Section 1: Introduction

Table 1.1 Declarations and plans containing targets for malaria control and elimination 2000–2015
The table shows major declarations and plans that contain targets for malaria control and elimination 2000–2015.

Table 1.2 MDG 6 and associated malaria target and indicators
The table shows the Millennium Development Goal (MDG), target and indicators. Source: Millennium Development Goals Indicators (1).

Table 1.3 Roll Back Malaria objectives, targets for 2015 and indicators for measuring progress
This table shows the Global Malaria Action Plan (GMAP) targets and indicators. Source: World malaria report 2012 (2) and Household survey indicators for malaria control (3).

Section 2: Trends in infection prevalence, cases and deaths

Table 2.1 Estimated malaria cases and deaths, by WHO region, 2000–2015
The number of malaria cases was estimated by one of two methods:

i) For countries outside Africa and for low-transmission countries in Africa: estimates of the number of cases were made by adjusting the number of reported malaria cases for completeness of reporting, the likelihood that cases are parasite positive and the extent of health-service use. The procedure, which is described in the World malaria report 2008 (4, 5), combines data reported by national malaria control programmes (NMCPs) (reported cases, reporting completeness, likelihood that cases are parasite positive) with those obtained from nationally representative household surveys on health-service use. Projections to 2015 were made using the results of country-specific segmented regression analyses (6). The trend line from the most recent segment of years was extrapolated to project cases and deaths for 2014 and 2015. The number of P. vivax malaria cases in each country was estimated by multiplying the country's reported proportion of cases that are P. vivax by the total number of estimated cases for the country.

ii) For high-transmission countries in Africa: for some African countries, the quality of surveillance data did not permit a convincing estimate to be made from the number of reported cases. Hence, estimates of the number of malaria cases were derived from information on parasite prevalence obtained from household surveys. First, parasite prevalence data from 27 573 georeferenced population clusters between 1995 and 2014 were assembled within a spatiotemporal Bayesian geostatistical model, along with environmental and sociodemographic covariates and data on use of insecticide-treated mosquito nets (ITNs) and access to artemisinin–based combination therapies (ACTs). The geospatial model enabled predictions to be made of P. falciparum parasite prevalence in children aged 2–10 years at a resolution of 5 × 5 km² across all endemic African countries for each year from 2000 to 2015. Second, an ensemble model was developed to predict malaria incidence as a function of parasite prevalence. The model was then applied to the estimated parasite prevalence, to obtain estimates of the malaria case incidence at 5 × 5 km² resolution for each year from 2000 to 2015. Data for each 5 × 5 km² area were then aggregated within country and regional boundaries to obtain national estimates and regional estimates of malaria cases (7).

The number of malaria deaths was estimated by one of two methods:

i) For countries outside Africa and for low-transmission countries in Africa: the number of deaths was estimated by multiplying the estimated number of P. falciparum malaria cases by a fixed case fatality rate for each country, as described in the World malaria report 2008 (4). This method was used for all countries outside Africa and for low-transmission countries in Africa, where estimates of case incidence were derived from routine reporting systems. A case fatality rate of between 0.01% and 0.40% was applied to the estimated number of P. falciparum cases, and a case fatality rate of between 0.01% and 0.06% was applied to the estimated number of P. vivax cases. For countries in the pre-elimination and elimination phases, and those with vital registration systems that reported more than 50% of all deaths (determined by comparing the number of reported deaths with those expected given a country’s population size and crude deaths rate), the number of malaria deaths was derived from the number of reported deaths, adjusting for completeness of reporting.

ii) For countries in Africa with a high proportion of deaths due to malaria: child malaria deaths were estimated using a verbal autopsy multicause model developed by the Maternal and Child Health Epidemiology Estimation Group which estimates causes of death for children aged 1–59 months (8). Mortality estimates were derived for seven causes of post-neonatal death (pneumonia, diarrhoea, malaria, meningitis, injuries, pertussis and
other disorders), causes arising in the neonatal period (prematurity, birth asphyxia and trauma, sepsis, and other conditions of the neonate) and other causes (e.g., malnutrition). Deaths due to measles, unknown causes and HIV/AIDS were estimated separately. The resulting cause-specific estimates were adjusted, country by country, to fit the estimated 1–59 month mortality envelopes (excluding HIV and measles deaths) for corresponding years. Estimated malaria parasite prevalence, as described above, was used as a covariate within the model. Deaths in those aged over 5 years were inferred from a relationship between levels of malaria mortality in different age groups and the intensity of malaria transmission (9); thus, the estimated malaria mortality rate in children aged under 5 years was used to infer malaria-specific mortality in older age groups.

Table 2.2 Estimated malaria incidence and death rates, by WHO region, 2000–2015
Incidence rates were derived by dividing estimated malaria cases by the population at risk of malaria within each country. The total population of each country was taken from the 2015 revision of the World population prospects (10) and the proportion at risk of malaria derived from NMCP reports. Malaria death rates were derived by dividing annual malaria deaths by the mid-year population at risk of malaria within each country. Where death rates are quoted for children aged under 5 years, the number of deaths estimated in children aged under 5 years was divided by the estimated number of children aged under 5 years at risk of malaria.

Table 2.3 Estimated number of malaria deaths in children aged under 5 years, by WHO region, 2015
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria deaths in children aged under 5 years.

Figure 2.1 Estimated malaria case incidence and death rates globally, 2000–2015
See the methods notes for Table 2.1 and Table 2.2 for the calculation of incidence and death rates globally.

Figure 2.2 Percentage decrease in (a) estimated malaria case incidence and (b) malaria death rate, by WHO region, 2000–2015.
See the methods notes for Table 2.1 and Table 2.2 for the calculation of incidence and death rates by region.

Figure 2.3 Under-5 mortality rate in sub-Saharan Africa, 2000–2015
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria and total death rates in children aged under 5 years.

Figure 2.4 Leading causes of death among children aged under 5 years in sub-Saharan Africa, 2000–2015
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria death rates and death rates by other causes in children aged under 5 years.

Figure 2.5 Estimated P. falciparum infection prevalence among children aged 2–10 years (PPR<sub>2–10</sub>) in 2000 and 2015
See the methods notes for Table 2.1 for the estimation of malaria parasite prevalence. This figure was produced by the University of Oxford Malaria Atlas Project (7).

Figure 2.6 Estimated change in malaria case incidence 2000–2015, by WHO region
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria case incidence by WHO region.

Table 2.4 Summary of trends in reported malaria case incidence 2000–2015, by WHO region
The main source of information on reported numbers of malaria cases and deaths are the disease surveillance systems operated by ministries of health. Data from such systems have three strengths: (i) case reports are recorded continuously over time and can thus reflect changes in the implementation of interventions or other factors; (ii) routine case and death reports are often available for all geographical units of a country; and (iii) the data reflect the burden that malaria places on the health system. Changes in the numbers of cases and deaths reported by countries do not, however, necessarily reflect changes in the incidence of disease in the general population, for several reasons. First, not all health facilities report each month; hence, variations in case numbers may reflect fluctuations in the number of health facilities reporting rather than a change in underlying disease incidence. Second, 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. Finally, not all malaria cases reported are confirmed by microscopy or rapid diagnostic testing (RDT); hence, some of the cases reported as malaria may actually be other febrile illnesses (5,11). When reviewing data supplied by ministries of health in malaria endemic countries, the following strategy was used to minimize the influence of these sources of error and bias:

- Focusing on confirmed cases (by microscopy or RDT) to ensure that malaria (not other febrile illnesses) was tracked. For high burden countries in the WHO African Region, where there is little confirmation of cases, the numbers of malaria admissions (inpatient cases) and deaths were reviewed, because the predictive value of malaria diagnosis for an admitted patient is considered to be higher than that of an outpatient diagnosis. In such countries, the analysis may be heavily influenced by trends in cases of 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 (ABER), to ensure that potential differences in diagnostic effort or completeness of reporting are taken into account. To discern decreases in malaria incidence, the ABER should ideally remain constant or increase over time. In addition, it is useful to monitor
the percentage of suspected malaria cases that are examined with a parasite-based test. Some authorities recommend that the ABER should be >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%. A value of 10% may not be sufficient to detect all febrile cases. In Solomon Islands, a highly endemic country, the ABER exceeds 60%, with a slide positivity rate (SPR) of 25%, achieved solely through passive case detection.

- Monitoring trends in the SPR or RDT positivity rate. This rate should be less severely distorted by variations in the ABER than trends in the number of confirmed cases.
- Monitoring malaria admissions and deaths. For high-burden African countries, when reviewing the number of malaria admissions or deaths, it is also informative to examine the number of admissions from all causes, which should remain constant or increase over time. If the total number of admissions fluctuates, then it may be preferable to examine the percentage of admissions or deaths due to malaria, because this proportion is less sensitive to variation in reporting rates than the number of malaria admissions or deaths.

- Monitoring the number of cases detected in the surveillance system in relation to the total number of cases estimated to occur in a country. Trends derived from countries with high case detection rates are more likely to reflect trends in the broader community. When examining trends in the number of deaths, it is useful to compare the total number of deaths occurring in health facilities with the total number of deaths estimated to occur in the country.

- Examining the consistency of trends. Unusual variation in the number of cases or deaths that cannot be explained by climate or other factors, or inconsistency between trends in cases and in deaths, can suggest deficiencies in reporting systems.

- Monitoring changes in the proportion of cases due to *P. falciparum* or the proportion of cases occurring in children aged under 5 years. 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 aged under 5 years; however, unusual fluctuations in these proportions may point to changes in health-facility reporting or to errors in recording.

These procedures help to rule out data-related factors (e.g., incomplete reporting or changes in diagnostic practice) as explanations for a change in the incidence of disease. The aim is to ensure that trends in health-facility data reflect changes in the wider community, which is more likely in situations where changes in disease incidence are large; coverage with public health services is high; and interventions promoting change, such as use of ITNs, are delivered throughout the community rather than being restricted to health facilities.

Where data reported by NMCPs were sufficiently complete and consistent to reliably assess trends between 2000 and 2014, a country was classified as being on track to achieve, by 2015, a decrease in case incidence of >75%, 50–75% or <50%, or to experience an increase in case incidence by 2015, using 2000 as the baseline. A 75% reduction in malaria case incidence is equivalent to a 5% reduction per year between 2000 and 2015. Thus, to achieve a reduction of 75% by 2015, countries need to have reduced the incidence of malaria by at least 70% between 2000 and 2014. Countries that reduced malaria incidence rates by 48–70% between 2000 and 2014 are projected to achieve reductions in malaria case incidence of 50–75% in 2015.

Table 2.5 Summary of trends in estimated malaria case incidence 2000–2015, for countries in which trends could not be evaluated from reported data but can be assessed through modeling

See the methods notes for Table 2.1 and Table 2.2 for the estimation of incidence rates in high-transmission countries, where the quality of surveillance data did not permit a convincing estimate to be made from the number of reported cases.

Figure 2.7 Estimated number of cases in 2000 and 2015, by WHO region

The figure shows changes in the estimated number of cases by country within each WHO region. Each point represents a country. See the methods notes for Table 2.1 for the estimation of the number of malaria cases.

Figure 2.8 Number of countries with fewer than 1000, 100 and 10 cases, 2000–2015

See the methods notes for Table 2.1 for the estimation of the number of malaria cases.

Table 2.6 Classification of countries by programme phase, December 2015

The criteria used to classify countries according to programme phase were updated in 2012 to facilitate tracking of progress over time (2). These focus on three main components: the malaria epidemiological situation, case-management practices and the state of the surveillance system, as shown in Table A.1. The assessment concentrates on the situation in those districts of the country reporting the highest annual parasite index (API).
**Table A.1 Criteria for classifying countries according to malaria programme phase**

<table>
<thead>
<tr>
<th>Malaria situation in areas with most intense transmission</th>
<th>Pre-elimination</th>
<th>Elimination</th>
<th>Prevention of reintroduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test positivity rate</td>
<td>&lt;5% among suspected malaria patients (PCD) throughout the year</td>
<td>&lt;5 (i.e. fewer than 5 cases/1000 population)</td>
<td>(i) Recently endemic country with zero local transmission for at least 3 years; or (ii) country on the register or supplementary list that has ongoing local transmissions</td>
</tr>
<tr>
<td>API in the district with the highest number of cases/1000 population/year (ACD and PCD), averaged over the past 2 years</td>
<td>&lt;1 (i.e. fewer than 1 case/1000 population)</td>
<td>A manageable number (e.g. &lt;1000 cases, local and imported) nationwide</td>
<td></td>
</tr>
<tr>
<td>Total number of reported malaria cases nationwide</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Case management**

- All cases detected in the private sector are microscopically confirmed: National policy being rolled out
- All cases detected in the public sector are microscopically confirmed: National policy being rolled out
- Nationwide microscopy quality assurance system covers public and private sector: National policy being updated
- Radical treatment with primaquine for P. falciparum: National policy being updated
- Treatment with ACT plus single-dose primaquine for P. falciparum: National policy being updated

**Surveillance**

- Malaria is a notifiable disease nationwide: Laws and systems being put in place
- Centralized register on cases, foci and vectors: Initiated
- Malaria elimination database: Initiated
- Active case detection in groups at high risk or with poor access to services (proactive case detection): Initiated
- Reactive case detection and entomological investigation: Initiated

**Notes**

- ABER: annual blood examination rate; ACD: active case detection; API: annual parasite index; PCD: passive case detection.
- Ongoing local transmission = 2 consecutive years of local P. falciparum malaria transmission, or 3 consecutive years of local P. vivax malaria transmission, in the same locality or otherwise epidemiologically linked.
- The API has to be evaluated against the diagnostic activity in the risk area (measured as the ABER). Low values of ABER in a district raise the possibility that more cases would be found with improved diagnostic efforts.

**Figure 2.9 Indigenous malaria cases in the WHO European Region, by country, 1990–2015**

The number of indigenous cases shown are those reported to WHO by NMCPs.

**Figure 2.10 Indigenous malaria cases in the WHO European Region by parasite species, 2000–2015**

The number of indigenous cases shown are those reported to WHO by NMCPs.

**Section 3: Coverage of key interventions**

**Figure 3.1 Proportion of population at risk with access to an ITN and proportion sleeping under an ITN, sub-Saharan Africa, 2000–2015**

Estimates of ITN coverage were derived from a model developed by the Malaria Atlas Project (12). A two-stage process was followed. First, a mechanism was defined for estimating net crop – that is, the total number of ITNs in households in a country at a given point in time – taking into account inputs to the system (e.g. deliveries of ITNs to a country) and outputs (e.g. loss of ITNs from households). Second, empirical modelling was used to translate estimated net crops into resulting levels of coverage (e.g. access within households, use in all ages and use among children aged under 5 years).

The model incorporates three sources of information:

- data on the number of long-lasting insecticidal nets (LLINs) delivered by manufacturers to countries, as provided by Milliner Global Associates to WHO;
- data on ITNs distributed within countries, as reported by NMCPs to WHO; and
- nationally representative household surveys from 39 sub-Saharan African countries, from 2001 to 2014.

**Countries and populations at risk**

The main analysis covered 40 of the 47 malaria endemic countries or areas of sub-Saharan Africa. The islands of Mayotte (France) (for which no ITN delivery or distribution data were available) and Cabo Verde (which does not distribute ITNs) were excluded, as were the low-transmission countries of Namibia, Sao Tome and Principe, South Africa and Swaziland for which ITNs make up a small proportion of vector control. Analyses were limited to populations categorized as being at risk by NMCPs.

**Estimating national net crops through time**

As described by Flaxman et al. (13) with a large fraction of these resources directed toward the distribution of ITNs, national ITN systems were represented using a discrete...
time stock-and-flow model. Nets delivered to a country by manufacturers were modelled as first entering a “country stock” compartment (i.e. stored in-country but not yet distributed to households). Nets were then available from this stock for distribution to households by the NMCP or other distribution channels. To accommodate uncertainty in net distribution, number of nets distributed in a given year were specified as a range, with all available country stock as one extreme (the maximum nets that could be delivered) and the NMCP-reported value (the assumed minimum distribution level) as the other. New nets reaching households joined older nets remaining from earlier time steps to constitute the total household net crop, with the duration of net retention by households governed by a loss function. Rather than fitting the loss function to a small external dataset, as was done by Flaxman et al., the loss function was fitted directly to the distribution and net crop data within the stock-and-flow model itself. Loss functions were fitted on a country-by-country basis, allowed to vary through time, and defined separately for conventional ITNs (cITNs) and LLINs. The fitted loss functions were compared to existing assumptions about rates of net loss from households. The stock-and-flow model was fitted using Bayesian inference and Markov chain Monte Carlo methods, providing time-series estimates of national household net crop for cITNs and LLINs in each country along with evaluation of under-distribution, all with posterior credible intervals.

Estimating national ITN access and use indicators from net crop

Rates of ITN access within households depend not only on the total number of ITNs in a country (i.e. net crop), but on how those nets are distributed between households. One aspect that is known to strongly influence the relationship between net crop and household ownership distribution is the size of households in different countries (14), which varies greatly across sub-Saharan Africa.

Many recent national surveys report the number of ITNs observed in each surveyed household. This makes is possible to not only estimate net crop, but also to generate a histogram that summarizes the net ownership pattern (i.e. the proportion of households with zero nets, one net, two nets and so on). In this way, the size of the net crop was linked to distribution patterns among households, while accounting for household size, so that ownership distributions for each household size stratum could be generated. The bivariate histogram of net crop to distribution of nets among households by household size made it possible to calculate the two additional indicators: the proportion of households with at least one ITN for every two people, and the proportion of population with access to an ITN within their household. For the final ITN indicator – the proportion of the population who slept under an ITN the previous night – the relationship between ITN and access was defined using 62 surveys where both indicators were available (ITN use_{all ages} = 0.8133*ITN access_{all ages} + 0.0026, R² = 0.773). This relationship was applied to the Malaria Atlas Project’s country-year estimates of household access to obtain ITN use among all ages. The same method was used to obtain the country-year estimates of ITN use in children aged under 5 years (ITN use_{children under five} = 0.9327*ITN access_{all ages} + 0.0282, R² = 0.754).

Figure 3.2 Proportion of population sleeping under an ITN, sub-Saharan Africa, 2015
See the methods notes for Figure 3.1 for the estimation of population sleeping under ITNs.

Figure 3.3 Number of ITNs/LLINs delivered and distributed, and the estimated number of LLINs needed annually to achieve universal access in sub-Saharan Africa, 2004–2015
See the methods notes for Figure 3.1 for the sources of LLINs delivered and distributed. For estimating ITN requirements to achieve universal access, the two-stage modelling framework outlined in the notes for Figure 3.1 represented the pathway from ITN delivery from manufacturers through to resulting levels of net access and use in households. It also accounted for two potential factors that may reduce access levels (i.e. the efficiency of allocation of nets to households during distribution, and the loss of nets from households over time), and allowed these to be quantified through time for each country. Using this architecture, it was possible to simulate delivery of any volume of ITNs to a given country over a given future time period; to predict the levels of access and use that would result, and to examine the impact of different amounts of allocation efficiency and net loss. The model was used to estimate the levels of access likely to be achieved by 2015 under a broad spectrum of LLIN delivery levels across the 4-year period. These simulations were run under two scenarios: (i) ‘business-as-usual’, where current levels were maintained for allocation efficiency and net loss (approximately a 2-year median retention time); and (ii) with both maximized allocation efficiency and a 3-year median retention time.

Figure 3.4 Proportion of the population at risk protected by IRS by WHO region, 2009–2014
The number of persons protected by indoor residual spraying (IRS) and the population at risk of malaria was reported by NMCPs to WHO. See the methods notes for Table 2.2 for the calculation of the population at risk.

Figure 3.5 Proportion of the population protected by IRS or with access to ITNs in sub-Saharan Africa, 2014
See the methods notes for Figure 3.1 for derivation of the population at risk with access to an ITN in their household in 2015, and Figure 3.4 for the proportion benefitting from IRS. The proportion benefitting from IRS in 2015 was assumed to be the same as 2014 because this was the latest year for which data on populations protected by IRS were available. Analysis of household survey data indicates that about half
of the people in IRS-sprayed households are also protected by ITNs (15). Therefore, the proportion of the population protected by either ITNs or IRS was estimated by adding half the proportion of the population protected by IRS to the proportion with access to an ITN.

Figure 3.6 Proportion of pregnant women receiving IPTp, by dose, sub-Saharan Africa, 2007–2014
Women are eligible to receive intermittent preventive treatment in pregnancy (IPTp) after the first trimester of pregnancy; therefore, the total number of IPTp-eligible women is the total number of second- and third-trimester pregnancies in a given calendar year. This was calculated for years 2001 through 2014 by adding total live births and spontaneous pregnancy loss, specifically miscarriages and stillbirths, after the first trimester. Spontaneous pregnancy loss was previously calculated by Dellicour et al. (16). Country-specific estimates of IPTp coverage were calculated as the ratios of volumes of IPTp doses distributed to the estimated numbers of IPTp-eligible pregnant women in a given year. Antenatal care (ANC) attendance rates were derived in the same way, using the number of first-time ANC visits reported through routine information systems. Local linear interpolation was used to compute missing values. In countries that did not report data for the first year of the policy, or in any year before the policy adoption, the quantities of IPTp distributed were assumed to be zero one year before the policy adoption, allowing for interpolation of coverage estimates relative to reported volumes in later years. For each country, the percentage of pregnant women attending ANC and receiving IPTp doses were calculated only for years in which NMCPs reported that a nationwide IPTp policy was in place. Uncertainty around the point estimates was determined by using Monte Carlo simulations to sample from specified input distributions. Sampling from these distributions yielded 1000 point estimates for country-level IPTp dose-specific coverage and ANC attendance for each year, which were then summarized by country-specific means and 95% confidence intervals. Locally estimated regression (17), using the 1000 country-level estimates, was used to predict the continental coverage for each year.

Figure 3.7 Proportion of pregnant women receiving at least one dose of IPTp, sub-Saharan Africa, 2013–2014
See the methods notes for Figure 3.6 for the estimation of percentage of pregnant women receiving at least one dose of IPTp.

Figure 3.8 Proportion of suspected malaria cases attending public health facilities that received a diagnostic test, by WHO region, 2005–2014
The proportion of suspected malaria cases receiving a malaria diagnostic test in public facilities was calculated from NMCP reports to WHO. The number of malaria diagnostic tests performed included the number of RDTs and microscopic slide examinations. Few countries reported the number of suspected malaria cases as an independent value. For countries reporting the total number of malaria cases as presumed malaria cases (i.e. cases classified as malaria without undergoing malaria parasitological testing) and confirmed malaria cases, the number of suspected cases was calculated by adding the number of negative diagnostic tests to the number of presumed and confirmed cases. Using this method for countries that reported only confirmed malaria cases for the total number of malaria cases, the number of suspected cases is equal to the number of cases tested. This is not informative in determining the proportion of suspected cases tested; therefore, countries were excluded from the regional calculation for years in which they reported only confirmed cases for total malaria cases.

Figure 3.9 Proportion of febrile children presenting for treatment, by health sector, sub-Saharan Africa, 2013–2015
The estimates for source of care for febrile children were derived using data from 18 nationally representative household surveys (demographic and health surveys [DHS] and malaria indicator surveys [MIS]) conducted from 2013 through 2015. The surveys included the following data, provided by caregivers, on each child aged under 5 years living in the surveyed households: if the child had had a fever in the 2 weeks preceding the survey, whether care was sought for the fever, and if so, where care was sought, whether a diagnostic test was administered, and the treatment received.

Figure 3.10 Proportion of febrile children receiving a blood test, by health sector, sub-Saharan Africa, 2013–2015
See the methods notes for Figure 3.9.

Figure 3.11 Number of RDTs sold by manufacturers and distributed by NMCPs, by WHO region, 2005–2014
The numbers of RDTs distributed by WHO region are the annual totals reported to be distributed by NMCPs. Manufacturers reporting the number of RDT sales between 2008 and 2014 included 44 manufacturers that participate in RDT product testing by WHO, the Foundation for Innovative New Diagnostics (FIND), the United States Centers for Disease Control and Prevention (CDC) and the Special Programme for Research and Training in Tropical Diseases (TDR). The number of RDTs reported by manufacturers represents total sales to the public and private sector worldwide.

Figure 3.12 Ratio of ACT treatment courses distributed to diagnostic tests performed (RDTs or microscopy), WHO African Region, 2006–2014
The number of RDTs and ACTs distributed within countries by national programmes are reported by NMCPs to WHO, as are the number of microscopic examinations of blood slides performed for malaria parasites and number of RDTs performed. This figure shows the ratio of these data over time. The test positivity rate was calculated as the total number of positive tests (slide examinations and RDTs) divided by the total number tests (slides examinations and RDTs) reported by countries in the WHO African Region in 2014.
Figure 3.13 Estimated proportion of children aged under 5 years with confirmed *P. falciparum* malaria who received ACTs, sub-Saharan Africa, 2003–2014

The proportion of children with uncomplicated malaria (defined as fever in the 2 weeks preceding the survey, and parasite infection measured by RDT at the time of the survey) receiving an ACT was estimated for all countries in sub-Saharan Africa 2003–2014 using a three-step modelling approach:

1. Fitting a model to predict whether a child with fever has a malaria infection: Recent MIS and DHS include the malaria parasite infection status of a child, assessed from an RDT given at the time of the survey. It was assumed that a positive RDT provides a reasonable measure of a 2-week period prevalence of infection (18–20). A logistic regression model was created to predict malaria parasite infection among febrile children. Covariates in the model included the child’s age and sex, household wealth quintile, ITN ownership, facility type where treatment was sought (public/other), urban/rural status, and malaria transmission intensity as measured by proportion of children aged 2–10 years infected with *P. falciparum* (PR2–10).

2. Predicting the infection status of children in surveys in which RDTs were not used: Coefficients estimated from the logistic regression model in step 1 were used to obtain predictions of infection status among all children with a fever from DHS, MIS and multiple indicator cluster surveys (MICS) in which RDT testing had not been performed. The national survey-weighted proportion of febrile children with a malaria parasite infection (RDT measured or imputed) aged under 5 years who received an ACT was then calculated for all surveys.

3. Estimating the proportion of children with malaria that received an ACT: The ACT distribution data reported by NMCPs were used to calculate a predicted ACT “availability” per person at risk for *P. falciparum* malaria in each country. A linear model was then created to predict the proportion of children with malaria receiving an ACT, using ACT availability per capita in the current and previous year as a covariate, with additional covariates including national ITN coverage (by year), measles vaccination coverage, gross national income, and the proportion of births with a skilled birth attendant (20). The model was run in a Bayesian framework using Markov chain Monte Carlo methods, and included uncorrelated random effects for each country and correlated (autoregressive) random effects for each year. The proportion of children who received ACTs for each country and year (2003–2014) was imputed for non-survey years, based on the relationship between ACT coverage and ACT availability across countries.

Household survey data were considered if they included a module assessing fever treatment behaviour for children aged under 5 years, categorized by type of antimalarial received. For the period 2003–2014, 16 MIS, 61 DHS and 22 MICS were included. Annual estimates of mean *P. falciparum* parasite rates in children aged 2–10 years (PR2–10), as well as the total population at malaria risk, were ascertained from the Malaria Atlas Project (see methods notes for Table 2.1 and Table 2.2).

Figure 3.14 Proportion of febrile children who receive an ACT among those who receive any antimalarial, sub-Saharan Africa, 2004–2015

See the methods notes for Figure 3.9.

Figure 3.15 Proportion of febrile children receiving antimalarial treatments, by type, sub-Saharan Africa, 2013–2015

See the methods notes for Figure 3.9.

Figure 3.16 Proportion of febrile children who receive an ACT among those who receive any antimalarial, by place where care was sought, sub-Saharan Africa, 2013–2015

See the methods notes for Figure 3.9.

Figure 3.17 Number of ACT treatment courses distributed by NMCPs, by WHO region, and ACT treatment courses delivered by manufacturers to the public and private sector, 2005–2014

Data on ACT deliveries were provided by ten manufacturers eligible for procurement by WHO/UNICEF. ACT sales were categorized as either to the public sector or to the private sector. Data on ACTs distributed within countries through the public sector were taken from NMCP reports to WHO.

Figure 3.18 Predicted time series of PR2–10 across endemic Africa with and without interventions, 2000–2015

The model used to estimate malaria case incidence (described in the methods notes for Table 2.1) is based on various surveys of parasite prevalence undertaken between 2000 and 2015. It also incorporates time-series models of coverage for ITN use, IRS and access to ACTs within each country, and a suite of environmental and sociodemographic covariates. The model was used to predict a spatiotemporal “cube” of age-structured PR as a function of PR at 5 × 5 km resolution across all endemic African countries for each year from 2000 to 2015. During the process of modelling, flexible functional forms were fitted to capture the effect of each intervention on declining PR as a function of coverage reached and the starting (pre-intervention) PR in 2000. Using the observed effect of each intervention, it was possible to generate counterfactual maps estimating contemporary PR under hypothetical scenarios without interventions. This “no intervention” counterfactual was then used to estimate the total effect of interventions on parasite prevalence and case incidence.

Figure 3.19 Predicted cumulative number of malaria cases averted by interventions, sub-Saharan Africa, 2000–2015

See the methods notes for Figure 3.18.
Section 4: Costs of malaria control and cost savings

Figure 4.1 Investments in malaria control activities by funding source, 2005–2014

Domestic financing data included contributions from governments of malaria endemic countries for the period 2005–2014 that were obtained from NMCPs for the World malaria reports. When domestic financing data were not available for 2014, data from previous years were used. Domestic financing data exclude government spending on case management, including the cost of the time that health workers spend testing, treating and tracking malaria patients and the cost of capital (e.g. infrastructure and vehicles). Data also exclude household spending on malaria prevention and treatment. International financing data were obtained from several sources. The Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) provided disbursed amounts by year and country for the period 2005–2014. Data on funding from the government of the United States of America (USA) were sourced from the US Foreign Assistance Dashboard (22), with the technical support of the Kaiser Family Foundation. Funding data were available for the US Agency for International Development (USAID), the Centers for Disease Control and Prevention (CDC) and the US Department of Defense. Country-level data were available from USAID only, and only for the period 2006–2014. Financing data for other international funders included annual disbursement flows for the period 2005–2013, obtained from the Organisation for Economic Co-operation and Development’s Creditor Reporting System (CRS) aid activity database. For each year and each funder, the list of regional- and country-level project-type interventions and other technical assistance were abstracted. Contributions to programmes and funds managed by international organizations (e.g. Global Fund contributions) were excluded. International annual contributions for 2014 were estimated by projecting linearly 2011-2013 available estimates. To measure funding trends in real terms (i.e. corrected for inflation), all values were converted to constant 2014 US$ using the gross domestic product (GDP) implicit price deflators published by the World Bank (23).

The analysis concentrated on sub-Saharan Africa and took a public provider perspective. Data included:

- number of malaria cases averted from the decline in case incidence rates observed between 2000 and 2015 (see the methods notes for Table 2.1 and Table 2.2, and Figure 3.18);
- proportion of malaria cases estimated to seek care in the public sector from nationally representative household surveys.

Figure 4.3 Expenditures on ITN/LLIN, ACT, RDT and IRS, and trend in international funding, 2004–2014

Manufacturers’ sales volumes data on ITNs/LLINs (as provided by Milliner Global Associates to WHO), RDTs (see methods notes for Figure 3.11) and ACTs (see methods notes for Figure 3.16) and the number of people at risk covered by IRS (see methods notes for Figure 3.4) were used to estimate the amount spent each year in preventive and curative commodities.

1) Calculating expenditures for ITNs/LLINs: ITN/LLIN sales volumes data were sourced from the Net Mapping Project, which provided data for 47 sub-Saharan African countries from 2004 to 2014 and for 51 malaria endemic countries outside sub-Saharan Africa for the period 2011–2014. LLIN price data originated from a review of country-level transactions information available from the Global Fund’s Price & Quality Reporting (PQR) tool (23). LLIN price data included the name of the country of delivery, LLIN manufacturer name, net shape, net size, number of nets purchased, unit cost in US$ at the time of the transaction and transaction date. The review of price data concentrated on prices of rectangular nets of any size. For each country and each year, the average procurement price paid per net was calculated. For LLIN price observations for which there was no information on whether freight cost was included, freight cost was assumed not to be included, following the data entry guidelines of the PQR tool (24). For price observations for which freight cost was excluded, unit price data were inflated by 20%. For countries missing price data, the regional LLIN average price was imputed.

ii) Calculating expenditures for IRS: The unit cost of protecting one person per year with IRS, which varied by year, was estimated by calculating the average cost of covering one person with IRS across 10 countries for the years 2008–2012 (Abt Associates, personal communication, June 2014). IRS commodity cost included the costs of insecticide, shipping and equipment. The costs of spraying operations, local labour and local administration were excluded, to follow the approach used for the other commodities costed in this report.

iii) Calculating expenditures for RDTs and ACTs: RDT and ACT sales volumes were sourced from manufacturers’ reports to WHO. RDT price data originated from a review of country-level transactions information available from the Global Fund’s PQR tool (24). RDT average unit price was calculated as the average of all CareStart™ Malaria product prices. ACT price data were sourced from the Management Sciences for Health (MSH) international drug price database (25). ACT average treatment price was calculated across all ACT types with price information (including AL, AS-AQ, AS-MQ, AS–SP across different strengths) on the basis of a full dose for treating a 60 kg adult (26). ACT and RDT prices were inflated by 20% to reflect the cost of freight and insurance.

Figure 4.4 Provider savings in malaria case management costs attributable to expansion of malaria control activities, 2001–2014

The analysis concentrated on sub-Saharan Africa and took a public provider perspective. Data included:

- number of malaria cases averted from the decline in case incidence rates observed between 2000 and 2015 (see the methods notes for Table 2.1 and Table 2.2, and Figure 3.18);
- proportion of malaria cases estimated to seek care in the public sector from nationally representative household surveys;
derive from the relative contribution of each intervention savings attributable to malaria control interventions were the estimation of malaria cases and incidence rates. See the methods notes for Table 2.1 and Table 2.2 for versus estimated number of cases in a country in 2000 Figure malaria cases and deaths. See the methods notes for Table 2.1 for the estimation of share of the malaria disease burden deaths in 2015 for countries accounting for the highest of the global number of (a) malaria cases and (b) malaria Figure Section 5: Challenges in averting cases (see methods notes for Figure 3.8); and similarly inpatient admission costs were estimated in terms of average unit bed-day stay at primary and tertiary hospitals in each country also using the WHO CHOICE tool. Hospitalization for a severe malaria case was assumed to last for 3 days. An annual inflation rate of 3% was assumed when converting WHO-CHOICE tool price estimates for 2008 to cover the 2001–2014 period. To measure funding trends in real terms (i.e. corrected for inflation), all values were converted to constant 2014 US$ using the GDP implicit price deflators published by the World Bank (23). The cost savings attributable to malaria control interventions were derived from the relative contribution of each intervention in averting cases (see methods notes for Figure 3.18.)

Two countries with increases (negative decreases) were excluded from the figure.

**Figure 5.3 Proportion and number of people not receiving an intervention, sub-Saharan Africa, 2014**
See the methods notes for Figure 3.5, Figure 3.6 and Figure 3.7 for the estimation of the proportion of the target population receiving an intervention. The formula, 100% - (% receiving the intervention), was applied to the population at risk targeted by each intervention to calculate the population not receiving an intervention. See the methods notes for Figure 3.6 for estimation of the population of pregnant women. The population living in households was calculated by utilizing the population at risk, see the methods for Table 2.2 for the derivation of population sizes, and household size, as derived from nationally representative household survey data. The number of children aged under 5 years with malaria infection was estimated by applying the modelled country-specific age distribution of cases (29) to the total number of cases, calculated by the methods described for Table 2.1.

**Figure 5.4 Population at risk of malaria in sub-Saharan Africa with access to or using vector control, 2014**
See the methods notes for Figure 3.5 for the estimation of indicators related to vector-control coverage.

**Figure 5.5 Proportion of pregnant women attending ANC and proportion receiving IPTp, by dose, in sub-Saharan Africa, 2014**
See the methods notes for Figure 3.7 for the estimation of pregnant women receiving IPTp doses and attending ANC at least once.

**Figure 5.6 Proportion of febrile children aged under 5 years receiving antimalarial medicines, by place of where care was sought, among sub-Saharan countries with household surveys, 2013–2015**
See the methods notes for Figure 3.9.

**Figure 5.7 Number of nurses per 1000 population in malaria endemic countries versus estimated number of malaria deaths**
See the methods notes for Table 2.1 for the estimation of malaria cases. Data on nurses per capita were obtained from the Global Health Observatory Data Repository (nursing and midwifery personnel data by country) (30).

**Figure 5.8 Proportion of malaria cases seeking care (a) in public sector and (b) private sector versus estimated number of malaria cases, sub-Saharan Africa, 2015**
See the methods notes for Table 2.1 for the estimation of malaria cases. The percentage of malaria cases seeking care in the public sector was calculated using nationally representative household survey data applied to estimates of malaria cases.
Figure 5.9 Gross national income per capita versus estimated number of malaria cases, by WHO region, 2015
See the methods notes for Table 2.1 for the estimation of malaria cases. Data on gross national income per capita based on purchasing power parity was obtained from the World Bank (31).

Figure 5.10 (a) Domestic government spending on malaria control per capita and (b) international government spending on malaria control per capita versus estimated number of malaria deaths, by WHO region, 2015
See the methods notes for Table 2.1 for the estimation of malaria cases, and the methods notes for Figure 4.1 for the estimation of NMCP spending on malaria control per capita.

Figure 5.11 Estimated spending on malaria treatment, sub-Saharan Africa, 2001–2014
See the methods notes for Figure 4.3 for the estimation of spending on malaria treatment.

Table 5.12 Proportion of estimated malaria cases in each region due to P. vivax, 2015
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria cases.

Figure 5.13 Proportion of global P. vivax cases occurring in each WHO region
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria cases.

Figure 5.14 Proportion of reported malaria cases due to P. vivax, countries with different average caseloads between 2000 and 2014
See the methods notes for Table 2.1 and Table 2.2 for the estimation of malaria cases.

Figure 5.15 Insecticide resistance and monitoring status, by insecticide class and WHO region, 2010–2014
Insecticide resistance monitoring results were collected from NMCP reports to WHO, the African Network for Vector Resistance, Malaria Atlas Project, United States President’s Malaria Initiative (PMI) and the published literature. In these studies, confirmed resistance was defined as mosquito mortality <90% in bioassay tests with standard insecticide doses. Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status was considered.

Figure 5.16 Reported pyrethroid resistance status of malaria vectors, measured with insecticide bioassays since 2010
See the methods notes for Figure 5.16 for assessing pyrethroid resistance status.

Section 5.6: Antimalarial drug efficacy and resistance
The WHO global antimalarial drug efficacy database contains data from therapeutic efficacy studies (TES) conducted by NMCPs, research institutes and nongovernmental organizations. Currently, the database holds over 1130 TES, conducted in 62 malaria endemic countries from 2005 to 2015. About 900 of the studies were conducted on the treatment efficacy of ACTs against P. falciparum, and the remainder were conducted on treatment efficacy against P. vivax.

WHO encourages malaria endemic countries to conduct antimalarial TES on nationally recommended first- and second-line medicines once every 2 years. The WHO protocol provides standardized methods for conducting TES for both P. falciparum and P. vivax; such studies allow comparison of data across geographical regions and over time. Studies are conducted at sentinel sites, which are selected based on population distribution and density, accessibility, feasibility of supervision, malaria epidemiology, population mobility and migration. Updates on the global status of antimalarial drug efficacy for both P. falciparum and P. vivax are available on the WHO website (32).

Section 6: Moving forward
Table 6.1 Goals, milestones and targets of the Global technical strategy for malaria 2016–2030 and Action and investment to defeat malaria 2016–2030
The table shows the goals, milestones and targets of the Global technical strategy for malaria 2016–2020 and Action and investment to defeat malaria 2018–2030 (33).

Regional profiles
Figure A. Incidence was derived from reports of confirmed malaria cases in 2014 (by microscopy or RDT) from ministries of health to WHO, and from the number of people living at risk for malaria in each geographical unit, as reported by NMCPs. Values were corrected for reporting completeness by dividing the proportion of health-facility reports received in 2014 by the number expected. If subnational data on population or malaria cases were lacking, an administrative unit was labelled “insufficient data” on the map. In some cases, the subnational data provided by the NMCP did not correspond to a subnational administrative area known to WHO, because of either modifications to administrative boundaries, or the use of names not verifiable by WHO. The maps for countries outside of the WHO Region of the Americas and WHO European Region display a combination of cases per 1000 per year, and parasite prevalence in areas with >10 cases per 1000 population per year. The parasite prevalence used in regions with >10 cases per 1000 is the sum of the rates for P. falciparum and P. vivax calculated at each location (~1 km²). The parasite rate for P. falciparum was from two sources, one global (34) and one for Africa (7), with the African source taking precedence over the global source. The parasite rate for P. vivax was taken from one global source (35). Data on environmental suitability for malaria transmission were used to identify areas that would be free of malaria or have unstable malaria transmission.
Figure B. Sources of data for the financial contributions were as described for Figure 4.1.

Figure C. Sources of data for international and domestic contributions were as described in the notes for Figure 4.1. Funding per capita at risk was calculated by giving populations at low risk for malaria (i.e. those living in areas with fewer than one case reported per 1000 per year) half the weight of populations at high risk (i.e. those living in areas with one or more cases reported per 1000 per year). This procedure was followed to ensure that countries with 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.

Figure D. For the WHO African Region and for Djibouti, Somalia and the Sudan in the WHO Eastern Mediterranean Region, the proportion of the population with access to an ITN was derived from a model that takes into account household survey data, ITNs distributed by NMCPs, and ITNs delivered by manufacturers (see methods notes for Figure 3.1 and Figure 3.2). For other countries, the proportion of the population protected with ITNs was estimated from the number of ITNs delivered by NMCPs in the past 3 years, divided by the population at high risk. It is assumed that each net delivered can cover on average 1.8 people, that conventional nets are re-treated regularly, and that nets have a lifespan of 3 years. The denominator was the population living at high risk for malaria, since it is assumed that, in countries with lower levels of transmission, ITNs will be preferentially targeted to populations at higher risk. IRS coverage was calculated as the total number of people protected with IRS, divided by the population at high risk. There are limited data on the extent to which these interventions overlap, so the two bars simply represent the percentage of populations protected by the respective interventions individually. When no population at high risk was defined for a country, total population at risk was used as a denominator.

For the WHO European Region, the graph presents the number of introduced, imported and indigenous cases by year, reported by NMCPs.

Figure E. Few countries have information systems that record treatments given to individual patients. It is therefore necessary to use aggregate information on numbers of treatment courses delivered to public health facilities, and relate this information to the number of malaria cases among patients attending such facilities. For countries in the WHO African Region, the number of treatment courses available was calculated as the total number of ACT courses distributed by a ministry of health, divided by the estimated number of presumed cases recorded as malaria (without a diagnostic test having been performed) plus confirmed P. falciparum malaria cases at public health facilities. In other WHO regions, the number of treatment courses available is shown as a percentage of confirmed malaria cases plus presumed malaria cases reported in the public sector, correcting for reporting completeness. The bars for any antimalarial treatment show the number of all treatment courses supplied in relation to all malaria cases of any Plasmodium species, including the ACT to treat P. falciparum.

For the WHO European Region, the graph presents the number of indigenous cases reported by NMCPs.

Figure F. The percentage of confirmed cases in which P. falciparum or a mixed infection was detected was calculated as the total number of P. falciparum and mixed infections between 2010 and 2014, divided by the number of confirmed cases over that period. For countries in the elimination phase, only locally acquired P. falciparum cases and mixed infections were considered.

For the WHO African Region, the estimated incidence (as described in the methods for Table 2.1 and Table 2.2) is presented for years 2000 and 2015. The bars represent the estimated incidence and the lines represent the 95% credible intervals of the estimation.

For the WHO European Region, the figure presents the total number of P. falciparum and P. vivax by year, reported by ministries of health.

Figure G. Analysis of changes in malaria incidence rates focuses on confirmed cases (by microscopy or RDT) reported by ministries of health, to ensure that malaria (not other febrile illnesses) is tracked. For countries in the WHO African Region (except for Algeria, Cabo Verde, Namibia and South Africa), and Papua New Guinea in the WHO Western Pacific Region, the figure shows percentage reductions in the rate of hospital admissions and deaths and in the rate of reported malaria deaths. Although the diagnosis of admitted patients is not always confirmed with a diagnostic test, the predictive value of diagnosis undertaken for an admitted patient is considered to be higher than for outpatient diagnosis. See the methods notes for Table 2.4 for more details of the analysis undertaken.

Country profiles

1. Epidemiological profile

Maps: The procedures used to create the map of confirmed cases were the same as those used for Figure A for the regional profiles; that is, for countries outside the WHO Region of the Americas and the WHO European Region, if an area has >10 cases per 1000, the parasite prevalence is used instead. For countries in the WHO Region of the Americas and WHO European Region, only the cases per 1000 data are used. For the map showing the proportion of cases due to P. falciparum, the proportion is only shown
where the number of cases is >0.1 per 1000. Otherwise, the cases per 1000 is shown instead of the proportion. The proportion (where shown) was calculated from the \textit{P. falciparum} prevalence divided by the sum of \textit{P. falciparum} and \textit{P. vivax} prevalence.

**Population:** The total population of each country was taken from the 2015 revision of the \textit{World population prospects} (10). The country population was subdivided into three levels of malaria endemicity, as reported by the NMCPs:

i) areas of high transmission, where the reported incidence of confirmed malaria due to all species was >1 per 1000 population per year in 2014;

ii) areas of low transmission, where the reported malaria case incidence from all species was ≤1 per 1000 population per year in 2014, but >0 (transmission in these areas is generally highly seasonal, with or without epidemic peaks); and

iii) malaria free areas, where there is no continuing local mosquito-borne malaria transmission, and all reported malaria cases are imported; an area is designated “malaria free” when no cases have occurred for several years.

Areas may be naturally malaria free because of factors that are unfavourable for malaria transmission (e.g. altitude or other environmental factors), or they may become malaria free as a result of effective control efforts. In practice, malaria-free areas can be accurately designated by NMCPs only after the local epidemiological situation and the results of entomological and biomarker investigations have been taken into account.

In cases where an NMCP did not provide the number of people living in high- and low-risk areas, the numbers were inferred from subnational case incidence data provided by the programme. The population at risk is the total population living in areas where malaria is endemic (low and high transmission), excluding the population living in malaria free areas. The population at risk is used as the denominator in calculating the coverage of malaria interventions, and is therefore used in assessing current and future needs for malaria control interventions, taking into account the population already covered. For countries in the pre-elimination and elimination stages, “population at risk” is defined by the countries, based on the resident populations in foci where active malaria transmission occurs.

**Parasites and vectors:** The species of mosquito responsible for malaria transmission in a country, and the species of \textit{Plasmodium} involved, are listed according to information provided by WHO regional offices. The proportion of malaria cases due to \textit{P. falciparum} was estimated from the number of \textit{P. falciparum} and mixed infections detected by microscopy, divided by the total number of malaria cases confirmed by microscopy in 2014.

### II. Intervention policies and strategies

**Intervention policy:** The policies and strategies adopted by each country were reported by NMCPs to WHO. They vary according to the epidemiological setting, socioeconomic factors and the capacity of the NMCP or the country’s health system. Adoption of policies does not necessarily imply immediate implementation, nor does it indicate full, continuous implementation nationwide.

**Antimalarial treatment policy:** Antimalarial treatment policies were reported by NMCPs to WHO.

**Therapeutic efficacy tests:** Data on therapeutic efficacy were extracted from the WHO global antimalarial drug efficacy database. The data originated from three main sources: published data, unpublished data and regular monitoring data from surveillance studies conducted according to the WHO standard protocol. The percentage of treatment failures is the total number of failures (early treatment failures + late clinical failures + late parasitological failures), divided by the total number of patients who completed the study follow-up. The number of studies included in the analysis and the years during which the studies were conducted are shown for each antimalarial medicine. The minimum, median and maximum describe the range of treatment failures observed in the studies for each antimalarial medicine.

### III. Financing

**Sources of financing:** The data shown are those reported by NMCPs. The government contribution is usually the declared government expenditure for the year. In cases where government expenditure was not reported by the programme, the government budget was used. External contributions are those allocated to the programme by external agencies; however, such contributions may or may not be disbursed. Additional information about contributions from specific donor agencies, as reported by these agencies, is given in Annex 3. All countries were asked to convert their local currencies to US$ for reporting on sources of financing.

**Expenditure by intervention in 2014:** The pie chart shows the proportion of malaria funding from all sources that was spent on ITNs, insecticides and spraying materials, IRS, diagnosis, antimalarial medicines, monitoring and evaluation, human resources, technical assistance and management. There are differences in the completeness of data between countries, and the activities for which expenditures are reported do not necessarily include all items of expenditure. For example, government expenditures usually only include expenditures specific to malaria control, and do not take into account costs related to health-facility staff, infrastructure and so on.
IV. Coverage

ITN and IRS coverage: Indicators are shown according to data availability:

a) With access to an ITN (survey) – the proportion of all individuals that could be covered by available ITNs in each household, assuming each ITN can be shared by two people. The indicator is calculated from nationally representative household surveys such as DHS, MICS and MIS.

b) All ages who slept under an ITN (survey) – the proportion of all individuals who spent the previous night in surveyed households who slept under an ITN, as measured in a nationally representative household survey such as DHS, MICS or MIS.

c) With access to an ITN (model) – for high-transmission countries in the WHO African Region, a model was used to estimate the proportion of the population with access to an ITN within their household for years in which household survey results were not available. The methods used to estimate the indicator were the same as those described for Figure 3.1 and Figure 3.2.

d) At high risk protected by ITNs – for countries in WHO regions other than the African Region, nationally representative household surveys are not undertaken sufficiently frequently to allow an assessment of levels and trends in ITN coverage. Therefore, the number of ITNs distributed by NMCPs is used. The proportion of the population potentially protected with ITNs is calculated as 1.8 × (number of LLINs distributed in the past 3 years + number of conventional ITNs distributed or re-treated in the past year) divided by the population at high risk for malaria. LLINs are considered to have an average useful lifespan of 3 years and conventional ITNs 1 year; also, each net is assumed to protect two people. The ratio of 1.8 is used in the formula to allow for only one person sleeping under some ITNs in households with an odd number of inhabitants. The population at high risk is used as the denominator because it is assumed that populations at high risk will be preferentially targeted to receive an ITN. For countries in the elimination phase, those residing in foci are considered to be the population at risk.

e) At high risk protected by IRS – calculated as the number of people living in a household where IRS has been applied during the preceding 12 months, divided by the population at risk (the sum of populations living in low- and high-transmission areas). For areas outside Africa, the population at high risk is used as the denominator. The percentage of people protected by IRS is a measure of the extent to which IRS is implemented and the extent to which the population at risk benefits from IRS nationwide. The data show neither the quality of spraying nor the geographical distribution of IRS coverage in a country.

Cases tested and cases treated in the public sector

Suspected cases tested – the number of suspected cases examined by microscopy or by RDT, divided by the total number of suspected malaria cases. For countries that do not report the number of suspected cases independently, the number of suspected malaria cases is derived from the number of presumed and confirmed cases, the number tested and the number of positive tests. This indicator reflects the extent to which a programme can provide diagnostic services to patients attending public health facilities. It does not consider patients attending privately run health facilities, and therefore does not reflect the experience of all patients seeking treatment. In many situations, health facilities in the private sector are less likely to provide a diagnostic test than those in the public sector. The indicator may also be biased if those health facilities that provide a diagnostic test (e.g. hospitals) are more likely than other facilities to submit monthly reports.

Under 5 with fever with finger/heel stick (survey) – the proportion of children aged under 5 years with fever in the past weeks who had a finger or heel stick, as measured in a nationally representative household survey such as DHS, MICS or MIS.

Antimalarial medicines distributed versus cases – few countries have information systems that are able to record the treatments given to individual patients. Instead, data on the numbers of antimalarial medicines distributed by the country’s ministry of health are used to calculate proxy indicators of access to treatment. Three indicators are shown:

a) Antimalarials distributed versus all malaria cases – the number of first-line treatment courses distributed, divided by the estimated number of malaria cases attending public sector health facilities.

b) ACTs distributed versus P. falciparum malaria cases – the number of ACT treatment courses distributed, divided by the estimated number of P. falciparum malaria cases attending public sector health facilities.

c) Primaquine distributed versus P. vivax malaria cases – the number of primaquine treatment courses distributed, divided by the estimated number of P. vivax malaria cases attending public sector health facilities. For high-transmission countries in the WHO African Region, the estimated number of malaria cases attending public sector health facilities is used as a denominator. For other countries, the denominator is the number of confirmed cases plus the number of presumed cases, adjusted for reporting completeness. These indicators can provide information on whether the NMCP delivers sufficient antimalarial medicines to treat all malaria patients who seek treatment in the public sector. It is not a direct measure of the proportion of patients with malaria that have received treatment.
ACTs as a percentage of all antimalarials received (survey) – children aged under 5 years with fever in the past 2 weeks who received ACTs as a proportion of children aged under 5 years with fever who received any antimalarial.

Cases tracked

Reporting completeness – calculated as the total number of health–facility reports received by a ministry of health during a year, divided by the total number of facility reports that were expected in that year. The expected number of facility reports is the number of health facilities multiplied by the frequency of reporting; that is, if 100 facilities are expected to report each month, 1200 reports would be expected during a year.

Percentage fever cases <5 seeking treatment at public health facility (survey) – the proportion of children aged under 5 years with fever in the past 2 weeks who sought treatment at a public health facility, derived from a nationally representative household survey such as DHS, MICS or MIS (for programmes in the control phase only).

Cases investigated – the proportion of reported confirmed malaria cases that are investigated for additional information on the characteristics of the case; most importantly, whether the case was imported or locally acquired (for programmes in the pre-elimination and elimination phase only).

Foci investigated – the proportion of foci of malaria transmission that are investigated for additional information on the characteristics of transmission of malaria, including evidence of local malaria transmission and entomological information such as vector breeding sites within the transmission focus (for programmes in the pre-elimination and elimination phase only).

V. Impact

Test positivity slide positivity rate (SPR) – the number of microscopically positive cases divided by the total number of slides examined.

RDT positivity rate – the number of positive RDT tests divided by the total number of RDT tests carried out. The RDT positivity rate and SPR are derived from the number of parasitologically positive cases per 100 cases examined by RDT or microscopy. They measure the prevalence of malaria parasites among people who seek care and are examined in health facilities. Trends in these indicators may be less distorted by variations in the ABER than by trends in the number of confirmed cases.

Parasite prevalence (survey) – the proportion of people tested for malaria parasites in a survey (usually children aged under 5 years) who have malaria parasites (programmes in control phase only).

Confirmed malaria cases per 1000 and ABER (microscopy and RDT) – the number of parasitological tests (by microscopy or RDT) undertaken per 100 population at risk per year. The numbers of parasitological tests were derived from reports by NMCPs to WHO. The ABER provides information on the extent of diagnostic testing in a population. It can be useful to take ABER into account when interpreting trends in confirmed cases. To discern changes in malaria incidence, the ABER should ideally remain constant (see the methods notes for Table 2.4). There is no set threshold or target for ABER; rather, it is the trend in ABER in relation to reported case incidence that is most informative.

Cases (all species) – the total number of confirmed malaria cases (by microscopy or RDT) divided by the population at risk. The numbers of confirmed cases were derived from reports by NMCPs to WHO. The indicator is useful in assessing changes in the incidence of malaria over time, provided that there has been consistency in patient attendance at facilities, diagnostic testing and case reporting over time.

Cases (P. vivax) – the total number of confirmed P. vivax malaria cases (by microscopy or RDT) divided by the population at risk. The numbers of confirmed cases were derived from reports by NMCPs to WHO (the numbers exclude mixed infections). For countries in the pre-elimination or elimination phases, the total number of indigenous cases (acquired within the country) and imported cases were also plotted.

Malaria admissions and deaths (for countries in the control phase) – numbers for malaria admissions and deaths for countries in the control phase were derived from reports by NMCPs to WHO.

Admissions (all species) – the number of patients admitted for malaria with malaria as the primary discharge diagnosis, divided by the population at risk.

Admissions (P. vivax) – the number of patients admitted for malaria with P. vivax malaria as the primary discharge diagnosis, divided by the population at risk.

Deaths (all species) – the number of patients dying in health facilities with malaria as the primary cause of death, divided by the population at risk.

Deaths (P. vivax) – the number of patients dying in health facilities with P. vivax malaria as the primary cause of death, divided by the population at risk.


