

Summary and Key Points

The *World Malaria Report 2011* summarizes information received from 106 malaria-endemic countries and other sources and updates the analyses presented in the 2010 report. It highlights continued progress made towards meeting the international targets for malaria control set for 2010 and 2015.

International funding for malaria control has continued to rise, to a peak of US\$ 2 billion in 2011. The amounts committed to malaria, while substantial, still fall short of the resources required to reach malaria control targets, estimated at more than US\$ 5 billion per year for the years 2010–2015. Moreover, funding is projected to remain at these levels or decrease before 2015 unless new sources of funds are identified.

The financing provided for malaria control has enabled endemic countries to greatly increase access to insecticide-treated mosquito nets (ITNs); the percentage of households owning at least one ITN in sub-Saharan Africa is estimated to have risen from 3% in 2000 to 50% in 2011 while the percentage protected by indoor residual spraying (IRS) rose from less than 5% in 2005 to 11% in 2010. Household surveys indicate that 96% of persons with access to an ITN within the household actually use it. The number of rapid diagnostic tests (RDTs) and artemisinin-based combination therapies (ACTs) procured is increasing, and the percentage of reported suspected cases receiving a parasitological test has also increased, from 67% globally in 2005 to 76% in 2010, with the largest increase in sub-Saharan Africa. Despite this significant progress, however, more work is needed before the target of universal access is attained.

Reductions in reported malaria cases of more than 50% have been recorded between 2000 and 2010 in 43 of the 99 countries with ongoing transmission, while downward trends of 25%–50% were seen in 8 other countries. There were an estimated 216 million episodes of malaria in 2010, of which approximately 81%, or 174 million cases, were in the African Region. There were an estimated 655 000 malaria deaths in 2010, of which 91% were in Africa. Approximately 86% of malaria deaths globally were of children under 5 years of age. The estimated incidence of malaria globally has reduced by 17% since 2000 and malaria-specific mortality rates by 26%. These rates of decline are lower than internationally agreed targets for 2010 (reductions of 50%) but nonetheless, they represent a major achievement.

Resistance to artemisinins – a vital component of drugs used in the treatment of *P. falciparum* malaria – has been reported in a growing number of countries in South-East Asia. Resistance to pyrethroids, the insecticides used in ITNs – and most commonly used in IRS – has been reported in 27 countries in Africa and 41 countries worldwide. Unless properly managed, such resistance potentially threatens future progress in malaria control.

Internationally agreed targets and goals for malaria control

The year 2010 was an important milestone on the way to achievement of internationally agreed goals and targets for

malaria control. In the light of progress made by 2010, targets for the Global Malaria Action Plan (GMAP) of the Roll Back Malaria Partnership were updated in June 2011.

1. The year 2010 was the date set to achieve universal coverage for all populations at risk of malaria using locally appropriate interventions for prevention and case management, and to reduce the malaria burden by at least 50% compared to the levels in the year 2000.
2. In the light of progress made by 2010, the Roll Back Malaria (RBM) targets were updated in June 2011. The targets are now to: (i) reduce global malaria deaths to near zero by end-2015; (ii) reduce global malaria cases by 75% from 2000 levels by end-2015; and (iii) eliminate malaria by end-2015 in 10 new countries since 2008, including in the WHO European Region. These targets will be met by: achieving and sustaining universal access to, and utilization of, preventive measures; achieving universal access to case management in the public and private sectors and in the community (including appropriate referral); and accelerating the development of surveillance systems.

Financing malaria control

The funds committed to malaria control from international sources are expected to peak in 2011 at US\$ 2 billion and remain substantially lower than the resources required to achieve global targets, estimated at > US\$ 5 billion for the years 2010–2015.

3. International funding is expected to peak in at US\$ 2 billion 2011. From 2012 to 2013 it is projected to remain relatively stable, but then decrease to US\$ 1.5 billion in 2015. A reduction in commitments from the Global Fund is partly offset by increased commitments from the United Kingdom's Department for International Development (DFID) of up to US\$ 800 million by 2015. Information on domestic government funding for malaria control is less complete. Available information suggests that domestic funding is generally less than US\$ 1 per person at risk and represents a small proportion of the total financing of malaria control in the most highly endemic countries.
4. Cost savings within vector control programmes may be possible but are likely to be modest, for several reasons: (i) the price of an ITN, which represents the largest component of the cost of ITN programmes, has decreased by 29% between 2007 and 2011, but the reductions may not be maintained if manufacturers cut their manufacturing capacity; (ii) large purchasers usually obtain the lowest prices, leaving little room for efficiencies through improved procurement; (iii) the costs of the two main strategies for delivering ITNs, via mass campaigns or health services, are similar and typically comprise only 5%–10% of the total cost of delivery; moreover delivery costs may increase when programmes need to deliver only to households requiring replacement nets rather than to all households; (v) there is scope for reducing the cost per person protected by IRS by expanding IRS programmes, but the cost per person

- protected per year is US\$ 2.62 in large programmes, compared to approximately US\$ 1.39 for ITNs.
5. Expenditure on treatment is expected to decrease as parasitological testing is expanded to all suspected cases of malaria. With current prices of RDTs and ACTs (US\$ 0.50 for RDT and US\$ 1.40 for AL), and perfect compliance with test results, savings on commodities could amount to US\$ 68 million in the public sector in the WHO African Region. However, expanding the use of RDTs may not lead to overall cost savings because of the possible added costs due to increased staff time to perform tests, establishing quality control systems, alternative therapies for patients with negative test results, and the start-up costs of changing malaria case management policy. Any additional costs would need to be balanced against the improved quality of care provided to patients, better health outcomes, the potential reduction in the risk of emergence and spread of antimalarial drug resistance, and improved malaria surveillance.
 6. Improved malaria control should result in lower numbers of malaria cases and lead to reductions in the cost of treating patients; attainment of universal access to ITNs in the WHO African Region in 2015 could reduce the number malaria cases attending public health facilities by 31 million to 48 million. The savings on commodities alone (ACTs and RDTs) would amount to more than US\$ 59 million per year in the African Region. However the full potential of these savings will not be realized if all fever cases are treated presumptively as malaria, without confirmation by a diagnostic test.
 7. Potentially large savings could be made through new technologies. The development and deployment of ITNs lasting 5 years could reduce the total number of ITNs required between 2011 and 2020 from 1.25 billion to 750 million. If the unit cost of delivering both types of ITNs were similar, at US\$ 7.66, a total of US\$ 3.8 billion could be saved from a financing requirement of US\$ 9.6 billion. The price of RDTs has fallen by 11%–15% annually from 2008 to 2010. The development of still cheaper tests could lead to considerable cost reductions; even if RDTs were used for only half the suspected malaria cases attending public health facilities in the WHO African Region, halving the price from the current US\$ 0.50 to US\$ 0.25 would save US\$ 45 million per year.
 8. Malaria programmes accounted for approximately 8% of Official Development Assistance (ODA) for health and population in 2009, increasing from 3% in 2005. Overall financing for health and population remained stable between 2008 and 2009, and is likely to do so thereafter. Given stable total funding, and that malaria programmes already receive a significant proportion of health and population financing, further increases in malaria funding within health sector financing may be unlikely.
 9. There appears to be scope for domestic governments to invest more in malaria control. If just 1% of total domestic spending were made available for malaria control, 75 of the 99 countries with ongoing malaria transmission could raise enough to provide each person at risk with access to an ITN. Global economic growth has allowed many malaria-endemic countries to increase total domestic government spending; more than 42 countries increased per capita spending by US\$ 1000 between 2000 and 2010.
 10. Innovative financing mechanisms are in the early stages of development. Taxes on bonds and derivatives transactions may offer the greatest potential for revenue generation – estimated in excess of US\$ 250 billion – but their suggested uses go beyond malaria control. Taxes on airline journeys currently raise more than US\$ 200 million for health development and their extension to additional countries could generate significant additional funds. Other country-specific schemes, such as tourist taxes, may offer opportunities to raise funds for control programmes in malaria-endemic countries.

Progress in vector control

Coverage with ITNs and IRS has increased rapidly in some countries of sub-Saharan Africa, with household ITN ownership reaching 50% by mid-2011 and IRS protecting 11% of the population at risk. Resistance to pyrethroids has been detected in 27 countries in sub-Saharan Africa.

Insecticide-treated mosquito nets

11. In 2010, 27 countries in the African Region and 42 in other WHO Regions had adopted the WHO recommendation to provide ITNs for *all* persons at risk for malaria, not only pregnant women and children; this represents an increase of 4 countries since 2009. A total of 82 countries, of which 38 are in the African Region, distribute ITNs free of charge.
12. The number of ITNs delivered by manufacturers increased dramatically from 5.6 million in 2004 to 145 million in 2010 in sub-Saharan Africa. The numbers procured between 2008 and 2010 (294 million) were sufficient to cover 73% of the 800 million persons at risk, but this does not take into account delays in delivering ITNs in countries or loss of ITNs after delivery to households.
13. The number of ITNs supplied by manufacturers in 2011 appears to have decreased to approximately 100 million. This is partly because some countries have made substantial progress towards achieving universal access to ITNs in 2010 and are not yet scheduled to reorder ITNs, but also because some countries are still not expanding programmes to a sufficient scale.
14. Using a model that takes into account the number of ITNs supplied by manufacturers, the number of ITNs delivered by national malaria control programmes (NMCPs), and household survey data, the percentage of households owning at least one ITN in sub-Saharan Africa is estimated to have risen from 3% in 2000 to 50% in 2011. Considerably more work is required to ensure that ITNs reach all households where they are needed.
15. Analysis of recent household surveys indicates that approximately 96% of persons with access to an ITN within the household actually use it, suggesting that the main constraint to enabling persons at risk of malaria to sleep under an ITN remains the insufficient availability of nets.
16. The rapid scale-up of ITN distribution in Africa is an enormous public health achievement, but also presents a formidable

challenge for the future in ensuring that the levels of coverage are maintained. There is uncertainty over the extent to which ITN effectiveness decays over time, but the lifespan of a long-lasting insecticidal net (LLIN) is currently estimated to be 3 years. Nets delivered in 2007 and 2008 are therefore now due for replacement, soon to be followed by those delivered in 2009 and 2010.

Indoor residual spraying

17. IRS with WHO-approved chemicals (including DDT) remains one of the main interventions for reducing and interrupting malaria transmission through vector control in all epidemiological settings. In 2010, 73 countries, including 36 in the African Region, recommended IRS for malaria control and 13 countries reported using DDT for IRS.
18. A total of 185 million people were protected by IRS in 2010, representing 6% of the global population at risk. The number of people protected by IRS in the African Region increased from 10 million in 2005 to 78 million in 2010; including all countries in sub-Saharan Africa 81 million people were protected, which corresponds to protection for 11% of the population at risk. In other WHO Regions the number of people protected by IRS is generally stable.

Insecticide resistance

19. Monitoring of insecticide resistance is a necessary element of any medium-scale or large-scale deployment of an insecticidal intervention. In 2010, 78 countries reported that they were carrying out insecticide resistance monitoring.
20. Current methods of malaria control are highly dependent on a single class of insecticides, the pyrethroids, which is the only insecticide class used for ITNs and accounts for approximately 77% of IRS in terms of spray area covered. The widespread use of a single class of insecticide increases the risk that mosquitoes will develop resistance to it. This risk is of particular concern in sub-Saharan Africa, where insecticidal vector control is being deployed with unprecedented levels of coverage. Resistance to pyrethroids has been reported in 27 countries in sub-Saharan Africa; the point at which this reduces the effectiveness of vector control is still uncertain, and may depend on the locally identified resistance mechanism. As requested by the World Health Assembly, WHO is currently working with a wide variety of stakeholders to develop a Global Plan for Insecticide Resistance Management in malaria vectors, to be released in early 2012.

Progress on chemoprevention

The percentage of pregnant women who received two doses of IPTp during pregnancy in ranged from 4% to 68%.

21. Intermittent preventive treatment (IPT) is recommended for population groups in areas of high transmission who are particularly vulnerable to *Plasmodium* infection and its

consequences, particularly pregnant women and infants. A total of 35 of 45 sub-Saharan African countries had adopted IPT for pregnant women (IPTp) as national policy by the end of 2010. Papua New Guinea, in the Western Pacific Region, also adopted this policy in 2009.

22. In the 21 high-burden countries in the African Region which have adopted IPTp as national policy, data reported by NMCPs indicate that the percentage of women attending antenatal clinics who received the second dose of IPTp in 2010 was 55% (inter-quartile range 47% – 61%).
23. In 13 countries in the African Region for which household survey data were available for 2008–2010, the percentage of women who received two doses of IPTp during pregnancy in ranged from 4% in Namibia to 68% in Zambia; the weighted average remained low, at 24%, primarily due to low coverage in Nigeria and the Democratic Republic of Congo.
24. All infants at risk of *P. falciparum* infection in countries in sub-Saharan Africa with moderate to high malaria transmission should receive 3 doses of sulfadoxine-pyramethamine (SP), to be provided through immunization services at defined intervals corresponding to routine vaccination schedules. No country has yet adopted a national policy of IPT for infants (IPTi) since its recommendation in 2009.

Progress in diagnostic testing and malaria treatment

The number of RDTs and ACTs procured is increasing, and the percentage of reported suspected cases receiving a parasitological test has also increased, from 67% globally in 2005 to 73% in 2009. Many cases still are treated presumptively without a parasitological diagnosis.

Diagnostic testing

25. Prompt parasitological confirmation by microscopy or RDT is recommended for all patients with suspected malaria, before treatment is started. In 2010, 37 of 43 malaria-endemic countries in the African Region and 53 of 63 endemic countries in other WHO Regions reported having adopted a policy of providing parasitological diagnosis for all age groups, an increase of 4 countries in the African Region since 2009, and 8 elsewhere.
26. The number of RDTs supplied by manufacturers increased from 45 million in 2008 to 88 million in 2010. Product testing has shown an improvement in test quality over time, and proportionally more high quality tests are being procured over time; nearly 90% of RDTs procured in 2011 had panel detection scores of more than 75%, compared with only 23% of RDTs procured in 2007.
27. The percentage of reported suspected malaria cases receiving a parasitological test has increased between 2005 and 2010, particularly in the African Region (from 26% to 45%), Eastern Mediterranean Region (60% to 91%) and South-East Asia

Region excluding India (from 58% to 95%). Low rates persist in the majority of African countries: in 21 out of 42 countries which reported on testing, the percentage of cases tested was less than 20%.

28. Data from a limited number of countries suggest that both microscopy and RDTs are less widely available in the private sector than in the public sector. A total of 48 countries report deployment of RDTs at the community level and 11 million patients were tested through such programmes in 2010.

Treatment

29. Confirmed cases of uncomplicated *P. falciparum* malaria should be treated with an ACT. In 2011, 84 countries and territories had adopted ACT for first-line treatment of *P. falciparum* malaria, representing an increase from 77 countries in 2010. *P. vivax* malaria should be treated with chloroquine where this drug is effective, or an appropriate ACT in areas where *P. vivax* is resistant to chloroquine. Treatment of *P. vivax* should be combined with a 14-day course of primaquine to prevent relapse.
30. The number of ACT treatment courses procured by the public sector increased greatly from 11.2 million in 2005 to 76 million in 2006, and reached 181 million in 2010. A total of 35 million treatments were estimated to have been procured by the private sector in 2010. Total ACT demand is projected to reach 287 million treatment courses in 2011, an increase of 32% over that in 2010. The main driver of this increase is the almost 10-fold increase in subsidized private sales through the AMFm.
31. A limited number of recent household surveys undertaken between 2008 and 2010 suggest that febrile patients attending public health facilities are more likely to receive an ACT than those attending private facilities, but this may change in 2011 for those countries participating in the AMFm pilot programme.
32. In the African Region in 2010, the number of ACTs distributed by NMCPs was more than twice the total number of tests (microscopy + RDTs) carried out in 2010, indicating that many patients continue to receive ACTs without confirmatory diagnostic testing.

Drug resistance

33. WHO recommends that oral artemisinin-based monotherapies be withdrawn from the market and replaced with ACTs. By November 2011, 25 countries were still allowing the marketing of these products (no change from 2010) and 28 pharmaceutical companies were marketing them (down from 39 in 2010). Most of the countries that still allow the marketing of monotherapies are in the African Region, while most of the manufacturers are in India.
34. Therapeutic efficacy studies remain the gold standard for guiding drug policy and should be undertaken at least every 2 years. Efficacy studies of first-line or second-line antimalarial treatments were completed in 31 of 75 countries where *P. falciparum* efficacy studies are possible (in 17 countries efficacy

studies are impractical because of low malaria incidence, and 15 countries are endemic for *P. vivax* only). A further 12 had planned to conduct studies in 2010 or 2011. Efficacy studies were last conducted more than three years ago in 32 countries.

35. Suspected resistance to artemisinins has now been identified in four countries in the Greater Mekong subregion: Cambodia, Myanmar, Thailand and Viet Nam. Containment efforts have shown that a reduction in malaria incidence, a key component of the overall containment plan to halt the spread of resistant parasites, can be achieved. Despite the observed changes in parasite sensitivity to artemisinins, the clinical and parasitological efficacy of ACTs remains high in most settings. However, high treatment failure rates to several ACTs, in particular to dihydroartemisinin-piperaquine which is one of the newest ACTs, has already been identified in Pailin province in Cambodia. This highlights the need for vigilance not only to protect the efficacy of artemisinins, but also the partner medicines in the drug combinations.
36. In 2011 WHO published the *Global Plan for Artemisinin Resistance Containment* (GPARC), which recommends five key activities for successful management of artemisinin resistance: stop the spread of resistant parasites; increase monitoring and surveillance to evaluate the threat of artemisinin resistance; improve access to diagnostics and rational treatment with ACTs; invest in research related to artemisinin resistance; and motivate action and mobilize resources.

Impact of malaria control

A growing number of countries have recorded decreases in the number of confirmed cases of malaria and/ or reported admissions and deaths since 2000. Global control efforts have resulted in a reduction in the incidence of malaria and malaria-specific mortality rates.

37. A total of 8 countries and one area in the WHO African Region showed > 50% reduction in either confirmed malaria cases or malaria admissions and deaths in recent years (Algeria, Botswana, Cape Verde, Namibia, Rwanda, Sao Tome and Principe, South Africa, Swaziland, and Zanzibar, United Republic of Tanzania). Eritrea, Ethiopia, Senegal and Zambia showed reductions of 25%–50%. In all countries, the decreases are associated with intense malaria control interventions.
38. The increases in malaria cases observed in Rwanda and in Sao Tome and Principe in 2009 (two countries that had previously reported reductions) were reversed after intensification of control measures. This highlights the need to build systems for effective surveillance of malaria and to rigorously maintain control programmes even when cases have been reduced substantially. According to available information, increases in cases and deaths observed in Zambia in 2009 have not yet been reversed.
39. While substantial decreases in the numbers of malaria cases are observed in countries with well developed surveillance systems, it is much more difficult to detect such changes in countries where surveillance systems are weaker, particularly in the more populous countries of Central and West Africa. In

countries which are expanding the use of microscopy and RDTs the numbers of confirmed cases have risen, reflecting changes in diagnostic practice and concealing the underlying trends in malaria incidence. More detailed investigation of trends in malaria cases and changes in diagnostic practice is needed to obtain a more accurate picture of the real changes in malaria incidence.

40. In other WHO Regions, the number of reported cases of confirmed malaria decreased by more than 50% in 35 of the 53 countries with ongoing transmission between 2000 and 2010 and downward trends of 25%–50% were seen in 4 other countries. In 2010, the European Region reported only 176 indigenous cases. The number of cases continued to fall least in countries with the highest incidence rates, indicating that greater attention should be given to countries which harbour most of the malaria burden outside Africa.
41. There were 8 countries in the pre-elimination stage of malaria control in 2011 and 9 countries are implementing elimination programmes nationwide (8 having entered the elimination phase in 2008). A further 8 countries (Bahamas, Egypt, Georgia, Iraq, Jamaica, Oman, Russian Federation, and Syrian Arab Republic) have interrupted transmission and are in the prevention of reintroduction phase. Armenia was certified as free of malaria by the WHO Director-General in 2011.
42. An estimated 3.3 billion people were at risk of malaria in 2010. Of this total, 2.1 billion were at low risk (< 1 reported case per 1000 population), 94% of whom were living in geographic regions other than the WHO African Region. The 1.2 billion at high risk (> 1 case per 1000 population) were living mostly in the WHO African (47%) and South-East Asia Regions (37%).
43. There were an estimated 216 million episodes of malaria in 2010, with a wide uncertainty interval (5th–95th centiles) from 149 million to 274 million cases. Approximately 81%, or 174 million (113–239 million) cases, were in the African Region, with the South-East Asian Region accounting for another 13%.
44. There were an estimated 655 000 (537 000 – 907 000) malaria deaths in 2010, of which 91% (596 000, range 468 000 – 837 000) were in the African Region. Approximately 86% of malaria deaths globally were of children under 5 years of age.
45. The estimated incidence of malaria has fallen by 17% globally between 2000 and 2010. Larger percentage reductions are seen in the European (99.5%), American (60%) and Western Pacific regions (38%). Malaria specific mortality rates have fallen by 25% between 2000 and 2010 with the largest percentage reductions seen in the European (99%), American (55%), Western Pacific (42%) and African Regions (33%).
46. Estimates of malaria incidence are based, in part, on the numbers of cases reported by NMCPs. These case reports are far from complete in most countries. A total of 24 million confirmed malaria cases was reported by NMCPs in 2010, or 11% of the estimated global case incidence.