying (IRS). In some specific settings and circumstances (if the breeding sites are few, fixed, and easy to identify) these core interventions may be complemented by other methods such as larval control or environmental management. WHO recommendations for vector control are the following:

1. Because high coverage rates are needed to realize the full potential of either ITNs or IRS, WHO GMP recommends "universal coverage" of all people at risk in areas targeted for malaria prevention. In the case of ITNs, this means that all people at risk in areas targeted for malaria prevention should be covered with ITNs *(3, 4)*.
2. ITNs should be either free of charge or highly subsidized. Cost should not be a barrier to making them available to all people at risk, especially young children and pregnant women *(3)*.
3. Universal coverage with long-lasting insecticidal nets (LLINs) can be achieved and maintained by combining distribution through occasional campaigns with continuous distribution to pregnant women and infants at routine antenatal and immunization contacts *(3)*.
4. Only LLINs recommended by the WHO Pesticide Evaluation Scheme (WHOPES) should be procured by national malaria programmes and partners for malaria control. These nets are designed to maintain their biological efficacy against vector mosquitoes for at least three years in the field under recommended conditions of use, obviating the need for regular insecticide treatment *(5, 6)*.
5. IRS consists of the application of insecticides to the inner surfaces of dwellings, where endophilic anopheline mosquitoes often rest after taking a blood meal *(4)*. IRS is applicable in many epidemiological settings, as long as operational and resource feasibility is considered in policy decisions. Twelve insecticides belonging to four chemical classes are currently recommended by WHO for IRS. An insecticide for IRS in a given area is selected on the basis of data on resistance, the residual efficacy of the insecticide, cost, safety and the type of surface to be sprayed. Special attention must be given to preserving susceptibility to pyrethroids, because they are the only class of insecticide currently used on ITNs.
6. Scientific evidence indicates that IRS is effective in controlling malaria transmission and thus reduces the related burden of morbidity and mortality as long as most houses and animal shelters (e.g. > 80%) in targeted communities are treated. IRS is effective only if the operation is performed correctly, which depends on the existence at national, provincial and district levels of adequate infrastructure and programme capacity for implementation, monitoring and evaluation *(4)*.
7. DDT has comparatively long residual efficacy (≥ 6 months) against malaria vectors and plays an important role in the management of vector resistance. 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 met and until locally appropriate, cost-effective alternatives are available for a sustainable transition from DDT *(7)*.
8. Resistance to insecticides, especially pyrethroids, is an urgent and growing threat to the sustainability of current methods of vector control. Monitoring and managing resistance to the insecticides used in both ITNs and IRS are vital *(3, 4)*.
9. In most settings where IRS has been or is being deployed, ITNs or LLINs are already in use. Neither LLINs nor IRS alone will be sufficient to achieve and maintain interruption of transmission in holoendemic areas of Africa or in hyperendemic areas in other regions *(3)*. Some observational evidence indicates that the combination of IRS and LLIN is more effective than either intervention alone, especially if the combination helps to increase overall coverage with vector control *(8)*. More formal trials are being planned. In using the combination of IRS and ITNs, it is preferable to use a non-pyrethroid insecticide for IRS.

2.2.2 Resistance to antimalarial drugs

Antimalarial drug resistance is a major public health problem, which hinders the control of malaria. The rapid spread of resistance to these drugs over the past few decades has led to intensification of the monitoring of their efficacy, to ensure proper management of clinical cases and early detection of changing patterns of resistance in order to revise national malaria treatment policies. Surveillance of therapeutic efficacy over time is an essential component of malaria control. The results of tests for therapeutic efficacy (in vivo tests) provide the most important information for determining whether first- and second-line drugs are still effective and also provide evidence for ministries of health to update their national malaria treatment policies.

WHO's role in the global management of drug resistance has been twofold. Its normative and standard-setting role results in a harmonized approach to this global concern. In order to interpret and compare results within and between regions, and to follow trends over time, tests must be conducted with similar standardized procedures, and WHO has standarded the available methods. Since 1996, WHO has updated the protocol for assessing antimalarial drug efficacy on the basis of expert consensus and feedback from the field *(9)*. WHO has also prepared a field manual on *in vitro* assays for the sensitivity of malaria parasites to antimalarial drugs *(10)* and a guideline on genotyping malaria parasites to distinguish between reinfection and recrudescence during therapeutic efficacy tests. Genotyping is now becoming mandatory with the longer follow-up of patients *(11)*. Apart from its normative role, WHO GMP is also providing technical assistance to countries in both the surveillance of drug resistance and guidance on treatment policies. Routine surveillance systems put in place by countries and coordinated by WHO have shown that the failure rate of currently used ACTs is increasing on both sides of the Thai-Cambodian border, due mainly to local emergence of resistance to artemisinin derivatives. WHO is investigating this problem and implementing strategies to contain and prevent the dissemination of resistance further.

In response to the challenge posed by the emergence of resistance to antimalarial drugs, WHO has established a global database of information and the results of antimalarial drug efficacy tests at country

level. The database is used by governments to review and update their treatment policies. The continuously updated database can also be made available to other stakeholders. The data will be analysed for a report on global monitoring in 2009, focusing on the efficacy of ACTs, which will describe WHO's work in monitoring resistance to antimalarial drugs, setting up the database, standardizing therapeutic efficacy tests, promoting more rational use of the available tests for evaluating resistance and showing how the results of these tests are used for updating national malaria treatment policies.

2.3 Goals, indicators and targets

The vision of the RBM Partnership is "a world free from the burden of malaria" *(12)*. As of 2007, the United Nations (through the MDGs), the World Health Assembly and the RBM Partnership had consistent goals for intervention coverage and impact for 2010 and 2015 *(13–15)*. Coverage is meant to reach ≥ 80% by 2010 with four key interventions: ITNs for people at risk, appropriate antimalarial medicines for patients with probable or confirmed malaria, IRS for targeted households at risk and intermittent preventive treatment in pregnancy (in moderate-to-high transmission settings). The global impact targets are a reduction in the number of malaria cases and deaths per capita by 50% or more between 2000 and 2010, and by 75% or more between 2000 and 2015.

The RBM partnership added three additional targets as part of the Global Malaria Action Plan in September 2008 *(16)*. The first is to reduce the global number of malaria deaths to near-zero preventable deaths by 2015. This target is more aggressive than the previous target of a 75% reduction in the number of malaria deaths by 2015, although there is no global consensus on how to measure preventable deaths. The second is that malaria should be eliminated in 8–10 countries by 2015 and afterwards in all countries that are in the pre-elimination phase today (2008). The third goal is, "in the long term, eradicate malaria worldwide by reducing the global incidence to zero through progressive elimination in countries".

The Inter-agency and Expert Group on MDG Indicators has established specific indicators for malaria *(13)*:

6.6 Incidence and death rates associated with malaria.

6.7 Proportion of children under 5 years sleeping under insecticide-treated bed nets.

6.8 Proportion of children under 5 years with fever who are treated with appropriate antimalarial medicines.

Table 2.1 draws together the work of RBM since 1998, the Abuja Declaration in 2000 *(14)*, the resolution of the Health Assembly in 2005 *(15)*, and various subsequent revisions of the MDGs for malaria and the RBM Global Action Plan for Malaria. It shows practical indicators recommended by WHO for use by national malaria programmes to measure coverage with malaria control interventions and epidemiological impact. Core national operational logistics and reporting indicators are also listed. The only substantial change from last year's indicator list is the addition of a new IRS indicator: percentage of at-risk population targeted by IRS. This indicator has no target but is intended to monitor the contribution of IRS to overall malaria control.

The indicators in Table 2.1 apply to countries with high, moderate and low transmission that are in the control phase but not to those in the pre-elimination or elimination phases. Indicators have not yet been developed for the phases of pre-elimination, elimination and prevention of reintroduction.

Table 2.1 Malaria indicators, targets and sources of data (*17–19*)

A. TRENDS IN MALARIA CASES AND DEATHS

IMPACT MEASURE	INDICATOR	NUMERATOR	DENOMINATOR	DATA TYPE/SOURCE	TARGET
Malaria cases					
	1.1 Confirmed malaria cases (microscopy or RDT, per 1000 persons per year) [a]	Confirmed malaria cases per year (< 5 years or total)	Population (< 5 years or total)	Routine surveillance	Reduction in cases per capita: ≥ 50% by 2010, and ≥ 75% by 2015 in comparison with 2000
	1.2 Inpatient malaria cases (per 1000 persons per year) [b]	No. of inpatient malaria cases per year (< 5 years or total)	Population (< 5 years or total)	Routine surveillance	Reduction in cases per capita: ≥ 50% by 2010, and ≥ 75% by 2015 in comparison with 2000
Malaria transmission					
	1.3 Malaria test positivity rate (both microscopy and RDT) [a]	No. of laboratory-confirmed malaria cases	No. of suspected malaria cases with parasite-based laboratory examination	Routine surveillance	No target set, indicates level of control [c]
Malaria deaths					
	1.4 Inpatient malaria deaths (per 1000 persons per year)	No. of inpatient malaria deaths per year (< 5 years or total)	Population (< 5 years or total)	Routine surveillance	Reduction in deaths per capita: 50% by 2010 and ≥ 75% by 2015 in comparison with 2000 [d]
	1.5 Malaria-specific deaths (per 1000 persons per year)	No. of malaria deaths per year (< 5 years or total)	Population (< 5 years or total)	Verbal autopsy (surveys), complete or sample vital registration systems	
	For high-transmission countries 1.6 Deaths of children < 5 years old from all causes (per 1000 children < 5 years old per year)	No. of deaths in children < 5 years old from all causes	Population (< 5 years)	Household surveys, complete or sample vital registration systems	No target set

B. COVERAGE WITH INTERVENTIONS

CONTROL STRATEGY	INDICATOR	NUMERATOR	DENOMINATOR	DATA TYPE/SOURCE	TARGET
Prompt access to effective treatment					
	2.1 Appropriate antimalarial treatment of children < 5 years within 24 hours of onset of fever [e–g] (MDG indicator 6.8)	No. of children < 5 years receiving appropriate antimalarial treatment (according to national policy) within 24 hours of onset of fever	No. of children < 5 years with fever in the past 2 weeks in surveyed households [e]	Household surveys	≥ 80%
Mosquito control with ITNs					
	2.2 ITN use by all persons or children < 5 years or pregnant women (MDG indicator 6.7) [h]	No. of persons (all ages) or children < 5 years or pregnant women who reported sleeping under an ITN during previous night	No. of persons (all ages) or children < 5 years old or pregnant women in surveyed households	Household surveys	≥ 80%
	2.3. "Administrative" ITN coverage [i]	No. of persons with ITN from numbers of ITN distributed [i]	No. of persons at risk for malaria	Routine NMCP data	≥ 80%
Mosquito control by IRS					
	2.4. Percentage of population at risk that is targeted for indoor-residual spraying (IRS)	No. of persons that are targeted for IRS	No. of persons at risk for malaria	Routine NMCP data	No target set. Indicates contribution of IRS to overall malaria control
	2.5. Households sprayed with insecticide among those targeted	No. of households sprayed at least once in one year according to national guidelines	No. of households targeted according to national guidelines	Routine NMCP data	100%
Prevention of malaria in pregnancy					
	For high-transmission countries 2.6. Pregnant women who received two doses of intermittent preventive therapy	No. of pregnant women who received two doses of intermittent preventive therapy	No. of pregnant women who made at least one ANC visit in one year	Routine antenatal clinic data	≥ 80%

C. OPERATIONAL INDICATORS USED AT HEALTH FACILITY, DISTRICT AND NATIONAL LEVELS, MEASURED USING ROUTINE HEALTH INFORMATION SYSTEMS

MONITORING	INDICATOR	NUMERATOR	DENOMINATOR	DATA TYPE/SOURCE	TARGET
Diagnosis					
	3.1. Percentage of outpatient suspected malaria cases that undergo laboratory diagnosis [j]	No. of outpatient suspected malaria cases that undergo laboratory diagnosis (by age group)	No. of outpatient suspected malaria cases that should be examined (by age group)	Routine surveillance data	≥ 90%
Appropriate treatment at health facilities					
	3.2. Percentage of outpatient cases that received appropriate antimalarial treatment according to national policy	No. of malaria cases receiving appropriate antimalarial treatment at health facility	No. of outpatient malaria cases expected to be treated at health-facility level with appropriate antimalarial medicine	Routine logistic data	100%
Routine distribution of mosquito nets					
	3.3. ITN distribution to vulnerable sub-groups	No. of ITNs distributed to vulnerable groups [k]	No. of persons in vulnerable groups targeted for receiving ITNs	Routine logistic data	≥ 80%
Antimalarial drug supplies					
	3.4. Health facilities without stock-outs of first-line antimalarial medicines, mosquito nets and diagnostics, by month	No. of health facilities without stock-outs of any first-line antimalarial medicines, ITNs and RDTs, by month [l]	No. of health facilities	Routine logistic data	100%
Reports for programme management					
	3.5. Completeness of monthly health facility reports on logistics or surveillance [m]	No. of health facility reports received each month, on logistics or surveillance	No. of health facility reports expected each month	Routine surveillance and logistic data	> 90%

From references *17–19*

RDT: rapid diagnostic test; MDG: Millennium Development Goal; ITN: insecticide-treated net; IRS: indoor residual spraying

a. Use only if > 90% of suspected cases have examination for parasites (microscopy or RDT).

b. Marker for severe malaria.

c. Malaria test positivity rate < 5% during the malaria season marks the readiness for transition from control stage to pre-elimination stage.

d. A new RBM target was introduced in the 2008 Global Malaria Action Plan: "near zero preventable malaria deaths" by 2015. This target is more ambitious than the target of 75% reduction in malaria deaths by 2015. There is no global consensus on how to measure preventable malaria deaths.

e. As malaria incidence is reduced, a smaller percentage of fevers will be due to malaria. With improved diagnosis, treatment can be targeted at confirmed cases. This indicator is currently under review.

f. In areas where *P. vivax* is dominant and in areas of low transmission, this indicator may be less useful.

g. The intention is to treat all persons with an appropriate antimalarial medicine; however, children are at greatest risk, especially in areas of high transmission.

h. Indicator should be calculated separately for all persons, children and pregnant women.

i. "Administrative" or operational ITN coverage is measured from the number of LLINs or ITNs distributed by ministries of health and partners. LLINs are the preferred type of ITN; they are assumed to protect for 3 years and conventional ITN for 1 year. One LLIN is assumed to protect two persons. This indicator mainly measures distribution and not hanging or use.

j. Laboratory diagnosis includes microscopy and RDT; this is also an indicator of the quality of surveillance.

k. e.g. pregnant women attending antenatal clinics, children attending in the context of the expanded programme on immunization.

l. This indicator has three subindicators: one each for antimalarial medicines, ITNs and RDTs.

m. This indicator can have one to three subindicators, depending on the data collection forms and reporting channels. For example, the inpatient data channel may be separate from the outpatient data channel, or logistics and disease surveillance data channels may be separate.

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Chapter 3.
Interventions to control malaria

This chapter addresses the implementation of policies and coverage with interventions. The first part contains a description of how national programmes have adopted and implemented policies and strategies as compared with those recommended by WHO. Second, information is provided on global ACT supplies, the artemisinin market situation and oral artemisinin-based monotherapy medicines. The third section describes intervention coverage in high-burden countries in the WHO African Region. The fourth section gives the numbers of ITNs, ACTs and RDTs distributed, by WHO Region.

3.1 Adoption of policies and strategies for malaria control

Adoption of policies and strategies is reported to WHO by countries (see Annex 4.A). National adoption and implementation of policies by WHO Region is shown in **Table 3.1.** In 2008, 23 countries in the WHO African Region and 35 outside of the African Region had adopted the WHO policy recommendation to provide bed nets to all age groups at risk of malaria, an increase of 13 countries since 2007. In 2008, 44 countries, including 19 in Africa, reported implementing IRS. DDT use for IRS was reported by 12 countries: eight countries in the African Region, three in the South-East Asia Region and one in the Western Pacific Region. In 2008, 20 of 45 malaria endemic countries in the WHO Africa Region and 51 of 64 endemic countries in other regions reported having adopted a policy of providing parasitological diagnosis to all age groups. Twelve African countries are using RDTs at community level. Details of country policies are given in Annex 4.A. Thirty-three countries in the African Region, three in the Eastern Mediterranean Region and one in Western Pacific Region had adopted the policy by 2009.

3.2 Information on global ACT supplies and the artemisinin market situation

The sources of information on global adoption of the WHO policy on ACTs and their deployment, on artemether-lumefantrine supplies, on overall ACT sales, on the artemisinin market situation and on oral artemisinin-based monotherapy medicines are given below.

Information on adoption of the WHO policy on ACTs and their deployment:

- country adoption of ACTs: the WHO/GMP Antimalarial Drug Policies Database (http://www.who.int/malaria/treatmentpolicies.html) and
- 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.

Information on ACT sales for public sector use by manufacturers eligible for procurement by WHO in 2008 was obtained from various companies.

- Artemether-lumefantrine: Ajanta, Cipla, Novartis
- Artesunate + amodiaquine fixed-dose combination: Sanofi Aventis
- Artesunate + amodiaquine co-blisters: Cipla, Guilin, Ipca, Sanofi Aventis, Strides Arcolab
- Artesunate + mefloquine: data on number of treatment courses not available
- Artesunate + sulfadoxine-pyrimethamine: Cipla, Guilin

Information on the artemisinin market situation:

- Price fluctuations of artemisinin raw material: from the International Conference on Artemisinin Production and Marketing Needs: Meeting Global Demand, Bangkok, 25–26 June 2007, Medicines for Malaria Venture, WHO (http://www.mmv.org/article.php3?id_article=374) and the Artemisinin Forum 2008: Joint Meeting on Ensuring Sustainable Artemisinin Production: Meeting Global Demand, 24–26 November 2008 (http://www.mmv.org/article.php3?id_article=562).

Information on oral artemisinin-based monotherapy medicines:

- The position of pharmaceutical companies in relation to WHO recommendations on oral artemisinin-based monotherapy medicines: the WHO/GMP database at www.who.int/malaria/pages/performance/marketingmonotherapies.html.
- Countries and marketing authorization of oral artemisinin-based monotherapy medicines: the WHO/GMP database at www.who.int/malaria/pages/performance/monotherapycountries.html.

Table 3.1 Adoption and implementation of WHO-recommended policies and strategies for malaria control, by WHO Region, 2008

INTERVENTION	WHO REGION						
	AFR	AMR	EMR	EUR	SEAR	WPR	TOTAL
Number of endemic countries [a]	43	23	13	9	10	10	108
Number of *P. falciparum* endemic countries	42	11	9	1	9	9	81
Insecticide-treated net (ITN)							
Targeting population – All	14	12	7	3	8	8	52
Distribution – Free	33	5	10	4	9	7	68
Indoor residual spraying (IRS)							
IRS is the primary vector control intervention	15	11	4	8	5	2	45
DDT is used for IRS (public health only)	8	0	0	0	3	1	12
Diagnosis and treatment							
ACT for treatment of *P. falciparum*	42	8	8	1	9	9	77
ACT is free of charge for children < 5 years in the public sector	23	4	10	1	8	6	52
Oral artemisinin-based monotherapies banned	17	5	10	1	8	3	44
Parasitological confirmation for all age groups	20	21	7	8	9	6	71
Diagnosis of malaria of inpatients based on parasitological confirmation	23	9	8	7	6	9	62
Pre-referral treatment at health facility level with quinine or artemether intramuscularly or artesunate suppositories	19	1	9	0	5	5	39
RDTs used at community level [b]	12	5	3	0	4	5	29
Oversight regulation of case management in the private sectors	14	2	6	3	4	4	33
Intermittent preventive therapy (IPT)							
Intermittent preventive therapy to prevent malaria during pregnancy	33	0	3	0	0	1	37

ACT: artemisinin-based therapy; RDT: rapid diagnostic test

[a] Includes countries in prevention of re-introduction phase

[b] Recommended by WHO in high transmission areas where there is poor access to health services

3.2.1 ACT policy adoption and deployment

By 2009, 77 of 81 *P. falciparum* malaria-endemic countries and territories had adopted ACTs for use in their national drug policy. As of 2008, French Guiana, Guatemala and Haiti were the only countries yet to adopt the policy of using ACT for treatment of *P. falciparum* malaria. Sixty countries are deploying these medicines in the general health services, with varying levels of coverage (**Fig. 3.1**).

3.2.2 Artemether-lumefantrine supplies

WHO is monitoring the global supply of and demand for the artemether-lumefantrine fixed-dose combination as part of the requirements of the Memorandum of Understanding signed with the manufacturer, Novartis, in 2001, to make Coartem® available at cost price for distribution in the public sector of malaria-endemic developing countries. The total supplies of this combination increased substantially, from 11.2 million treatment courses in 2005 to 62 million in 2006 and 66.3 million in 2007, with procurement of more than 78 million treatment courses in 2008. In the period 2006–2008, most artemether-lumefantrine was procured for young children weighing < 15 kg, and the smallest proportion was supplied for patients with a body weight of 25–34 kg (**Fig. 3.2**). Most countries that procure artemether-lumefantrine are located in the African Region (**Fig.3.3**).

Besides UNICEF, other agencies (Crown Agents, IDA Solutions, John Snow, Inc., Medical Export Group, Médecins Sans Frontières, Missionpharma, UNDP, UNOPS) have established direct procurement agreements with Novartis to supply Coartem® at the same prices negotiated by WHO. While overall artemether-lumefantrine supplies have increased since 2007, procurement of this medicine through WHO has proportionally decreased, while procurement through other agencies has proportionally increased (**Fig. 3.4**). Between December 2008 and May 2009, two additional preparations of artemether-lumefantrine, manufactured by Ajanta and Cipla, were prequalified by WHO.

3.2.3 Overall ACT sales

Public-sector sales of artemether-lumefantrine, artesunate + amodiaquine, and artesunate + sulfadoxine-pyrimethamine, manufactured by seven companies eligible for WHO procurement, are shown in **Figure 3.5**. During the period 2006–2008, procurement of fixed-dose combination ACTs progressively increased, and sales of co-blistered ACTs (**Fig. 3.6**), which represent a relatively small proportion of overall ACT sales to the public sector, showed a decreasing trend. Artemether-lumefantrine is the ACT that represents the largest volume of sales to the public sector, followed by artesunate + amodiaquine.

Figure 3.1 Adoption of policy and deployment of artemisinin-based therapy (ACT) by year, global data, 2001–2008

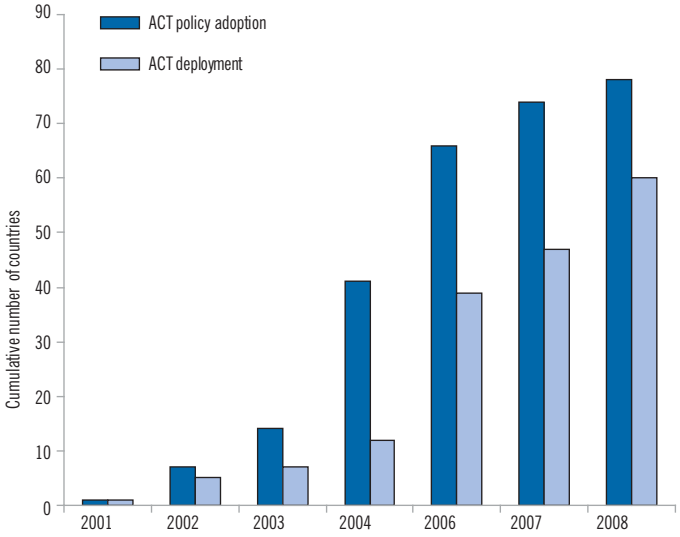


Figure 3.2 Procurement of artemether-lumefantrine for public sector use by weight-based dose package, global data, 2005–2008

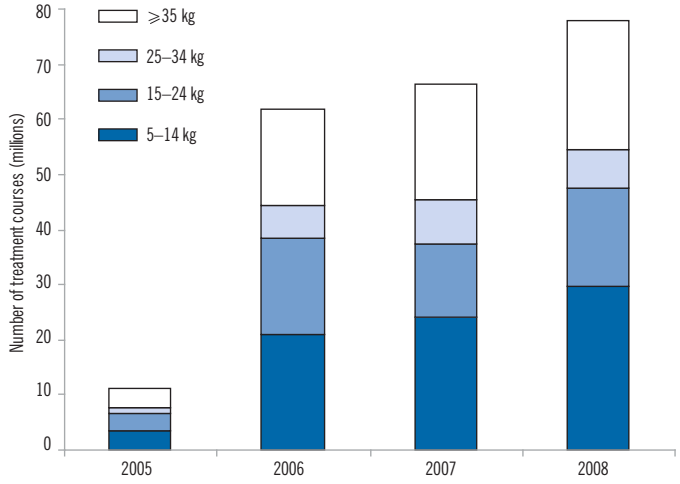


Figure 3.3 Public sector procurement of artemether-lumefantrine by year, by WHO Region, 2006–2008

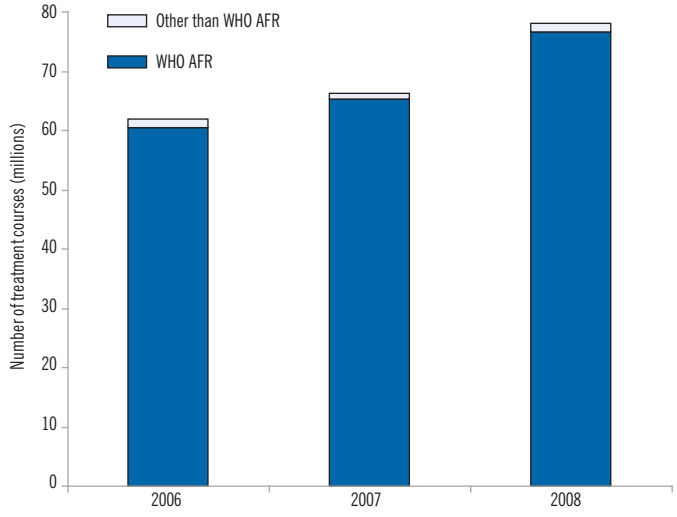


Figure 3.4 Number of artemether-lumefantrine treatment courses procured for public-sector use by procurement agency by year, global data, 2005–2008

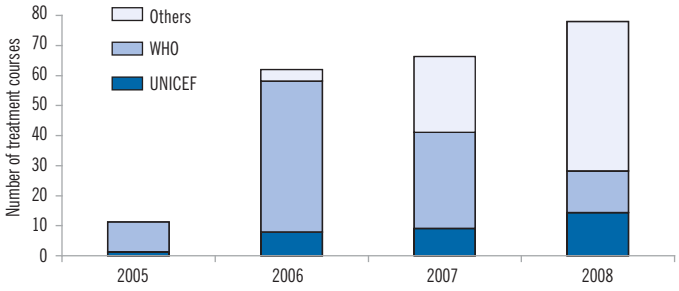
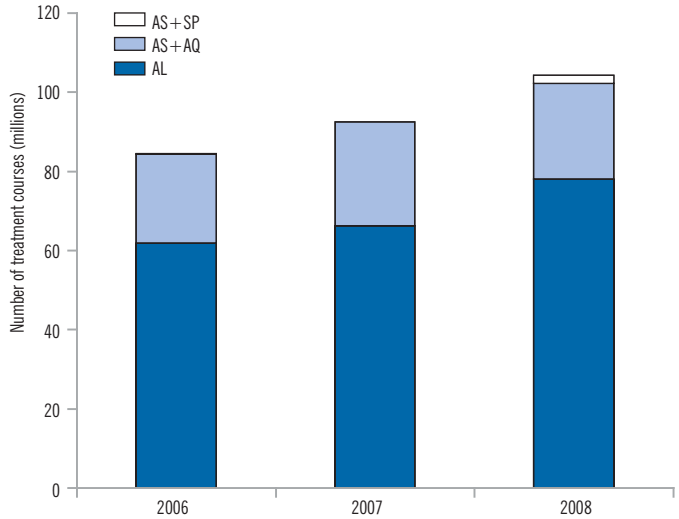
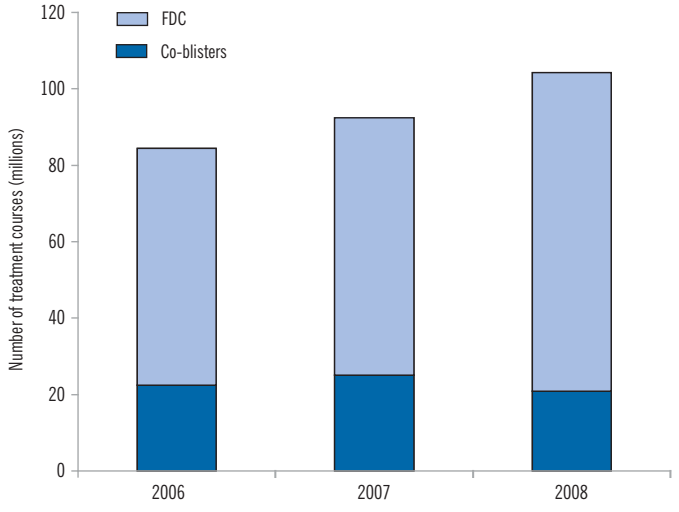


Figure 3.5 WHO-recommended artemisinin-based therapy courses procured for public sector use by year, global data



AL, artemether-lumefantrine; AS+AQ, artesunate + amodiaquine; AS+MQ, artesunate + mefloquine; AS+SP, artesunate + sulfadoxine/pyrimethamine

Figure 3.6 Co-blister packs and fixed-dose combination (FDC) artemisinin-based combination therapy procured for public-sector use by year; global data, 2006–2008



3.2.4 Artemisinin market situation

The major investments and the expansion in agricultural production of *Artemisia annua* and extraction of artemisinin in 2006–2007 were not matched by a similar increase in demand for artemisinin by ACT manufactures and suppliers of artemisinin-based active pharmaceutical ingredients. The resulting production surplus of artemisinin has led to a reduction in the prices of artemisinin raw material, even to below production costs, reaching as low as US$ 200 per kg by the end of 2007 and 2008. The subsequent withdrawal of many artemisinin producers and extractors from the market in 2008 is likely to create a shortage of artemisinin-based active pharmaceutical ingredients in 2010, when demand for ACTs will increase because of greater mobilization of funds from international agencies, including the Affordable Medicine Facility for malaria. To counteract these market dynamics, a new UNITAID-funded Initiative, based on credit-line facilities for artemisinin extractors, has been introduced. Production of artemisinin-based antimalarial medicines will remain dependent on agricultural production, as production of artemisinin with biotechnology from yeast culture will not become available until at least 2012.

3.2.5 Oral artemisinin-based monotherapy medicines

The presence of oral artemisinin-based monotherapies on the market continues to represent a threat to the therapeutic life of these medicines, by encouraging the development of resistance. To contain this risk and to ensure high cure rates of *P. falciparum* malaria, WHO recommends the withdrawal of oral artemisinin-based monotherapies from the market and use of ACTs instead. After publication of the *WHO Guidelines for the treatment* of malaria in January 2006, pharmaceutical companies were asked to stop producing and marketing the oral monotherapies. Major procurement and funding agencies as well as international suppliers cooperated with WHO by agreeing not to fund or procure these drugs. The recommendations were endorsed by all WHO Member States and are included in resolution WHA60.18 adopted by the 60th World Health Assembly in May 2007.

World Health Assembly Resolution WHA60.18

In May 2007, the 60th World Health Assembly resolved to take strong action against oral artemisinin-based monotherapies and approved resolution WHA60.18, which:

- urges Member States to cease progressively the provision in both the public and private sectors of oral artemisinin-based monotherapies, to promote the use of artemisinin-combination therapies, and to implement policies that prohibit the production, marketing, distribution and the use of counterfeit antimalarial medicines;

- requests international organizations and financing bodies to adjust their policies so as progressively to cease to fund the provision and distribution of oral artemisinin monotherapies, and to join in campaigns to prohibit the production, marketing, distribution and use of counterfeit antimalarial medicines.

The full text of the resolution can be found at the following link:
http://apps.who.int/gb/ebwha/pdf _ files/WHA60/A60 _ R18-en.pdf.

Since 2006, WHO GMP has convened several meetings in various countries to inform national drug regulatory authorities and representatives of the private sector about the WHO recommendations. As a result, a number of countries have taken regulatory measures to phase out the production and marketing of oral artemisinin-based monotherapies, including Benin, China, India, Pakistan and Viet Nam. The Indian experience is presented in **Box 3.1.**

To monitor implementation of the WHO recommendation to remove oral artemisinin-based monotherapies progressively from the market, WHO GMP is using a web-based system to compile data on both manufacturers' compliance and the regulatory steps taken by malaria-endemic countries. Twenty-two of 68 pharmaceutical companies identified by WHO by December 2008 had declared their intention to comply with the recommendation to stop production and marketing of the drugs, and another 12 have actually ceased production and marketing. While 24 malaria-endemic countries have either never registered or have taken regulatory measures to withdraw marketing authorizations for these medicines, and another 11 countries have declared their intention to comply with the WHO recommendation, 41 countries still allowed marketing of these products as of the end of 2008 (**Fig. 3.7**). Most of the countries that still allow the production and marketing of monotherapies are located in the African Region, followed by the regions of the Americas and South-East Asia.

Web-based WHO monitoring system for the implementation of WHA60.18

Information on manufacturing companies is available from:

http://apps.who.int/malaria/pages/performance/marketingmonotherapies.html.

Information on countries complying with the resolution is available from:

http://apps.who.int/malaria/pages/performance/monotherapy-countries.html

BOX 3.1

Country example: India

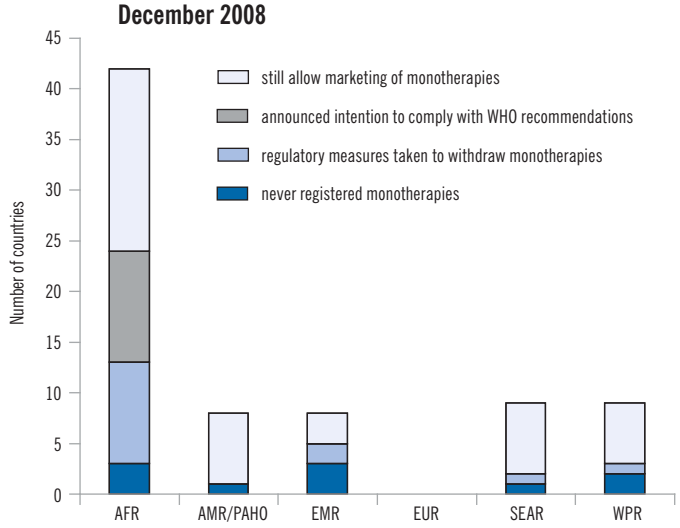
Indian pharmaceutical companies export large quantities of artemisinin-based antimalarial medicines to African countries, and up to 70 companies marketing these medicines have been identified. In April 2006 and October 2008, two meetings were convened with Indian manufacturers to inform them about the risks for artemisinin resistance and about the WHO recommendations to phase out oral artemisinin-based monotherapies from the market. At the meeting in October 2008, which was chaired by the Drug Controller General of India, feasible mechanisms and timelines for the progressive withdrawal of oral artemisinin-based monotherapies from the Indian market were identified. In December 2008, the Drug Controller General of India requested the State Licensing Authorities to withdraw the production licenses and marketing authorization of these products over a 6-month period, affecting both their domestic and export markets.

Challenges to implementation of resolution WHA60.18 remain. As the private-sector pharmaceutical markets in many malaria-endemic countries are unregulated, pharmaceutical companies tend to ignore the WHO guidelines. Moreover, when responsible companies comply with the recommendation by withdrawing their oral artemisinin-based monotherapies from the market, they leave "niche markets", which are exploited by opportunistic companies manufacturing substandard products. More collaboration and involvement of national drug regulatory authorities is required to implement the resolution and to ensure complete elimination of oral artemisinin-based monotherapy medicines from all countries.

Compliance in some countries and positive responses from several manufacturers show that it is possible to phase out artemisinin-based monotherapies. The following timetable, based on the initial experience of countries that have succeeded, can be used as a guide.

ACTION	TASK	TIMELINE
STEP 1	Agreement on time frame of phasing out oral artemisinin-based monotherapies and introduction/implementation of artemisinin-based combination therapies	immediate
STEP 2	No more new marketing approvals for oral artemisinin-based monotherapies	immediate
STEP 3	No grand import licence for artemisinin or its derivatives to companies that are exclusively marketing oral artemisinin-based monotherapies	3–4 months
STEP 4	Large scale deployment of artemisinin-based combination therapies in the public sector	Time X
STEP 5	Promotion of widespread availability and affordability of ACTs in the private sector and communication campaigns to move prescribers and consumers away from monotherapies	Time Z
STEP 6	Withdrawal of manufacturing licences for oral artemisinin-based monotherapies as finished pharmaceutical products (FPP)	6 months after Time X
STEP 7	No export license for oral artemisinin-based monotherapies as FPP	6 months after Time X
STEP 8	Complete elimination of oral artemisinin-based monotherapies as FPP from the market	10–12 months after Time X

Figure 3.7 Countries' regulatory position on oral artemisinin-based monotherapy medicine by year and WHO Region, as of December 2008



3.3 Intervention coverage in high-burden countries in the WHO African Region

This section describes coverage with interventions in 35 high-burden countries that comprised 87% of the population of African Region in 2008 and 99% of the population at risk. We have excluded low-burden countries: Botswana, Cape Verde, Namibia, South Africa, Swaziland and Zimbabwe.

3.3.1 Definitions

Three sources were used to estimate intervention coverage: logistics data reported by national programmes, the number of commodities delivered by manufacturers, and national surveys. Estimates for six interventions (ITNs, ACTs, IRS, parasite-based testing, RDTs and IPT for pregnant women) were derived from logistics or administrative data reported by ministries of health; these estimates are referred to as "operational" or "administrative" indicators and are summarized in **Box 3.2**.

The numerator for operational percentage coverage with ITNs is the number of persons covered by the ITNs distributed, assuming that one ITN covers two persons *(1)*. As LLINs are assumed to last 3 years, the numerator includes the number of nets distributed over 3 years. The denominator is the population at risk, i.e. persons in a country who are at risk for malaria, as reported to WHO by national programmes. The percentage of the national population at risk was 100% for most countries in the African Region, except for e.g. Ethiopia and Kenya, where part of the country is considered by national experts as being at no risk (mostly areas at higher elevation). Persons living in areas of unstable transmission of malaria, where malaria is absent during most of the year but can occur as outbreaks, are still considered "at risk".

BOX 3.2

Six practical indicators obtained from routine data

1. **ITNs –** Operational ITN coverage: number of LLINs distributed in previous 3 years multiplied by 2 (assuming one long-lasting insecticidal net covers two persons) divided by population at risk for malaria.
2. **ACTs –** Percentage of reported malaria cases with access to ACTs: number of ACT treatment courses distributed divided by the number of reported malaria cases.
3. **IRS –** Percentage of population at risk protected by IRS: number of persons protected by IRS divided by population at risk.
4. **Parasite-based testing for malaria –** Percentage of suspected malaria cases tested by microscopy or RDT.
5. **RDTs –** Percentage of reported suspected malaria cases with access to RDTs: number of RDTs distributed divided by reported suspected malaria cases.
6. **IPT for pregnant women –** Percentage of women attending antenatal care at least once who received second dose of IPT: number of women receiving second dose of IPT divided by number who attended antenatal care at least once.

The numerators for ACT and RDT coverage are the numbers of ACT treatment courses and RDTs distributed at national level. The denominator for the ACT indicator was the number of reported malaria cases, and that for the RDT indicator was the number of reported suspected malaria cases.[1] Most ACTs and RDTs reported as distributed by ministries of health go to public-sector facilities. The denominator for IPT of pregnant women is the number of women making at least one antenatal care visit. The numerator is the number of pregnant women receiving a second dose.

3.3.2 Long-lasting insecticidal nets

Logistics. The numbers of LLINs distributed in countries reported from national programmes (public sector) and from manufacturers' data on the numbers of nets delivered to high-burden countries are compared in **Table 3.2** and **Figure 3.8**. Except in Nigeria, manufacturers reported delivering 25% more nets than the number of nets reported to have been distributed by national programmes in 2008. The difference could be due to the lag between delivery and distribution, inadequate record-keeping or other, unknown factors. In countries with large private sectors, ministry of health data might not include distribution by the private sector. For example, in Nigeria, manufacturers reported delivering 15 million LLINs, and the national programme reported distributing nearly 7 million. Some of the difference might be accounted for by delivery of nets to private-sector enterprises. The number of nets needed to cover all persons at risk in high-burden countries in 2008 was approximately 336 million (one half of the 671 million persons at risk, assuming that one net covers two persons). The cumulative number of LLINs delivered in 2006–2008 by manufacturers was 141 million, which represents 42% of the 336 million needed in 2008 (assuming a lifespan of 3 years). Data from ministries of health indicate that an estimated 35% of the nets needed were distributed.

Surveys. **Table 3.3** shows data on ITNs from the national surveys that were publicly available for 2006–2008 as of October 2009. Indicators from 2007–2008 surveys were available from reports to WHO and from preliminary reports of demographic and health surveys and malaria indicator surveys. Data were available (Table 3.3) for at least one indicator from 13 countries (49% of the at-risk population in the African Region) in 2008, from 9 countries (26% of the at-risk population) in 2007 and from 15 countries (27% of the at-risk population) in 2006. Table 3.3 shows both the weighted average and median for each year. The weighted average depended heavily on whether survey data were available for Nigeria (for 2008), the Democratic Republic of the Congo (for 2007) or neither of those countries (for 2006), as the ITN indicators for both countries are low, and their inclusion decreases the weighted average. The weighted average of household ITN ownership was 30%, and that of ITN use by children < 5 years was 24% in 2008. Seven countries (Equatorial Guinea, Ethiopia [population living at < 2000 m], Gabon, Mali, Sao Tome and Principe, Senegal and Zambia) had reached ≥ 60% household ITN ownership by 2007 or 2008, as also seen in Zanzibar, United Republic of Tanzania (**Fig. 3.9**).

The relation between ITN use by children < 5 years old and ITN household ownership from 35 surveys conducted in 2006–2007 from which data on both ITN use and household ITN ownership were available is shown in **Figure 3.10**. The figure also shows the relation between ITN use by persons of all ages and ITN household ownership in seven countries for which survey datasets were available to calculate use by persons of all ages (three in 2007 and four in 2006).

The percentage of children < 5 years old who had used an ITN the previous night, given household ownership of at least one ITN, was 51% (median; range, 14–68%) in six countries for which survey data were available in 2006–2007. As all six surveys were demographic and health surveys, which are usually conducted in the dry season, use in the wet season might be higher.

Figure 3.8 Reported numbers of long-lasting insecticidal nets (LLIN) delivered by manufacturers (manufacturers' data) and number distributed by ministries of health (MOH data), 2004–2008, 35 high-burden WHO African Region countries

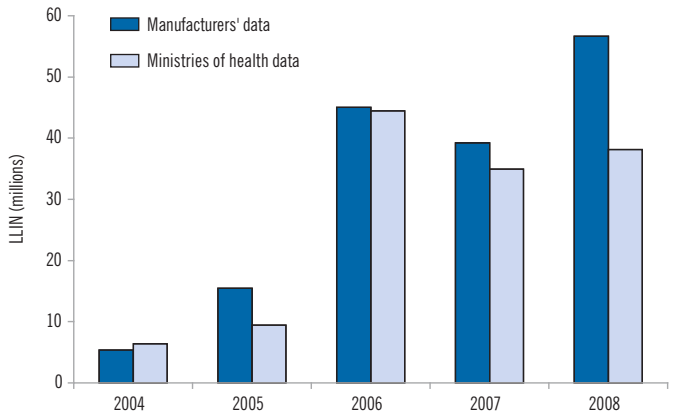
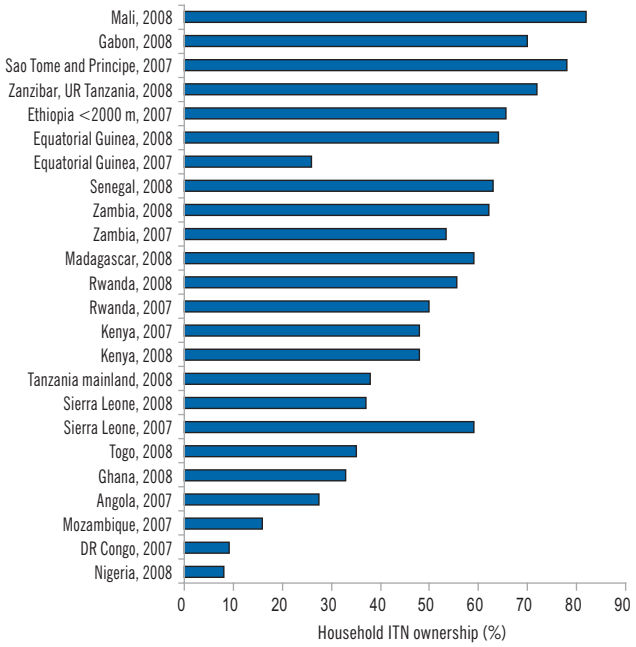


Figure 3.9 Household insecticide-treated net (ITN) ownership as measured by national surveys, 2007–2008, high-burden WHO African Region countries



1. In most countries in the African Region in which there is little parasite-based testing of suspected malaria cases, the number of reported malaria cases and the number of reported suspected malaria cases are the same or similar. As the fraction of suspected cases tested for parasites increases, countries often start reporting confirmed cases alone or confirmed plus probable (untested) malaria cases as the official total of malaria cases.

Table 3.2 Number of long-lasting insecticidal nets (LLIN) reported to have been distributed by ministries of health, as reported to WHO, and numbers reported to have been delivered to countries by manufacturers, 2006–2008, high-burden African countries. These data, with survey data, were used to estimate ITN indicators (household ITN ownership and use) in a model

SUB-REGION / COUNTRY	Population at risk, 2008	Number of LLIN reported delivered by manufacturers					Number of LLIN reported to have been distributed, ministry of health data reported to WHO				
		2006	2007	2008	Cumulative 2006–2008	Operational ITN coverage, 2008* (%)	2006	2007	2008	Cumulative 2006-2008	Operational ITN coverage, 2008* (%)
Central											
Burundi	6 907 854	1 037 300	584 135	1 514 765	3 136 200	91	586 588	1 203 763	895 355	2 685 706	78
Central African Rep.	18 920 235	147 500	365 000	891 536	1 404 036	15	121 828	498 050	846 966	1 466 844	16
Cameroon	4 424 294	38 605	146 225	1 187 372	1 372 202	62	16 800	0	802 105	818 905	37
Chad	10 958 573	129 400	244 500	98 348	472 248	9	267 000	83 000	126 000	476 000	9
Congo	3 847 188	121 800	100 000	226 519	448 319	23	Data not av.				
DR Congo	64 703 615	1 750 841	3 317 755	8 506 216	13 574 812	42	2 981 026	2 385 684	5 788 513	11 155 223	34
Equatorial Guinea	519 697	28 330	166 000	105 150	299 480	115		152 992	65 913	218 905	84
Gabon	1 350 153	290 236	125 360	12 700	428 296	63	216 523	352 994	10 640	580 157	86
Rwanda	10 008 624	2 061 537	748 116	43 346	2 852 999	57	1 957 720	1 162 275	17 926	3 137 921	63
Sao Tome Principe	157 848	84 548	28 114	24 000	136 662	173	Data not av.				
South-East											
Angola	17 499 407	1 753 142	1 977 589	1 361 111	5 091 842	58	826 656	1 495 165	1 471 200	3 793 021	43
Eritrea	5 005 680	197 811	223 191	455 442	876 444	35	80 673	159 360	134 399	374 432	15
Ethiopia	57 948 997	12 294 218	4 639 411	1 935 148	18 868 777	65	8 606 640	4 475 301	3 316 696	16 398 637	57
Kenya	29 244 399	8 700 429	1 555 150	3 235 173	13 490 752	92	6 378 465	1 591 492	2 437 621	10 407 578	71
Madagascar	20 215 202	1 328 808	2 938 410	1 243 231	5 510 449	55	1 614 187	3 359 244	907 739	5 881 170	58
Malawi	14 288 374	273 466	997 465	378 494	1 649 425	23	120 000	255 266	858 026	1 233 292	17
Mozambique	21 812 550	567 000	1 386 233	2 484 777	4 438 010	41	313 102	1 586 534	2 086 367	3 986 003	37
UR Tanzania	41 463 923	39 200	193 000	1 021 387	1 253 587	6	549 244	322 516	927 461	1 799 221	9
Uganda	31 902 611	2 438 134	1 603 181	1 870 846	5 912 161	37	1 999 449	1 622 001	2 273 413	5 894 863	37
Zambia	12 154 060	806 564	3 226 109	671 119	4 703 792	77	1 162 578	2 458 183	1 188 443	4 809 204	79
West											
Benin	9 309 367	183 250	2 002 310	578 542	2 764 102	59	49 773	1 716 942	283 058	2 049 773	44
Burkina Faso	15 213 315	198 390	907 858	1 011 491	2 117 739	28	121 100	13 000	724 547	858 647	11
Côte d'Ivoire	19 624 238	350 200	394 200	1 591 308	2 335 708	24	336 000	0	0	336 000	3
Gambia	1 754 067	29 060	193 100	324 048	546 208	62	32 466	77 163	290 393	400 022	46
Ghana	23 946 817	3 268 898	2 015 509	2 663 727	7 948 134	66	2 268 336	1 934 460	257 717	4 460 513	37
Guinea	9 572 042	515 540	131 000	115 288	761 828	16	120 500	312 500	246 000	679 000	14
Guinea Bissau	1 745 835	147 083	12 000	129 773	288 856	33	182 906	91 700	2 064	276 670	32
Liberia	3 942 215	470 083	771 086	632 022	1 873 191	95	92 308	342 639	714 500	1 149 447	58
Mali	12 716 080	1 206 778	3 428 525	1 210 722	5 846 025	92	90 900	2 982 346	682 461	3 755 707	59
Mauritania	2 233 066	40 300	40 000	30 153	110 453	10	49 616	0	0	49 616	4
Niger	14 730 794	225 100	207 100	2 467 390	2 899 590	39	2 665 000	710 000	700 000	4 075 000	55
Nigeria	151 478 123	2 147 404	2 724 304	15 310 222	20 181 930	27	8 853 589	3 225 594	6 700 000	18 779 183	25
Senegal	12 687 625	462 000	1 487 810	1 103 037	3 052 847	48	400 000	0	1 572 261	1 972 261	31
Sierra Leone	12 687 625	1 546 220	193 230	638 126	2 377 576	37	1 301 164	319 199	541 265	2 161 628	34
Togo	6 762 422	154 700	123 000	1 618 370	1 896 070	56	65 235	43 946	1 261 706	1 370 887	41
Total annual	**671 736 915**	**45 033 875**	**39 195 976**	**56 690 899**	**140 920 750**	**42**	**44 427 372**	**34 933 309**	**38 130 755**	**117 491 436**	**35**
Total annual without Nigeria		**42 886 471**	**36 471 672**	**41 380 677**			**35 573 783**	**31 707 715**	**31 430 755**		
Total cumulative without Nigeria					**120 738 820**					**98 712 253**	

*based on 1 ITN per 2 persons

Manufacturers' data from John Milliner, USAID, as part of RBM Alliance for Malaria Prevention. National ministry of health data from that reported to WHO as part of the *World Malaria Report 2009*.
Operational coverage with ITNs was calculated from administrative data on number of LLIN delivered or distributed over 3 years times 2 (assuming one LLIN covers two persons) divided by the population at risk.

Table 3.3 Information on ITN ownership and use, parasitaemia and haemoglobin levels from national surveys, 2006–2008, high-burden African Region countries

COUNTRY	Population (million)	Month/year of survey	Type of survey	Aggregate data available	Dataset available for detailed analysis	ITNs						Parasitaemia	Haemoglobin g/dl	
						ITN use, < 5 years								
						ITN household ownership	ITN use, all ages	ITN use < 5 years	ITN use, equity ratio	ITN use, lowest wealth quintile	ITN use, rural	%	% <7	% <8
2008														
1 Angola	17	05/08–05/09	MICS	No	No	No data av.								
2 Equatorial Guinea	0.5		National	Yes	No	64		ND						
3 Ghana	24	09/08–11/08	DHS	Yes	No	33		28						
4 Gabon	1.4		National	Yes	No	70		55						
5 Kenya	38	11/08–02/09	DHS	Yes	No	48		39	1.4	35	48			
6 Madagascar	20		National	Yes	No	59		60						
7 Mali	13	04/08	National	Yes	No	82		79						
8 Mozambique	22	04/08	MICS	No	No	No data av.								
9 Nigeria	151	06/08–10/08	DHS	Yes	No	8		6			5			
10 Rwanda	10	12/07–04/08	DHS	Yes	No	56		56	2.1	47	55	2.6 (RDT)	8.3	
11 Sao Tome and Principe	0.16		DHS	No	No	No data av.								
12 Senegal	13	10/08–12/08	MIS	Yes	No	63		31						
13 Sierra Leone	6	04/08–06/08	DHS	Yes	No	37		26						
14 Togo	7	12/07–02/08	MOH-CDC	Yes	No	55		35						
15 Zambia	12	04/08–05/08	MIS	Yes	No	62		41	1.0	39	42	10.2		4.3
16 UR Tanzania, Mainland	41	10/07–03/08	AIS/MIS	Yes	Yes	38		25	3.1	22	32		2.7	7.5
Zanzibar, UR Tanzania			AIS/MIS	Yes	No	72		59	1.1	67	72		1.0	4.7
Number of countries with data						**13**		**12**	**4**	**4**	**5**	**2**	**2**	**2**
Median						**56**		**37**						
Weighted average						**30**		**24**						
Population, countries with surveys or data	**376**					**337**		**336**						
2007														
1 Kenya	38	06/07–07/07	MIS	Yes	No	48		39	1.5	29	39	7.6(BS) / 3.3 (RDT)		4.4
2 Mauritania	3	05/07–09/07	MICS	No	No	No data av.								
3 Nigeria	148	03/07–04/07	MICS	No	No	No data av.								
4 Rwanda	10	06/07–07/07	MIS	Yes	No	50		56						
5 DR Congo	63	01/07–08/07	DHS	Yes	Yes	9	4	6	5.2	2	4		3.4	9.0
6 Liberia	4	12/06–04/07	DHS	No	No	No data av.							ND	ND
7 Zambia	12	04/07–10/07	DHS	Yes	Yes	53	22	28	1.7	19	27		ND	ND
8 Sao Tome and Principe	0.2		National	Yes	No	78		54						
9 Mozambique	21	06/07–07/07	MIS	Yes	Yes	16		7	0.9	7	6	38.5 (BS)/ 51.5 (RDT)		11.9
10 Angola	17	11/06–04/07	MIS	Yes	Yes	28	12	17	0.8	17	19	19.5(RDT)	0.7	3.0
11 Sierra Leone	6	10/07–11/07	MIS	Yes	No	59		56						
12 Ethiopia	83	10/07–12/07	MIS	Yes	No	53		33	1.0	35	33	0.7		5.5
< 2000 m						66		42				0.9		6.6
> 2000 m						28		14				0.1		3.1
13 Equatorial Guinea	0.5		Other	Yes	No	26		42						
Number of countries with data						**9**	**3**	**9**	**5**	**6**				
Median						**49**		**36**						
Weighted average						**36**		**25**						
Population, countries with surveys or data	**404**					**249**		**249**						

* highest/ lowest wealth quintile

Table 3.3 *Continued*

COUNTRY	Population (million)	Month/year of survey	Type of survey	Aggregate data available	Dataset available for detailed analysis	ITNs						Parasitaemia	Haemoglobin g/dl	
						ITN use, < 5 years								
						ITN household ownership	ITN use, all ages	ITN use < 5 years	ITN use, equity ratio	ITN use, lowest wealth quintile	ITN use, rural	%	% < 7	% < 8
2006														
1 Burkina Faso	14	03/06–05/06	MICS	Yes	Yes	23		10	5.7	5	6			
2 Central African Rep.	4	06/06–11/06	MICS	Yes	No	25		15						
3 Sao Tome and Principe	0.16		MICS	No	No	No data av.								
4 Zambia	12	04/06–05/06	MIS	Yes	No	44		23	1.6	19	21	22.1		13.8
5 Benin	9	08/06–11/06	DHS	Yes	Yes	25	14	32	1.8	22	30		6.7	13.8
6 Cameroon	18	05/06–06/06	MICS	Yes	Yes	4		3	3.8	1	2			
7 Côte d'Ivoire	19	08/06–10/06	MICS	Yes	Yes	10		3	4.6	1	2			
8 Ghana	23	08/06–11/06	MICS	Yes	Yes	10		18	1.0	21	21			
9 Guinea-Bissau	2	05/06–06/06	MICS	Yes	Yes	44		40	0.7	41	44			
10 Mali	12	05/06–12/06	DHS	Yes	Yes	50	21	27	1.2	26	26		8.7	19.3
11 Malawi	14	07/06–11/06	MICS	Yes	Yes	38		25	2.7	16	23			
12 Niger	14	01/06–05/06	DHS	Yes	Yes	43	4	7	2.6	5	6		6.1	15.3
13 Senegal	12	11/06–12/06	MIS	Yes	Yes	36	12	16	0.6	20	17		ND	ND
14 Togo	6	05/06–06/06	MICS	Yes	Yes	40		38	0.9	41	40			
15 Uganda	30	04/06–10/06	DHS	Yes	Yes	16	7	9	1.4	10	8		5.8	12.0
16 Gambia	1.7	12/05–03/06	MICS	Yes	Yes	46		28	1.2	21	28			
Number of countries with data						**15**	**5**	**15**	**14**	**14**	**14**			
Median						**31**	**12**	**23**	**1.5**	**19**	**21**			
Weighted average						**26**		**17**						
Population, countries with surveys or with data	**192**					**192**		**192**						

MICS: multiple indicator cluster service; DHS: demographic health survey; MOH: ministry of health; CDC: Centers for Disease Control and Prevention (USA); MIS: malaria indicator survey; AIS: AIDS indicator survey; RDT: rapid diagnostic test; BS: blood spot; N/A: not applicable; ND: no data

Surveys that were not DHS, MIS, or MICS, but were reported to cover the national at-risk population were included.

Estimating household ITN ownership and ITN use by chidren < 5 years old, by country and year, from both survey and administrative data. Flaxman and colleagues at the Institute for Health Metrics and Evaluation at the University of Washington (USA), in collaboration with WHO and the United States Centers for Disease Control and Prevention, have constructed a model to combine data from surveys, manufacturers and ministries of health to obtain annual estimates of ITN ownership and use *(2)*. The method for the model is shown in **Box 3.3**. The weighted average estimate of household ITN ownership was 31%, and ITN use by children < 5 years old was 24% in all 35 high-burden countries in 2008 (**Table 3.4** and **Fig. 3.11**). These estimates were partially driven by very low household ITN ownership in the Democratic Republic of the Congo and Nigeria, two populous countries. Table 3.4 shows household ITN ownership by country in 2004–2008. As of 2008, 13 (37%) countries had reached ≥ 50% household ITN ownership, and 10 (29%) had reached ≥ 60%. Because this model can provide an estimate of ITN coverage for each country each year, it provides information that complements the data gathered directly in surveys.

Coverage and effectiveness of LLINs over time after mass distribution. Four countries have conducted surveys ≥ 12 months after the month of mass ITN distribution to children and pregnant women. In Sierra Leone, household ITN ownership declined 37% within 2–3 years after mass campaign. In Togo, ownership declined 13% and ITN use in children <5 years old declined 20% within three years of the campaign (**Table 3.5**), although differences in survey methods could have accounted for some of the difference. The Ministry of Health in Togo in collaboration with the United States Centers for Disease Control and Prevention retrieved LLINs 36 months after their distribution during the mass campaign and found that between 30% and 40% of the nets collected did not pass the WHO bioassay for killing mosquitoes or had at least one hole that was ≥ 10 cm in diameter *(3)*. Multi-country studies for the WHO Pesticide Evaluation Scheme have identified surprisingly large country-to-country variations in mean net life *(4)*. Decreased ownership, use and net durability (physical and insecticide) might be reducing the effectiveness of ITNs in field situations. These data suggest that routine ITN systems after mass distribution may not have been adequate to sustain the high, equitable coverage that was achieved during the mass campaign. Waning ITN ownership and use, as well as limitations of net durability (physical and insecticide) might reduce the public health impact of this important malaria control tool.

In contrast, household ITN ownership coverage was maintained for 15 months in Rwanda (50% in the 2007 malaria indicator survey and 56% ,15 months after the campaign) and for 30 months in Kenya (51% immediately after campaign and 48%, 30 months later) (Table 3.5).

BOX 3.3

Summary of model for estimating coverage with ITNs

Background

Most of the information on the distribution and coverage of ITNs consists of annual data on the numbers of long-lasting insecticidal nets delivered to countries by manufacturers; annual data on the distribution of both long-lasting insecticidal and non-long-lasting insecticidal nets by national malaria control programmes to health facilities and operational partners; and periodic data on household net ownership and use by children under the age of 5. While data from manufacturers and national malaria control programmes provide important information on the supply and distribution of ITNs, the only direct measurement of whether ITNs are reaching and are being used by households is from surveys, which are, at best, conducted only every 3–5 years. It is therefore not possible to track properly the scale-up of control programmes to reduce the burden of malaria. The challenge is to impute, in an objective and replicable way, missing survey coverage from information from manufacturers and national malaria control programmes. The method should ideally resolve the issue that data from manufacturers, national malaria control programmes and households capture the stock and flow of nets at different points of the supply and distribution chain. For example, surveys measure the stock of nets in households at a specific time, whereas manufacturer data represent flows to a country over 1 year.

Model

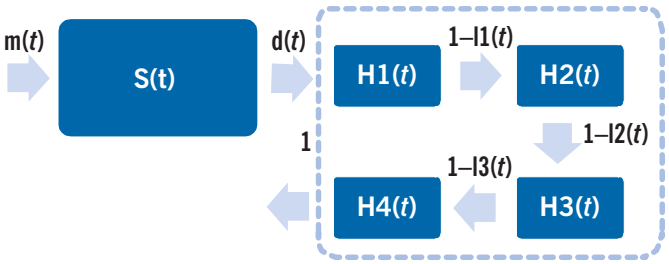
A Bayesian inference-based compartmental model was developed to make annual estimates between 1999 and 2008 of ITN coverage, defined as the proportion of households owning at least one ITN, and ITN use by children under 5, defined as the proportion of children under the age of 5 years sleeping under an ITN during the wet season. Briefly, the model is based on the precise relations between net supply, distribution and ownership over time; for example, for a net to be owned by a household, it must have been distributed or purchased sometime in the past, and before that it must have been manufactured and sent to the organizations responsible for distribution or to the commercial sector for household purchase.

The compartmental model, with parameters describing the supply, distribution, ownership and discard of nets by households, is shown below. In this model the "supply" compartment reflects both public and commercial supply, and "distribution" includes public distribution as well as the purchase of nets by households from the commercial sector. The model includes a discrete 1-year step and allows flows into a compartment to be part of flows out of the compartment for the same year. This model ensures that estimates of supply, distribution, ownership and discard of nets are consistent over time. Compartmental model parameters are limited to long-lasting insecticidal nets, as manufacturer delivery data is available only for these nets and also because the stock of non-long-lasting nets is essentially equivalent to the flow of non-long-lasting ITNs in this model, given that they must be re-treated yearly. On the basis of previous studies the primary assumption is that a long-lasting insecticidal net is no longer active after four years and is not included in the household stock.

The compartmental model gives an estimate of the total number of long-lasting insecticidal nets in households in each country over time. We add to this a parameter that accounts for non-long-lasting ITNs in households to determine the total number of ITNs in households. We estimate the number ITNs per capita in each country by dividing by the estimated total population. A negative binomial distribution is used to estimate the distribution of ITNs per household; that is, the fraction of households with zero, one, two or three or more ITNs. The parameters of the model and the steps used to determine ITN ownership coverage are estimated by Bayesian inference; it provides a way of assessing uncertainty about the inputs and outputs of the model. As the model is further refined it is possible that default values for parameters – or the way they are handled – may change, which could influence the results.

ITN use by children under 5

An important factor that determines use of nets by children under 5 is the season in which surveys are conducted; people are more likely to sleep under ITNs when the risk for mosquito bites is higher. A regression model was used to estimate ITN use by children under 5 from ITN ownership coverage and the proportion of the total population represented by children under 5, while controlling for the season (wet or dry) in which the survey was conducted, from all available survey data (47 surveys). The regression parameters were then applied to the Bayesian inference-based compartmental model estimates of ITN ownership coverage to predict ITN use by children under 5 during the wet season.



Stocks

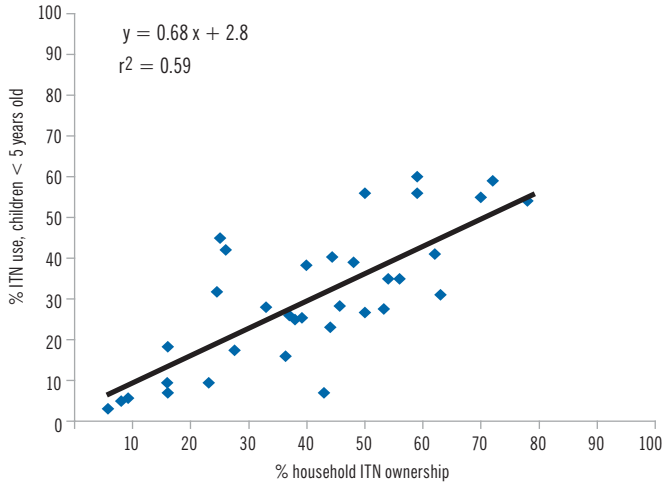
S(t) = ITNs in national supply for distribution at time t
H1(t) = 1 year old LLINs in households at time t
H2(t) = 2 year old LLINs in households at time t
H3(t) = 3 year old LLINs in households at time t
H4(t) = 4 year old LLINs in households at time t

Flows

m(t) = LLINs delivered to national supply by manufacturers during time period t
d(t) = LLINs distributed by agencies to households during time period t
l1(t) = number of 1 year old LLINs discarded by a household during time period t
l2(t) = number of 2 year old LLINs discarded during time period t
l3(t) = number of 3 year old LLINs discarded during time period t

Figure 3.10 Correlation between household insecticide-treated net (ITN) ownership and ITN use by children < 5 years old (35 surveys) and persons of all ages (7 surveys); 2006–2008, high-burden WHO African Region countries

a) *ITN use by children < 5 years old vs. household ITN ownership*



b) *ITN use by persons of all ages vs. household ITN ownership*

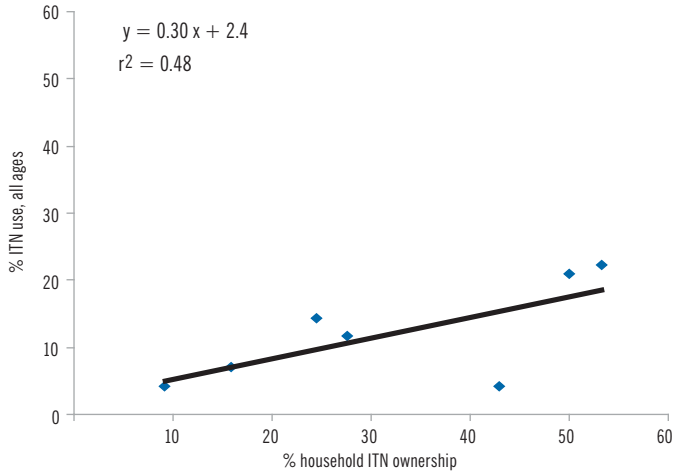


Figure 3.11 Percentage household ownership of insecticide-treated nets (ITNs) estimated from model, 2000–2008, 35 high-burden WHO African Region countries

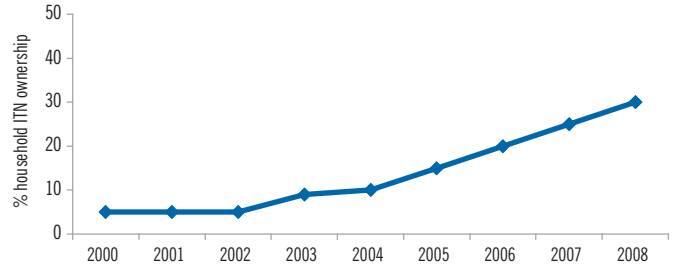


Table 3.4 Model-based estimates of percentage household insecticide-treated net (ITN) ownership, by year, high-burden African Region countries, 2004–2008; ordered by estimate of ownership in 2008

COUNTRY	MODEL ESTIMATES OF HOUSEHOLD ITN OWNERSHIP						
	2004	2005	2006	2007	2008	2008 lower limit	2008 upper limit
Sao Tome and Principe	21	18	39	76	91	76	99
Mali	4	10	38	69	80	76	86
Zambia	3	7	17	40	70	60	80
Madagascar	11	22	46	54	69	58	78
Ethiopia	3	7	16	39	66	57	75
Equatorial Guinea	2	3	17	42	65	58	75
Eritrea	3	5	8	27	64	57	72
Liberia	77	67	64	59	64	29	93
Rwanda	3	6	24	53	61	44	82
Guinea-Bissau	8	17	35	52	60	42	73
Kenya	20	36	48	48	57	29	80
Niger	11	16	30	48	55	41	70
Togo	12	30	57	59	54	41	73
Senegal	41	58	43	45	49	37	62
Sierra Leone	17	20	29	37	48	41	54
Gambia	19	35	38	30	37	22	53
Benin	8	15	30	35	36	19	57
UR Tanzania	16	20	26	39	36	25	47
Malawi	4	5	14	40	34	31	37
Ghana	31	28	37	37	33	19	49
Central African Rep.	5	6	15	24	31	25	37
Uganda	7	13	23	26	25	11	43
Angola	3	7	17	22	24	15	34
Mozambique	5	6	14	20	23	14	33
Burundi	7	7	10	15	21	15	28
Cameroon	6	9	13	17	20	10	31
Burkina Faso	6	12	22	22	18	9	26
DR Congo	9	12	20	20	16	10	25
Congo	3	5	8	12	15	10	22
Côte d'Ivoire	3	6	8	10	11	5	20
Gabon *							
Mauritania	1	3	5	8	9	6	13
Chad	4	4	5	6	9	4	13
Guinea	1	2	3	5	8	6	10
Nigeria	2	2	3	4	7	6	9
TOTAL	7	9	17	25	31	29	33

* Revision of Gabon data was made too late to be fully incorporated in this Report. Estimated household ITN ownership was 80% in 2008.

3.3.3 Indoor residual spraying

The number of persons protected by IRS more than doubled between 2006 and 2008, from 15 to 59 million (**Fig. 3.12**). This represented 9% of the at-risk population in the African Region in 2008. Seven countries protected > 10% of their at-risk populations with IRS in 2008: Botswana (38%), Equatorial Guinea (56%), Ethiopia (51%), Madagascar (32%), Mozambique (30%), Namibia (16%) and Zambia (47%).

3.3.4 Rapid diagnostic tests

In 2009, WHO recommended that persons of all ages with suspected malaria undergo diagnostic testing. In 2008, 22% of suspected malaria cases were tested in 18 of 35 countries reporting. **Figure 3.13** shows the percentage tested by year. Nine countries (Angola, Burundi, Equatorial Guinea, Gabon, Liberia, Madagascar, Niger, Rwanda, Senegal) reported testing > 50% of suspected malaria cases.

RDTs distributed. The number of RDTs delivered increased rapidly in 2007 and 2008, from near zero in 2005 (Fig. 3.13). The total number of RDTs distributed in 2008, however, corresponded to only 13% of all malaria cases reported in the 12 countries reporting, indicating a continuing gap in malaria diagnostic capacity.

3.3.5 Treatment

The number of ACTs distributed at country level increased significantly between 2004 and 2006, while the rate of increase in 2006–2008 was lower (**Fig. 3.14**). This is due at least partly to the low approval rate of grants for malaria activities in rounds 5 and 6 of the Global Fund, which influenced procurement of ACTs in 2006 and 2007. Data from manufacturers showed an 18% increase in ACT sales to the public sector in 2008 as compared with 2007.

Access to ACTs in the public sector can be estimated from operational or administrative data. If it is assumed that all ACTs reported by ministries of health were used for public sector facilities, enough ACTs were distributed to treat 48% of persons with malaria attending those facilities. **Figure 3.15** show the percentages of reported malaria cases with access to ACTs (ratio of ACTs distributed to reported malaria cases in 2008) by country. Fourteen of 35 countries reported distributing enough ACTs to treat at least 50% of reported malaria cases in the public sector; five countries reported distributing enough ACTs to treat all reported malaria cases in 2008 (**Table 3.6**).

Data from surveys in 2006–2008 on access to ACT are shown in **Table 3.7**. Preliminary reports from 10 countries were available in 2008, providing data primarily for two treatment indicators: percentage of children treated with any antimalarial medicine, and percentage of children treated with ACTs. The weighted average percentage of children with fever in the 2 weeks preceding the survey who received any antimalarial medicine was 32%. The percentage of children with fever who received an ACT was 16%, but data were available from only seven countries. Of 13 countries with survey-based data on ACT coverage in 2007 or 2008, the percentage of children with fever receiving ACT exceeded 15% in only two (Gabon, with 25%, and the United Republic of Tanzania, with 22%).

Figure 3.12 Numbers of persons protected with at least one round of indoor residual spraying (IRS), 2001–2008, WHO African Region countries

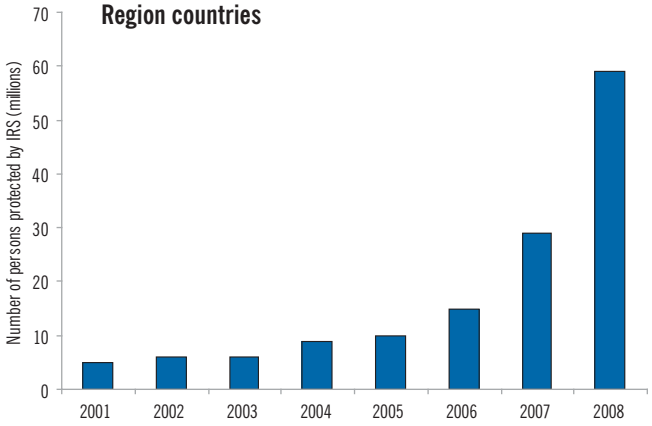
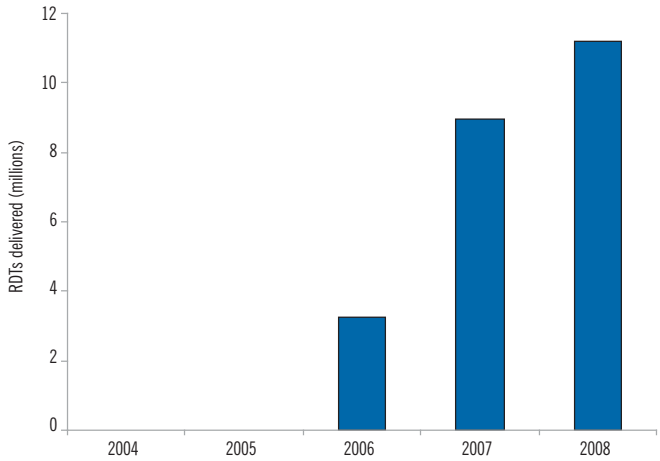


Figure 3.13 High-burden WHO African Region countries, 2004–2008

a) *Number of rapid diagnostic tests (RDTs) distributed*



b) *Percentage of reported malaria cases tested (microscopy or RDTs)*

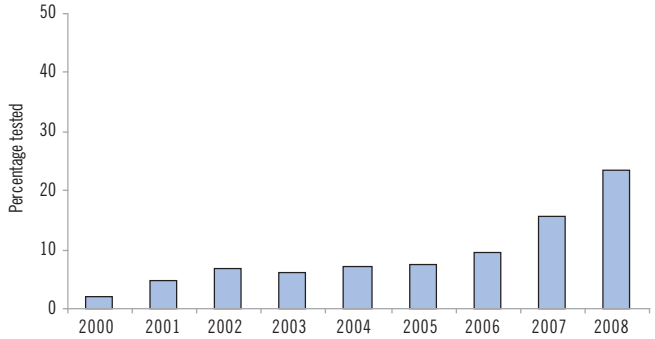


Figure 3.14 Numbers of ACT treatment courses distributed by countries, high-burden WHO African Region, 2003–2008

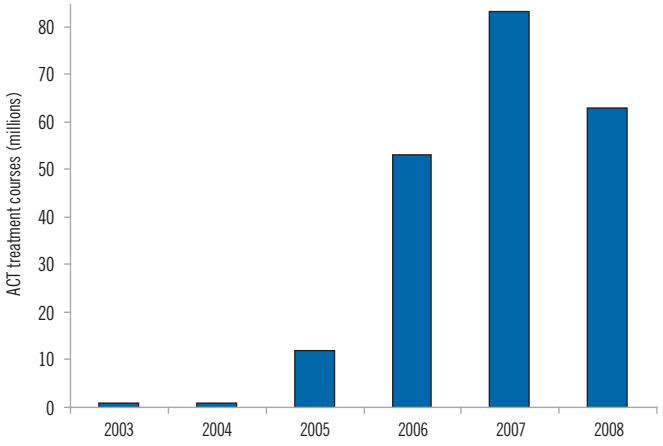


Table 3.5 Trends of household ownership and use of insecticide-treated nets (ITNs) by children < 5 years old in countries with at least two surveys after mass distribution of nets; Togo, Sierra Leone, Rwanda, and Kenya, 2004–2008

TYPE OF SURVEY	Dates of survey	Duration after campaign	(%) Household ownership any net	(%) Household ITN ownership, at least 1	(%) ITN use in children <5 years old
TOGO: mass distribution conducted in December 2004 to children 9–59 months and pregnant women					
CDC	Jan.–Feb. 2005	+ 1 month (dry)	66	63	44
CDC	Sept. 2005	First rainy season after campaign	64	60	53
MICS	May–Jun. 2006	+ 1.5 year (between dry/wet)	46	40	38
CDC	Dec. 2007–Feb. 2008	+ 3.0 year (between wet/dry)	55	55	35
% decline, last survey compared with first survey			17%	13%	20%
SIERRA LEONE: mass distribution conducted in November 2006 to children 9–59 months and pregnant women					
DataDyne	Jan. 2007	+ 1 month (dry)			51
CDC	Nov. 2007	+ 1 year	64	59	53
DHS	Apr.–Jun. 2008	+ 2.5 year (dry)	40	37	26
% decline, last survey compared with first survey			38%	37%	49%
RWANDA: mass distribution conducted in September 2006 to children 9–59 months and pregnant women					
MIS 2007	Jun.–Jul. 2007	+ 9 months	–	50	56
DHS 2008	Dec. 2007–Feb. 2008	+ 16–18 months	59	56	56
% decline, last survey compared with first survey				– 12%	0%
KENYA: mass distribution was conducted in two phases in July and September 2006 to children 9–59 months and pregnant women					
MOH-CDC 2006	Oct.–Nov. 2006	+ 1–2 months	54	51	52
MIS 2007	Jun.–Jul. 2007	+ 1 year	63	48	39
DHS 2008	Nov. 2008–Feb. 2009	+ 2 years	–	48	39
% decline, last survey compared with first survey				6%	25%

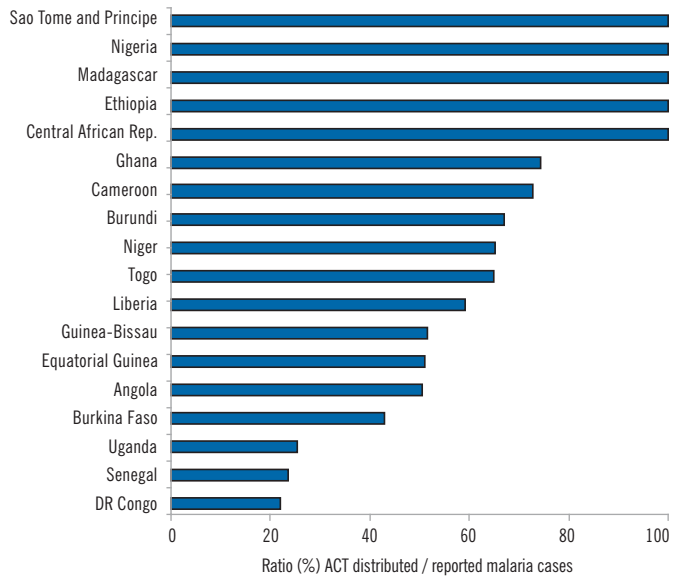
MOH = ministry of health; CDC = US Centers for Disease Control and Prevention; DHS= Demographic and Health Survey; MICS = Multiple Indicator Cluster Survey; MIS = Malaria Indicator Survey; DataDyne is a technical non-governmental organization.

Intermittent preventive treatment of pregnant women. For 10 of the 35 high-burden countries (Burkina Faso, Central African Republic, Equatorial Guinea, Gabon, Ghana, Niger, Nigeria, Senegal, Togo and Uganda), consistent data were available on both the second dose of IPT (numerator) and the number of women who had attended antenatal care at least once (denominator) for 2007 and 2008. Data on IPT for pregnant women from surveys in 2007–2008 were available for nine countries with a total population of 217 million. In 2007–2008, the percentage of women who received two doses of treatment during pregnancy ranged from 3% in Angola to 66% in Zambia; the weighted average was 20%.

3.3.6 Quality of administrative data on LLINs, ACTs, RDTs and diagnostic testing

The quality of the management information available was poor in many countries, especially for ACTs (see missing data in Table 3.7). For example, some countries rounded the estimated numbers of LLINs and ACTs distributed to the thousands, indicating incomplete data recording systems. Inadequate management information systems are likely to lead to inadequate monitoring of stock-outs of nets, ACTs and RDTs in health facilities. Poor management information

Figure 3.15 Estimated percentage of reported malaria cases with access to artemisinin-based combination therapy (ACT). Ratio of number of ACTs distributed to number of reported malaria cases, national data, 2008, high-burden WHO African Region countries



Countries without data are not shown

Table 3.6 Information on treatment from national surveys, 2006–2008, high-burden African Region countries

COUNTRY	POPULATION (million)	TREATMENT			IPT in pregnancy (births in past 2 years)	
		% with any antimalarial	% with any anti-malarial within 24 h	% with any ACT	2 (or more) doses of IPT during pregnancy	2 (or more) doses of IPT at least one of which was during an ANC visit
2008						
Angola	17	No data available				
Equatorial Guinea	0.5	16		3		
Gabon	0.0	48		25		
Ghana	24	24		12		
Kenya	38	24		ND		
Madagascar	20	No data available		ND		
Mali	13	No data available				
Mozambique	22	No data available				
Nigeria	151	33	15	ND		7
Rwanda	10	6	0	5		
Sao Tome and Principe	0.16	No data available				
Senegal	13	ND		ND		
Sierra Leone	6	30		ND		
Togo	7	37		11		
Zambia	12	43	29	13	66	60
UR Tanzania, Mainland	41	57	39	22	30	30
Zanzibar, UR Tanzania		38	37	10	55	52
Number of countries with data		**10**	**4**	**7**	**2**	**3**
Median		**32**		**12**		
Weighted average		**32**		**16**		
Population, countries with surveys or with data	**375**	**310**		**95**		
2007						
Kenya	38	24	15	8	13	
Mauritania	3	No data available				
Nigeria	148	No data available				
Rwanda	10				18	17
Democratic Rep. Congo	63	30	17	1	7	5
Liberia	4	59	26	9	12	
Zambia	12	38	21	11	66	63
Sao Tome and Principe	0.2	No data available	ND	ND		
Mozambique	21	23	18	ND	16	
Angola	17	29	13	3	3	3
Sierra Leone	6	No data available				
Ethiopia	83	10	4	4		
< 2000 m		12	5			
> 2000 m		2	1			
Equatorial Guinea	0.5	No data available				
Number of countries with data		**7**	**7**	**6**	**7**	**4**
Median		**29**	**17**	**6**		
Weighted average		**22**	**12**	**4**	**14**	
Population, countries with surveys or with data	**404**	**237**	**237**	**216**	**164**	
2006						
Burkina Faso	14	48	41	0	1	
Central African Rep.	4	No data available				
Sao Tome and Principe	0.2	No data available				
Zambia	12	53	32	10	59	57
Benin	9	54	42	0	3	
Cameroon	18	59	39	2	6	
Côte d'Ivoire	19	36	26	3	8	
Ghana	23	61	48	4	28	
Guinea-Bissau	2	46	27	2	7	
Mali	12	48	22	ND	11	4
Malawi	14	25	21	0	47	
Mauritania	1.3	21	10	1		
Senegal	12	20	9	6	51	49

Table 3.6 *Continued*

COUNTRY	POPULATION (million)	TREATMENT			IPT in pregnancy (births in past 2 years)	
		% with any antimalarial	% with any anti-malarial within 24 h	% with any ACT	2 (or more) doses of IPT during pregnancy	2 (or more) doses of IPT at least one of which was during an ANC visit
2006 *continued*						
Togo	6	48	38	1	18	
Uganda	30	61	29	3	18	16
Gambia	1.7	63	52	0	33	
Number of countries with data		**15**	**15**	**13**	**13**	**4**
Median		**48**	**29**	**2**	**18**	
Weighted average		**47**	**31**	**3**	**22**	
Population, countries with surveys or with data	**192**	**187**	**187**		**172**	

ND, no data; SP=sulfadoxine-pyramethamine; ANC=antenatal clinic; ACT=arteminsin-based combination therapy

Table 3.7 Outpatient malaria cases, number of suspected malaria cases tested, number ACT treatment courses received, number of RDT received, along with three key indicators comparing those data elements, 2006-2008, high-burden WHO African Region countries.

SUB-REGION / COUNTRY	2007			2008		
	% Outpatient malaria cases tested	Ratio (%) RDT/ outpatient malaria cases	Ratio (%) ACT received/outpatient malaria cases	% Outpatient malaria cases tested	Ratio (%) RDT/ outpatient malaria cases	Ratio (%) ACT received/outpatient malaria cases
Central						
Burundi	47		75	50		67
Cameroon			184			73
Central African Republic			510			533
Chad	13			13		
Congo						
Democratic Rep. Congo	17	0	19	30	0	22
Equatorial Guinea				72	9	51
Gabon	68		234	70		
Rwanda	100	NA		100	NA	
South-East						
Angola	51	16	53	77	3	51
Eritrea	NA	NA		NA	NA	
Ethiopia	88	276		35	164	211
Kenya						
Madagascar	18	66	57	65	360	255
Malawi						
Mozambique						
Uganda	21		80	16	4	25
UR Tanzania	0	2				
Zambia		6			44	
West						
Benin						
Burkina Faso	3			2	3	43
Côte d'Ivoire						
Gambia						
Ghana				22		74
Guinea	2	5	3			
Guinea Bissau	17			29		52
Liberia	96		70	122		59
Mali			72			
Mauritania				1		
Niger	45	9	55	72	26	65
Nigeria		0	327		5	423
Sao Tome and Principe	NA	NA	176	NA	NA	181
Senegal	19			71	69	23
Sierra Leone				20		
Togo	52			22	65	65
Total	**14**	**9**	**39**	**22**	**13**	**48**

NA = not applicable. The RDT indicator does not work well when a high percentage of reported malaria cases are confirmed. The indicator for percentage of outpatient malaria cases tested does not work well if the number of suspected malaria cases is not reported. Sao Tome and Principe and Eritrea reported confirmed malaria cases only and not suspected malaria cases.

systems may contribute to inadequate stock-out monitoring, low ACT coverage, a low percentage of suspected malaria cases being tested and inadequate routine distribution of LLINs. National malaria control programmes should strengthen their management information systems and link them to supervision and quarterly performance assessments to improve programme effectiveness.

3.3.7 Summary of coverage with all interventions

Table 3.8 shows summary coverage indicators for all key interventions and diagnostics in high-burden countries. The number of commodities distributed and coverage with all interventions have been increasing. By 2007–2008, 37% of 35 high-burden countries had reached 50% household ITN ownership or more. In 2008, 24% of children < 5 years old had used an ITN the previous night. IRS is increasing but covers only 9% of the population at risk. IRS protects an important percentage (> 10%) of the population in seven countries.

Less progress has been made on treatment, diagnostics and IPT of pregnant women. The percentage of children with fever treated with an ACT was ≥ 15% in only two (Gabon and the United Republic of Tanzania) of 13 countries for which survey data were available for 2007–2008. Only 14 countries reported distributing enough ACT to treat at least 50% of reported malaria cases in the public sector, and only five countries reported distributing enough ACT to treat all reported malaria cases in 2008. Only 13% of the RDTs needed to test all reported malaria cases was distributed in 2008. Based on limited survey data, IPT coverage of pregnant women was 20%.

3.4 Intervention coverage in countries outside the WHO African Region

In regions other than the African Region, effective coverage with interventions is more difficult to measure, for several reasons. First, the target population for each intervention (treatment, IRS, ITNs) may be different within a country and is not standard for all countries. For example, interventions such as IRS and ITN are often targeted to hard-to-reach or mobile populations who are most at risk (e.g. migrants, workers in mining and forest areas). Secondly, surveys are less useful in areas with focalized malaria and are conducted less often.

Despite these limitations, operational coverage with interventions was estimated by using the population at high risk (> 1 malaria case per 1000 population) as the denominator and the numbers of ITNs and ACT doses distributed as the numerators. The reporting systems of many national malaria programmes do not, however, distinguish between procurement and delivery of ITNs, drugs and other commodities.

Administrative or operational coverage with ITNs was low in all regions, ranging from 1% to 5%. Analysis by country showed that ITN coverage was relatively high (> 20%) in Suriname (58%), Malaysia (54%), Sudan (55%), Vanuatu (41%), the Lao People's Democratic Republic (37%), Bangladesh (31%), Solomon Islands (25%), Bhutan (23%), Cambodia (23%), China (23%) and Tajikistan (19%) The IRS coverage of the high-risk population was more than 50% in Bhutan, Malaysia and Tajikistan, whereas that in India, Pakistan, the Philippines, Solomon Islands and Sudan was 20–40%. Regional trends in coverage with IRS are shown in **Figure 3.16**.

Table 3.8 Summary of intervention coverage, 2008, high-burden African countries

ITN COVERAGE		TREATMENT AND DIAGNOSTICS	
All ages		**Treatment**	
Operational ITN coverage with LLINs delivered by manufacturers	42	% fever cases in children < 5 years treated with any antimalarial, survey data	32
Operational ITN coverage with LLINs distributed, national programme data	35	% fever cases in children < 5 years treated with ACT, survey data	16*
		% ACT coverage in public sector (ACT distributed / reported malaria cases), administrative and disease surveillance data	48
Children < 5 years old		**Intermittent preventive treatment of pregnant women**	
Weighted average of ITN use by children < 5 years from surveys in 12 countries in 2008	24	% pregnant women receiving at least 2 doses during last pregnancy (previous 2 years), survey data	20**
Estimate of ITN use by children < 5 years old from model	24		
Household ownership		**Diagnostics**	
Weighted average of household ITN ownership from surveys in 13 countries in 2008	30	% reported malaria cases tested, disease surveillance data	22
Estimate of household ITN ownership from model (all countries)	31	% RDT delivered / reported malaria cases, administrative and disease surveillance data	13

* Data from only 7 countries representing 95 million persons.

** Data from only 9 countries in 2007-2008 representing 217 million persons.

Surveys showed that ITN ownership was low (< 20% of households) in Djibouti, Somalia and Sudan and also in Viet Nam (19%). In the Cambodia Malaria Survey 2007, 96% of households owned a net and 88% of children under 5 had slept under a net the previous night. However, most were untreated nets: only 36% of households owned an ITN and 28% of children slept under an ITN the previous night.

In most countries outside the African Region, access to first-line treatment was adequate to treat all reported confirmed malaria cases. All countries except some in the South-East Asia Region had distributed more than two treatment courses per confirmed case.

Table 3.9 shows the numbers of ITNs, ACT and RDTs distributed globally by national programmes in 2004–2008 by WHO region. The number of ITNs distributed in regions outside Africa increased steadily, from 5 million in 2005 to 22 million in 2008. The number of ACT treatment courses distributed increased to 10 million in 2008. The number of RDTs distributed has increased progressively, to 12 million in 2008.

Figure 3.16 Coverage with indoor residual spraying (IRS) of high-risk populations in WHO regions outside Africa, national programme data, 2001–2008

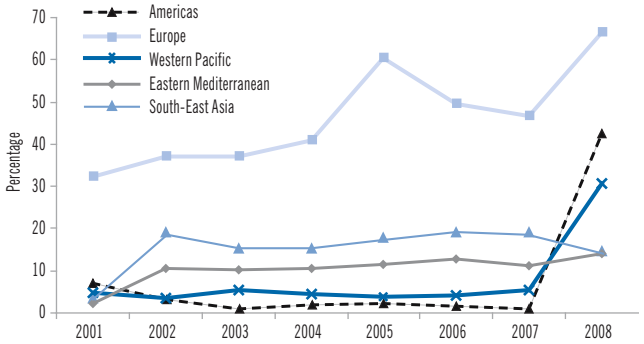


Table 3.9 Numbers of insecticide-treated nets (ITNs), artemisinin-based therapies (ACTs) and rapid diagnostic tests (RDT) reported by national programmes to have been distributed, by year, by WHO region

WHO REGION	2004	2005	2006	2007	2008
Number of ITNs					
Eastern Mediterranean	2 194 030	2 223 164	3 268 398	6 456 000	7 699 772
European	22 952	25 919	15 150	29 438	29 494
Americas	0	597 277	732 552	638 246	777 012
South-East Asia	1 939 995	3 578 065	7 127 021	7 803 354	10 587 135
Western Pacific	905 126	2 809 881	2 882 557	3 243 781	3 843 482
Outside African	5 062 103	9 234 306	14 025 678	18 170 819	22 936 895
African	14 720 440	25 869 098	52 451 596	40 098 395	45 316 731
Total	19 782 543	35 103 404	66 477 274	58 269 214	68 253 626
Number of ACT treatment courses					
Eastern Mediterranean	0	0	5 667 856	5 354 398	6 289 371
European	151	81	28	7	2
Americas	89 960	95 099	136 839	85 131	1 915 200
South-East Asia	4 528	78 900	604 241	959 118	1 308 199
Western Pacific	646 025	635 805	776 033	494 431	600 175
Outside African	740 664	809 885	7 184 997	6 893 085	10 112 947
African	1 213 541	12 245 271	53 666 521	83 196 974	62 637 244
Total	1 954 205	13 055 156	60 851 518	90 090 059	72 750 191
Number of RDTs					
Eastern Mediterranean			226 200	153 700	714 600
European	151	81	28	7	2
Americas					
South-East Asia		1 200 000	2 862 000	9 452 500	10 068 000
Western Pacific	32 150	318 000	368 425	683 300	1 556 168
Outside African	32 301	1 518 081	3 456 653	10 289 507	12 338 770
African	0	100 000	3 328 091	9 149 939	11 500 855
TOTAL	**32 301**	**1 618 081**	**6 784 744**	**19 439 446**	**23 839 625**

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Chapter 4.
Impact of malaria control

This chapter summarizes the global burden of malaria and provides assessments of the evidence that malaria control activities have had an impact on malaria disease burden in each WHO Region.

4.1 Global estimates of malaria cases and deaths in 2008

The global numbers of malaria cases and deaths in 2008 were estimated by one of the two methods described in the *World Malaria Report 2008 (1)* (Annex 1). In brief, the numbers of malaria cases were estimated: *i)* by adjusting the number of malaria cases for completeness of reporting, the extent of health service use and the likelihood that cases are parasite-positive; when the data permit, this is generally the preferred method and was used for countries outside Africa and for selected African countries; or *ii)* from an empirical relation between measures of malaria transmission risk and case incidence; this procedure was used for countries in Africa where a convincing estimate could not be made from reports.

The numbers of malaria deaths were estimated: *i)* by multiplying the estimated number of *P. falciparum* malaria cases by a fixed case fatality rate for each country, for countries where malaria accounts for a relatively small proportion of all deaths and where reasonably robust estimates of case incidence could be made, primarily outside Africa; or *ii)* from an empirical relation between measures of malaria transmission risk and malaria-specific mortality rates, primarily for countries in Africa where estimates of case incidence could not be made from routine reports.

4.1.1 Cases

In 2008, there were an estimated 243 million cases of malaria (5th–95th centiles, 190–311 million) worldwide (**Table 4.1**). The vast majority of cases (85%) were in the African Region, followed by the South-East Asia (10%) and Eastern Mediterranean Regions (4%). The totals are similar to those reported in the *World Malaria Report 2008 (1)* (for the year 2006), except that the number of cases in the Region of the Americas is lower because of updated information from household surveys and other information on the number of cases detected by surveillance systems. The number of cases in the South-East Asia Region is higher, owing to updated household survey information for Bangladesh and Indonesia on where patients seek treatment for fever. The estimates also reflect progress in reducing the number of cases in several countries, but because most reductions have been seen in smaller countries, they do not yet have much influence on the regional and global totals. The estimates are accompanied by large uncertainty intervals, which overlap those of previous estimates.

4.1.2. Deaths

Malaria accounted for an estimated 863 000 deaths (5th–95th centiles, 708–1003 million) in 2008, of which 89% were in the African Region, followed by the Eastern Mediterranean (6%) and the South-East Asia Regions (5%). The estimated numbers of deaths are similar to those reported in the *World Malaria Report 2008 (1)* (for the year 2006), but the number of deaths in Africa is lower by 34 000, primarily because of a reduction in the total number of deaths from all causes among children under 5 years of age *(2)*. The number of malaria deaths is assumed to follow this trend, although evidence on trends in malaria-specific mortality is not available for most of the countries in which a reduction in under-5 mortality is documented.

Table 4.1 Estimated numbers of malaria cases (in millions) and deaths (in thousands) by WHO Region, 2008

WHO REGION	CASES				DEATHS			
	Point	*Lower*	*Upper*	*P. falciparum* (%)	*Point*	*Lower*	*Upper*	Under 5 (%)
AFR	208	155	276	98	767	621	902	88
AMR	1	1	1	32	1	1	2	30
EMR	9	7	11	75	52	32	73	77
EUR	0	0	0	4	0	0	0	3
SEAR	24	20	29	56	40	27	55	34
WPR	2	1	2	79	3	2	5	41
Total	**243**	**190**	**311**	**93**	**863**	**708**	**1003**	**85**

The number of deaths due to malaria is also higher in the Eastern Mediterranean Region, owing to increases in envelops for mortality from all causes in children under 5 in Somalia and Sudan *(2)*, although specific evidence of a rise in malaria mortality is lacking. The number of deaths in the South-East Asia region is higher owing to the increased estimate of the number of cases that was due to better information on where fever cases seek treatment; there is no specific evidence of an upward trend in the number of malaria deaths. The estimates are accompanied by large uncertainty intervals, which overlap those of previous estimates.

4.2 Assessing the impact of malaria interventions

4.2.1 Investigating 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 main sources of information on these indicators are the disease surveillance systems operated by ministries of health. Data from such systems have two strengths. First, case reports are recorded continuously over time and can thus reflect changes in the implementation of interventions or climate conditions. Secondly, routine case and death reports are often available for all geographical units of a country. 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 slide examination or RDT, so that cases reported as malaria may be other febrile illnesses *(3)*. When reviewing data supplied by ministries of health in malaria-endemic countries, we attempted to minimize the influence of these sources of error and bias by pursuing the following strategy:

- 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 number of inpatient malaria cases is reviewed because the predictive value of an inpatient diagnosis is considered to be higher than outpatient diagnoses based only on clinical signs and symptoms; in such cases, 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 annual blood examination rate, which is the number of laboratory tests undertaken per 100 people at risk per year, to ensure that potential differences in diagnostic effort or completeness of reporting are taken into account. The annual blood examination rate should ideally remain constant or be increased if attempting to discern decreases in malaria incidence.[1] When reviewing the number of malaria admissions and deaths, the health facility reporting rate should remain constant and should be high, i.e. > 80%.
- Monitoring trends in the malaria (slide or RDT) positivity rate. This rate should be less severely distorted by variations in the annual blood examination rate than trends in the number of confirmed cases. For high-burden African countries, when the number of malaria inpatients is being reviewed, it is also informative to examine the percentage of admissions or deaths due to malaria, as this proportion is less sensitive to variation in reporting rates than the number of malaria inpatients 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.[2] 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 informative to compare the total number of deaths occurring in health facilities with the total number of deaths estimated to occur in a 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. 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, unusual fluctuations in these proportions may point to changes in health facilities 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 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.

1. Some authorities recommend that the annual blood examination rate 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 annual blood examination rate in the Solomon Islands, a highly endemic country, exceeds 60%, with a slide positivity rate of 25%, solely by passive case detection.

2. The *World Malaria Report 2008* described methods for estimating the total number of malaria cases in a country based on the number of reported cases and taking into account variations in health facility reporting rates, care-seeking behaviour for fever as recorded in household surveys and the extent to which suspected cases are examined in laboratory tests.

4.2.2 Assessing coverage with malaria interventions

Data on the number of ITNs distributed by malaria programmes and populations covered by IRS are supplied annually by ministries of health to WHO as part of reporting for the *World Malaria Report*. Such information may contain inaccuracies or gaps, particularly for earlier years. Hence, if data for earlier years are missing, it might be inferred incorrectly that preventive activities have recently been intensified. Nevertheless, for many countries, data from ministries of health are the only source of information on preventive activities and are consistent over the years. Data from nationally representative household surveys are available for selected countries, but these surveys are usually not undertaken frequently enough to allow assessment of trends in intervention coverage or to provide contemporary information. Information on access to treatment is less complete than data on ITNs and IRS, as few countries supply information on the number of courses of antimalarial medicines distributed in relation to the number of cases treated in the public sector. Information on preventive activities or treatment provided by the private sector is almost completely absent. It is therefore not always possible to obtain a complete picture of the extent of control activities in a country. Similarly, information on other factors that can affect malaria incidence is often not available, such as climate variations, deforestation or improved living conditions.

4.2.3 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 robust 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 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.

Countries for which there is evidence from good-quality surveillance data of a large, sustained decrease (> 50% or 25%) in the number of cases since 2000 are presented below by WHO region. Information on the scale of malaria control interventions is also summarized, to identify countries with preventive programmes that cover > 50% of the population at high risk and countries that undertake extensive case detection and treatment. Countries in which there is evidence of both a sustained decrease in cases since 2000 and extensive control activities are highlighted as providing evidence of an impact of malaria control activities. Selected high-burden countries in the African Region are discussed individually. For other regions, the results of the analysis are shown in a standard set of graphs, as described in **Box 4.1**.[3]

BOX 4.1

Explanation of graphs

Population at risk: the population at high risk for malaria is that living in areas where the incidence is 1 or more 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 fewer than 1 case of malaria per 1000 per year (see Methods in Annex 1).

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

Annual blood examination rate: number of slide examinations undertaken each year in relation to the population at risk for malaria, expressed as a percentage.

Confirmed cases reported as a percentage of total estimated: total number of confirmed cases in relation to the estimated number of malaria cases in a country. The estimated number of cases is calculated by taking into account: *i)* the completeness of reporting from health facilities, *ii)* the extent to which people with fever use public health facilities for treatment and *iii)* the extent to which public health facilities undertake case confirmation (see technical notes). The line in the centre of the bar represents the point estimate of the percentage of estimated cases captured by the surveillance system. The width of the bars reflects uncertainty around the estimate of the number of cases.

Change in number of reported cases: the number of confirmed malaria cases is shown on the vertical axis, with each country indexed at 100 in 2000 (or a later year if data were not available for 2000); i.e. a value of 200 in 2005 indicates that the number of cases in 2005 was twice that reported in 2000 and represents a 100% increase. Countries with evidence of a decrease are generally those in which there has been a consistent decrease in the number of cases and consistency in reporting of malaria cases (e.g. stable annual blood examination rate). Countries for which there is little evidence of a decrease are those that do not show a decrease in the number of cases or where there have been irregular variations in surveillance data (e.g. annual blood examination rate falling, or unexplained variations in the percentage of cases due to *P. falciparum*).

IRS and ITNs delivered. The vertical scale shows the percentage of the population at risk for malaria potentially covered by preventive programmes with IRS and ITNs. It is assumed that each bed net delivered can cover two people, that conventional nets are retreated regularly and that each net is not replaced for 3 years. IRS is assumed to target a different population from that receiving bed nets. The percentage of the population potentially covered is therefore the maximum possible covered by the interventions delivered. The denominator is the population living at high risk for malaria, as the number of malaria cases in areas of low risk is small. The scale of preventive efforts in any year is calculated as: 100 x (number of ITNs delivered in past 3 years + number of people protected by IRS in current year)/population at high risk. Note that this indicator can exceed 100% if interventions are also applied to populations at low risk.

3. Countries in the prevention of re-introduction phase with only sporadic cases are excluded from the analysis.

4.3 African Region

4.3.1 High burden countries

This section updates the trends in morbidity and mortality from malaria presented in the *World Malaria Report 2008*. As the quality of the information received from most of the 35 high-burden countries in the WHO African Region was poor, trends could be analysed for only four of these countries, Eritrea, Rwanda, Sao Tome and Principe, Zambia and for the Zanzibar area of the United Republic of Tanzania. The four countries were among the ten with the highest rates of ITN ownership, as estimated in Chapter 3, the percentage of households owning at least one ITN exceeding 60% in 2008. A household survey undertaken in Zanzibar at the end of 2007 showed that 72% of households owned at least one ITN.

Eritrea. Eritrea had a population of 3.8 million in 2001 and reported a total of 126 000 malaria cases in that year. More than 1.1 million nets were distributed between 2001 and 2008 (an average of 139 000 per year), with LLIN distribution starting in 2005. In 2004, 73% of households in areas of high transmission owned an ITN and 59% of children 0–5 years slept under a net *(4)*. A malaria indicator survey in 2008 showed that 71% of households owned at least one ITN, and 39% of children < 5 years slept under an ITN (Eritrea Ministry of Health, unpublished data). Annual rounds of IRS protected approximately 238 000 people per year between 2001 and 2006. An average of 28 000 courses of ACT were distributed annually between 2006–2008, which was sufficient to treat all cases of *P. falciparum* malaria in outpatients.

The number of malaria outpatients fell by more than 90% between 2001 and 2008 (**Fig. 4.1**). The number of patients admitted to hospital for any reason increased by 44% between 2001 and 2008, but the number of malaria inpatients decreased by 68%. There were 86% fewer deaths from malaria among inpatients in 2008 than in 2001. A review of the evidence suggested that the observed decreases in the numbers of cases and deaths were due to malaria control interventions and not solely to environmental or other factors *(4)*.

Rwanda. Two sources of information on trends in the numbers of malaria cases and deaths were available from Rwanda: the results of a study by the Ministry of Health and WHO on the impact of malaria control in 2001–2008 on the basis of information from 19 health facilities in all 10 provinces and nationwide case records from surveillance activities in 2001–2007[4], as reported to WHO.

Approximately 765,000 ITNs (not LLINs) were distributed between 2001 and 2005 for a population of 8–9 million; 185,000 LLINs were added in 2005. During a nationwide campaign targeting children < 5 years in 2006, 1.96 million LLINs were distributed, and a further 1.16 million LLINs were distributed in 2007, increasing the percentage of the population potentially covered by nets to 70%. ACTs were distributed nationwide between September and October 2006, at the same time as the mass distribution of LLINs. A malaria indicator survey in 2007 showed that 50% of households owned an ITN and 56% of children < 5 slept under an ITN. A demographic and health survey conducted in 2007–2008 showed that 56% of households owned an ITN and 56% of children < 5 slept under a net.

The numbers of malaria cases and deaths appeared to decrease rapidly after the distribution of LLINs and ACT in 2006 (**Fig. 4.2**). In the 19 health facilities visited for the impact study in 2009, the annual number of confirmed malaria cases (all ages) in 2008 was 53% lower than the average for 2001–2005 (data not available by age group). The number of malaria inpatients was 52% lower, and the number of malaria deaths was 41% lower in 2008 than in 2001–2005 among children < 5 years old (target age group of the ITN campaign).

A similar trend is seen in an aggregation of surveillance data nationwide for 2001–2007. The annual number of confirmed malaria cases (all ages) in 2007 was 31% lower than in 2001–2005, the number of admissions for malaria was 43% lower, and the number of malaria deaths was 66% lower among children < 5 years old.[4] The slide positivity rate fell from an average of 52% between 2001 and 2005 to 22% in 2007. The annual blood examination rate increased from 8% in 2001 to 16% in 2007. Health facility reporting rates were high throughout the period, averaging 92%, the lowest value being obtained in 2006.

In summary, mass distribution of ITNs to children < 5 and to pregnant women, distribution of ACTs to public-sector facilities and increased rates of household ITN ownership and use by children exceeding 50% were associated with approximately 50% decreases in the numbers of confirmed outpatient cases, inpatient cases and deaths due to malaria over 24 months.

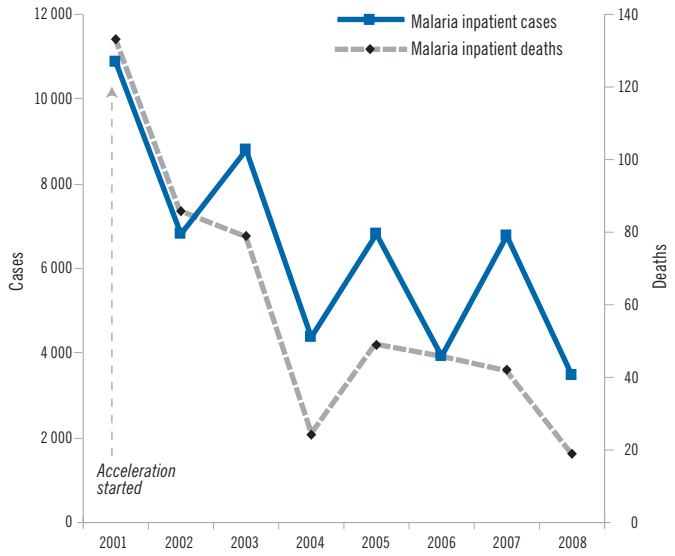
Sao Tome and Principe. The population of Sao Tome and Principe was 160 000 in 2008. IRS protected 140 000 people in 2005, 126 000 in 2006 and 117 000 in 2007. By 2007, nationwide ITN coverage was among the highest in Africa: 78% of households owned at least one ITN, and 54% of children < 5 years of age slept under an ITN. ACT was introduced for treatment of malaria in 2005, and the number of treatment courses distributed in 2005–2008 was enough to cover all reported cases.

The annual number of confirmed malaria cases in 2005–2008 was 84% lower than in 2000–2004, and the slide positivity rate fell from 47% between 2000 and 2004 to < 13% between 2005 and 2008 (**Fig. 4.3**). The number of admissions due to malaria was 87% lower in 2005–2008 than in 2000–2004, while the percentage of admissions for malaria fell from an average of 62% in 2000–2004 to 23% in 2005–2008. Similarly, the number of malaria inpatient deaths in 2005–2008 was 86% lower than in 2000–2004, and the percentage of deaths due to malaria in health facilities fell from 23% to 4%. The number of deaths from malaria among children < 5 fell by 89%, while the number of deaths from all causes among children < 5 decreased by 59%. By 2008, the numbers of inpatient malaria cases and deaths and outpatient malaria cases had decreased by > 90% in comparison with 2000–2004. All-cause inpatient deaths declined by 53%.

In Sao Tome and Principe, therefore, a strong association is seen between interventions and impact, albeit on a relatively small scale *(5)*.

4. As a new information system was introduced in 2008, it is difficult to compare data from the national health information system for 2008 with those for previous years.

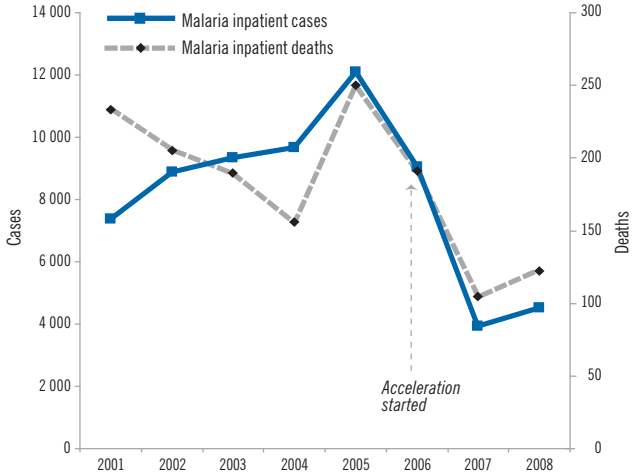
Figure 4.1 Malaria inpatient cases and deaths by year, all ages, 2001–2008, Eritrea



Source: Ministry of Health routine surveillance data

Figure 4.2 Malaria inpatient cases and deaths among children < 5 by year and outpatient all-cause and confirmed malaria cases in all ages, 19 health facilities, 2001–2008, Rwanda

a) *Malaria inpatient cases/deaths, children <5 years old*



* Mass distribution of ITN to children < 5 years old and pregnant women and distribution of ACT to public health facilities

b) *Outpatients: all-cause cases and malaria test positivity rate, all ages*

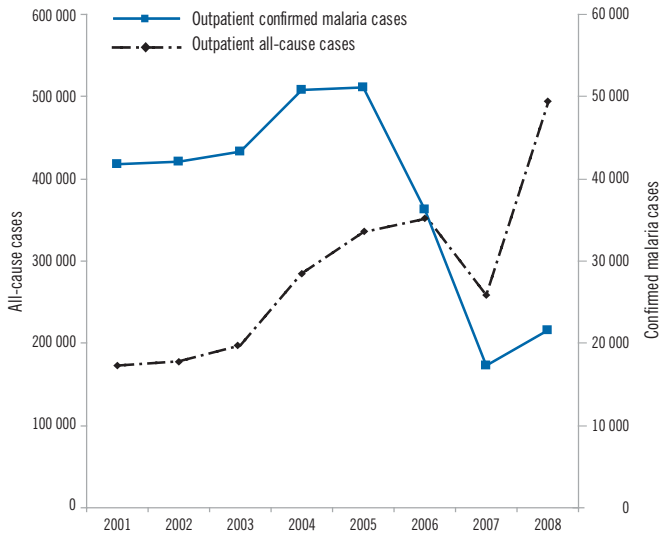
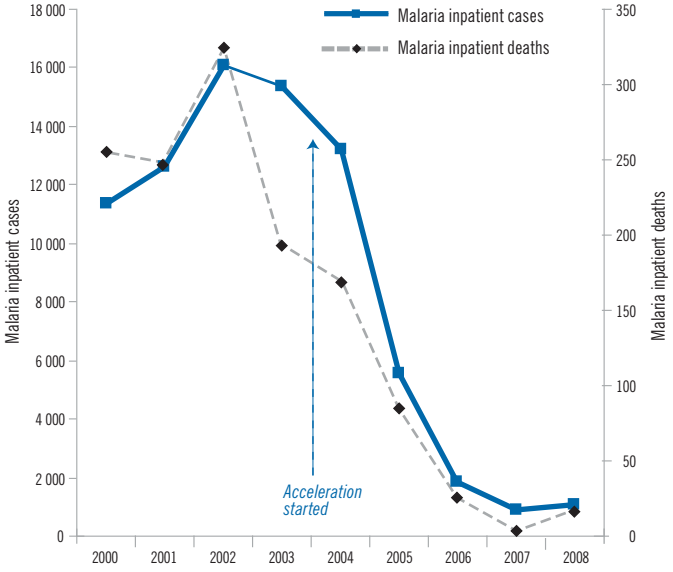
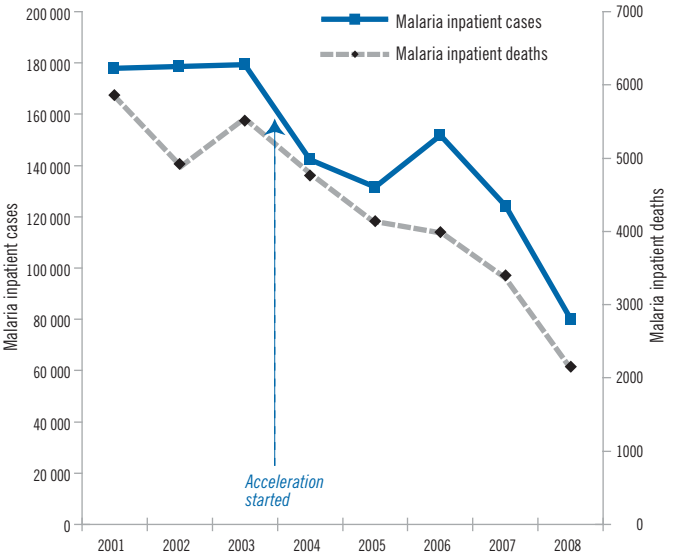


Figure 4.3 Malaria inpatient cases and deaths, all ages, by year, 2000–2008, Sao Tome and Principe



Source: Ministry of Health routine surveillance data

Figure 4.4 Malaria inpatient cases and deaths by year, all ages, first and second quarter each year, 2001–2008, Zambia



Source: Ministry of Health routine surveillance data

Zambia. Data on malaria trends in Zambia are more comprehensive than those for most countries, because: *i)* records from the health management information system were more or less complete between 2001 and the first half of 2008, and *ii)* two nationally representative household surveys that included testing for malaria parasites and anaemia were undertaken in 2006 and 2008.

Zambia had a population of 12.6 million in 2008. During 2002–2005, 1.26 million LLINs were distributed, enough to protect about 2.5 million people (assuming one net protects two people). An additional 4.8 million LLINs were distributed between 2006 and 2008 – enough to protect 9.6 million people, or 76% of the population. IRS covered an average of 0.9 million persons between 2003 and 2005, 2.4 million in 2006 (mostly in urban areas), 3.3 million in 2007 and 5.7 million in 2008. ACT was made available nationwide in 2004. The number of ACT treatment courses distributed increased from 1.2 million in 2004 to 3.1 million in 2008, coverage increasing from 29% of the malaria cases reported in public health facilities to 100%.

A nationally representative household survey in 2006 found that 44% of households owned an ITN, and 23% of children < 5 slept under an ITN. In 2008, these proportions had risen to 62% of households and 41% of children < 5. Approximately 47% of the population (mostly urban) were protected by IRS; 13% of children with fever in the previous 2 weeks had received ACTs, and 16% had received other antimalarial medicines.

A switch to a new health management information system during the third and fourth quarters of 2008 resulted in some incompleteness of reporting for those quarters. Therefore, data for the first two quarters of each year (the peak malaria season in most years) are presented. These surveillance data show that the numbers of malaria inpatients and deaths were 55% and 60% lower, respectively, in 2008 than the average for 2001–2002 for all ages (**Fig. 4.4**). The numbers of admissions and deaths from diseases other than malaria or anaemia decreased by 0% and 6%, respectively.

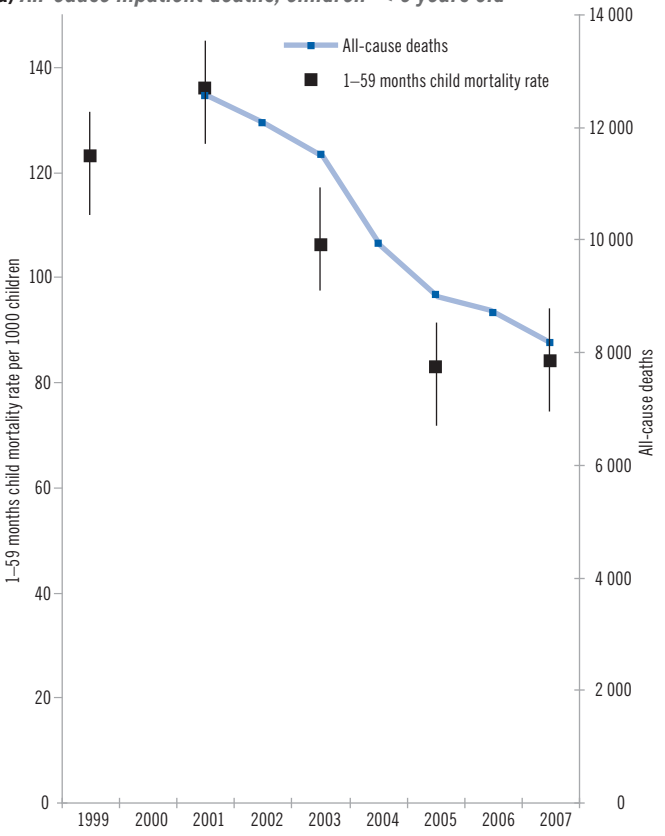
The scale of change observed in health facility data on inpatient cases is consistent with that from household surveys. The parasite prevalence among children < 5 decreased by 53% between 2006 and 2008 (from 21.8% to 10.2%), and the percentage of children with severe anaemia (< 8 g/dl haemoglobin) decreased by 68% (from 13.3% to 4.3%). The numbers of inpatient malaria cases and deaths among children < 5 decreased by 57% and 62%, respectively, while the number of admissions for anaemia decreased by 47%.

The magnitude of the decrease in numbers of inpatient deaths from all causes among children < 5 was similar to that of the decrease in mortality among children aged 1–59 months observed in the 2007 demographic and health survey (**Fig. 4.5**). A possible reason for the similarity between inpatient and population trends might be the geographically homogeneous ITN coverage: the 2008 malaria indicator survey showed that ITN coverage in Zambia was similar for the poorest (63%) and richest quintiles (65%) and in urban (59%) and rural areas (64%).

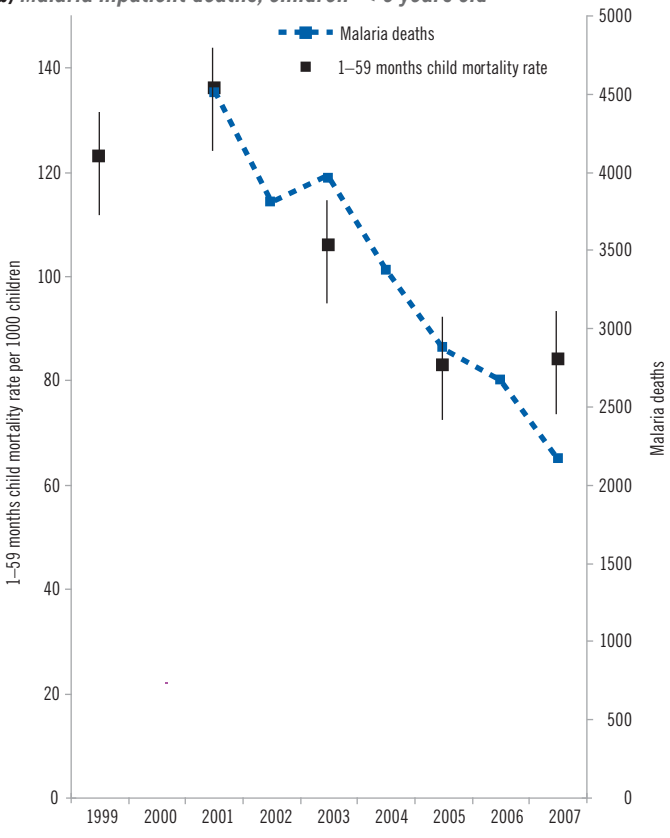
Zanzibar, United Republic of Tanzania. The islands of Zanzibar had a population of 1.2 million in 2008. ACT was made freely available in all public health facilities in September 2003. Approximately 245 000 LLINs were distributed in 2006, enough to cover 40% of the population, while a further 213 000 were distributed in 2007–2008. ITN household ownership was 72% and ITN use by children was 59%

Figure 4.5 Trends in 1–59-month child mortality rate from a demographic and health survey (DHS) compared with inpatient all-cause and malaria deaths from routine health information system, 1999–2007, Zambia. Mortality rates in children 1–59 months in 2-year intervals from DHS data are shown in black squares (95% confidence interval shown as line)

a) *All-cause inpatient deaths, children < 5 years old*

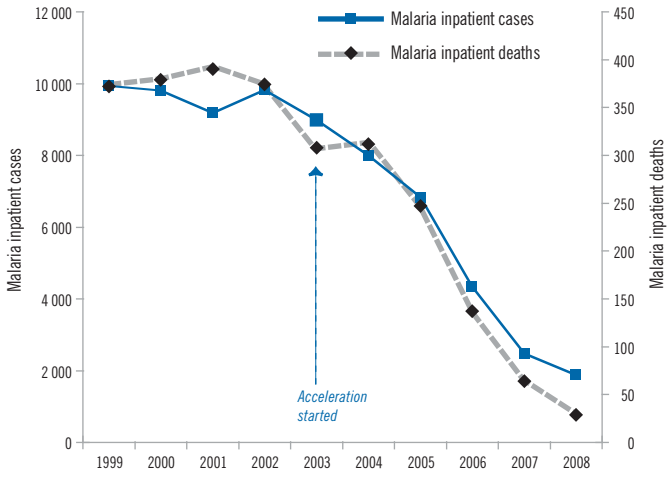


b) *Malaria inpatient deaths, children < 5 years old*



* Mortality rates from DHS data were calculated by Julie Rajaratnam, Linda N. Tran and Alison Levin-Rector at Institute for Health Metrics and Evaluation

Figure 4.6 Malaria inpatient cases and deaths, all ages, by year, 1999–2008, six of seven hospitals in Zanzibar, United Republic of Tanzania



Source: Ministry of Health routine surveillance data

at the end of 2007. One round of IRS was carried out in 2006, followed by a further two rounds in 2007 and a single round in 2008. Each round covered nearly all households.

The numbers of inpatient cases and deaths from malaria decreased substantially between 2003 and 2008, and in 2006–2008, the numbers of malaria admissions and deaths were 70% lower than the numbers recorded in 2001 and 2002 (**Fig. 4.6**). By 2008, the numbers of inpatient malaria cases and deaths were lower by 80% and 92%, respectively. In contrast the number of admissions for conditions other than malaria was 20% higher.

Before acceleration of malaria control activities in 2005, 52% of cases and 53% of deaths among all inpatients were diagnosed as malaria. The number of inpatient deaths from all causes among children decreased by 57% and that of cases by 48% in 2008 as compared with 1999–2003, before acceleration. While the decrease in the number of admissions for malaria is dramatic and its timing is associated with high coverage with antimalarial interventions, it is uncertain how much of the decrease is due to improved diagnosis of cases, as fewer cases were diagnosed symptomatically and consequently fewer non-malarial fevers were classified as malaria. (A total of 650,000 RDTs were distributed by the Zanzibar malaria control programme between 2005 and 2006.) Other evidence for an impact of malaria interventions comes from a detailed investigation in one district, where, among children < 5, there were substantial reductions in *P. falciparum* prevalence, malaria-related admissions, blood transfusions, crude mortality and malaria-attributed mortality after introduction of ACTs in 2003 *(6)*.

4.3.2 Low-transmission countries in the African Region

In Botswana, Cape Verde, Namibia, South Africa, Swaziland and Zimbabwe, malaria is highly seasonal, and transmission is of much lower intensity than in the rest of sub-Saharan Africa. The vast majority of cases are due to *P. falciparum* (**Fig. 4.7b**). Five countries (Botswana, Cape Verde, Namibia, South Africa and Swaziland) demonstrated decreases >50% in the numbers of confirmed cases and deaths due to malaria between 2000 and 2008 (**Fig. 4.7e**), although the decrease in cases appears to have levelled off, the numbers of cases remaining at 10–25% of those in 2000. The reasons are not yet clear, but the few cases remaining may be more difficult to prevent, detect and treat. Four of these countries (Botswana, Namibia, South Africa and Swaziland) also reported large decreases in the number of deaths due to malaria (**Table 4.2**) while Cape Verde reported only 2 deaths in 2008. In Zimbabwe, an increase in the number of confirmed malaria cases from 16 990 in 2004 to 92 900 in 2008 was associated with a sixfold increase in the number of slides examined; in contrast, the total of all reported malaria cases, which includes unconfirmed cases, decreased from 1.8 million in 2004 to 1 million in 2008. The increase in the number of slides examined is a positive development but makes it difficult to assess trends in the number of cases.

The scale of IRS has remained fairly constant over the past 8 years; South Africa and Swaziland protect 80% and 100% of their population at risk per year, while Botswana, Namibia and Zimbabwe protected 91%, 26% and 20% of those populations between 2000 and 2008, respectively. Namibia delivered 630 000 LLINs between 2006 and 2008, enough to cover 92% of the population at high risk (a ratio of one LLIN per two persons at risk); Swaziland reached about 47% of the population at risk by delivering about 85 000 LLINs during the same period; and the number of ITNs delivered in Botswana was negligible. South Africa adopted ACTs for first-line treatment of malaria in 2001, and their introduction, with improved mosquito control (including spraying with DDT), has been associated with a decrease in malaria cases. Botswana, Namibia and Swaziland adopted ACTs after 2005. Zimbabwe adopted a policy of treating *P. falciparum* cases with ACTs in 2008, but the programme has not yet reported deployment to public health facilities. The malaria programme in Cape Verde focuses on case detection and treatment.

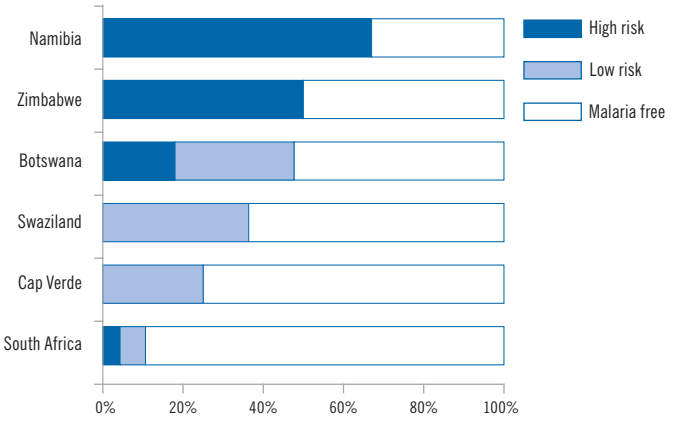
In summary, five of the six low-transmission countries in the African Region (Botswana, Cape Verde, Namibia, South Africa and Swaziland) showed > 50% decreases in the numbers of malaria cases and deaths between 2000 and 2008. Each of these countries implemented widescale malaria programmes, but a drought affecting Namibia, South Africa, Swaziland and Zimbabwe between 2001 and 2003 might also have contributed to an initial decrease. It is not possible to determine whether the number of cases in Zimbabwe is increasing, stable or decreasing, but preventive activities appeared to cover > 50% of the population at high risk in 2008.

Table 4.2 Reported numbers of deaths due to malaria in southern African low-transmission countries

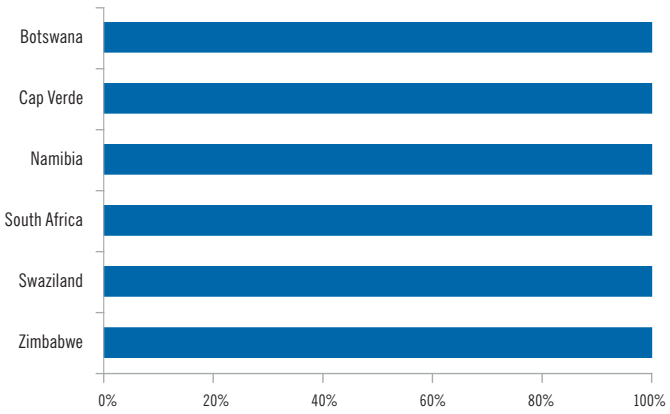
COUNTRY	2000	2001	2002	2003	2004	2005	2006	2007	2008
Botswana		29	23	18	19	11	40	6	12
Namibia		1728	1504	1106	1185	1325	571	181	171
Swaziland		62	46	30	25	17	27	14	5
South Africa	458	119	96	142	89	64	87		
Zimbabwe			1844	1044	1809	1916	802	285	

Figure 4.7 WHO African Region, low transmission countries

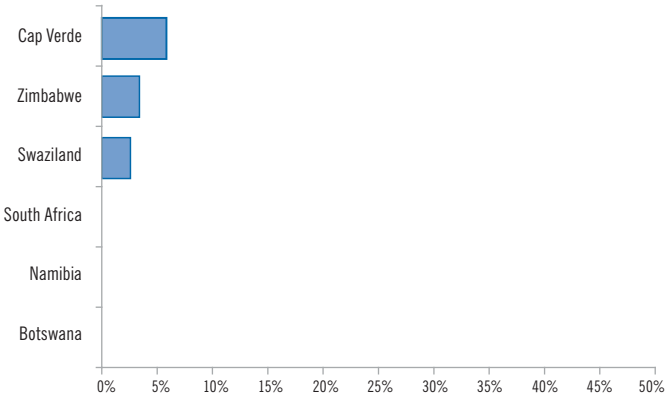
a) *Population at risk, 2008*



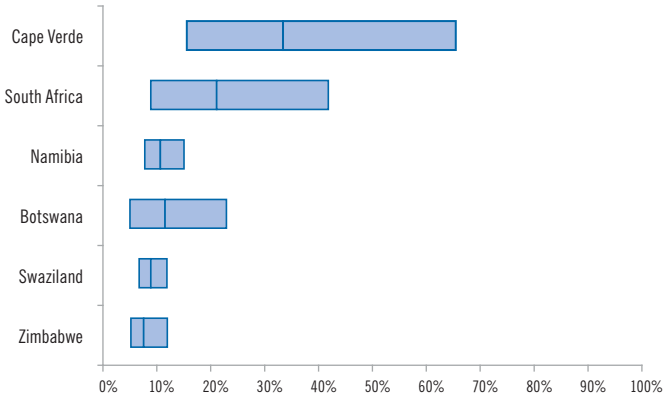
b) *Percentage of cases due to* P. falciparum, *2008*



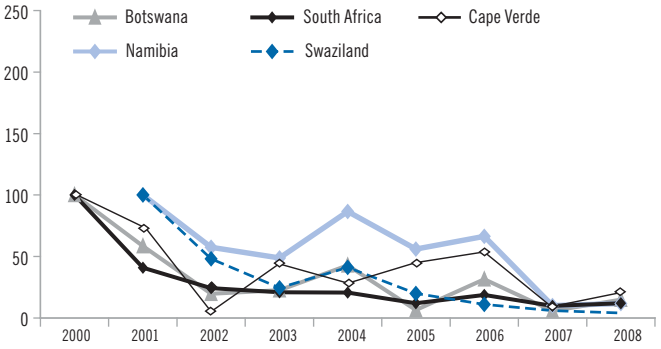
c) *Annual blood examination rate, 2000–2008*



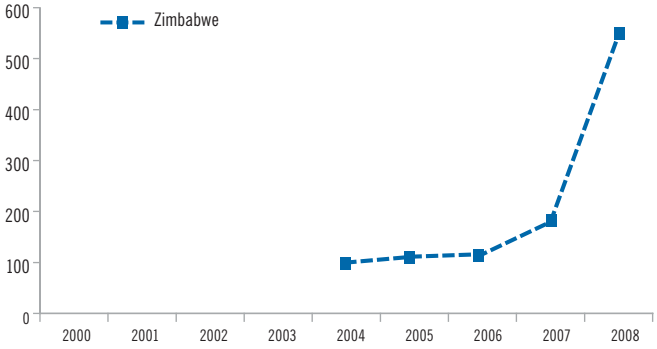
d) *Confirmed cases as a percentage of total estimated for 2008*



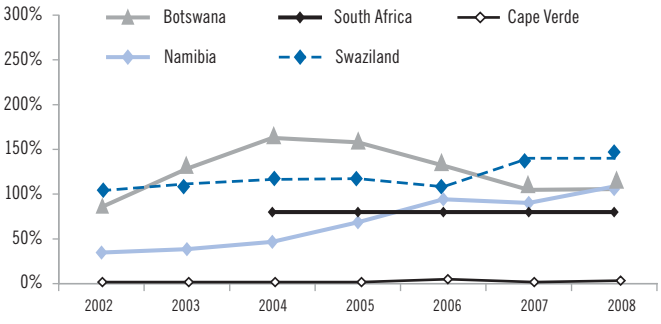
e) *Changes in numbers of confirmed cases, 2000–2008:* *countries with evidence of sustained decrease in cases*



f) *Changes in numbers of confirmed cases, 2000–2008:* *countries with limited evidence of sustained decrease in cases*



g) *IRS and ITNs delivered – maximum percentage of high risk population* ***potentially covered:*** *countries with evidence of sustained decrease in cases*



h) *IRS and ITNs delivered – maximum percentage of high risk population* ***potentially covered:*** *countries with limited evidence of sustained decrease*

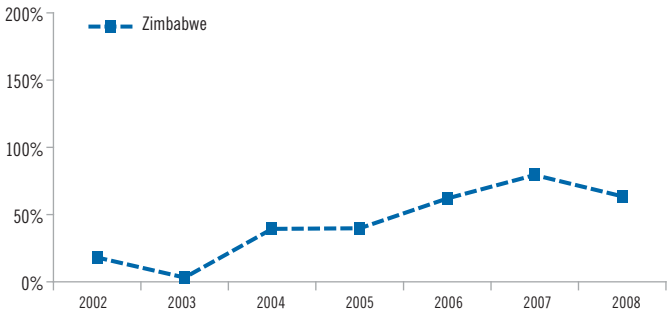
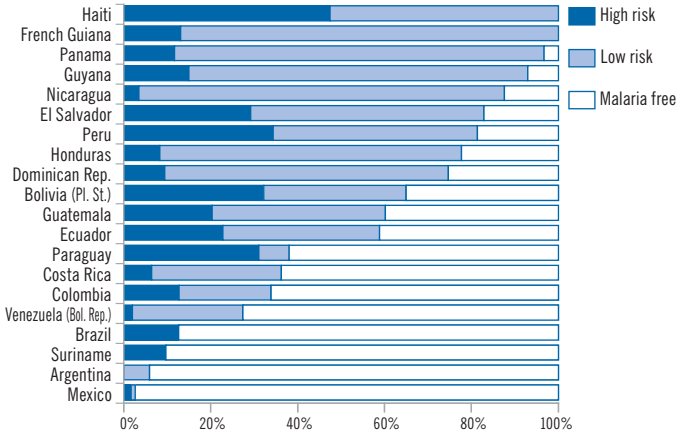
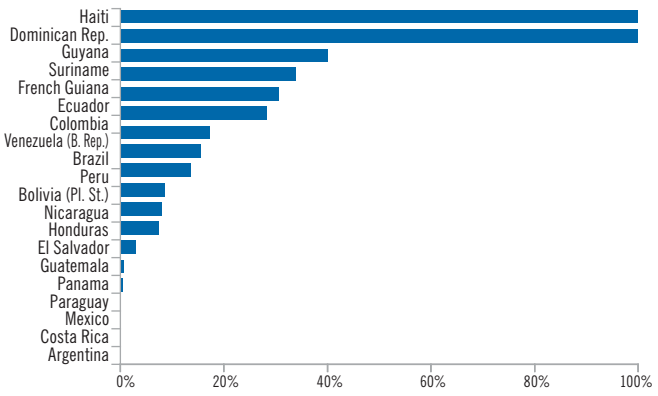


Figure 4.8 WHO Region of the Americas by IRS in 2006

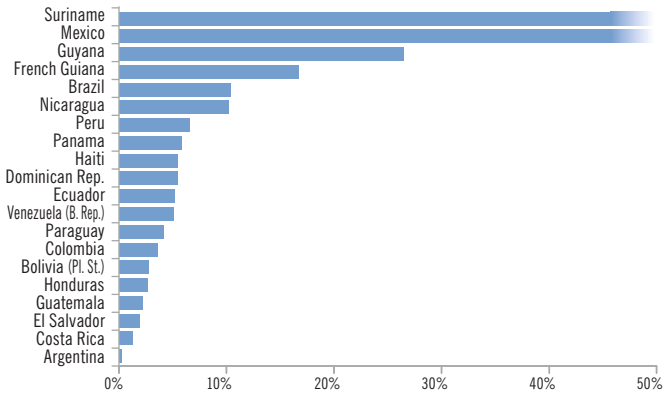
a) *Population at risk, 2008*



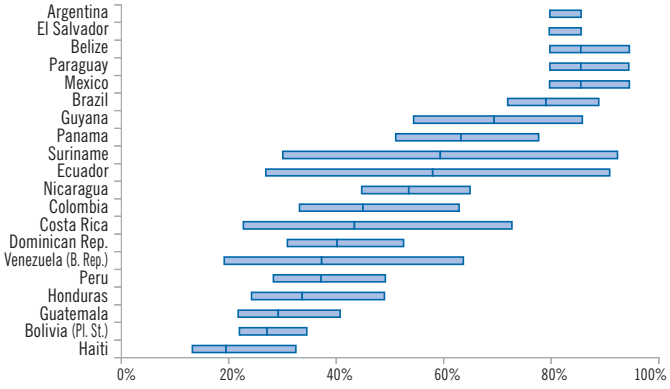
b) *Percentage of cases due to* P. falciparum, *2008*



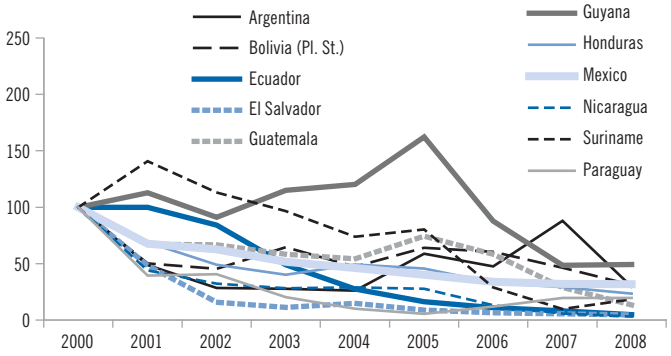
c) *Annual blood examination rate, 2000–2008*



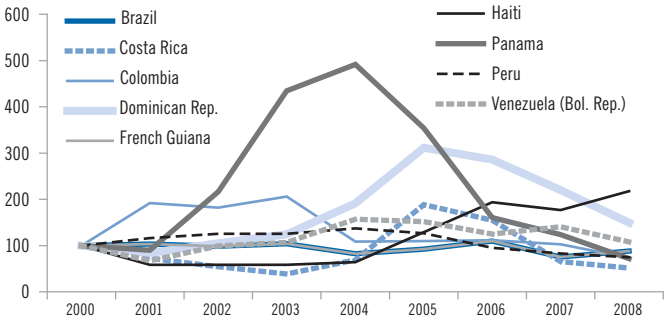
d) *Confirmed cases as a percentage of total estimated for 2008*



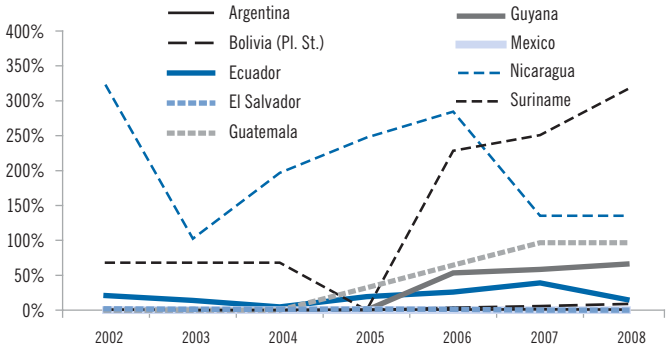
e) *Changes in numbers of confirmed cases, 2000–2008:* *countries with evidence of sustained decrease in cases*



f) *Changes in numbers of confirmed cases, 2000–2008:* *countries with limited evidence of sustained decrease in cases*



g) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered:* *countries with evidence of sustained decrease in cases*



h) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered:* *countries with limited evidence of sustained decrease*

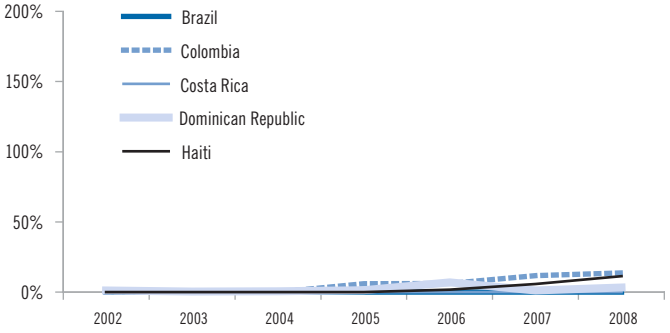
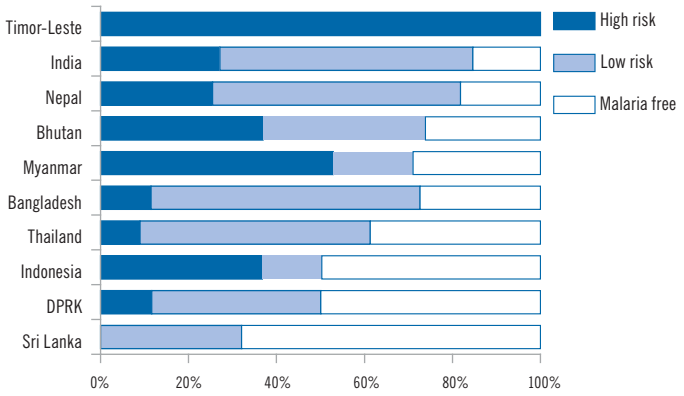
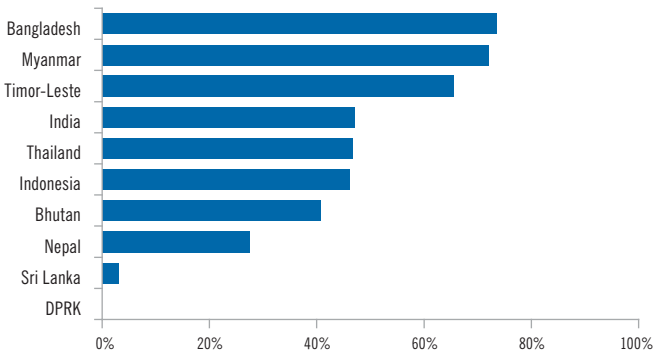


Figure 4.9 WHO South-East Asia Region

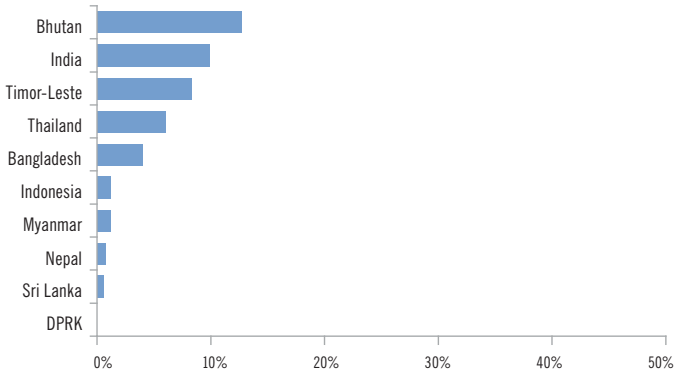
a) *Population at risk, 2008*



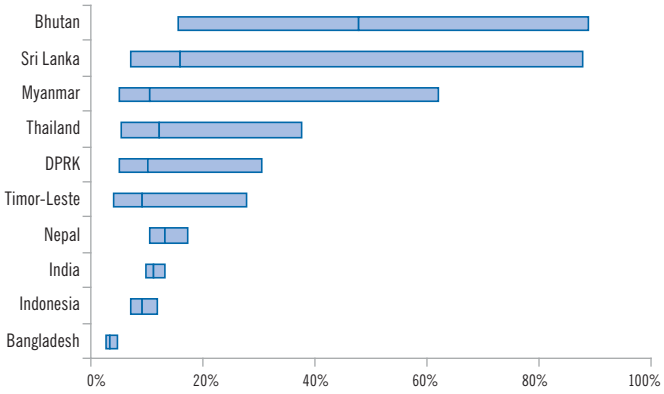
b) *Percentage of cases due to* P. falciparum, *2008*



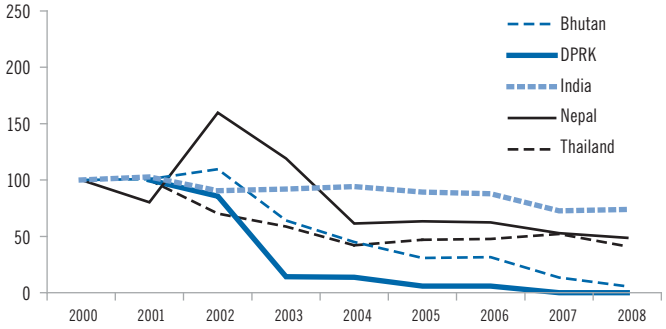
c) *Annual blood examination rate, 2000–2008*



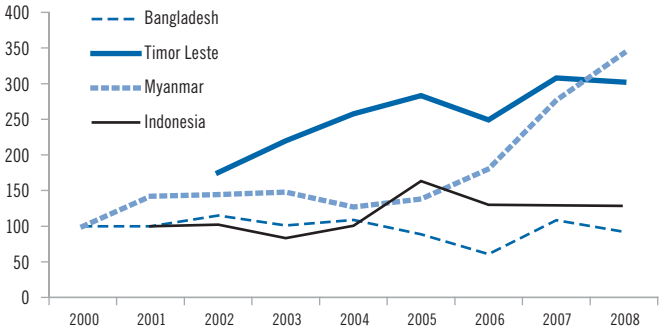
d) *Confirmed cases as a percentage of total estimated for 2008*



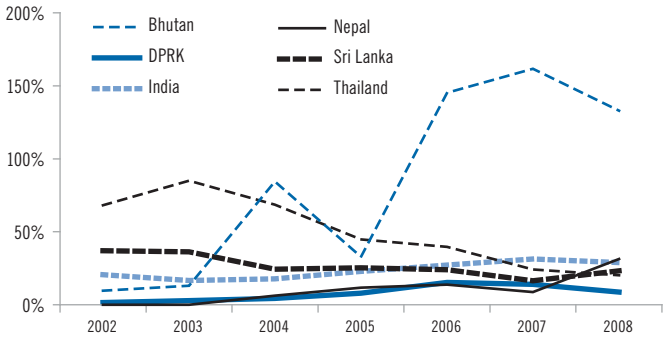
e) *Changes in numbers of confirmed cases, 2000–2008:* *countries with evidence of sustained decrease in cases*



f) *Changes in numbers of confirmed cases, 2000–2008:* *countries with limited evidence of sustained decrease in cases*



g) *IRS and ITNs delivered – maximum percentage of high risk population* ***potentially covered:*** *countries with evidence of sustained decrease in cases*



h) *IRS and ITNs delivered – maximum percentage of high risk population* ***potentially covered:*** *countries with limited evidence of sustained decrease*

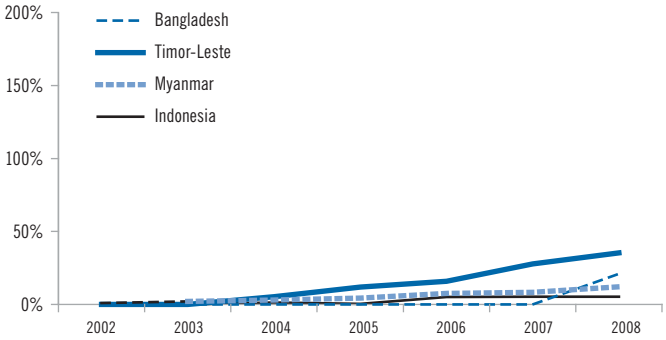
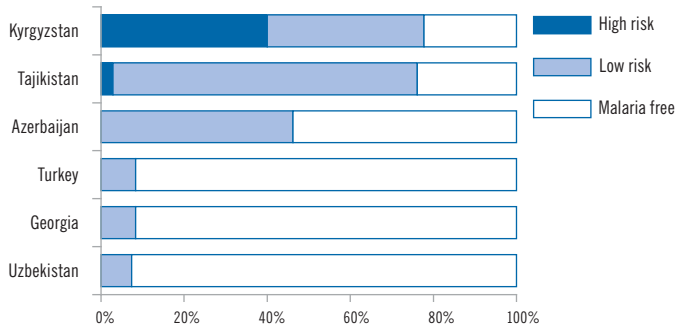
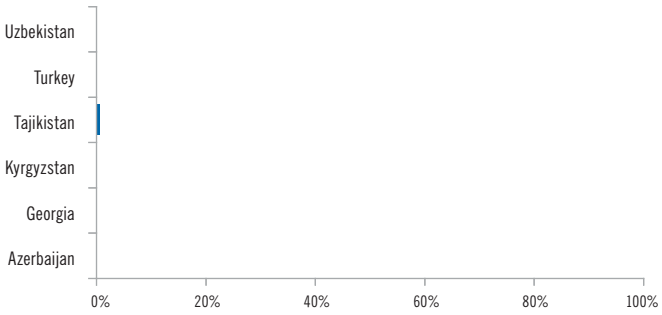


Figure 4.10 WHO European Region

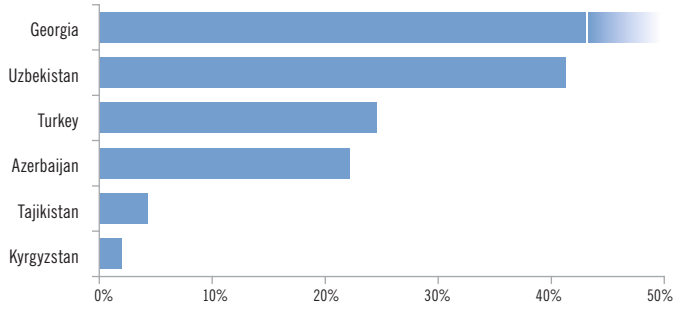
a) *Population at risk, 2008*



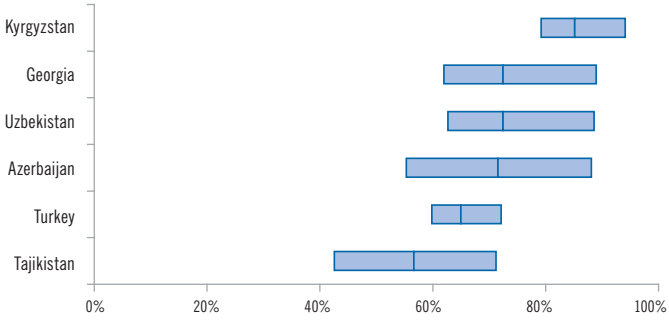
b) *Percentage of cases due to* P. falciparum, *2008*



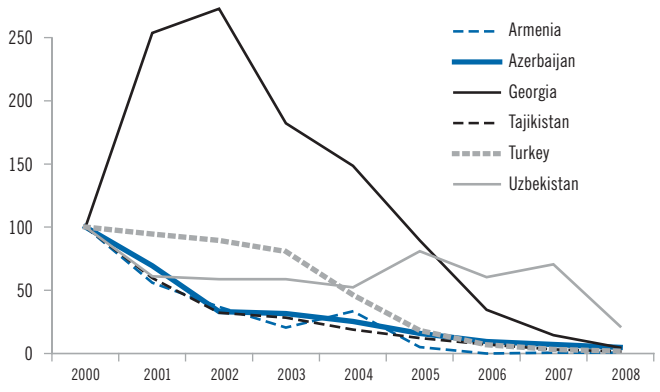
c) *Annual blood examination rate, 2000–2008*



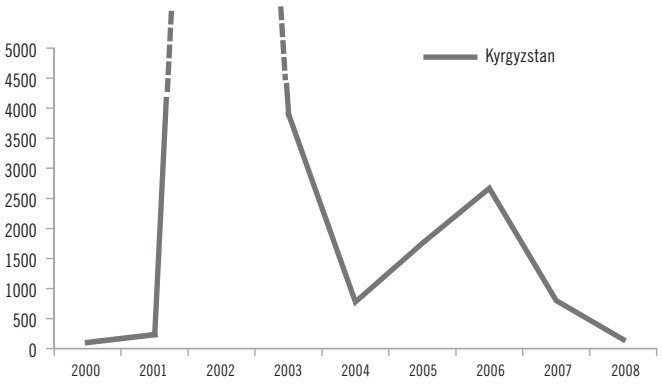
d) *Confirmed cases as a percentage of total estimated for 2008*



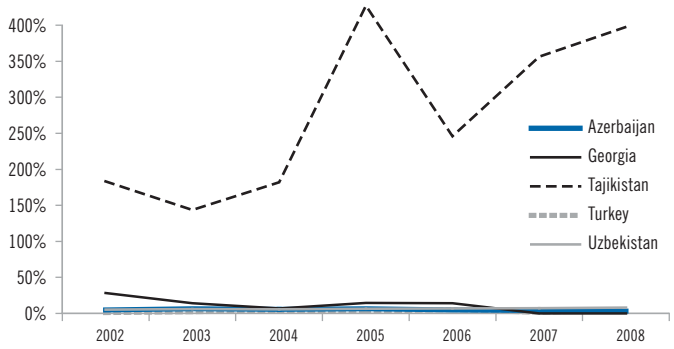
e) *Changes in numbers of confirmed cases, 2000–2008:*
countries with evidence of sustained decrease in cases



f) *Changes in numbers of confirmed cases, 2000–2008:*
countries with limited evidence of sustained decrease in cases



g) ***IRS and ITNs delivered – maximum percentage of high risk population potentially covered:*** *countries with evidence of sustained decrease in cases*



h) ***IRS and ITNs delivered – maximum percentage of high risk population potentially covered:*** *countries with limited evidence of sustained decrease*

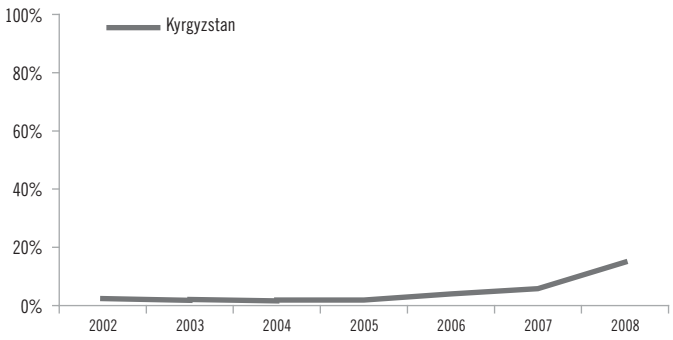
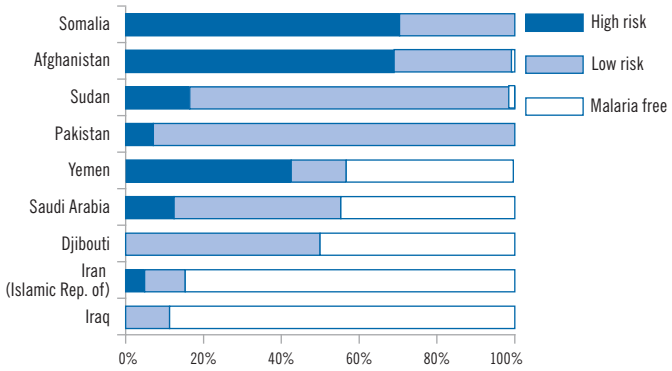
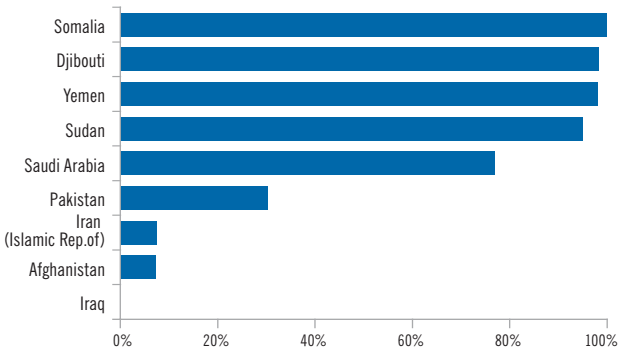


Figure 4.11 WHO Eastern Mediterranean Region

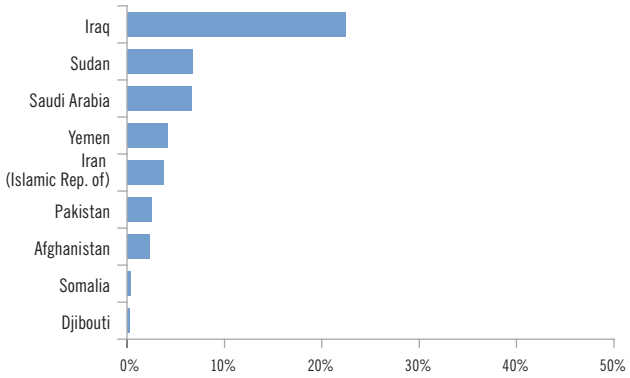
a) *Population at risk, 2008*



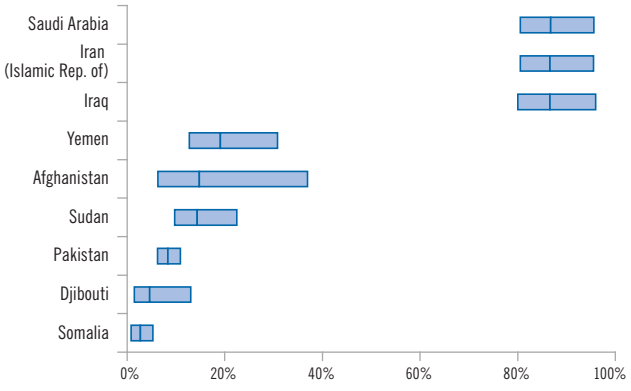
b) *Percentage of cases due to* P. falciparum, *2008*



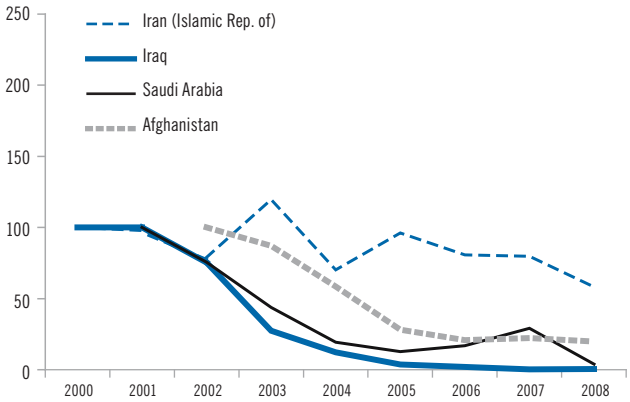
c) *Annual blood examination rate, 2000–2008*



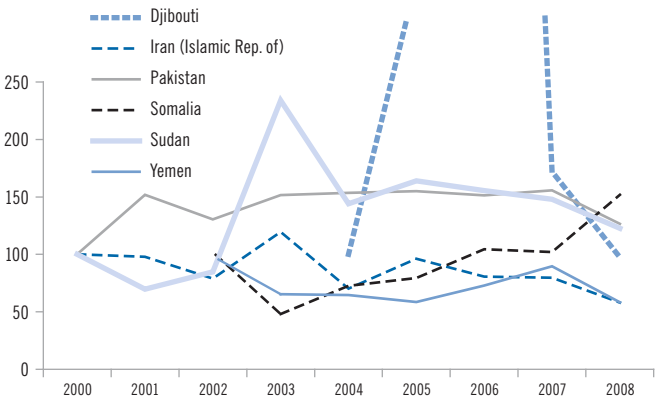
d) *Confirmed cases as a percentage of total estimated for 2008*



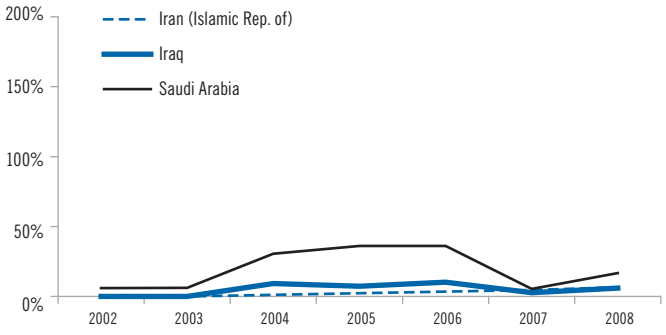
e) *Changes in numbers of confirmed cases, 2000–2008: countries with evidence of sustained decrease in cases*



f) *Changes in numbers of confirmed cases, 2000–2008: countries with limited evidence of sustained decrease in cases*



g) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered: countries with evidence of sustained decrease in cases*



h) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered: countries with limited evidence of sustained decrease*

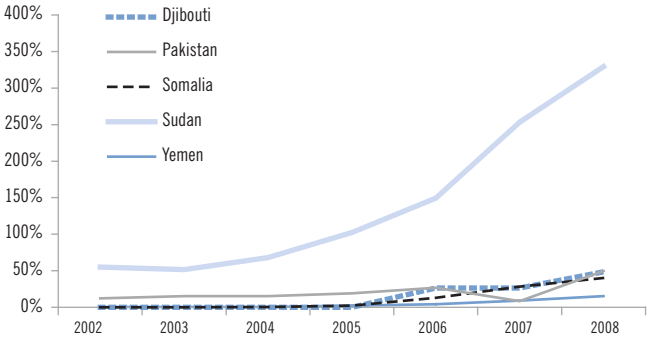
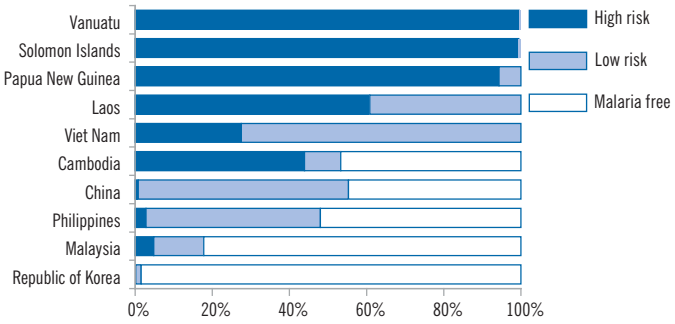
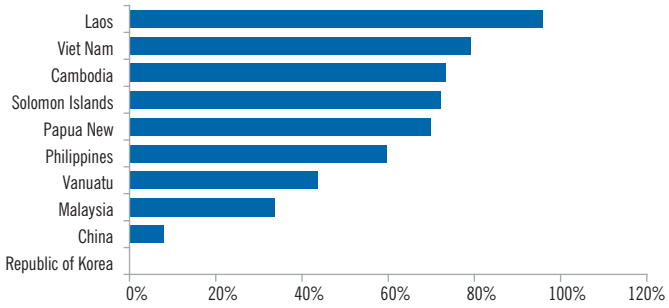


Figure 4.12 WHO Western Pacific Region

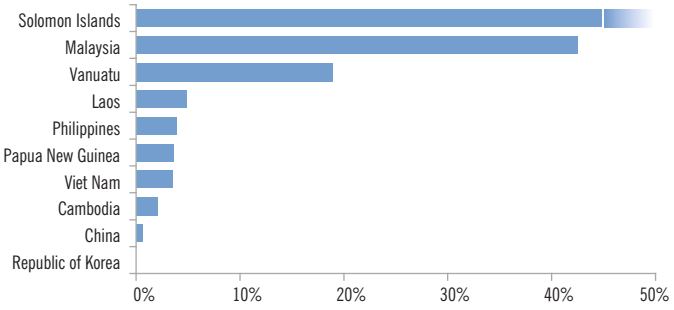
a) *Population at risk, 2008*



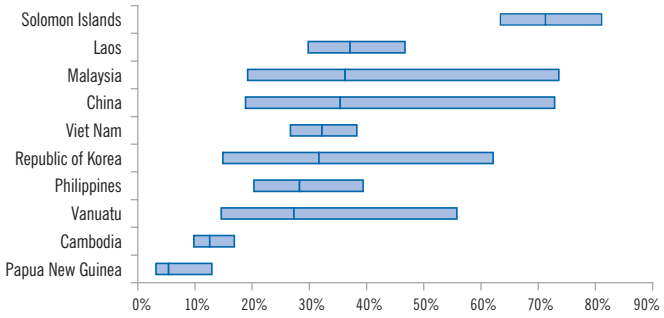
b) *Percentage of cases due to* P. falciparum, *2008*



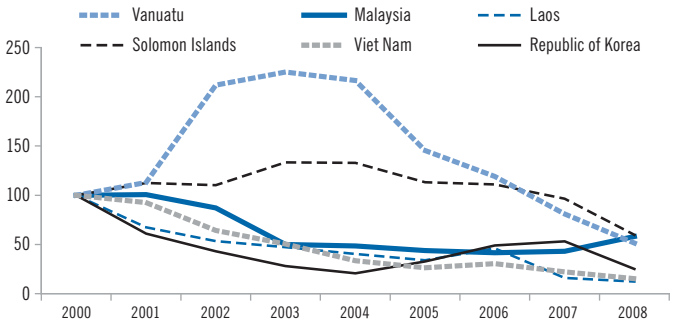
c) *Annual blood examination rate, 2000–2008*



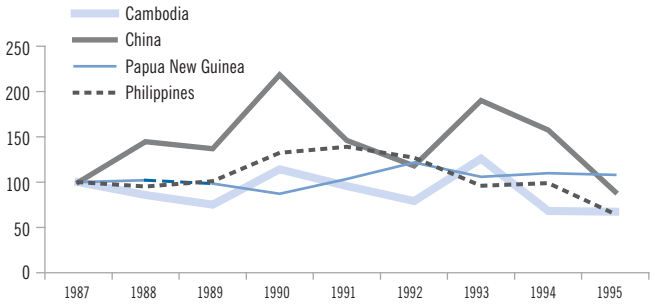
d) *Confirmed cases as a percentage of total estimated for 2008*



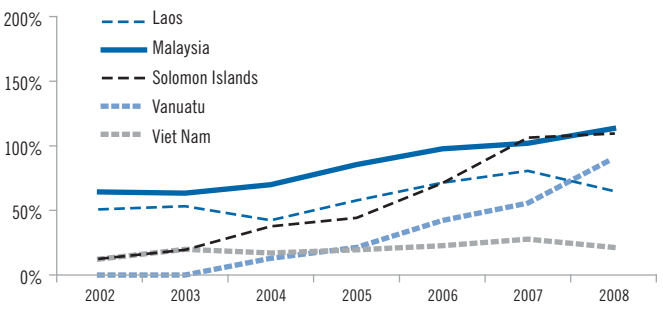
e) *Changes in numbers of confirmed cases, 2000–2008:*
countries with evidence of sustained decrease in cases



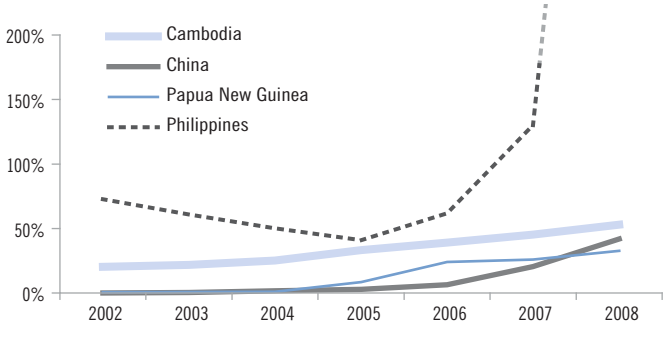
f) *Changes in numbers of confirmed cases, 2000–2008:*
countries with limited evidence of sustained decrease in cases



g) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered:* *countries with evidence of sustained decrease in cases*



h) *IRS and ITNs delivered – maximum percentage of high risk population potentially covered:* *countries with limited evidence of sustained decrease*



4.4 Region of the Americas

Malaria transmission occurs in 21 countries of the Region, with almost 3 of every 10 persons at varying degrees of risk for malaria transmission. *P. vivax* accounted for 77% of all cases reported in 2008, but the percentage of cases due to *P. falciparum* was almost 100% in Haiti and the Dominican Republic (**Fig. 4.8b**). The number of cases reported in the Region decreased from 1.14 million in 2000 to 572 000 in 2008. Reductions of > 50% were reported in 12 countries (Argentina, Belize, Bolivia, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Paraguay and Suriname) (**Fig. 4.8e**). Four of the countries (Argentina, El Salvador, Mexico and Paraguay) are in the elimination or pre-elimination phase, with active follow up of suspected cases. In five others (Belize, Guyana, Guatemala, Nicaragua and Suriname), control activities are implemented extensively among populations at risk for malaria; three of these countries (Guyana, Nicaragua and Suriname) also have high rates of annual blood examinations, which indicate good access to malaria treatment. Five countries (Brazil, Colombia, Costa Rica, Panama and Peru) reported fluctuations in the number of cases between 2000 and 2008, which may be associated with reductions in recent years. Brazil has greatly extended the availability of diagnosis and treatment through a network of more than 40 000 health workers, who reach individual households. The number of confirmed cases in French Guiana showed little change between 2000 and 2008. Three countries (Dominican Republic, Haiti and Bolivarian Republic of Venezuela) reported increased numbers of cases between 2000 and 2008, although the increase in Haiti is associated with an increased rate of annual blood examinations.

Thus, nine countries – Argentina, Belize, El Salvador, Guatemala, Guyana, Mexico, Nicaragua, Paraguay and Suriname – experienced a > 50% decrease in the number of cases, associated with intense malaria programme activity.

4.5 South-East Asia Region

Ten of the 11 countries of the region are malaria-endemic; there has been no indigenous transmission of malaria in the Maldives since 1984. Approximately 8 of 10 people in the region live at some risk for malaria, of whom 3 of 10 live at high risk (areas with a reported incidence of > 1 case per 1000 population per year). In 2008, 2.4 million laboratory-confirmed malaria cases and 2408 deaths were reported, whereas the estimates were about 24 million cases and 40 000 deaths, respectively. Four countries accounted for 97% of the estimated cases in the region in 2008 (Bangladesh, 10%; India, 55%; Indonesia, 15% and Myanmar, 17%). Most cases in the region are due to *P. falciparum*, although the proportion varies by country; transmission is due almost entirely to *P. falciparum* in Myanmar and Timor-Leste but due exclusively to *P. vivax* in the Democratic People's Republic of Korea (**Fig. 4.9b**). Reductions of more than 50% in the number of reported cases between 2000 and 2008 were seen in five countries (Bhutan, the Democratic People's Republic of Korea, Nepal, Sri Lanka and Thailand; **Fig. 4.9e**). Reductions of > 25% but < 50% were seen in one country (India). There was evidence of widescale implementation of antimalarial interventions in two countries that showed decreases in the number of cases (Bhutan and Thailand), although the decrease in Thailand levelled off in 2006 as the number of persons potentially reached by malaria prevention programmes decreased. Two countries in the pre-elimination stage actively follow up all suspected cases (Democratic People's Republic of Korea and Sri Lanka). The scale of preventive interventions appears to be small in India and Nepal, with less than 50% of the population at high risk covered. The remaining malaria-endemic countries reported no change or an increase in the number of cases (Bangladesh, Indonesia, Myanmar and Timor-Leste), and the scale of control activities appeared to be small in relation to the total population at risk.

In summary, four countries (Bhutan, the Democratic People's Republic of Korea, Sri Lanka and Thailand) experienced a decrease in the number of malaria cases, which was associated with malaria programme activity, although the decrease in Thailand appears to have levelled off between 2006 and 2008.

4.6 European Region

Locally acquired malaria cases were reported in 6 of the 53 Member States of the region in 2008: Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan. Transmission of *P. falciparum* is confined to Tajikistan, with only two cases reported in 2008; in other countries, transmission is due exclusively to *P. vivax*, although imported cases of *P. falciparum* may occur. In all affected countries, malaria transmission is seasonal, occurring between June and October, and shows a marked focal distribution. The number of reported cases of malaria in the Region has been reduced substantially, from 32,474 in 2000 to 660 in 2008, only Kyrgyzstan failing to register a decrease of > 50% in the number of cases since 2000. In Kyrgyzstan, the number of cases rose from 12 in 2000 to 2744 in 2002, before falling to 18 in 2008 (**Fig. 4.10e,f**). Tajikistan and Turkey accounted for 80% of the reported cases in the Region in 2008.

Intensive control activities are implemented throughout the Region. IRS is the primary means of vector control in all countries and is applied with strict total coverage of all residual and new foci of malaria, with a view to interrupting transmission over the target area as soon as possible and preventing its re-establishment. The intensity of activity is not evident from **Figure 10g**, as the denominator used is the total population at risk rather than that living in active foci. ITNs are also used for protection, particularly in Tajikistan. The use of larvivorous *Gambusia* fish is promoted by almost all affected countries in rice-growing areas.

Blood slides are taken from clinically suspected malaria cases for active and passive case detection. All cases detected are treated, and information on their origins is obtained to facilitate epidemiological classification of malaria foci. Particular attention is given to situations in which there is a risk for spread of malaria between neighbouring countries and regions. In 2005, all nine malaria-affected countries in the region endorsed the Tashkent Declaration *(7)*, the goal of which is to interrupt malaria transmission by 2015 and eliminate the disease within the region. Since 2008, national strategies on malaria have been revised to reflect the new elimination challenges.

In summary, all the malaria-endemic countries in the European Region have active malaria control programmes, and five of six

countries reported sustained decreases of > 50% in the number of cases. Kyrgyzstan was the only country that did not show a sustained decrease in the number of cases since 2000, but only 18 cases were reported in 2008.

4.7 Eastern Mediterranean Region

The region contains six countries with areas of high malaria transmission (Afghanistan, Djibouti, Pakistan, Somalia, Sudan and Yemen), and three countries with low, geographically limited malaria transmission and effective malaria programmes (Islamic Republic of Iran, Iraq and Saudi Arabia). *P. falciparum* is the dominant species of parasite in Djibouti, Saudi Arabia, Sudan and Yemen, but the majority of cases in Afghanistan and Pakistan and almost all cases in the Islamic Republic of Iran and Iraq are due to *P. vivax* (**Fig. 4.11b**). The Eastern Mediterranean region reported 890 000 confirmed cases in 2008, from an estimated regional total of 8.6 million cases. Four countries accounted for 90% of the estimated cases: Afghanistan, 7% ; Pakistan, 18%; Somalia, 10% and Sudan, 62%. Four countries reported downward trends in malaria frequency (Afghanistan, Islamic Republic of Iran, Iraq and Saudi Arabia), and in the last three there is evidence of intense control activities, these countries having been classified as in the elimination or pre-elimination stage (**Fig. 4.11e**). Other countries in the region have not registered consistent decreases in the number of cases (Djibouti, Pakistan, Somalia, Sudan and Yemen), although Sudan has extended the coverage of malaria preventive activities to more than 50% of the population at risk for malaria and any change in cases may be masked by changes in reporting practices.

In summary, three countries (Islamic Republic of Iran, Iraq and Saudi Arabia) showed evidence of a sustained decrease in the number of cases associated with widescale implementation of malaria control activities.

4.8 Western Pacific Region

The epidemiology of malaria in the Western Pacific Region is highly heterogeneous. Transmission is intense and widespread in the Pacific countries of Papua New Guinea, Solomon Islands and, to a lesser extent, Vanuatu; however, malaria is highly focal in the countries and areas of the Greater Mekong subregion, such as Cambodia, Yunnan (China), the Lao People's Democratic Republic and Viet Nam, occurring in remote forested areas and disproportionately affecting ethnic minorities and migrants. Malaria is also restricted to particular geographical locations in Malaysia, the Philippines and the Republic of Korea. Most countries have both *P. falciparum* and *P. vivax*, but transmission is entirely due to *P. vivax* in the Republic of Korea and central areas of China (**Fig. 4.12b**). Approximately 240 000 confirmed cases were reported from the Western Pacific Region in 2008, while 1.75 million cases were estimated for the region in 2008. Two countries accounted for 82% of the estimated cases in 2008 (Papua New Guinea, 68%; and Cambodia, 15%). Three countries reported decreases in the numbers of confirmed cases of > 50% between 2000 and 2008 (the Lao People's Democratic Republic, the Republic of Korea and Viet Nam), and three countries reported decreases of 25–50% (Malaysia, Solomon Islands and Vanuatu) (**Fig. 4.12e**). In all six countries, there is evidence of widescale implementation of malaria control activities. No evidence for a sustained decrease in the number of cases was found in Cambodia, China, Papua New Guinea or the Philippines. Evidence of increased preventive or curative activities was seen in all these countries, particularly the Philippines, but this has either been too recent for effects to be apparent in the long term, or weaknesses in surveillance systems have meant that changes are not detected.

In summary, six countries in the Western Pacific Region showed evidence of a sustained decrease in the number of cases associated with widescale implementation of malaria control activities (Lao People's Democratic Republic, Malaysia, Republic of Korea, Solomon Islands, Vanuatu and Viet Nam).

4.9 Conclusions

4.9.1 WHO African Region

Reductions in the number of reported malaria cases and deaths of ≥ 50% have been observed in four high-burden countries of the WHO African Region (Eritrea, Rwanda, Sao Tome and Principe and Zambia) and one area (Zanzibar, United Republic of Tanzania). Reductions achieved in 2007 were maintained in 2008. Reductions of > 50% were also observed in five low transmission African countries (Botswana, Cape Verde, Namibia, South Africa and Swaziland). All the reductions were associated with intense malaria programme activity. The role of the climate and other factors in promoting change cannot be excluded; in particular, a drought in 2001–2003 may have contributed to an initial decrease in southern African countries. Nevertheless, decreases have been seen consistently for more than five years in seven countries or areas (Botswana, Eritrea, South Africa, Sao Tome and Principe, Swaziland, Zambia and Zanzibar, United Republic of Tanzania) and are unlikely to be due entirely to climate variation. In Rwanda, large decreases in the number of cases were observed soon after a rapid scale-up of malaria control activities, and these also are unlikely to be due to climate factors, although it would be valuable to test this hypothesis formally.

In Botswana, Cape Verde, Namibia, Sao Tome and Principe, South Africa and Swaziland, large initial decreases in the numbers of cases appear to have levelled off, the numbers of cases remaining at 10–25% of those seen in 2000. The reasons are not yet clear, but the few cases remaining may be more difficult to prevent, detect and treat, and it may be necessary to strengthen the programmes further.

When comparisons are possible, correspondence is seen between the trends in data from health facilities, household surveys and individual studies. The magnitude of the change seen in data from health facilities in the numbers of confirmed malaria cases, admissions for anaemia and overall numbers of childhood deaths is consistent with changes in parasite prevalence, prevalence of severe anaemia and mortality rates for children < 5 reported from household surveys. The magnitude of the decreases seen in the numbers of cases and deaths in health facilities is also consistent with the impact expected from controlled trials of the interventions. These observations suggest that surveillance data can be used to monitor the impact of interventions.

It is important, however, to ensure completeness of reporting and to choose indicators for monitoring trends that are highly specific for malaria (i.e. confirmed malaria cases or malaria admissions).

All 10 countries in the African Region that were reviewed had > 50% coverage with vector control activities. Some evidence of changes in the malaria burden in other countries with high coverage rates has been published, but the studies – in Equatorial Guinea *(8)*, the Gambia *(9)* and Kenya *(10)* – were confined to limited geographical areas, and the generalizability of the results is uncertain. More studies are needed to measure the impact of high coverage in the countries identified in Chapter 3, particularly high-transmission areas in western and central Africa.

The main reason for the lack of additional evidence for a change in the malaria burden has been weak disease surveillance systems. Although many governments and partners have scaled-up malaria control interventions massively, their impact is not being measured consistently and continuously. The ability of malaria-endemic countries to monitor changes in the numbers of confirmed malaria cases, admissions for severe malaria and malaria-associated deaths must be strengthened. Inadequate monitoring can lead to poor adjustment of strategies, inefficient use of funds and inadequate "learning" for malaria programmes. Once malaria transmission has been reduced, national programmes must be able to detect malaria resurgence quickly and respond with appropriate resources. As experience suggests that malaria transmission decreases heterogeneously, robust surveillance systems are essential to identify residual transmission foci and target additional resources to those areas. Strengthening of surveillance systems will require investment in diagnostic services, reporting systems and capacity-building to manage systems and undertake appropriate data analysis and dissemination.

In countries where malaria control has been scaled-up, not only have the rates of malaria cases, hospitalizations and deaths dropped dramatically, but overall child mortality rates are also in steep decline. National disease surveillance data from Eritrea, Sao Tome and Principe, Rwanda, Zambia and Zanzibar, United Republic of Tanzania, showed a > 50% reduction in malaria cases and deaths in health facilities after the introduction of accelerated malaria control. In Sao Tome and Principe and Zanzibar, these gains were mirrored by a > 50% decrease in inpatient cases and deaths from all causes among children < 5 years of age. In Zambia, child mortality rates from all causes fell by 35%, as measured both by the number of deaths recorded in health facilities and by < 5 mortality rates derived from the Demographic and Health Survey of 2007. The magnitude of these decreases is similar to that found in a recent study on Bioko Island, Equatorial Guinea, in which population-based mortality among children < 5 had decreased by 66% in the fourth year after the start of intensive malaria control *(8)*. If this finding is confirmed by additional studies, intensive malaria control can be considered an important intervention for helping African countries to reach the MDG target of reducing child mortality by 2015.

4.9.2 Other WHO Regions

A > 50% decrease in the reported number of cases of malaria was found between 2000 and 2008 in 29 of the 56 malaria-endemic countries outside Africa (**Table 4.3**), and downward trends of 25–50% were seen in five other countries, most of which showed longer-term decreases of > 50%. The European Region has been the most successful, as almost all countries have reduced their case loads. Most small countries in the South-East Asia Region also reported substantial progress in reducing their malaria burden, while in other regions, large decreases in the number of malaria cases were observed in countries with strong political and financial support and well-developed health systems at central and peripheral levels.

Of the 34 countries that showed a decrease of > 25% in the number of cases, there was evidence of extensive control activities in 27 (in comparison with 4 of 22 for which there was limited evidence of a decrease). In 10 countries, the decrease in the number of cases was associated with an increase in preventive activities to > 50% of the population at high risk and strengthened case management (Guyana, Guatemala, Nicaragua and Suriname in the Region of the Americas; Bhutan and Thailand in the South-East Asia Region; and the Lao People's Democratic Republic, Malaysia, Solomon Islands and Vanuatu in the Western Pacific Region). In 15 countries, the decrease was associated mainly with intensive case detection and treatment, combined with rapid response to outbreaks (Argentina, El Salvador, Mexico and Paraguay in the Region of the Americas; Azerbaijan, Georgia, Tajikistan, Turkey and Uzbekistan in the European Region; the Islamic Republic of Iran, Iraq and Saudi Arabia in the Eastern Mediterranean Region; the Democratic People's Republic of Korea and Sri Lanka in the South-East Asia Region; and the Republic of Korea in the Western Pacific Region).

The magnitude and consistency of the changes observed in these countries are unlikely to be due to variations in case reporting, and, while factors such as climate variation, the environment or improved living conditions may have had some influence on the number of cases, they are unlikely to be entirely responsible for the change. It was not possible to link the scale and timing of interventions precisely with the changes in disease incidence in the analyses undertaken here; that would require disaggregation of the information on numbers of cases and control activities by month and subnationally. Until more detailed analyses can be undertaken, the association between implementation of control activities and changes in disease incidence is suggestive but not conclusive.

The size of the decrease observed in health facility data may not be seen in the wider community; however, with changes as large as those observed and with typically ≥ 40% of affected persons attending public health facilities, some impact can be expected in the wider community. The analytical approach used might result in an underestimate of the impact of control efforts in countries in which the effect is not noticeable at national level or in which the impact is more recent and cannot yet be distinguished from changes due to year-to-year climate variations or possible changes in reporting practices.

The countries that saw > 50% decreases in the numbers of cases comprised only 4% of the total estimated cases outside Africa in 2006 (850 000 cases out of 34 million estimated). The countries with the highest malaria burdens in each region (such as Bangladesh, Brazil, Cambodia, Colombia, Indonesia, Myanmar, Pakistan, Papua New Guinea and Sudan) were less successful in reducing the numbers of cases of malaria nationally. The scale of interventions in relation to populations at risk appears to be particularly small in the South-East Asia Region, presumably because of the additional challenges

of implementing programmes on a larger scale, requiring not only considerable financial resources but also time to build systems for, e.g. the distribution of commodities (ITNs, insecticide, diagnostic tools, medicines and equipment), training staff, mobilizing communities, quality control and supervision. Nevertheless, some of these countries have reported successful control in some parts of their territory, due either to targeted efforts in some communities or to phasing implementation over a wide scale. Further work is needed to determine if current levels of investment and programme implementation are likely to yield more positive results in the near future. Current evidence suggests, however, that, while smaller countries are making considerable progress towards reaching the MDGs and other malaria targets, more attention should be given to ensuring success in the countries that account for most malaria cases and deaths.

Table. 4.3 Summary of progress in reducing the number of malaria cases between 2000 and 2008

Decrease in cases > 50%	Decrease in cases > 25%	Limited evidence of decrease
African Region		
Botswana		Angola
Cape Verde		Benin
Eritrea		Burkina Faso
Namibia		Burundi
Rwanda		Cameroon
Sao Tome and Principe		Central African Republic
South Africa		Chad
Swaziland		Comoros
Zambia		Congo
		Côte d'Ivoire
		DR Congo
		Equatorial Guinea *
		Ethiopia**
		Gabon
		Gambia *
		Ghana
		Guinea
		Guinea-Bissau
		Kenya *
		Liberia
		Madagascar***
		Malawi
		Mali
		Mauritania
		Mozambique
		Niger
		Nigeria
		Senegal
		Sierra Leone
		Togo
		Uganda
		UR Tanzania*
		Zimbabwe

Decrease in cases > 50%	Decrease in cases > 25%	Limited evidence of decrease
Region of the Americas		
Argentina		**Brazil**
Belize		Colombia
Bolivia (Plurinational State of)		Costa Rica
Ecuador		Dominican Republic
El Salvador		French Guiana
Guatemala		Haiti
Guyana		Panama
Honduras		Peru
Mexico		Venezuela (Bolivarian Rep. of)
Nicaragua		
Paraguay		
Suriname		
South-East Asia Region		
Bhutan	India	Bangladesh
DPRK		Indonesia
Nepal		Myanmar
Sri Lanka		Timor-Leste
Thailand		
European Region		
Armenia		**Kyrgyzstan**
Azerbaijan		
Georgia		
Tajikistan		
Turkey		
Uzbekistan		
Eastern Mediterranean Region		
Afghanistan	**Islamic Rep. of Iran**	Pakistan*
Iraq		Somalia
Saudi Arabia		**Sudan***
		Yemen*
Western Pacific Region		
Lao People's Dem. Rep.	**Malaysia**	Cambodia
Rep. of Korea	**Solomon Islands**	China
Viet Nam	**Vanuatu**	Papua New Guinea
		Phillipines*

The assessment of whether a country has evidence of decreases in cases or widespread coverage of programmes was made according to the data available to WHO at the time of publication of this Report. It is possible that additional evidence of decreases in cases or widespread coverage of programmes is available at country level.

Countries in bold show evidence of wide scale implementation of malaria control activities to more than 50% of the population at high risk.

* The country reports some progress sub-nationally where interventions have been intensified.

** A ministry of health/WHO study, 2001–2007 previously reported a 50% decrease in cases and deaths, but national data as reported to WHO in 2008 are inconsistent; further investigation is required.

*** Data submitted in 2008 were different from data published in the *World Malaria Report 2008*. Therefore observed decreases of more than 50% in cases and deaths need further investigation.

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Chapter 5.
Elimination of malaria

This chapter describes the state of malaria elimination in the world, to illustrate progress towards the elimination targets. It provides a summary of the progress being made in countries that have embarked on eliminating malaria, including their progression through the different phases from pre-elimination to certification of elimination by WHO. The chapter also provides a brief background to the WHO strategies and guidelines, as well as a historical perspective of malaria elimination in these countries.

5.1 Background

From a country perspective, interruption of local mosquito-borne malaria transmission or elimination of malaria is the ultimate goal of malaria control. Malaria elimination has been achieved progressively in parts of the world since the recorded history of the disease. By the mid-19th century, malaria had been eliminated from several countries in temperate zones in which it had been endemic. In the context of the Global Malaria Eradication Programme (1955–1968) and up to 1987, 24 countries were certified as malaria-free. Since then, an additional 9 countries have reported (periods of) zero locally acquired cases, leading to a further contraction of the world map of malaria endemicity *(1)*. Using the momentum created by the global efforts against malaria of the past decade, some countries in the subtropical and even the tropical belt have reduced their malaria incidence to the extent that they are considering moving towards malaria elimination. The repertoire of antimalarial tools and interventions available today is sufficient to eliminate malaria from countries where transmission is low and unstable, provided health systems have nationwide coverage and are capable of implementing rigorous and responsive surveillance. Supported by the advocacy efforts of the Malaria Elimination Group *(2)*, there is now renewed interest in pushing the boundaries of malaria-free areas of the world even further.

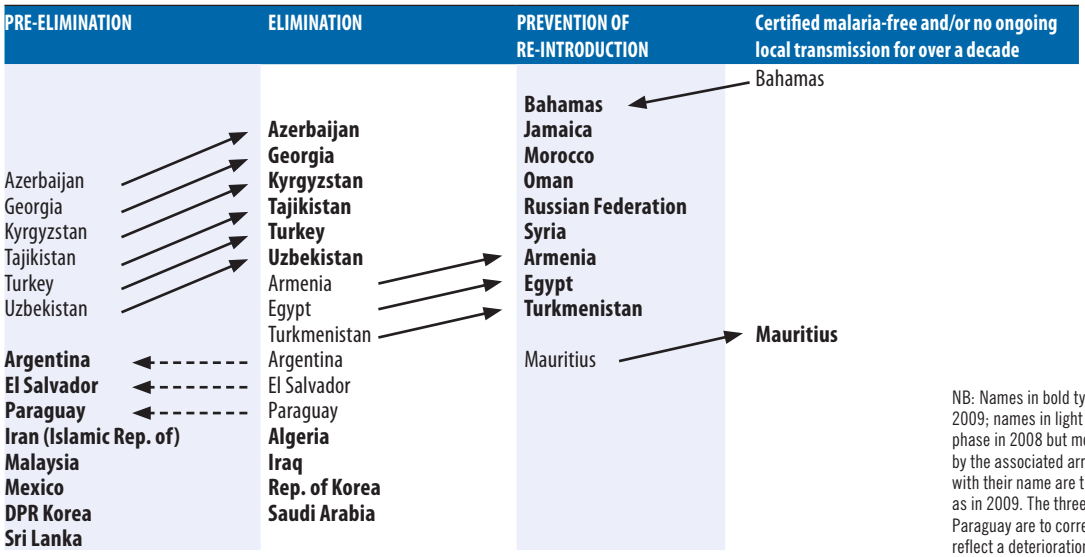
The elimination of malaria from selected countries is stated explicitly in the targets of the Global Malaria Action Plan *(3)*, as follows:

- By 2015, at least 8–10 countries currently in the elimination stage will have achieved zero incidence of locally transmitted infection.
- Beyond 2015, countries currently in the pre-elimination stage will move to elimination.

Current elimination efforts are driven by the ministries of health of malaria-endemic countries. They receive technical support from WHO and its partners, and some are supported by financial awards by the Global Fund, but most funds come from national governments.

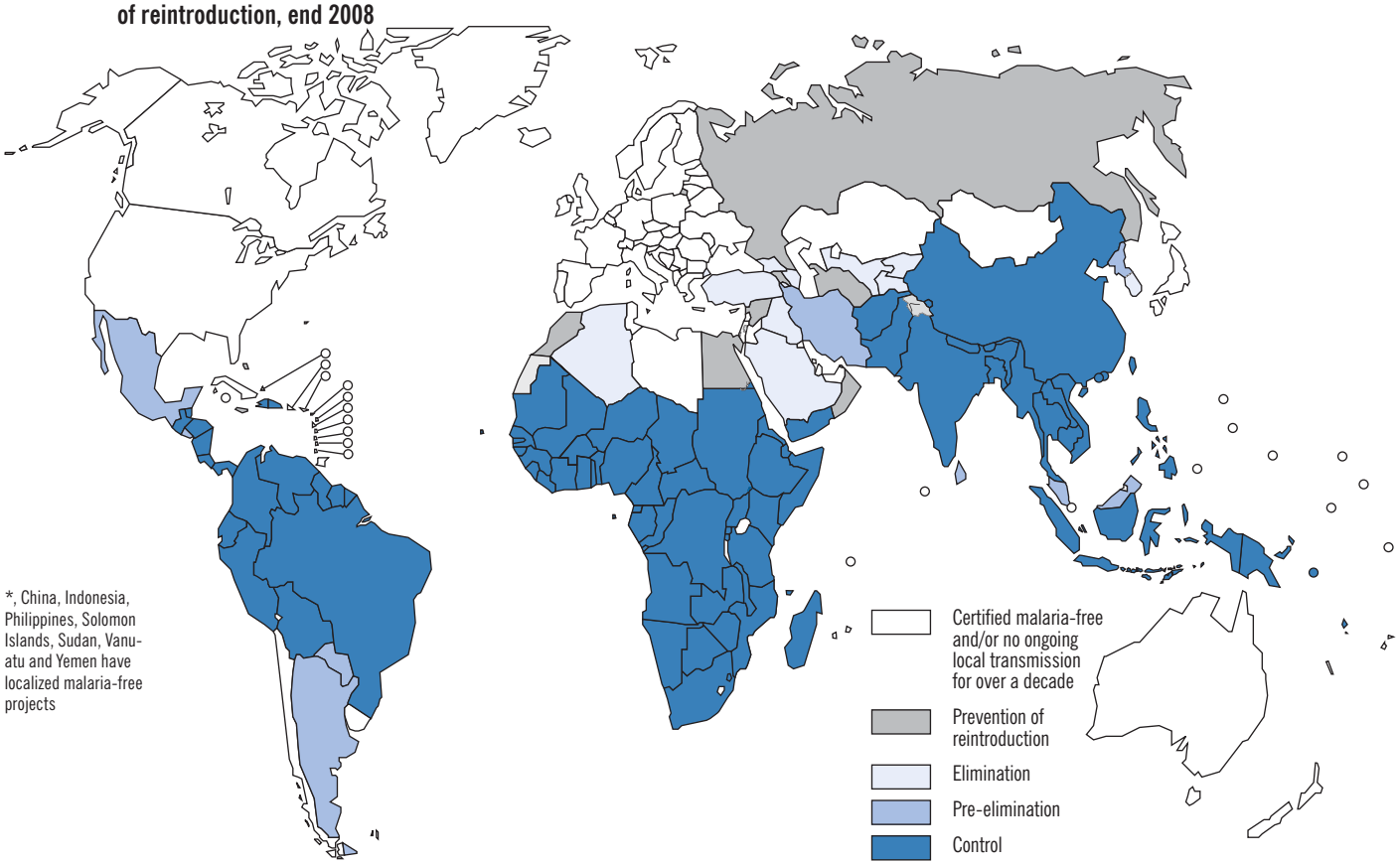
Considerable progress has been made in malaria elimination during the past few years. Consistent with the goals of the Global Malaria Action Plan, as of 2009, three countries that were in the elimination phase, Armenia, Egypt and Turkmenistan, have reported no locally acquired cases for more than 3 years, and have moved to the phase of prevention of reintroduction. Six countries (Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan, all in the WHO European Region), had moved from the pre-elimination stage to a nationwide elimination approach by 2009 (**Fig. 5.1**). The types of malaria programmes currently implemented worldwide are shown in **Figure 5.2**.

Figure 5.1 Movement of countries between types of programme between 2008 and 2009



NB: Names in bold type are of countries in the programme phase as of 2009; names in light type are of countries that were in the programme phase in 2008 but moved a category forward or backward as indicated by the associated arrows. Countries that have no arrows associated with their name are those which were in the same category in 2008 as in 2009. The three backwards arrows for Argentina, El Salvador and Paraguay are to correct for a previous error in classification and do not reflect a deterioration of the programme status of these countries.

Figure 5.2 Malaria-free countries and malaria-endemic countries in phases of control*, pre-elimination, elimination and prevention of reintroduction, end 2008



5.2 Definitions

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

Malaria elimination: the interruption of local mosquito-borne malaria transmission; 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 elimination: can be 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 specific agent; applies to a particular malaria parasite species. Intervention measures are no longer needed once eradication has been achieved.

5.3 WHO position on malaria elimination *(4)*

1. With rapid scale-up and sustained efforts, major reductions in malaria morbidity and mortality can be made in all epidemiological situations within a relatively short time. Malaria transmission can be interrupted in low-transmission settings and greatly reduced in many areas of high transmission. Global eradication cannot, however, be expected with existing tools.
2. Failure to sustain malaria control and the resulting resurgence of malaria, as has happened in the past, must be avoided at all costs. Therefore, public and government interest in intensified malaria control and elimination must be sustained, even when the malaria burden has been greatly reduced.
3. Countries in areas of low, unstable transmission should be encouraged to proceed to malaria elimination. Before making this decision, however, they should assess its feasibility and take into account the malaria situation in neighbouring countries. Malaria elimination might require cross-border initiatives and regional support and will require strong political commitment.
4. 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)* control achievements are sustained, even in the face of limited disease; *ii)* health services adapt to the new clinical and epidemiological situation with a lower case load and reduced levels of immunity; and *iii)* surveillance systems are strengthened to allow rapid response to new cases. This transformation phase precedes a decision to reorient programmes towards elimination.
5. Complete interruption of malaria transmission is likely to require additional, novel tools, especially in high-transmission situations.
6. Because malaria control today relies heavily on a limited number of tools, in particular artemisinin derivatives and pyrethroids, which could be lost to resistance at any time, the development of new tools for vector control and other preventive measures, diagnosis, treatment and surveillance must be a priority.

5.4 Strategies

5.4.1 Progression from malaria control to elimination and certification

Countries may envisage elimination of malaria when the malaria control programme has succeeded in reducing morbidity to a marginal level (e.g. not more than five of every 100 episodes of febrile illness are due to malaria during the high-transmission season). The steps for eliminating malaria from a country or area that has reduced its malaria transmission intensity to low levels are shown in **Figure 5.3**. Not all countries will be able to interrupt malaria transmission with the currently available tools.

"Pre-elimination" consists of the period of reorientation of malaria control programmes between the sustained control and elimination stages, when coverage with good-quality laboratory and clinical services, reporting and surveillance are reinforced, followed by other programme adjustments to halt transmission nationwide.

Elimination programmes are characterized by four programme approaches, supported by large investments of local expertise and resources:

- management of all malaria cases: detection, notification, investigation, classification and supervised treatment;
- prevention of onward transmission from existing cases;
- prevention and early detection of imported malaria infections;
- management of malaria foci: identification, investigation, classification, effective vector control in all foci of transmission, geographical mapping over time.

In elimination programmes, the main indicator is the total number of locally acquired infections.

WHO's classification of countries is based on the type of malaria programme being implemented in the worst-affected endemic areas of the country.

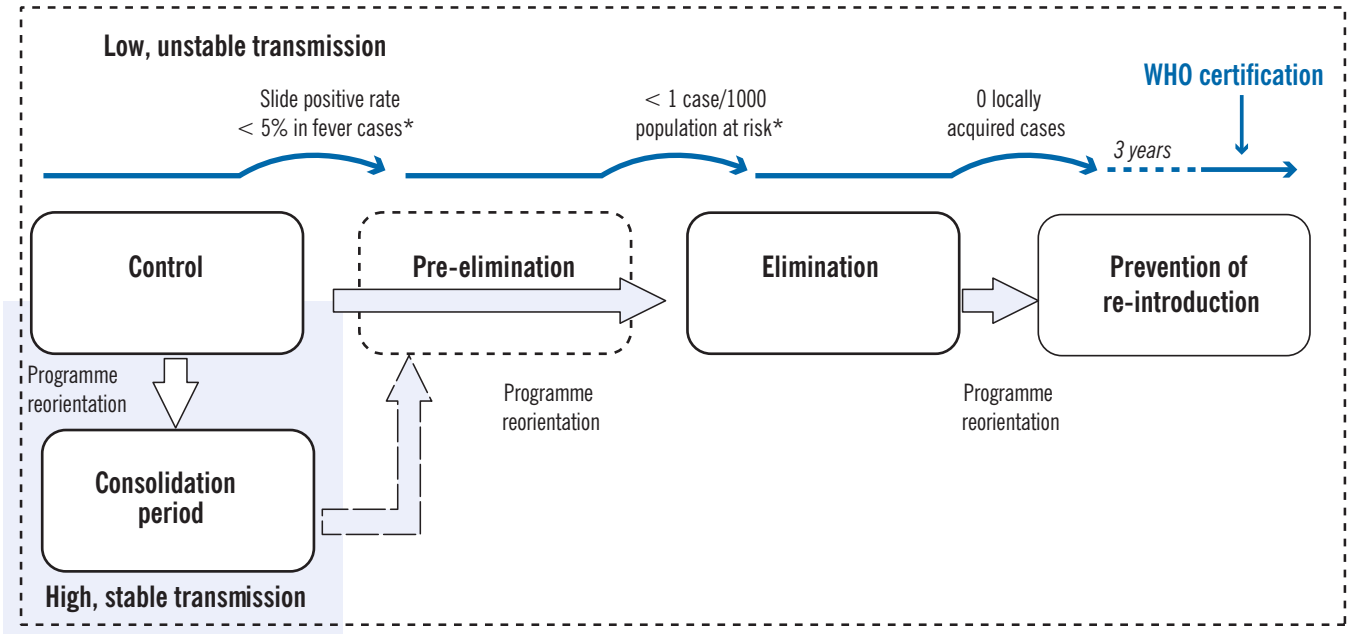
5.4.2 Programme profiles in different phases of elimination

As country programmes are redirected towards an elimination approach, the changing programme goal affects the objectives of the interventions and the geographical units in which interventions are made. This change in profile by programme type is summarized in **Table 5.1**, which also lists the "milestones" at which programme transition may become feasible. These milestones should be adjusted for each country and situation, keeping in mind the resource requirements for notification, investigation and follow-up of every malaria case once the elimination programme is set in motion. The actual programme transitions will thus depend on the workload that programme staff can realistically handle, given local circumstances and infrastructure, the available resources and competing demands on the health services. Countries that are currently implementing elimination programmes made the decision to pursue elimination when they had a low remaining case load, usually < 1000 cases per year nationwide.

5.4.3 Type of intervention in each phase of elimination

The type of intervention and the required quality of operations evolve as country programmes are redirected towards an elimination approach, as shown in **Table 5.2** *(5)*.

Figure 5.3 Programme phases from malaria control to elimination



Source: reference *(1)*

* These milestones are indicative only: in practice, the transitions will depend on the malaria burden that a programme can realistically handle (including case notification and case investigation).

5.5 Progress towards malaria elimination

The parasite species, programme phase, starting year of elimination efforts and last reported cases in countries in pre-elimination, elimination and prevention of reintroduction phases as of 2009 are shown in **Table 5.3**.

5.5.1 Countries that have interrupted transmission and are in the stage of preventing reintroduction of malaria

By 2009, nine countries had interrupted malaria transmission and were implementing intensive programmes to prevent its reintroduction:

- Six countries recently achieved zero cases and aim to maintain this situation: Armenia, Egypt, Morocco, Oman, the Syrian Arab Republic and Turkmenistan.
- Three countries that are generally considered nonendemic, having been malaria-free for well over a decade, experienced outbreaks of locally acquired malaria subsequent to importation of parasites: *P. falciparum* in the Bahamas and Jamaica (certified malaria-free in 1966) and *P. vivax* in the Russian Federation. No deaths were reported in these outbreaks.

The numbers of reported malaria cases in these countries over the past 10 years are shown in **Figure 5.4**.

Table 5.1 Profile by programme type

ITEM	CONTROL PROGRAMME	Pre-elimination programme	Elimination programme	Prevention of reintroduction programme
Main programme goal	Reduce morbidity and mortality	Halt local transmission nationwide	Halt local transmission nationwide	Prevent re-establishment of local transmission
Epidemiological objective	Reduce burden of malaria	Reduce number of active foci to zero Reduce number of locally acquired cases to zero	Reduce number of active foci to zero Reduce number of locally acquired cases to zero	Prevent introduced cases and indigenous cases secondary to introduced cases
Transmission objective	Reduce transmission intensity	Reduce onward transmission from existing cases	Reduce onward transmission from existing cases	Reduce onward transmission from imported cases
Unit of intervention	Country- or area-wide	Transmission foci	Transmission foci, individual cases (locally acquired and imported)	Recent transmission foci (receptive areas), individual cases (imported cases only)
Indicative milestones for transition to next programme type[a]	SPR <5% in suspected malaria cases	< 1 case per 1000 population at risk per year	Zero locally acquired cases	
Data sources for measuring progress towards reaching milestones	Proxy data: health facility data Confirmatory data: population-based surveys	Proxy data: health facility data, notification reports Confirmatory data: population-based surveys	Notification reports, individual case investigations, genotyping	

Source: reference *(5)*; SPR: slide or rapid diagnostic test positivity rate.

[a]. In practice, the transitions will depend on the malaria burden that a programme can realistically handle, given the local circumstances and available resources and keeping in mind the need to assure notification, investigation and due follow up of all malaria cases.

Figure 5.4 Confirmed locally acquired malaria cases in countries that have interrupted transmission and are preventing the reintroduction of malaria, 1998–2008

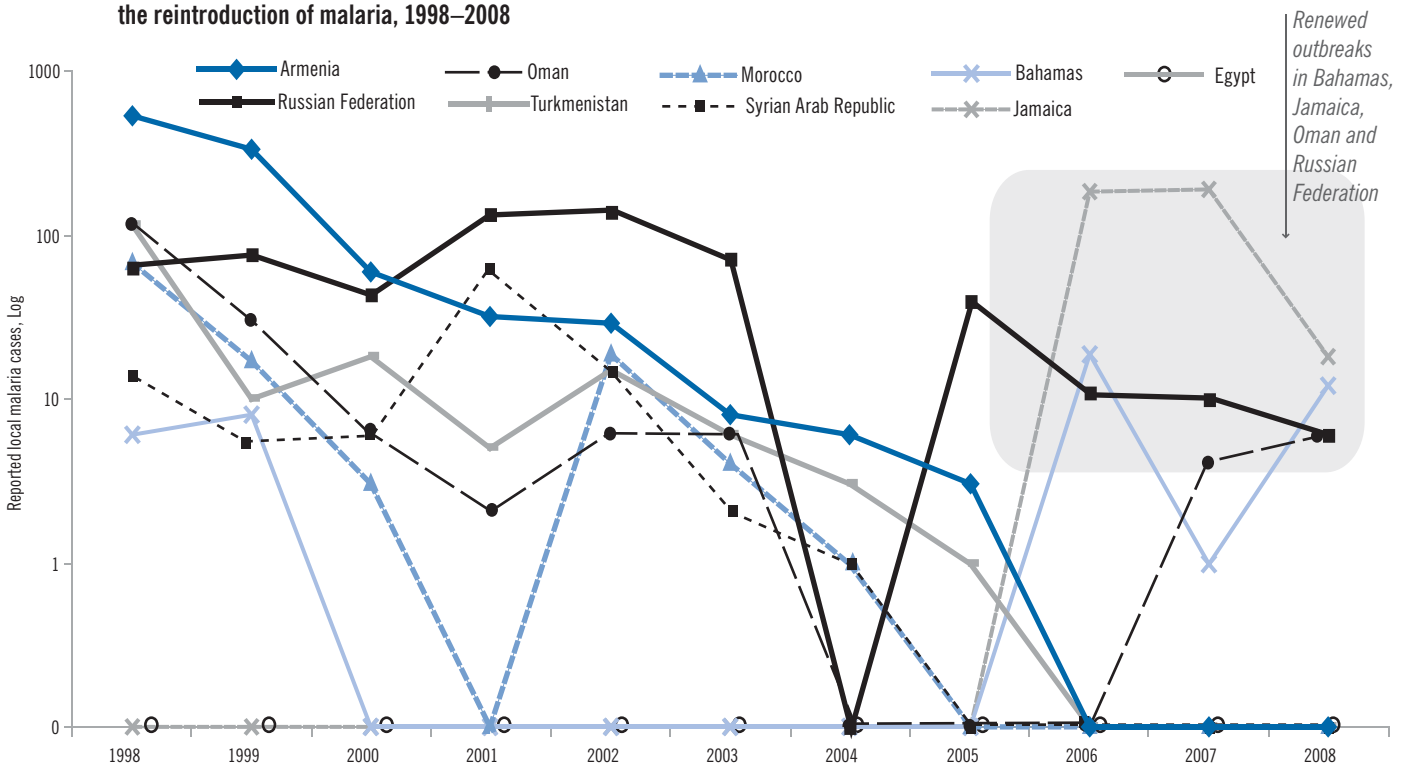


Table 5.2 Interventions by programme type

INTERVENTION	Control programme	Pre-elimination programme[a]	Elimination programme	Prevention of reintroduction programme
Case management	Update drug policy, use of ACT QA/QC of laboratory diagnosis (microscopy/RDT) Clinical diagnosis sometimes acceptable Monitoring antimalarial drug resistance	Drug policy change to: – radical treatment for *P. vivax* – ACT and gametocyte treatment for *P. falciparum* 100% case confirmation by microscopy Microscopy QA/QC Monitoring antimalarial drug resistance	Implementation of new drug policy Routine QA/QC expert microscopy Active case detection Monitoring antimalarial drug resistance	Case management of imported malaria Awareness of drug resistance patterns abroad, to formulate prevention guidelines
Vector control and malaria prevention	Transmission reduction through high population coverage of ITN/LLIN and IRS Entomological surveillance Epidemic preparedness and response IPTp in hyperendemic areas	Geographical reconnaissance Total IRS coverage in foci Integrated vector management and ITN/LLIN as complementary measures in specific situations Epidemic preparedness and response Entomological surveillance	Geographical reconnaissance IRS to reduce transmission in residual active and new active foci Vector control to reduce receptivity in recent foci Outbreak preparedness and response Entomological surveillance Prevention of malaria in travellers	Perfect malaria case detection mechanism Cluster response and prevention Prevention of malaria in travellers, including health education and engagement of travel agencies
Monitoring and evaluation	Improve surveillance and national coverage Country profiles Malaria population surveys (MIS, MICS, DHS)	GIS-based database on cases and vectors Elimination database Central records bank Genotyping, isolate bank Malaria surveys Immediate notification of cases	Case investigation and classification Foci investigation and classification Routine genotyping Malaria surveys Immediate notification of cases Meteorological monitoring	Vigilance Case investigation *P. falciparum* outbreak notification in accordance with IHR Annual reporting to WHO on maintenance of malaria-free status
Health systems issues	Access to treatment Access to diagnostics Health system strengthening (coverage, private-public sectors, QA, health information system)	Engaging private sector Control of OTC sale of anti-malarial medicines Availability of qualified staff	Full cooperation of private sector No OTC sale of antimalarial medicines Free-of-charge diagnosis and treatment for all malaria cases	Integration of malaria programme staff into other health and vector control programmes
Programmatic issues	Programme management, coordination Procurement, supply management Resource mobilization Regional initiative Pharmacovigilance Adherence to the "Three ones" principles Integration with other health programmes for delivery of interventions, e.g. ITN/LLIN, IPTp Domestic/external funding	Elimination programme development Legislation Regional initiative Mobilization of domestic funding Establish malaria elimination committee Reorientation of health facility staff	Implementation of elimination programme Implementation of updated drug policy, vector control, active detection of cases Malaria elimination committee: – manage malaria elimination database – repository of information – periodic review – oversigh Reorientation of health facility staff	WHO certification process
Interventions throughout all programmes	Case management Integrated vector management, including monitoring of insecticide resistance Geographical information collection Human resources development Health education, public relations, advocacy Operational research Technical and operational coordination, including intra- and intersectoral collaboration, both within the country and with neighbouring countries Monitoring and evaluation Independent assessment of reaching milestones Resource mobilization Health systems strengthening			

[a]. The pre-elimination programme is a reorientation phase. The interventions mentioned in this column are introduced during this programme reorientation, to be fully operational at the start of the elimination programme.

ACT: artemisinin-based combination therapy; DHS: Demographic and Health Surveys; GIS: geographic information system; IHR: International Health Regulations (2005); IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated mosquito net; IVM: integrated vector management; LLIN: long-lasting insecticidal net; MICS: Multiple Indicator Cluster Surveys; MIS: Malaria Indicator Survey; OTC: over-the-counter; QA: quality assurance; QC: quality control; RDT: rapid diagnostic test.

Source: reference *(5)*

Table 5.3 Programme phases for pre-elimination, elimination and prevention of re-introduction

COUNTRY	Current /most recent local *Plasmodium* species	Programme phase in 2009	Start of elimination programme phase*	Last local *P.falciparum* case	Last reported indigenous case
Argentina	*vivax*	pre-elimination			ongoing
Dem. People's Rep. of Korea	*vivax*	pre-elimination			ongoing
El Salvador	both	pre-elimination		ongoing	ongoing
Iran (Islamic Republic of)	both	pre-elimination	2004	ongoing	ongoing
Malaysia	both	pre-elimination		ongoing	ongoing
Mexico	both	pre-elimination		ongoing	ongoing
Paraguay	*vivax*	pre-elimination			ongoing
Sri Lanka	both	pre-elimination		ongoing	ongoing
Algeria	*vivax*	elimination			ongoing
Azerbaijan	*vivax*	elimination	2007	before 1960s	ongoing
Georgia	*vivax*	elimination	2007	before 1960s	ongoing
Iraq	*vivax*	elimination	2005	1987	ongoing
Kyrgyzstan	*vivax*	elimination	2006	before 1960s	ongoing
Republic of Korea	*vivax*	elimination			ongoing
Saudi Arabia	both	elimination	2003	ongoing	ongoing
Tajikistan	both	elimination	2005 (*P.f.*); 2008 (*P.v.*)	ongoing	ongoing
Turkey	*vivax*	elimination	2008	before 1960s	ongoing
Uzbekistan	*vivax*	elimination	2008	before 1960s	ongoing
Armenia	*vivax*	prev. of re-introduction	2006	before 1960s	2005
Bahamas	*falciparum*	prev. of re-introduction		ongoing	ongoing
Egypt	*vivax*	prev. of re-introduction	1997	1997	1997**
Jamaica	*falciparum*	prev. of re-introduction	certified in 1966	ongoing	ongoing
Morocco	*vivax*	prev. of re-introduction	1997	1974	2004
Oman	both	prev. of re-introduction	1991	2003	2003, then local transmission in 2007–2008
Russian Federation	*vivax*	prev. of re-introduction	2005	before 1960s	ongoing
Syrian Arab Republic	*vivax*	prev. of re-introduction	1999	1960s	2004
Turkmenistan	*vivax*	prev. of re-introduction	2005	before 1960s	2005

* Source: reference 4

** Concern has been raised about the accuracy of the surveillance system

Many other countries, such as Australia, Singapore, Tunisia, the United Arab Emirates and the United States of America, were once endemic, have eliminated malaria, and continue to successfully prevent re-establishment of transmission. This is despite having areas with abundant malaria vectors and suitable climate conditions, which make them receptive to the resumption of transmission, and continued importation of parasites from abroad.

5.5.2 Countries in the elimination phase

In 2009, 10 countries were implementing nationwide malaria elimination programmes: Algeria, Azerbaijan, Georgia, Iraq, Kyrgyzstan, the Republic of Korea, Saudi Arabia, Tajikistan, Turkey and Uzbekistan. Only two countries in the elimination phase have remaining foci of active *P. falciparum* transmission: Saudi Arabia and Tajikistan. All others have only *P. vivax*.

As described in **Box 5.1** and shown in **Figure 5.5**, a majority of the 10 "elimination countries" had already eliminated malaria once before. These were countries in the WHO European Region in the Caucasus and Central Asia, and the Republic of Korea.

During the period 1998–2008, the annual number of reported local cases was reduced 100-fold or more in nearly all the elimination countries (**Fig. 5.6**). The exception was the Republic of Korea, which showed a more sustained transmission pattern. Together, the 10 elimination countries reported just 1672 locally acquired malaria infections in 2008, and 1730 imported cases. Over 60% of the local cases were reported by the Republic of Korea, followed by Tajikistan (19%) and Turkey (10%). None of the elimination countries has reported deaths due to local malaria transmission since 1998, but imported cases continue to result in occasional deaths; e.g. Turkey reported three deaths from imported malaria in 2008.

Since the *World Malaria Report 2008*, a large shift in types of country programme has occurred in the WHO European Region, where only 589 locally acquired malaria cases were reported in 2008, down from > 90 000 in 1995. All the malaria-affected countries of the Region have moved forward one programme phase (Fig. 5.1):

- All six endemic countries (Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan) have moved from pre-elimination to elimination; their national strategies on malaria have been revised to reflect the new elimination challenges.
- The two countries with elimination programmes (Armenia and Turkmenistan) have reported no indigenous cases since 2005 and have moved to the stage of prevention of reintroduction. Turkmenistan has initiated the process for certification of malaria-free status.

BOX 5.1

Historical perspective of "elimination countries"

As can be seen in Figure 5.5, which shows the numbers of reported malaria cases between 1982 *(6)* and 2008, six of the 10 elimination countries had already eliminated malaria once before: countries in the WHO European Region in the Caucasus and Central Asia, and the Republic of Korea.

The endemic areas in the 10 elimination countries, with the exception of southwestern Saudi Arabia, are all located in the Palearctic ecozone[a], which also includes Europe, northern Africa and the northern part of China. Historically, this region was characterized by widespread malaria endemicity, but malaria here was sensitive to overall development and control efforts and was greatly reduced from the mid-nineteenth century. The incidence diminished further with the advent of DDT in the 1940s and the Global Malaria Eradication Programme in the 1950s and 1960s. *P. falciparum* was eliminated from most of the countries in this ecozone by the middle of the past century and now survives only in Afghanistan and Tajikistan.

By 1975, the WHO European Region, including the former Union of Soviet Socialist Republics but excepting Turkey, was considered malaria-free *(7)*, even though sporadic cases continued to be reported in Azerbaijan and Tajikistan. An upsurge of imported cases, followed by the re-establishment of local transmission, occurred in the Caucasus and the Central Asian republics and to a lesser extent in Russia in the late 1980s and early 1990s, related to the war in Afghanistan and the dissolution of the Union of Soviet Socialist Republics. The reappearance of *P. falciparum* in Tajikistan was first noted in the mid-1990s; falciparum transmission peaked in 2001 at 826 cases nationwide, dropping to two in 2008. It is likely that this species will soon be eliminated from the WHO European Region. When that happens, the geographical spread of *P. falciparum* parasites of the "palearctic strain" will once again be limited to northern Afghanistan.

P. vivax malaria was highly prevalent throughout the Republic of Korea in the first half of the twentieth century but disappeared in the 1960s and 1970s due to malaria eradication efforts; the last two indigenous cases were reported in 1984 *(8)*. The Korean peninsula was subsequently considered non-endemic for malaria, until the 1990s, when malaria re-emerged near the Demilitarized Zone, followed by a protracted outbreak in this area, disproportionally affecting the northern part of the peninsula. In 2008, the Republic of Korea reported the highest number of local cases of the 10 elimination countries.

In Africa north of the Sahara, intensive malaria control and eradication efforts, dating back to the 1940s and 1950s, have led to the elimination of transmission from Egypt, the Libyan Arab Jamahiriya, Morocco and Tunisia and have greatly reduced the risk areas in Algeria. The risk for transmission in Algeria is now limited to small foci in oases, with isolated *P. falciparum* transmission reported in the southernmost areas, which are along the route of trans-Saharan migration and susceptible to importation of parasites. Algeria reported 12 530 cases of malaria in 1968, which was brought down to 90 cases in 1976 *(9)*. Over the next 10 years, the annual number of reported local malaria cases remained in the range 30–70, climbing to 100–200 cases annually in 1988–1998 *(6)* and returning to 30 or fewer annually thereafter.

Malaria was nearly eliminated from Iraq during implementation of the the Global Malaria Eradication Programme, when the reported numbers fell from 320 926 cases and 760 deaths in 1955 *(10)* to 2234 cases in 1962 *(9)*. The number of reported cases increased to over 14 000 in 1970 and 1975 *(9)* but was brought down to some 2000 cases annually in the mid-1980s *(6)*. *P. falciparum* was eliminated in 1987. The first Gulf war resulted in a malaria epidemic, with over 98 000 cases reported annually in 1994 and 1995 *(6)*. Reported local transmission of *P. vivax* malaria is currently limited to foci in the northern governorate of Erbil. Six locally acquired cases were reported in 2008.

The incidence of malaria in Turkey had been reduced from 13 759 reported cases annually in 1955 *(10)* to only 1263 cases in 1970 *(9)*. The annual number of reported cases remained at that low level until 1975, when it rebounded to 9828, with 37 320 cases the following year and a peak of 115 385 cases in 1977 *(9)*, linked to agricultural development and insecticide resistance in the Çukurova and Amikova plains of southern Turkey, coupled with insufficient coverage by the surveillance system during 1970–1975. The epidemic was steadily controlled, and the country reported only 8675 cases in 1990. A further peak of cases occurred in relation to the first Gulf war and the influx of refugees from Iraq: 84 345 and 82 096 cases were reported in 1994 and 1995. By 1998, Turkey still reported 36 780 local malaria cases. Finally, in 2006, the reported number of cases dropped to below the level achieved in 1970. In 2008, only 166 locally acquired cases were reported in eastern areas bordering the Syrian Arab Republic and Iraq.

Saudi Arabia is the only elimination country that maintained a steady high malaria burden over the past decades, peaking most recently at 36 139 reported confirmed local cases in 1998. The remaining endemic areas border highly endemic areas of Yemen and are part of the Afrotropical ecozone, which also includes Africa south of the Sahara. Over the past decade, Saudi Arabia has greatly reduced the number of locally acquired cases through intensive control, including cross-border cooperation with Yemen. Only 61 local cases were reported in 2008.

a. The world's eight ecozones ("zoogeographic regions") are separated from one another by geological features that formed barriers to plant and animal migration (e.g. oceans, high mountain ranges, broad deserts), resulting in the development of plant and animal species (including *Anopheles* species and *Plasmodium* strains) in relative isolation over long periods.

Figure 5.5 Confirmed malaria cases (local and imported) in elimination countries, 1982–2008

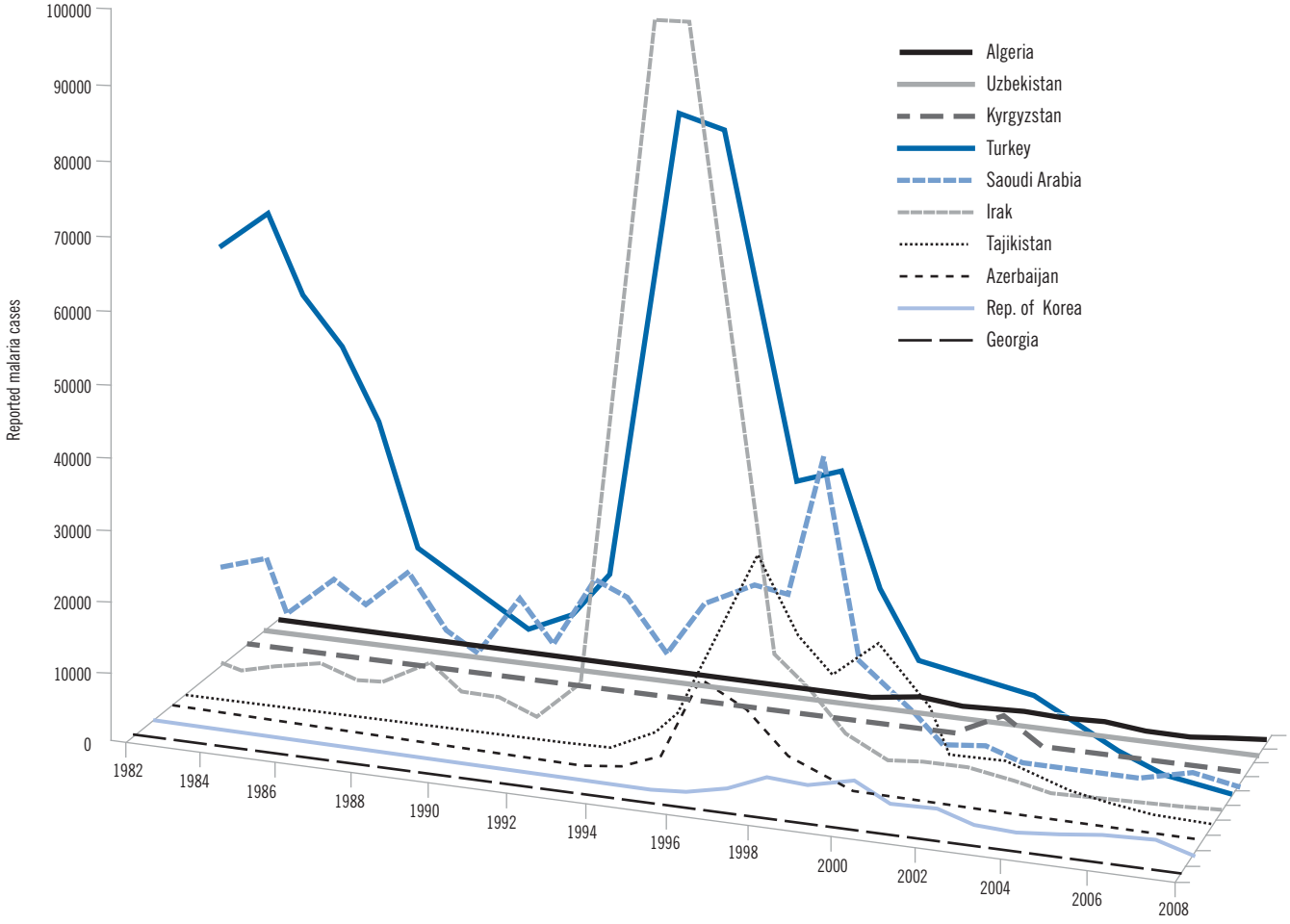
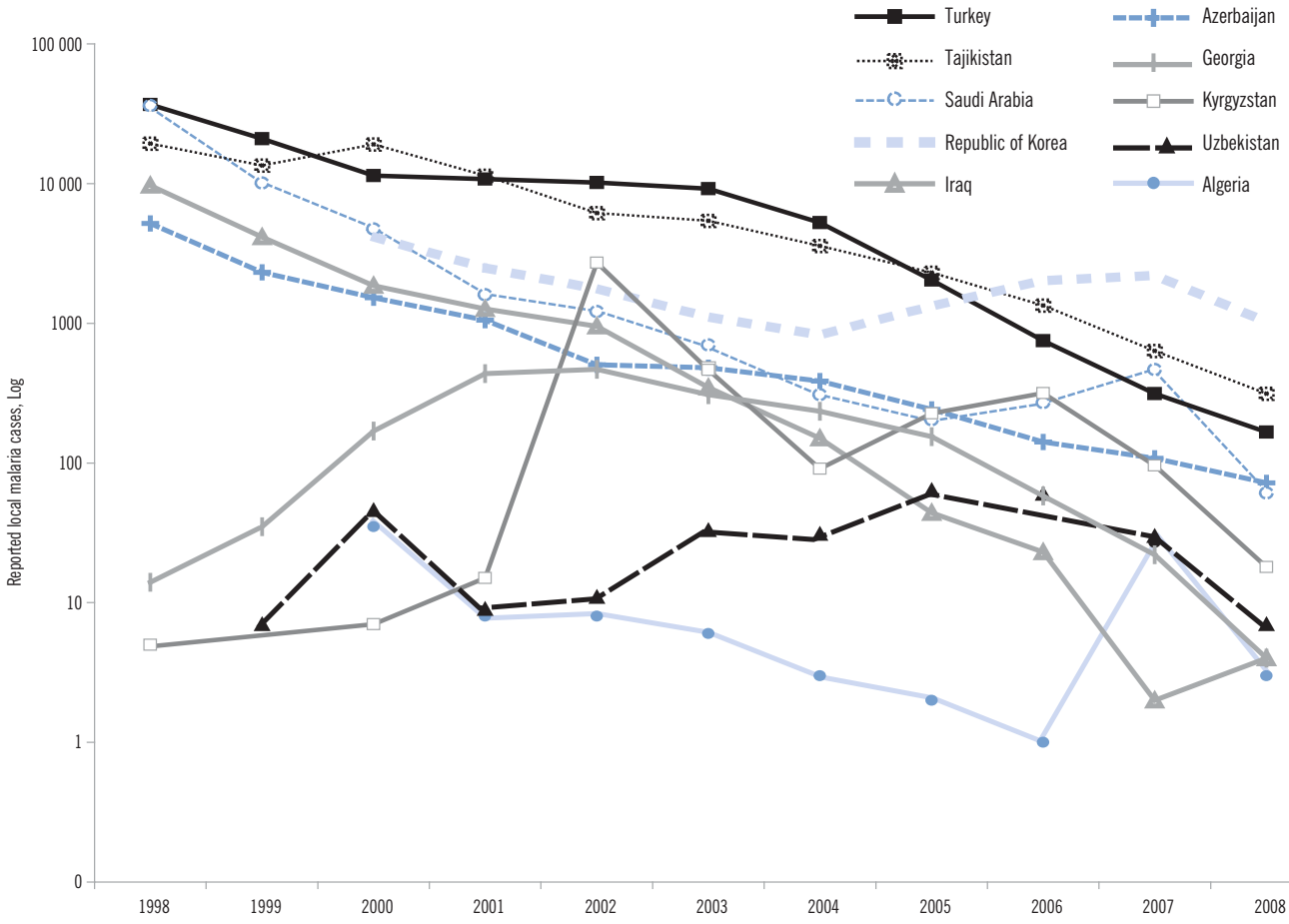


Figure 5.6 Locally acquired confirmed cases, elimination countries, 1998–2008



With increased cross-border cooperation, the Region aims for the elimination of malaria by 2015.

In 2008, three countries in the WHO Region of the Americas (El Salvador, Mexico and Paraguay) were considered to be implementing elimination programmes. As of 2009, these countries had been reclassified as in 'pre-elimination' to reflect more accurately the fact that the elimination approach is not yet fully being implemented countrywide in all affected areas. This change in classification does not reflect a deterioration of the programme status of these countries.

5.5.3 Pre-elimination group of countries

As of 2009, eight countries were in the pre-elimination programme phase and are reorientating their programmes to increase emphasis on the quality of surveillance, reporting and information systems: Argentina, Democratic People's Republic of Korea, El Salvador, Islamic Republic of Iran, Malaysia, Mexico, Paraguay and Sri Lanka.

As described in **Box 5.2** and shown in **Figure 5.7**, of the eight pre-elimination countries, four (Argentina, Democratic People's Republic of Korea, Paraguay and Sri Lanka) had nearly eliminated malaria once before.

The eight pre-elimination countries reported a total of 29 245 confirmed malaria cases in the last year for which data are available, with 96% of cases reported by just four countries: the Islamic Republic of Iran (39%), Malaysia (25%), the Democratic People's Republic of Korea (24%) and Mexico (8%). Sri Lanka had a protracted increase in case load between 1986 and 2000. With the exception of Sri Lanka, none of the pre-elimination countries has reported deaths from malaria during the past decade. In Sri Lanka, local malaria deaths decreased from 115 in 1998 to 2 in 2004; no deaths from malaria have been reported since then.

5.5.4 Countries aspiring to pre-elimination

Swaziland and a number of smaller African island states and territories that were until recently moderately to highly endemic aspire to join the group of "pre-elimination countries" in the coming years. Typically, relatively large parts of the territories of these countries are still affected by malaria. Intense vector control programmes (LLINs and IRS) have been implemented in recent years, with massive external funding, leading to 10-fold or greater reductions in the malaria case load, down to several thousand suspected cases annually. Eventual malaria elimination in these countries will be "ambitious and challenging" *(12)*.

Cape Verde presents a different scenario: the country took part in the malaria eradication campaign of the 1950s and 1960s, when it greatly reduced its original level of endemicity. Rebound epidemics occurred after favourable rains in the late 1970s and 1980s but were successfully controlled. At present, only one of the nine inhabited islands (São Tiago) is considered to have malaria transmission, with seasonal transmission linked to rainfall, resulting over the 12-year period (1996–2007) in a total of 798 malaria cases, of which 608 (75%) were locally acquired. The programme incorporates many aspects of the elimination approach and is reorienting its national strategy towards elimination.

BOX 5.2

Historical perspective of "pre-elimination countries"

The endemic areas in the eight pre-elimination countries are located in the Indo-Malay ecozone (Islamic Republic of Iran, Malaysia and Sri Lanka), the Neotropic ecozone (Argentina, El Salvador, Mexico and Paraguay) and the Palaearctic ecozone (Democratic People's Republic of Korea). Of the eight, only the Islamic Republic of Iran and Malaysia still have a considerable burden of *P. falciparum*, representing 12% and 30% of the total case loads reported in 2008, respectively. Argentina and the Democratic People's Republic of Korea have exclusively *P. vivax*, and the others have almost exclusively *P. vivax*.

Four of the current pre-elimination countries had already approached success in elimination in the second half of the twentieth century. Sri Lanka reported only 31 cases nationwide in 1963 *(9)*; the Democratic People's Republic of Korea was considered malaria-free in the 1980s; in Paraguay, intensive surveillance operations resulted in fewer than 50 reported locally acquired cases (all *P. vivax*) in 1982; and Argentina's reported malaria burden peaked at 5351 cases in 1959 *(10)* but was brought down to only 41 local cases in 1970 *(11)*.

Figure 5.7 shows that the largest numbers of malaria cases in this group were reported in recent decades in the Democratic People's Republic of Korea and Sri Lanka, which had all but eliminated malaria earlier.

El Salvador, the Islamic Republic of Iran, Malaysia and Mexico have seen more gradual decreases in the numbers of cases over the years, accelerated by implementation of the Global Malaria Control Strategy and the Roll Back Malaria programme in the early and late 1990s, respectively. The remaining endemic areas in these countries are located in regions that have relatively more favourable climate conditions for malaria transmission, combined with more difficult access by central health services and/or cross-border migration from neighbouring endemic countries. As shown in **Figure 5.8,** the remaining foci in these countries are more tenacious, resulting in a relatively flat profile in recent years.

Table 5.4 Within country localized "malaria free" initiatives

COUNTRY	WHO REGION	REGION OR SUB-NATIONAL LEVEL
China	Western Pacific	Hainan
Indonesia	South-East Asia	Java, Bali
Philippines	Western Pacific	Province by province
Solomon Islands	Western Pacific	Temotu
Sudan	Eastern Mediterranean	Khartoum, Gezira
Vanuatu	Western Pacific	Tafea
Yemen	Eastern Mediterranean	Socotra

Figure 5.7 Reported malaria cases in pre-elimination countries, 1982–2008

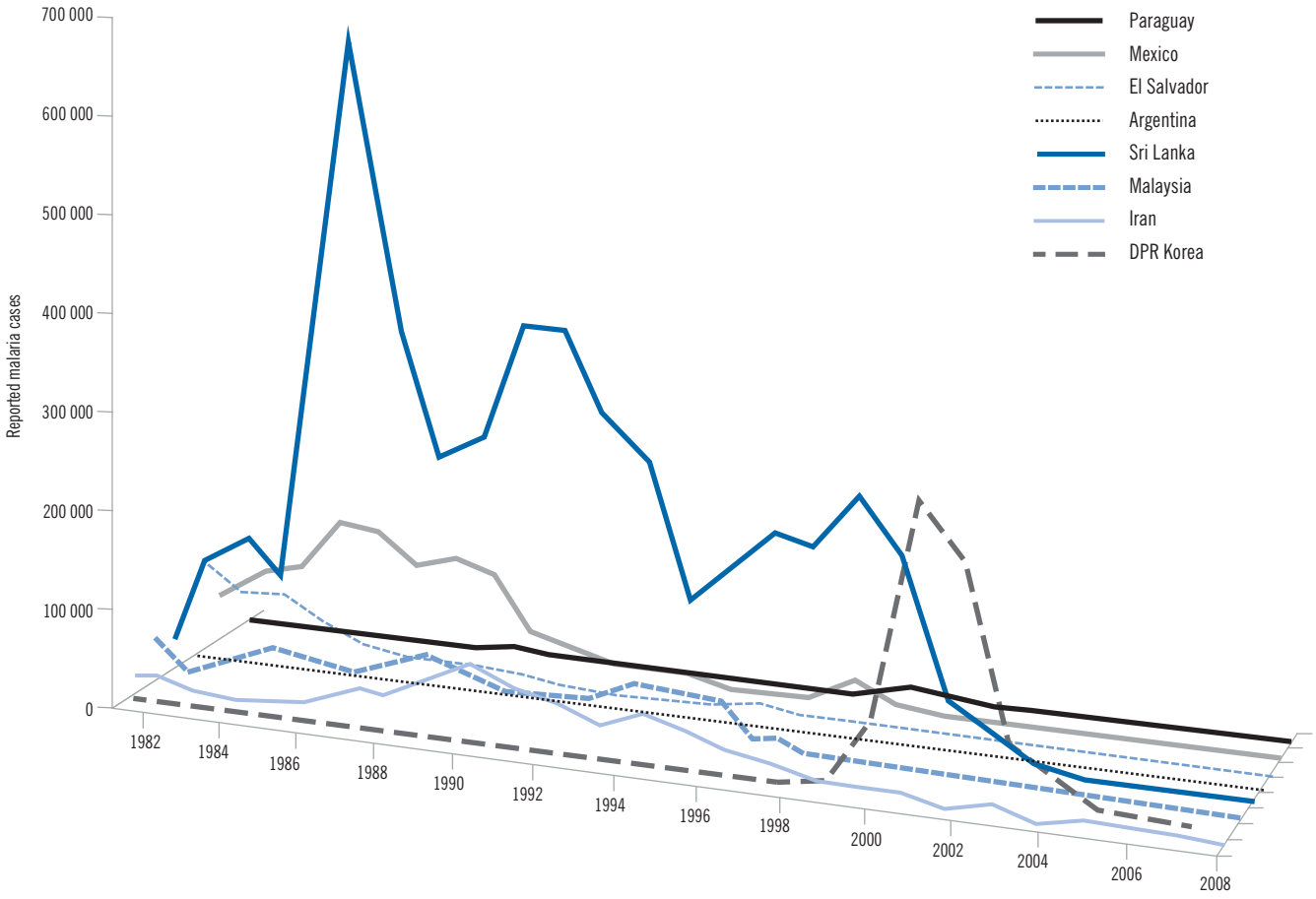
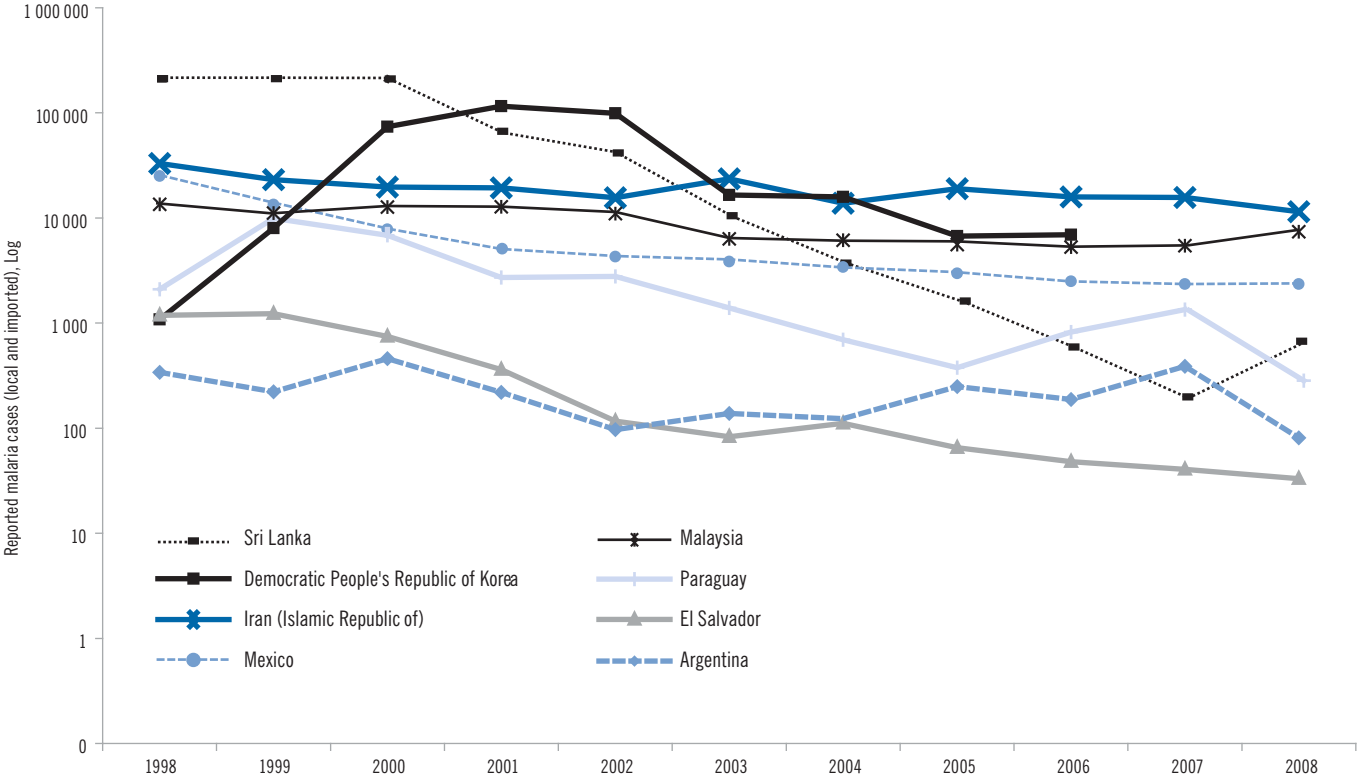


Figure 5.8 Total confirmed malaria cases (local and imported), pre-elimination countries in which trends have been stable, 1998–2008



5.5.5 Countries implementing projects in "malaria-free zones"

Seven malaria-endemic countries are implementing local projects aimed at achieving "malaria-free zones", while the remainder of the country is in the control phase. The term "malaria-free" is in this context not well-defined: while some countries are trying to eliminate the last locally acquired malaria infections in well-defined areas, for instance to encourage tourism (Socotra, Yemen), others in this group are trying to reduce mortality and morbidity due to malaria to a certain level (e.g. Khartoum, Sudan) *(13)*.

The countries that have declared 'malaria-free' projects are listed in **Table 5.4**.

5.6 WHO certification

When a country has had zero locally acquired malaria cases for at least three consecutive years, the government can ask WHO to certify the achievement of elimination. Certification requires proving beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in the entire country.

The burden of proof of elimination falls on the country requesting certification. This implies that all the available evidence has been evaluated and has been found to be consistent with the assertion that malaria elimination has been achieved and that good-quality surveillance systems are in place that would be capable of detecting local transmission if it were occurring.

The general principles of certification are:

- Certification is for a country as a whole and for all four human malaria species.
- Inspection and evaluation are carried out by a team led by WHO, which then recommends certification, if appropriate.
- The WHO Secretariat shares the final report with WHO and non-WHO experts on malaria elimination for critical review.
- The final decision rests with the WHO Director-General.
- Certification is published in the *Weekly Epidemiological Record*.

Details of the aspects to be covered by the evaluation teams are provided elsewhere *(14)*. Certification of malaria elimination is based on an assessment of the current situation and the likelihood that elimination can be maintained. Countries are requested to continue reporting annually to WHO on the maintenance of their malaria-free status.

Between 1961 and 1987, 24 countries (see **Table 5.5**) were certified as malaria-free by WHO and entered in the *WHO Official Register* of areas where malaria eradication has been achieved *(15–17)*.

Of the certified countries and areas Jamaica, Mauritius and northern Venezuela (Bolivarian Republic of) were unable to maintain the absence of local transmission. Malaria elimination in Mauritius was certified in 1973, but transmission was reintroduced in 1978 and lasted 20 years. Mauritius now has comprehensive surveillance mechanisms, however, and has not reported a local case since 1998; it is once again considered free from local malaria transmission.

In addition to the countries entered in the *WHO Official Register*, the Maldives and Tunisia succeeded in eliminating malaria in 1984 and 1979, respectively. The United Arab Emirates reported its last locally acquired malaria case in 1997, and elimination was certified in January 2007 *(17)*. A further six countries have reported (periods of) zero cases in recent years: Armenia, Egypt, Morocco, Oman, Syrian Arab Republic and Turkmenistan. Procedures for certification are under way with Morocco and have been initiated with Turkmenistan.

Table 5.5 Countries entered into the *WHO Official register* of areas where malaria eradication has been achieved, covering the period 1961–1987

COUNTRY/TERRITORY	DATE OF REGISTRATION
Venezuela, Bolivarian Rep. of (northern)	June 1961
Grenada and Carriacou	November 1962
Saint Lucia	December 1962
Hungary	March 1964
Spain	September 1964
Bulgaria	July 1965
China, Province of Taiwan	November 1965
Trinidad and Tobago	December 1965
Dominica	April 1966
Jamaica	November 1966
Cyprus	October 1967
Poland	October 1967
Romania	October 1967
Italy	November 1970
Netherlands	November 1970
United States of America and its outlying areas of Puerto Rico and the Virgin Islands	November 1970
Cuba	November 1973
Mauritius	November 1973
Portugal	November 1973
Yugoslavia	November 1973
Reunion	March 1979
Australia	May 1981
Singapore	November 1982
Brunei Darussalam	August 1987

Sources: *references 14–16*

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Chapter 6.
Financing malaria control

The three major sources of funds for malaria control programmes are national government spending, external assistance from donors and household or private "out-of-pocket" expenditure. In the Global Malaria Action Plan *(1)*, it is estimated that these sources comprised 34%, 47% and 19%, respectively, of total spending on malaria globally in 2007. This Report does not address household expenditures but focuses on external funding for malaria and national government spending. It considers the following issues: *i)* trends in international and domestic financing for malaria and their relation to estimated resource requirements; *ii)* how funds disbursed from external agencies have been allocated to different geographical regions, countries and programmes; and *iii)* the relation between external financing, programme implementation and disease trends.

6.1 Sources of information

The methods for obtaining information on malaria financing varied according to the type of information considered: commitments, disbursements or expenditures (see **Box 6.1** for definitions of these terms).

BOX 6.1

Types of financial information

PLEDGE – A non-binding announcement of intentions to contribute a certain amount of funds.

COMMITMENT – A firm obligation expressed in writing and backed by the availability of the necessary funds for a particular project, programme or sector.

DISBURSEMENT – The placement of resources at the disposal of a government or implementing agency.

EXPENDITURE – The use of funds to pay for commodities, buildings, equipment, services or salaries.

6.1.1 Commitments

Information on commitments to malaria programmes was obtained from two sources: records of funding agencies on malaria grants awarded (Global Fund, United States President's Malaria Initiative, UNITAID, World Bank[1]), and information supplied by malaria-endemic countries, particularly to obtain host government contributions. Information on commitments is available up to 2008 or 2009.

Commitments represent a firm agreement by a funding agency to provide funds according to a prescribed plan. This may be a budget approved by a national government or a grant agreement between a funding agency and a programme implementer. Commitments provide an indication of the funding priority given to malaria, to particular countries or programmes. Information on commitments can often be obtained for the most recent financial year but do not always translate into programme expenditures, as there may be delays in disbursement of funds or problems in programme implementation which lead to reprogramming of resources. Hence, in analysing what funds have been used for malaria control, it is usually preferable to examine disbursements or actual expenditures, which give a more accurate picture of the extent to which recipients have benefited.

6.1.2 Disbursements

Information on disbursements was obtained from three sources : the database on global health financing maintained by the Institute of Health Metrics and Evaluation *(2, 3)*; records of disbursements by funding agencies, notably the Global Fund and the United States President's Malaria Initiative; information supplied by malaria-endemic countries to WHO annually on host government expenditures and breakdowns of expenditures by type; and information recorded by the Global Fund Enhanced Financial Reporting system on breakdowns of Global Fund expenditures. The various data sources have different levels of completeness. The most comprehensive dataset on disbursements is that maintained by the Institute for Health Metrics and Evaluation, which provides information on the disbursements of 27 agencies that provide funding for malaria; this was supplemented with additional information on disbursements supplied by individual donor agencies. Information on disbursements is available up to 2007.

1 World Bank financing for malaria is usually mediated through a credit from the International Development Association, which is an interest-free loan, with repayments starting after 10 years and maturing at 35 or 40 years. An annual service charge of 0.75% applies.

Information on disbursements or expenditures usually lags behind that on budgets or commitments by a minimum of 1 year, because a programme needs time to make such disbursements or expenditures and to compile data. It is sometimes difficult to distinguish between disbursements and expenditures; e.g. transfer of money by a principal recipient of a Global Fund grant to subrecipients may be recorded as an expenditure, although it is yet to be translated into goods and services that benefit target populations. Also, some funds disbursed may not be spent during the year the disbursement was made. In such cases, actual spending may be much less than the disbursements reported by donors. Information on disbursements is, however, generally more complete than that available for expenditures, and was hence central to most of the analyses presented here.

6.1.3 Other health spending

The funds reported as being available for malaria control are usually for specific interventions, such as the purchase and distribution of ITNs, RDTs or medicines. They do not include government funding or external assistance for the support of health systems, because it is difficult to assign specific amounts to malaria, even though malaria programmes clearly benefit from such support. In addition, much external assistance is provided through multilateral channels as technical support or through nongovernmental organizations, and is not always captured by the sources of information examined. Hence, it is possible that the funds available for malaria are greater than those recorded here. Nevertheless, the analysis presented gives an indication of the overall levels of funding for malaria in relation to resource requirements and how these have changed over time.

6.2 Resource requirements and trends in international and domestic financing

6.2.1 Resource requirement

The Global Malaria Action Plan estimated that between US$ 5.0 billion and US$ 6.2 billion will be required per year between 2009 and 2015 to scale-up and sustain the control and elimination of malaria globally (**Table 6.1**).

6.2.2 Commitments by external agencies

Figure 6.1 shows the financial commitments to malaria control by the four largest sources of external funds for malaria. It shows a fivefold increase in commitments for malaria control, from approximately US$ 0.3 billion per year in 2003 to US$ 1.7 billion in 2009, with a particularly large increase in 2009.

6.2.3 Disbursements by external agencies to malaria endemic countries

International disbursements for malaria to malaria-endemic countries increased from US$ 35 million in 2000 to US$ 652 million in 2007[2], an 18-fold increase. The Global Fund accounted for US$,1.3 billion or 62% of all external funds disbursed to malaria-endemic countries between 2000 and 2007 (**Fig. 6.2**). The United States Agency for International Development (including the President's Malaria Initiative) was second to the Global Fund as a source of funds between 2000 and 2007, increasing its malaria funding to countries by a factor of 37, from US$ 6 million in 2000 to US$ 226 million in 2007. The United Kingdom Department for International Development was third, increasing its contributions from US$ 2 million in 2000 to US$ 29 million in 2007. Note that Global Fund disbursements for malaria, at US$ 1.3 billion, represent only 48% of the US$ 2.6 billion

Table 6.1 Annual global resource requirements (US$ millions) for malaria control

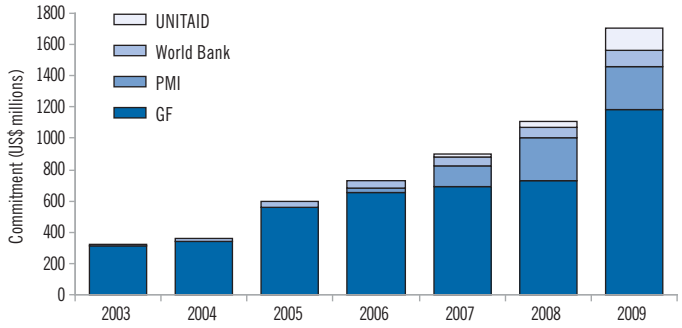
REQUIREMENT	2009	2010	2015	2020	2025
Prevention					
Long-lasting insecticidal nets and insecticide-treated nets	2091	2091	1689	1807	1035
Indoor residual spraying	1632	1883	2026	2047	1531
Intermittent preventive treatment in pregnancy IPTp	6	8	9	9	10
Subtotal	3729	3982	3724	3863	2576
Case management					
Rapid diagnostic tests RDTs	679	975	368	109	43
Artemisinin-based combination therapies ACTs	257	356	164	1087	41
Chloroquine and primaquine	5	5	2	1	–
Severe case management	27	23	16	9	4
Programme support	638	839	764	787	714
Total	5335	6180	5038	5856	3378

2 Another US$ 200 million were disbursed in 2007 but were either directed to research or to regional programmes and are difficult to assign to individual countries or programme implementation. In particular, the disbursement of the Bill and Melinda Gates Foundation for malaria was US$ 160 million in 2007, but much of this contribution was for research and is not represented in country contributions.

3 If government budgets or expenditure appeared to include external assistance, the external assistance was excluded.

committed for malaria by the Fund between 2003 and 2007; some of the commitments are withheld during initial grant negotiations and again at Phase 2 review when poorly performing grants are reduced. This illustrates that information on commitments to malaria may not provide an accurate picture of funds immediately available for malaria control.

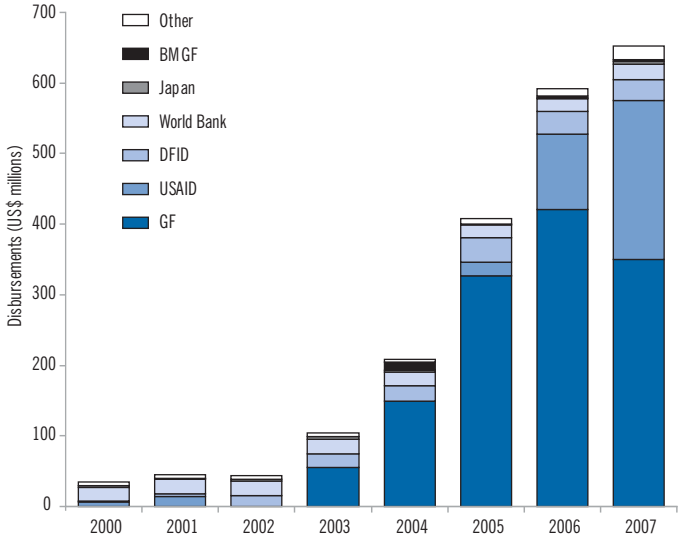
Figure 6.1 Funding commitments of the Global Fund, UNITAID, the US President's Malaria Initiative and the World Bank, 2003–2009



PMI: US President's Malaria Initiative; GF: Global Fund;

Annual commitments for World Bank-funded projects were calculated from the planned disbursements described in project appraisal documents, or, if these were not available, by assuming a constant flow of funds throughout the life of a project, with funding starting 6 months after board approval. Commitments of the PMI were allocated to calendar years proportionally according to the number of months of a financial year falling in each calendar year. Annual commitments of the Global Fund were calculated on the assumption of a project life span of 5 years and a constant flow of funds throughout that period. Commitments of UNITAID were distributed evenly to calender years according to the expected project length.

Figure 6.2 Disbursements to malaria-endemic countries 2000–2007



Source: *Institute of Health Metrics and Evaluation database with amendments to the President's Malaria Initiative and World Bank disbursements*

BMGF: Bill and Melinda Gates Foundation; DFID: Department for International Development (United Kingdom); USAID, United States Agency for International Development; GF: Global Fund to fight AIDS, Tuberculosis and Malaria

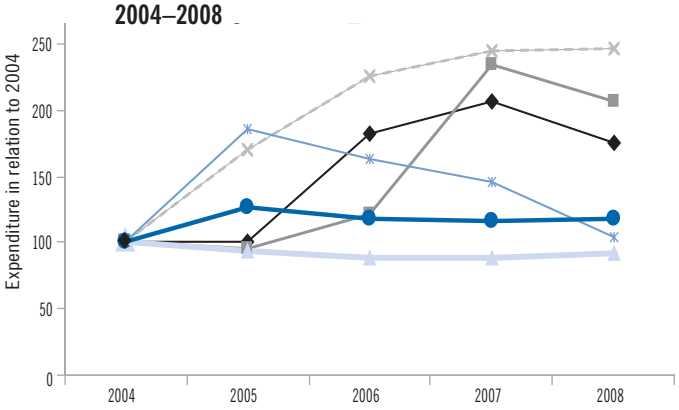
6.2.4 Domestic financing in malaria-endemic countries

Information on domestic financing for malaria is insufficiently complete to allow a comprehensive analysis of trends. An important issue, however, is whether government financing for malaria remains stable in the presence of large quantities of external financing, or whether it is reduced or increases. The analysis was restricted to 31 countries that provided information on government financing for malaria for at least 5 of the past 9 years and included data for 2007 or 2008. When possible, government expenditure was used; if this information was not available, government budgets for malaria were used[3]. **Figure 6.3** shows the changes in domestic financing for malaria in these countries, averaged for each WHO region, each country being given equal weight. Although the trends among these counties might not be generalizable, they represent the only information currently available. The evidence that external financing for malaria displaces government financing is mixed: domestic financing for malaria increased in a range of countries in all regions, but a potential downwards trend between 2007 and 2008 was seen in two regions, and there was a steady decrease between 2005 and 2008 in the South-East Asia Region. Better information on domestic financing for malaria would allow a more accurate, complete picture of global malaria financing.

6.2.5 Commitments in relation to projected requirements

While the increase in external assistance for malaria has been unprecedented, the total funds available for malaria control are still lower than the annual amount estimated in the Global Malaria Action Plan to be necessary for successful control of malaria globally: more than US$ 5 billion per year[4]. Even if the high level of malaria commitments for 2009 (US$ 1.7 billion) is translated into disbursements and programme expenditures and complemented by equal levels of government and private sector funding[5], the total funds available for malaria control would be in the region of US$ 3.4 billion, or only 70% of projected requirements.

Figure 6.3 Trends in governmental expenditures for malaria, 2004–2008



Source: National malaria programme reports to WHO

AFR, African Region; EMR, Eastern Mediterranean Region; EUR, European Region; RA, Region of the Americas; SEAR, South-East Asia Region; WPR, Western Pacific Region – Government financing for malaria in each region is indexed at 100 in 2004; subsequent values represent the percentage of the 2004 value, i.e. 250 for the Region of the Americas in 2008 indicates that government spending in 2008 value was 250% of the 2004 value or an increase of 150%.

4 Kiszewski et al. (2007) (4) estimated that US$ 3.5–5.6 billion would be required per year between 2006 and 2015 but used a slightly different basis for calculation, e.g. without budgeting for the use of RDTs for diagnosing malaria in children under 5 years of age in Africa.

5 In the Global Malaria Action Plan *(1)*, it was estimated that government and household financing had been approximately equal to external financing in 2007.

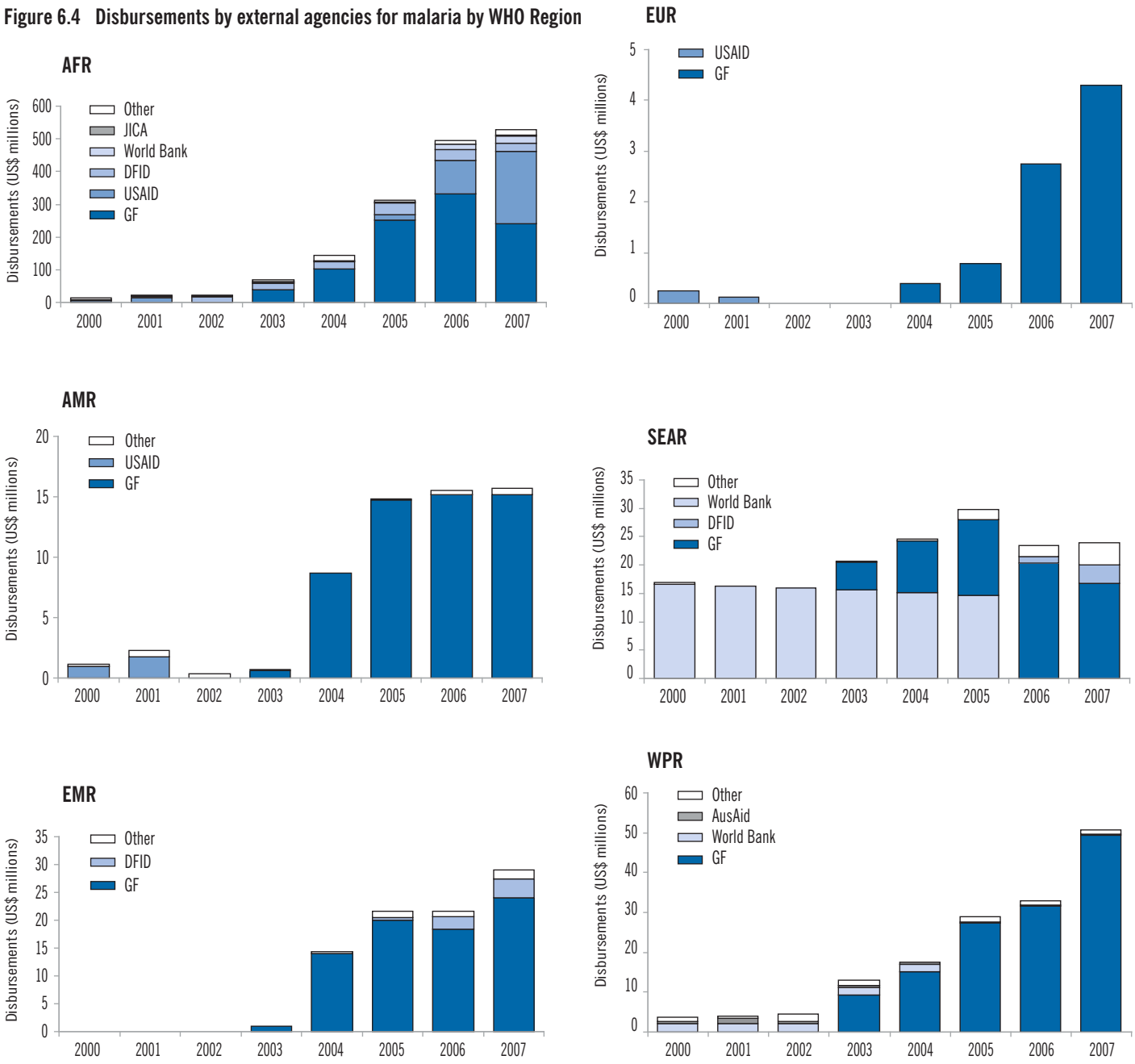
6.3 Allocation of disbursed funds from external agencies to regions, countries and programmes

6.3.1 Disbursements by external agencies, by WHO region

The Global Fund was the dominant source of external finance in all regions between 2000 and 2007, except for the South-East Asia Region, where World Bank funding accounted for 55% of disbursements by external agencies (**Fig. 6.4**). The Global Fund accounted for 96% of disbursements in the European Region, 88% in the Eastern Mediterranean Region and 92% in the Region of the Americas. In the African Region, Global Fund support represented 60% of external support, with 22% from the United States Agency for International Development, 9% from the United Kingdom Department for International Development, 3% from the World Bank and 1% from the Japan International Cooperation Agency.

Between 2000 and 2007, disbursements by external agencies for malaria increased by a factor of 40 in the WHO African Region, 30 in the Eastern Mediterranean Region (since 2003), 18 in the European Region, 14 in the Western Pacific Region and 14 in the Region of the Americas. Only the South-East Asia Region registered no substantial increase in external assistance, with 2007 levels only 1.4 times those of 2000. This was partly due to the conclusion of a major World Bank project in India in 2005, which was not replaced until 2008. Even if the new World Bank vector-borne disease control project is included, however, the increase in funding to the South-East Asia Region is the least of all regions.

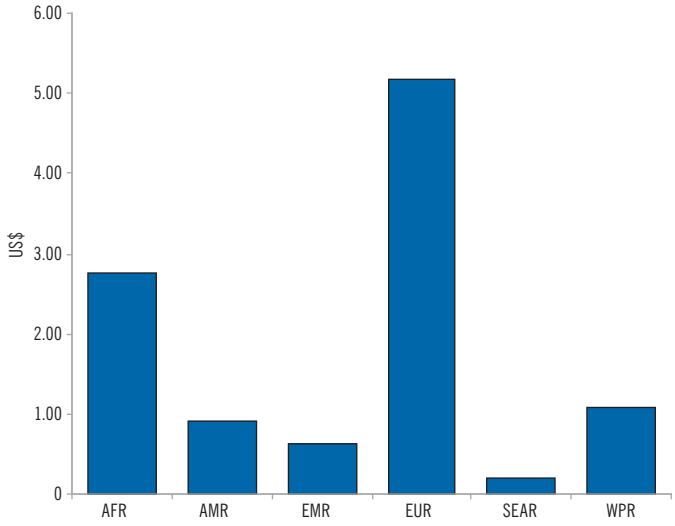
Figure 6.4 Disbursements by external agencies for malaria by WHO Region



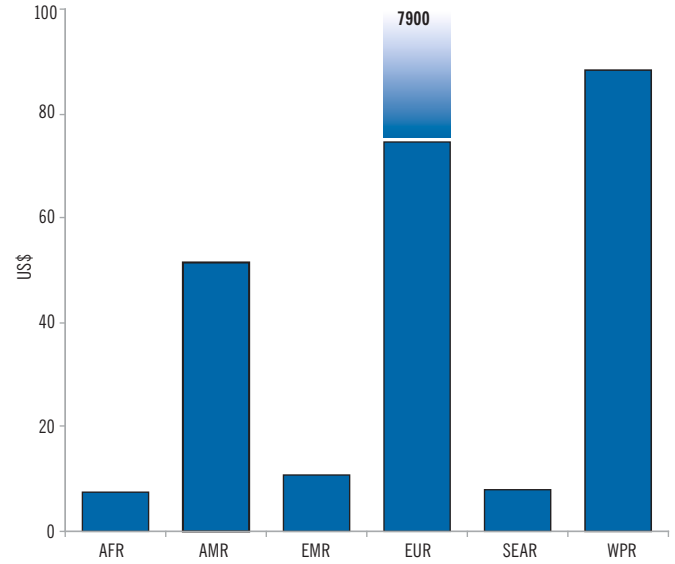
Source: Institute for Health Metrics and Evaluation database, with amendments to the disbursements of the United States President's Malaria Initiative and the World Bank
AFR, African Region; RA, Region of the Americas; EMR, Eastern Mediterranean Region; EUR, European Region; SEAR, South-East Asia Region; WPR, Western Pacific Region; JICA, Japan International Cooperation Agency; USAID, United States Agency for International Development; DFID, Department for International Development (United Kingdom); GFATM, Global Fund to fight AIDS, Tuberculosis and Malaria

Figure 6.5 Disbursements from external agencies 2000–2007, in relation to three measures of malaria burden

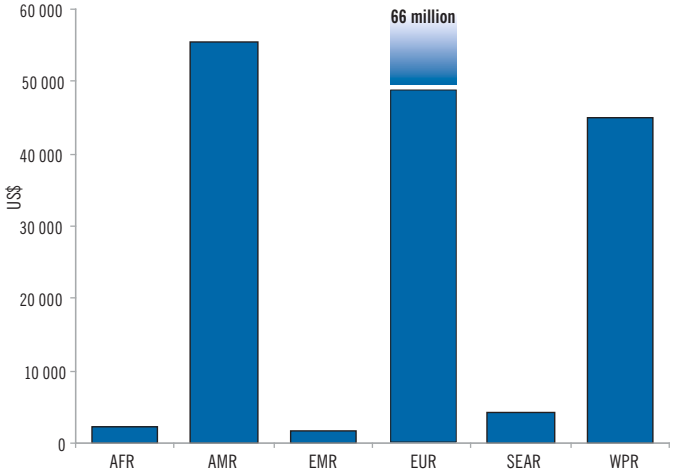
a) *Funding per person at risk of malaria*



b) *Funding per case of malaria*



c) *Funding per death from malaria*



Source: Institute for Health Metrics and Evaluation database with amendments to the disbursements of the United States President's Malaria Initiative and the World Bank

AFR: African Region; AMR: Region of the Americas; EMR: Eastern Mediterranean Region; EUR: European Region; SEAR: South-East Asia Region; WPR: Western Pacific Region

6.3.2 Disbursements by external agencies in relation to epidemiological need

Figure 6.5 shows external assistance in relation to three measures of malaria burden: population at risk for malaria,[6] estimated number of cases of malaria and estimated number of deaths from malaria. Such an analysis of funding in relation to need does not take into account domestic sources of funds, the overall level of development of malaria programmes in countries, purchasing power, the types of interventions needed in different epidemiological settings or their cost. Nevertheless, it can give some insight into the extent to which external assistance flows to countries with high disease burdens.

For many countries, the population at risk is the most useful measure, as it defines the number of people to be protected by vector control programmes, such as with ITNs or IRS. When implemented, vector control programmes are expected to account for the majority of a malaria programme's spending and hence can provide a guide to the levels of resource needs *(1)*. In countries with low disease burdens, where much of the population is classified as at low risk, however, the primary methods of control may be case detection and treatment, surveillance and epidemic prevention. In these countries, the number of malaria cases may be a better guide to resource need.

Populations at risk for malaria in the European Region received the most assistance, at US$ 5.18 per person, followed by the African Region, at US$ 2.76. The lower levels of assistance to other regions are partly due to the large numbers of people living in areas of relatively low risk (fewer than one case per 1000 per year). Figure 6.5 also shows disbursements in relation to the estimated numbers of cases and deaths due to malaria and suggests that larger amounts are received by malaria-endemic countries in the European, Western Pacific and the Americas regions. The African Region receives less external assistance in relation to the estimated numbers of cases or deaths due to malaria.

6.3.3 Disbursements by country

The number of countries receiving external assistance for malaria increased from 29 in 2000 to 76 in 2007 (out of a total of 108 malaria-endemic countries in 2007), the largest increase being in Africa (see **Fig. 6.6**). Only two malaria endemic sub-Saharan countries, Botswana and Chad, did not receive external assistance.

The number of agencies funding malaria control also increased between 2000 and 2007, from 14 to 22, with the largest increase in the African Region (from 12 to 19 agencies). In 2007, 15 countries in the Region received funds from a single external agency;[7] seven

6 Populations at low risk for malaria (living in areas with fewer than one case reported per 1000 per year) are given half the weight of populations at high risk (those living in areas with one or more case reported per 1000 per year). This procedure was followed in order that countries with only populations at low risk for malaria could be included in the analysis and also to take into account the greater need for malaria programmes and funds in countries with larger proportions of their population at high risk for malaria. The weighting is quite arbitrary, but similar results are obtained if populations at low risk are weighted as 0 or 1.

7 In 13 countries, the Global Fund was the sole external source of funds, the exceptions being the Congo (from Spain) and Liberia (from the United States).

Table 6.2 External assistance disbursed to malaria-endemic countries, 2000–2007 (US$ millions)

AFR	Total	% in region
Kenya	182	11%
UR Tanzania	155	10%
Ethiopia	151	9%
Uganda	123	8%
Mozambique	95	6%
Zambia	88	6%
Rwanda	79	5%
Nigeria	79	5%
Angola	68	4%
Malawi	63	4%
Madagascar	63	4%
DR Congo	62	4%
Senegal	56	3%
Ghana	51	3%
Niger	28	2%
Benin	28	2%
Burundi	23	1%
Cameroon	22	1%
Eritrea	20	1%
Mali	20	1%
Liberia	19	1%
Zimbabwe	17	1%
Gambia	15	1%
Burkina Faso	14	1%
Togo	13	1%
Gabon	12	1%
Namibia	11	1%
Central African Republic	11	1%
Sierra Leone	8	1%
Guinea	8	0%
Equatorial Guinea	5	0%
Côte d'Ivoire	4	0%
South Africa	3	0%
Mauritania	3	0%
Sao Tome and Principe	3	0%
Guinea-Bissau	2	0%
Comoros	2	0%
Swaziland	1	0%
Congo	0	0%
Cape Verde	0	0%
Botswana	–	0%
Chad	–	0%
TOTAL	1 606	100%

AMR	Total	% in region
Haiti	10	16%
Guatemala	9	16%
Honduras	8	13%
Peru	8	13%
Bolivia (Pluri. State of)	7	12%
Nicaragua	5	8%
Colombia	4	7%
Suriname	4	6%
Ecuador	2	3%
Venezuela (Bol. Rep. of)	2	3%
Guyana	1	2%
Brazil	0	0%
Argentina	–	0%
Belize	–	0%
Costa Rica	–	0%
Dominican Republic	–	0%
El Salvador	–	0%
French Guiana	–	0%
Mexico	–	0%
Panama	–	0%
Paraguay	–	0%
TOTAL	59	100%

EMR	Total	% in region
Sudan	44	50%
Somalia	21	24%
Yemen	8	9%
Afghanistan	7	8%
Pakistan	6	7%
Djibouti	2	2%
Islamic Republic of Iran	–	0%
Iraq	–	0%
Saudi Arabia	–	0%
TOTAL	88	100%

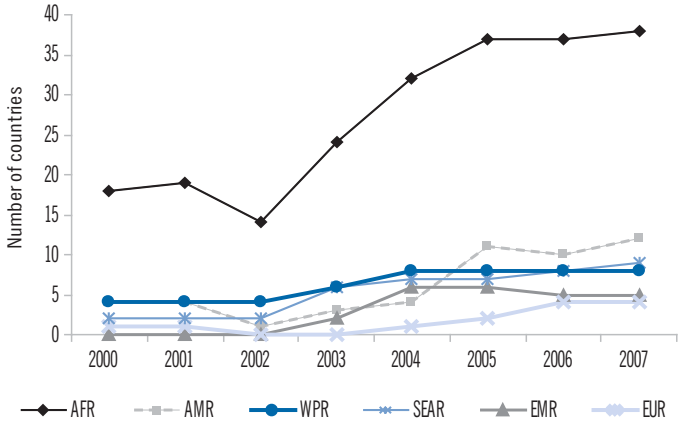
EUR	Total	% in region
Tajikistan	3.2	37%
Uzbekistan	2.0	23%
Georgia	1.7	20%
Kyrgyzstan	1.7	20%
Azerbaijan	–	0%
Turkey	–	0%
TOTAL	8.6	100%

SEAR	Total	% in region
India	108	63%
Indonesia	19	11%
Myanmar	11	6%
Bangladesh	8	5%
Timor-Leste	7	4%
Nepal	7	4%
Sri Lanka	6	4%
Thailand	5	3%
Bhutan	1	1%
Dem. People's Rep. Korea	–	0%
TOTAL	172	100%

WPR	Total	% in region
Philippines	37	24%
Lao People's Dem. Rep.	35	22%
China	27	18%
Viet Nam	18	11%
Cambodia	18	11%
Papua New Guinea	12	8%
Solomon Islands	6	4%
Vanuatu	3	2%
Malaysia	–	0%
Rep. of Korea	–	0%
TOTAL	155	100%

Source: Institute for Health Metrics and Evaluation database with amendments to disbursements from the United States President's Malaria Initiative and the World Bank
0% indicates that the country received less than US$ 0.5 million, while a dash indicates that the country received no external assistance.

Figure 6.6 Numbers of countries receiving external assistance for malaria control



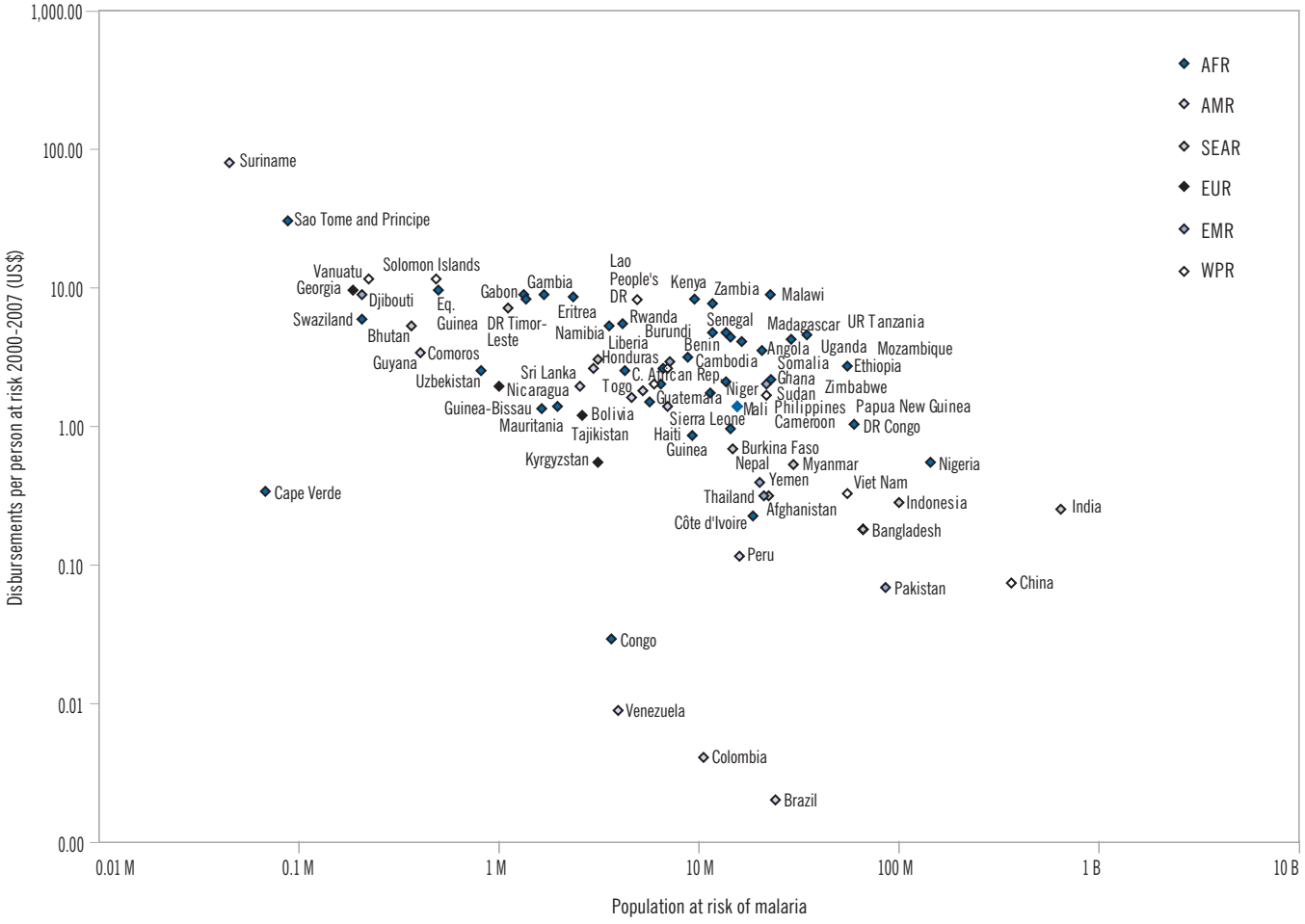
Source: Institute for Health Metrics and Evaluation database with amendments to the disbursements of the United States President's Malaria Initiative and the World Bank

AFR, African Region; AMR, Region of the Americas; EMR, Eastern Mediterranean Region; EUR, European Region; SEAR, South-East Asia Region; WPR, Western Pacific Region

countries from five or more external agencies (United Republic of Tanzania, 11; Kenya, 7; Mozambique, 6; Zambia, 6; Angola, 5; Nigeria, 5; and Uganda, 5). Ten countries accounted for 54% of disbursements between 2000 and 2007 (**Table 6.2**); all except India were in the African Region. The latest commitments for malaria in round 8 of the Global Fund and from the United States President's Malaria Initiative are likely to change this pattern.

Figure 6.7 shows malaria disbursements by external agencies per person at risk for malaria in relation to the size of the population at risk. It suggests that smaller countries (such as Sao Tome and Principe, Suriname and Vanuatu) receive more funds per capita than larger countries (such as China, India and Pakistan). Some countries receive more external assistance than others with equivalent populations at risk (e.g. Gambia, Kenya and Malawi). Other countries, such as Cape Verde, Congo and Brazil, are outliers from the overall trend and appear to have lower levels of external funding even after their size is taken into account. The pattern of funding whereby smaller countries receive higher per capita amounts may be appropriate if malaria programmes for smaller populations have proportionally higher fixed costs; however, programmes in smaller countries may also have lower costs for distribution of commodities such as ITNs, ACTs and diagnostics. An obstacle to increasing funding in larger countries is affordability; if all countries had received US$ 5 per capita (as received by the top 25% of countries) during the period analysed,

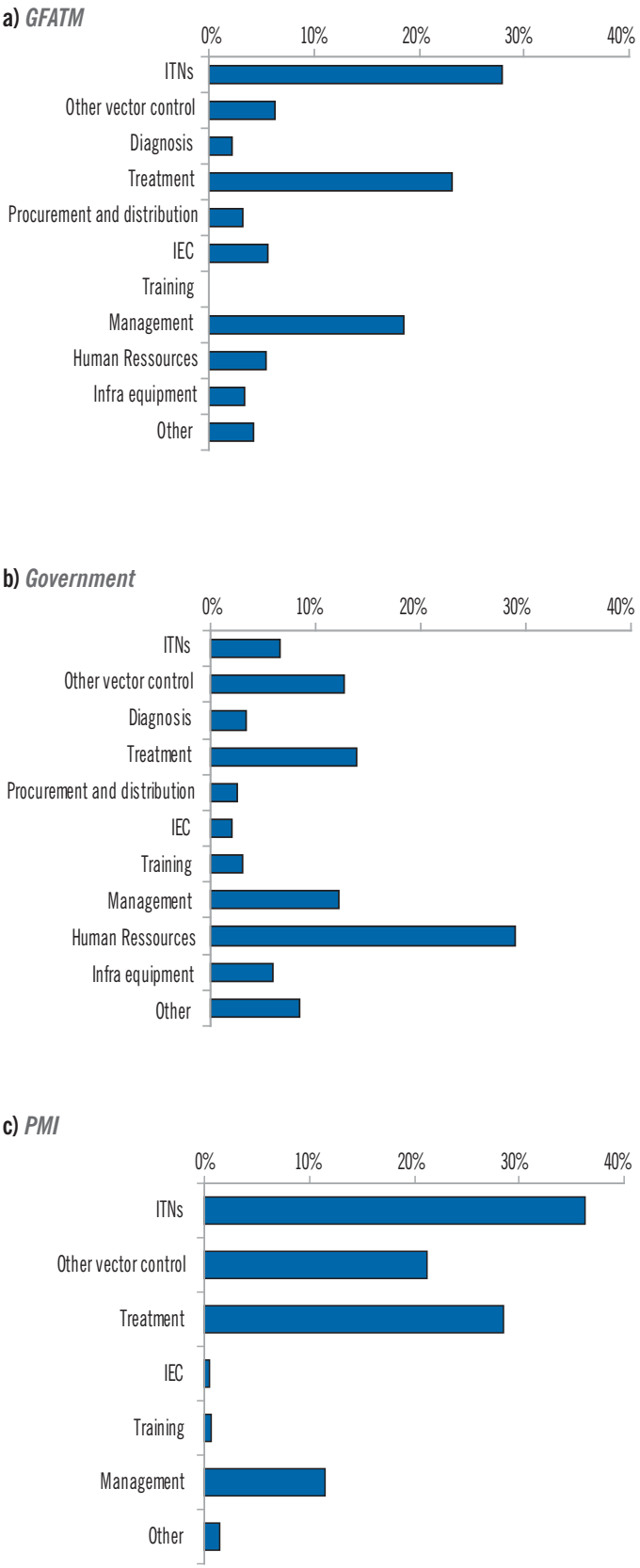
Figure 6.7 Relation between funds disbursed per person at risk for malaria and number of people at risk



Source: Disbursements: Institute for Health Metrics and Evaluation database with amendments to disbursements from the United States President's Malaria Initiative and the World Bank; populations at risk: reports from malaria-endemic countries to WHO

AFR, African Region; RA, Region of the Americas; SEAR, South-East Asia Region; EUR, European Region; EMR, Eastern Mediterranean Region; WPR, Western Pacific Region

Figure 6.8 Uses of funds from different sources



Sources: GFATM (Global Fund to fight AIDS, Tuberculosis and Malaria): Enhanced financial reporting system; Government, annual reports from malaria-endemic countries to WHO; PMI (United States President's Malaria Initiative): Third annual report, 2009 (6)
ITN, insecticide-treated net; IEC, information, education and communication

the amount required for malaria programmes would be more than US$ 2 billion per year, or three times current disbursements to endemic countries.

Very large countries such as China and India appear to be particularly disadvantaged with respect to receipt of external assistance for malaria control, as noted previously by Snow et al. *(5)*. Part of the reason for the apparently low levels of disbursements in very large countries might be that the populations at risk are estimated less precisely and may be overestimated. Populations at risk in large countries are defined within comparatively large administrative units (the median population size of a district in India is 1.5 million), in which the entire population may be classified as being at high risk, even if malaria is confined to a limited area. In smaller countries, where the administrative units are smaller (the median population of a district in Suriname is 22 000), areas with malaria transmission can be delineated more precisely. Therefore, while the observation that large countries receive less external financing is a concern, the imprecision in defining populations at risk in such countries should be taken into account, as should other factors that determine the need for external financing, such as the availability of domestic funds.

6.3.4 Expenditures by programme

Funds from different agencies are used in different ways. **Figure 6.8** gives a breakdown of government expenditure in 28 countries for which there were reports of how government financing for malaria was used in 2008. Each country is weighted equally. The breakdown of expenditures for any one country depends on factors that include the epidemiological situation, the level of external financing, the level of support from subnational administrative bodies and the level of health system development. The graph conceals wide variation among countries (e.g. countries in the South-East Asia Region appear to devote more resources to antimalarial medicines) but illustrates how government financing frequently covers the fixed costs of operating malaria programmes, including human resources and programme management (such as information systems, planning workshops and supervision). Figure 6.8 also shows that funds supplied by the Global Fund and the United States President's Malaria Initiative are often used to finance variable costs, such as the provision of commodities and their distribution.

The ratio of expenditures for vector control programmes to case management programmes is 1.11 for government financing, 1.34 for the Global Fund and 1.99 for the United States President's Malaria Initiative. The differences in ratios between funding sources may be due partly to differences in country representation, as the President's Malaria Initiative is limited to Africa. The projected ratio of funds required for vector control to case management in the Global Malaria Action Plan was 3.8 in 2009 and 2.9 in 2010, suggesting that more spending on vector control programmes is required.

6.4 Relations between external financing, programme implementation and disease trends

6.4.1 Disbursements and programme implementation

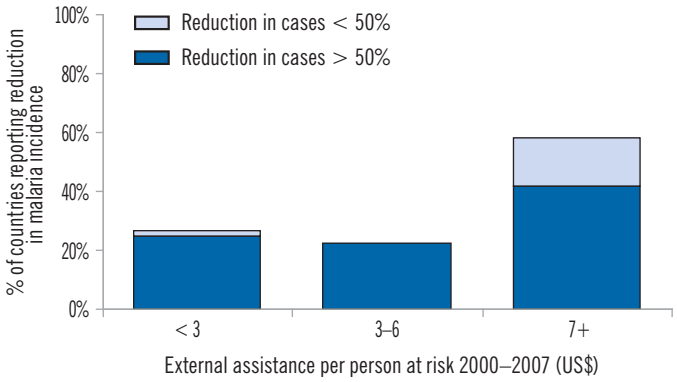
Figure 6.9 shows the numbers of nets procured between 2004 and 2008 per person at risk for malaria versus the amount of external assistance disbursed per head in the African Region between 2003 and 2007. It suggests that some countries that receive higher levels of external assistance per capita (Djibouti, Sao Tome and Principe) have been able to procure more nets per head of population than countries with lower funding ratios (Côte d'Ivoire, Nigeria). It also suggests that some countries have procured more nets per head of population than would be expected given the level of external assistance provided (Congo, Mali), possibly because of use of domestic resources, cost savings (e.g. using volunteers in mass campaigns) or gaps in the data. Other countries appear to have procured fewer nets than expected (Comoros, Swaziland, United Republic of Tanzania), perhaps because external assistance was targeted to other programmes, such as IRS or diagnosis and treatment, less efficient use of funds or gaps in the data on net procurement.

As information on net procurement and deliveries outside Africa is less complete, a similar analysis could not be undertaken. It would be informative to examine procurements of other commodities, such as RDTs and ACTs, but complete databases are not available.

6.4.2 Disbursements and malaria disease trends

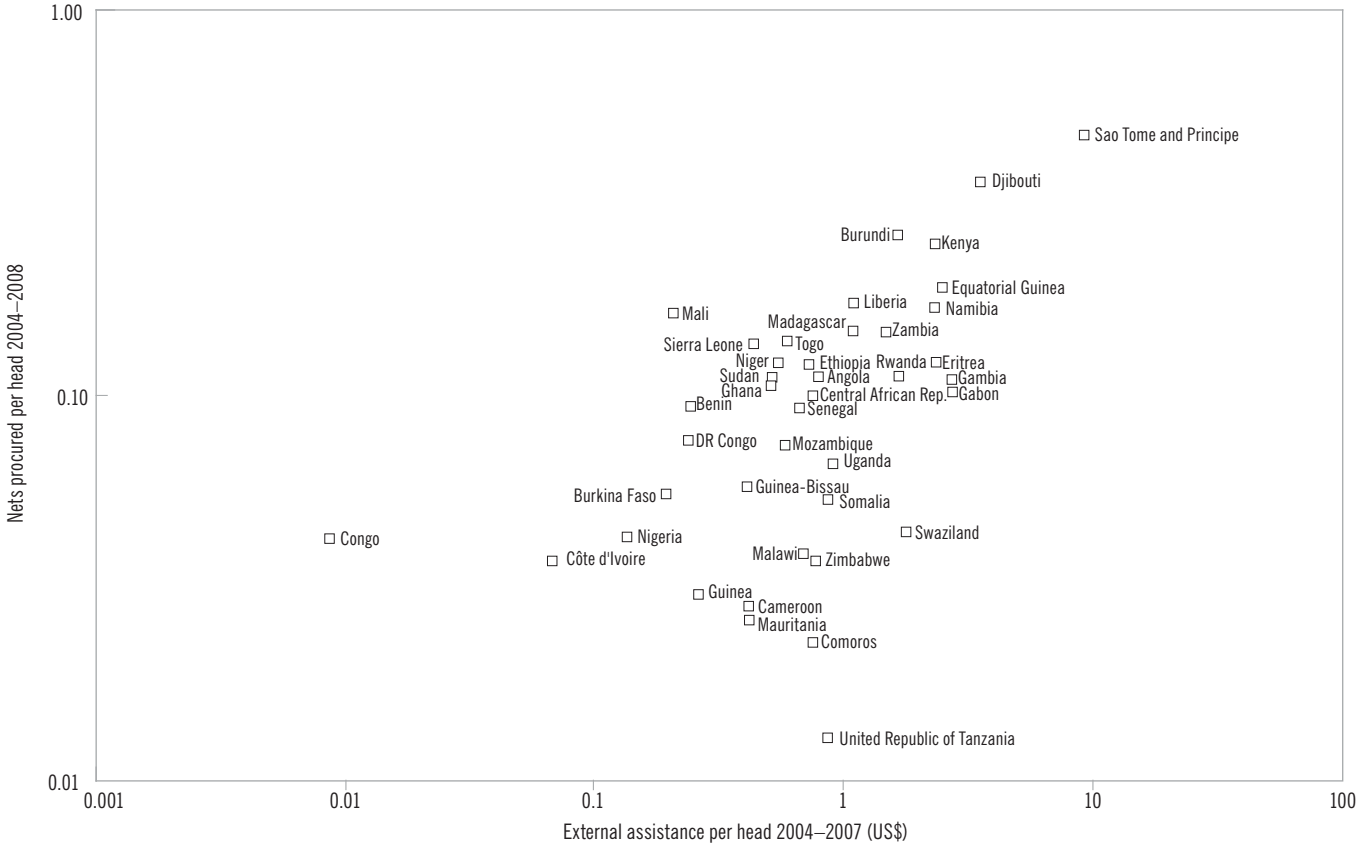
Figure 6.10 shows the relation between disbursements by external agencies per capita between 2000 and 2007 and evidence for a decrease in the burden of malaria, as highlighted in Chapter 4 of this Report. Approximately 60% of countries receiving more than US$ 7 per person at risk reported a reduction in the number of cases of malaria since 2000, whereas only 26% of countries receiving US$ 7 or less reported reductions. Although few (10) countries received

Figure 6.10 Relation between external assistance disbursed in 2000–2007 per person at risk for malaria and decrease in malaria cases, 2000–2008



Sources: Disbursements: Institute for Health Metrics and Evaluation database with amendments to disbursements by the United States President's Malaria Initiative and the World Bank; trends in cases: reports from malaria-endemic countries to WHO

Figure 6.9 Relation between disbursements by external agencies for malaria control and nets procured by endemic countries



Source: Disbursements: Institute for Health Metrics and Evaluation database with amendments to disbursements by the United States President's Malaria Initiative and the World Bank; nets procured: records of the Alliance for Malaria Prevention, updated March 2009

such a high level of assistance, the observation suggests that high levels of external assistance per person at risk for malaria are associated with decreases in the incidence of malaria.

While success in reducing the incidence of malaria is seen in some countries with high levels of external assistance (Eritrea, Georgia, Sa0 Tome and Principe, Suriname, Solomon Islands and Vanuatu), evidence is lacking for others (e.g. Djibouti, Equatorial Guinea[8] and Gabon), perhaps because control programmes are implemented less than optimally or because of other factors that reduce the impact of malaria control, such as unfavourable climate conditions. It may also be due to deficient surveillance systems that are unable to detect change because of inconsistent reporting or reliance on suspected rather than confirmed cases.

Some countries with less external assistance per capita have reported success in reducing the number of cases of malaria. These tend to be richer countries with better developed malaria programmes, which probably receive more domestic resources per head. Alternatively, some investments in health systems strengthening that affect malaria may not have been captured in this analysis. While high levels of funding may be responsible for decreases in malaria incidence, funding agencies may tend to place funds in countries where success is more likely or has already been demonstrated.

While the increases in funds have been substantial, the current level of financing does not yet meet the estimated requirements for successful control of malaria and for reaching the MDG of more than US$ 5 billion per year.

The limited funds for malaria control appear to be disproportionately focused on smaller countries with lower disease burdens. There is evidence that high levels of external assistance are associated with decreases in malaria incidence, but positive trends are seen primarily in countries with low disease burdens, where success is more easily achieved.

Countries that substantially reduce the burden of malaria cases can face difficulties in justifying continued investment in malaria control. Continued or increased support is, however, critical to protect current achievements and move towards elimination. Financing of malaria programmes is also placed at risk by the global financial crisis. A prolonged recession could force shelving of elimination plans in many countries and jeopardize the fragile progress made in malaria control.

Conclusions

The funds committed to malaria control from international sources have increased substantially, from around US$ 0.3 billion in 2003 to US$ 1.7 billion in 2009. The massive increase is due primarily to the emergence of the Global Fund and greater commitments to malaria control by the United States President's Malaria Initiative, UNITAID, the World Bank and a range of bilateral agencies.

Disbursements to malaria-endemic countries are less than the amounts committed; about US$ 0.65 billion were disbursed to malaria-endemic countries in 2007, the latest year for which comprehensive data are available. Approximately 80% of funds disbursed were targeted to the WHO African Region, which accounts for about 30% of the population at risk and 90% of global cases and deaths. The South-East Asia Region received the least money per person at risk for malaria and saw the smallest increase in disbursements from external financing between 2000 and 2007.

Contributions from national governments are more difficult to establish. Domestic financing for malaria has increased in many countries in all regions, although there may have been decreases between 2007 and 2008 in two regions, and there was a steady decrease in the South-East Asia Region between 2005 and 2008.

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8 Large reductions in mortality among children under 5 years were observed on Bioko Island after intensified vector control and improved access to treatment, but such success has not yet been reported elsewhere in Equatorial Guinea.