

Chapter 3.

Interventions to control malaria

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

3.1 Adoption of policies and strategies for malaria control

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

3.2 Information on global ACT supplies and the artemisinin market situation

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

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

- country adoption of ACTs: the WHO/GMP Antimalarial Drug Policies Database (<http://www.who.int/malaria/treatmentpolicies.html>) and
- country deployment of ACTs to general health services: compiled by the GMP Supply Chain Management Unit on the basis of reports from WHO regional and country offices.

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

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

Information on the artemisinin market situation:

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

Information on oral artemisinin-based monotherapy medicines:

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

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

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

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

^a Includes countries in prevention of re-introduction phase

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

3.2.1 ACT policy adoption and deployment

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

3.2.2 Artemether-lumefantrine supplies

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

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

3.2.3 Overall ACT sales

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

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

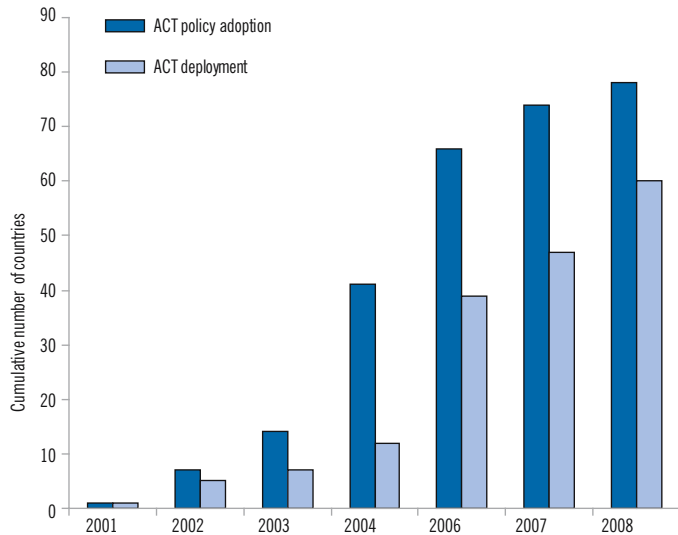


Figure 3.2 Procurement of artemether-lumefantrine for public sector use by weight-based dose package, global data, 2005–2008

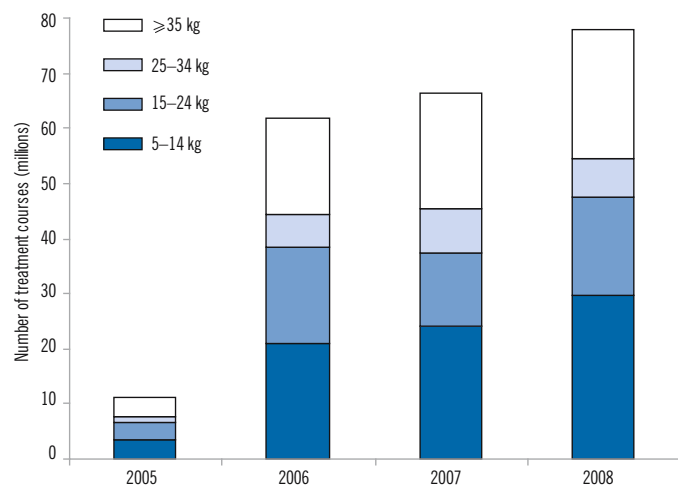


Figure 3.3 Public sector procurement of artemether-lumefantrine by year, by WHO Region, 2006–2008

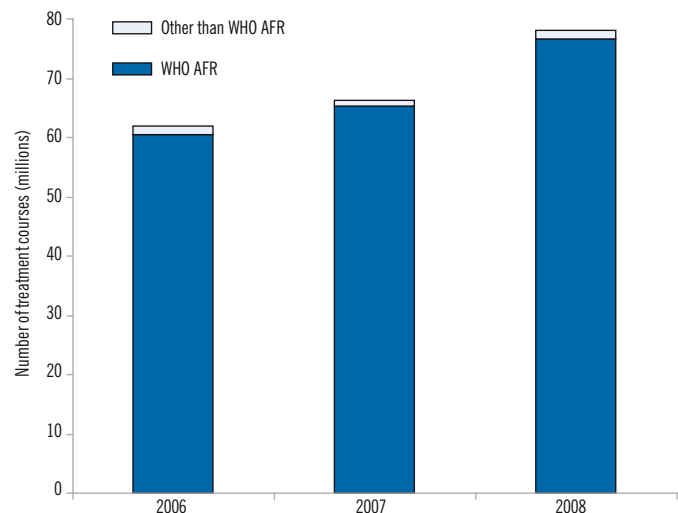


Figure 3.4 Number of artemether-lumefantrine treatment courses procured for public-sector use by procurement agency by year, global data, 2005–2008

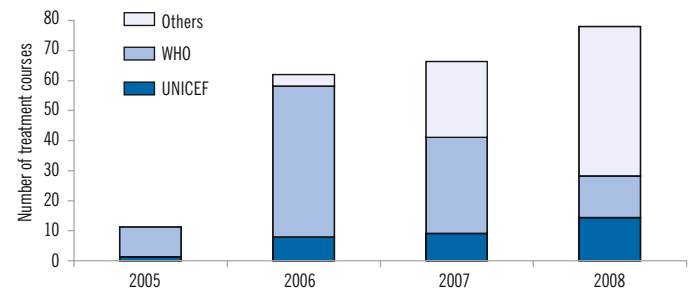
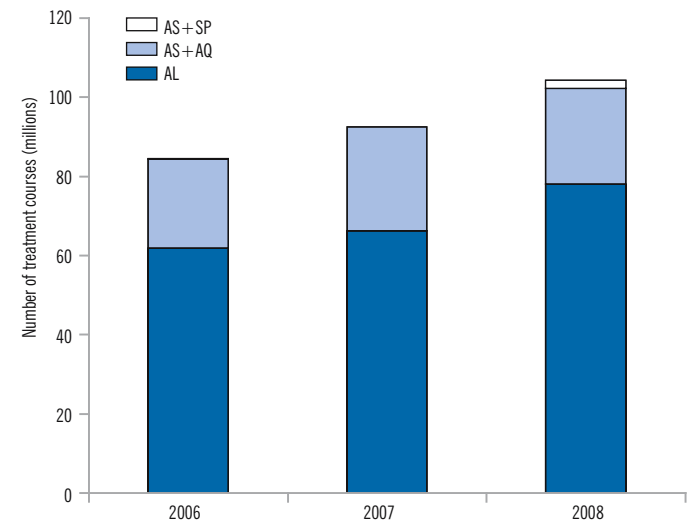
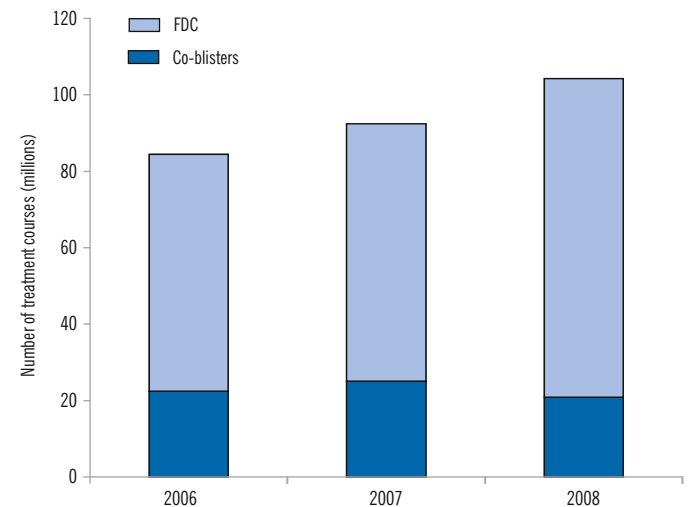


Figure 3.5 WHO-recommended artemisinin-based therapy courses procured for public sector use by year, global data



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

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



3.2.4 Artemisinin market situation

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

3.2.5 Oral artemisinin-based monotherapy medicines

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

World Health Assembly Resolution WHA60.18

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

- urges Member States to cease progressively the provision in both the public and private sectors of oral artemisinin-based monotherapies, to promote the use of artemisinin-combination therapies, and to implement policies that prohibit the production, marketing, distribution and the use of counterfeit antimalarial medicines;
- requests international organizations and financing bodies to adjust their policies so as progressively to cease to fund the provision and distribution of oral artemisinin monotherapies, and to join in campaigns to prohibit the production, marketing, distribution and use of counterfeit antimalarial medicines.

The full text of the resolution can be found at the following link:
http://apps.who.int/gb/ebwha/pdf_files/WHA60/A60_R18-en.pdf.

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

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

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

Information on manufacturing companies is available from:

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

Information on countries complying with the resolution is available from:

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

BOX 3.1

Country example: India

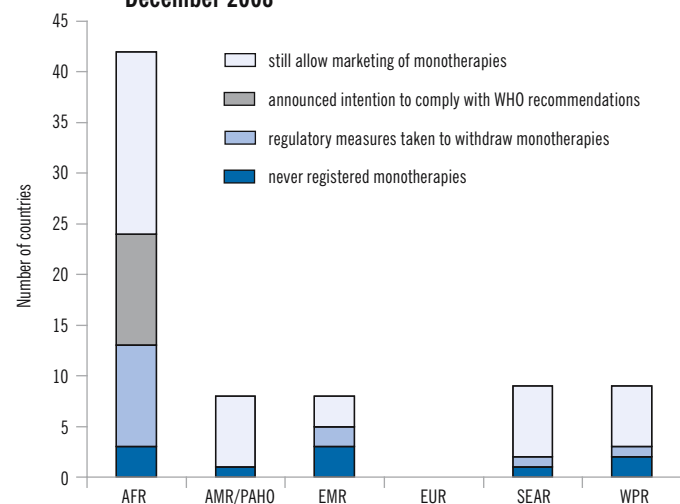
Indian pharmaceutical companies export large quantities of artemisinin-based antimalarial medicines to African countries, and up to 70 companies marketing these medicines have been identified. In April 2006 and October 2008, two meetings were convened with Indian manufacturers to inform them about the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

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

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

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

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



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

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

3.3.1 Definitions

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

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

BOX 3.2

Six practical indicators obtained from routine data

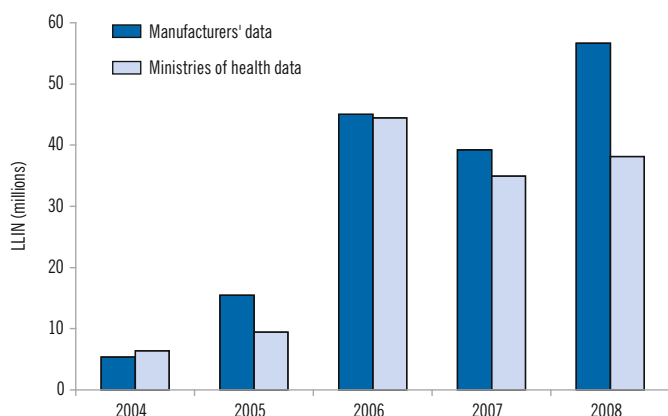
- ITNs** – Operational ITN coverage: number of LLINs distributed in previous 3 years multiplied by 2 (assuming one long-lasting insecticidal net covers two persons) divided by population at risk for malaria.
- ACTs** – Percentage of reported malaria cases with access to ACTs: number of ACT treatment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

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

3.3.2 Long-lasting insecticidal nets

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

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



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

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

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

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

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

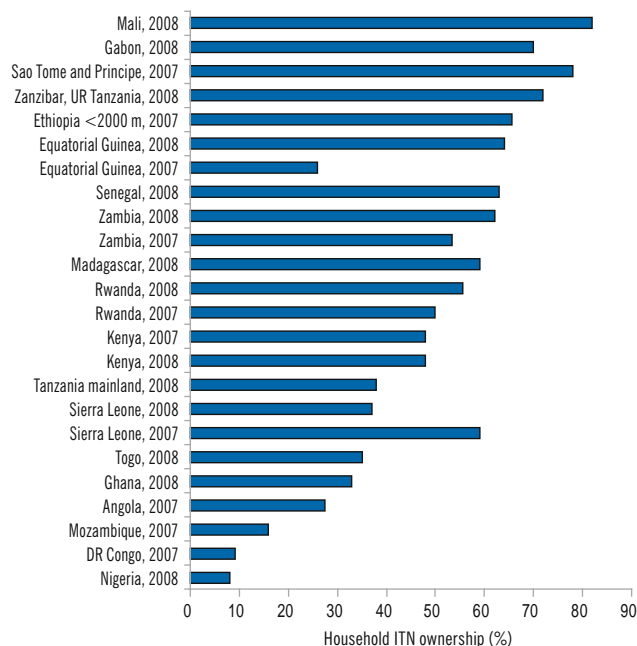


Table 3.2 Number of long-lasting insecticidal nets (LLIN) reported to have been distributed by ministries of health, as reported to WHO, and numbers reported to have been delivered to countries by manufacturers, 2006–2008, high-burden African countries. These data, with survey data, were used to estimate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

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

*based on 1 ITN per 2 persons

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

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

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

* highest/ lowest wealth quintile

Table 3.3 Continued

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

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

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

Estimating household ITN ownership and ITN use by children < 5 years old, by country and year, from both survey and administrative data.

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

Coverage and effectiveness of LLINs over time after mass distribution. Four countries have conducted surveys ≥ 12 months after the month of mass ITN distribution to children and pregnant women. In Sierra Leone, household ITN ownership declined 37%

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

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

Summary of model for estimating coverage with ITNs

Background

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

Model

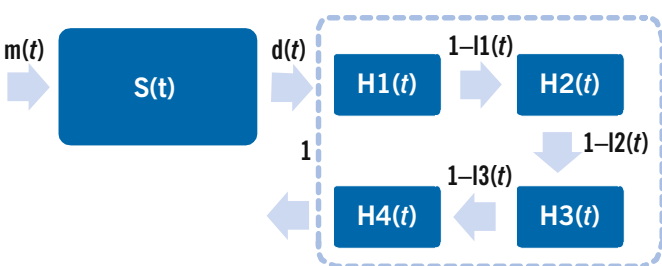
A Bayesian inference-based compartmental model was developed to make annual estimates between 1999 and 2008 of ITN coverage, defined as the proportion of households owning at least one ITN, and ITN use by children under 5, defined as the proportion of children under the age of 5 years sleeping under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

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

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

ITN use by children under 5

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



Stocks

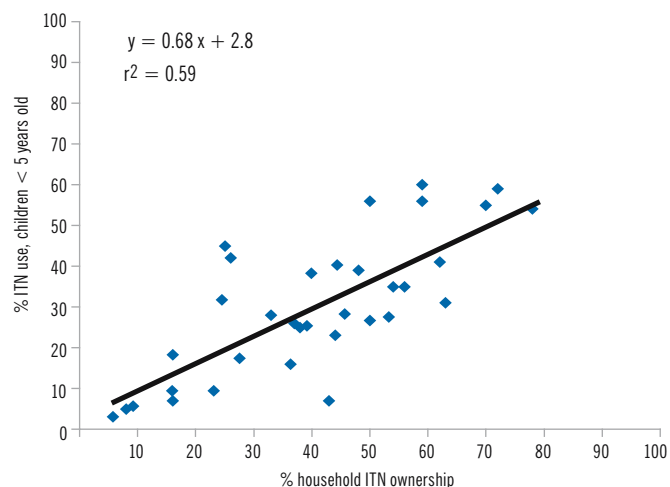
- $S(t)$ = ITNs in national supply for distribution at time t
- $H1(t)$ = 1 year old LLINs in households at time t
- $H2(t)$ = 2 year old LLINs in households at time t
- $H3(t)$ = 3 year old LLINs in households at time t
- $H4(t)$ = 4 year old LLINs in households at time t

Flows

- $m(t)$ = LLINs delivered to national supply by manufacturers during time period t
- $d(t)$ = LLINs distributed by agencies to households during time period t
- $I1(t)$ = number of 1 year old LLINs discarded by a household during time period t
- $I2(t)$ = number of 2 year old LLINs discarded during time period t
- $I3(t)$ = number of 3 year old LLINs discarded during time period t

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

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



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

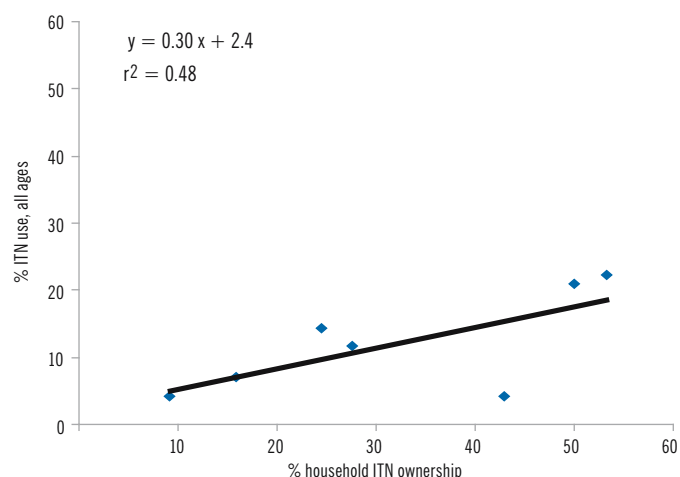


Figure 3.11 Percentage household ownership of insecticide-treated nets (ITNs) estimated from model, 2000–2008, 35 high-burden WHO African Region countries

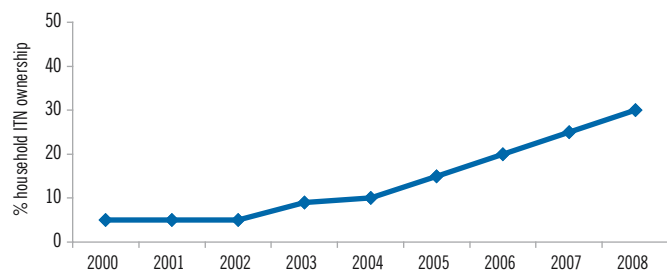


Table 3.4 Model-based estimates of percentage household insecticide-treated net (ITN) ownership, by year, high-burden African Region countries, 2004–2008; ordered by estimate of ownership in 2008

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

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

3.3.3 Indoor residual spraying

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

3.3.4 Rapid diagnostic tests

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

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

3.3.5 Treatment

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

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

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

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

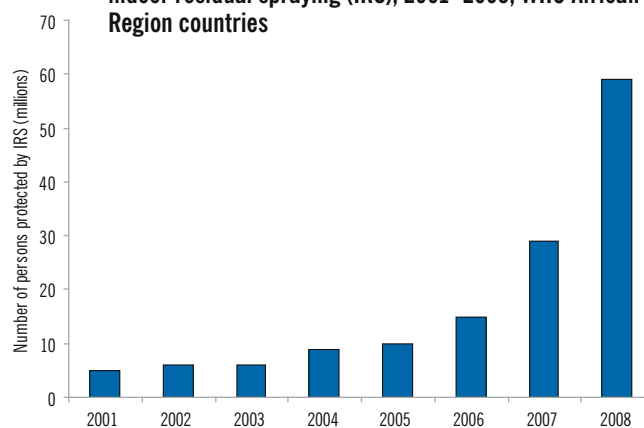
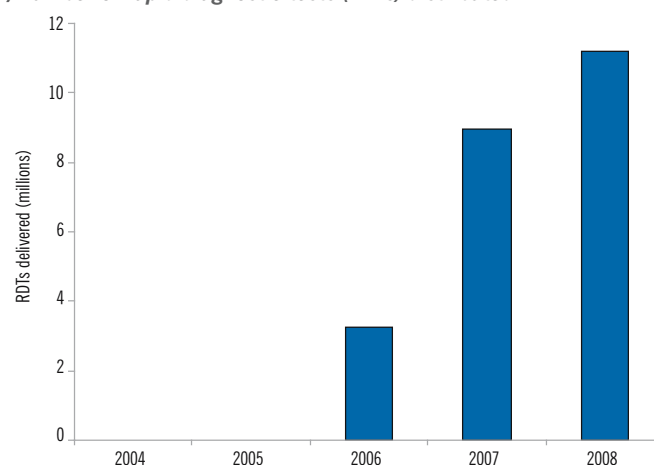


Figure 3.13 High-burden WHO African Region countries, 2004–2008

a) Number of rapid diagnostic tests (RDTs) distributed



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

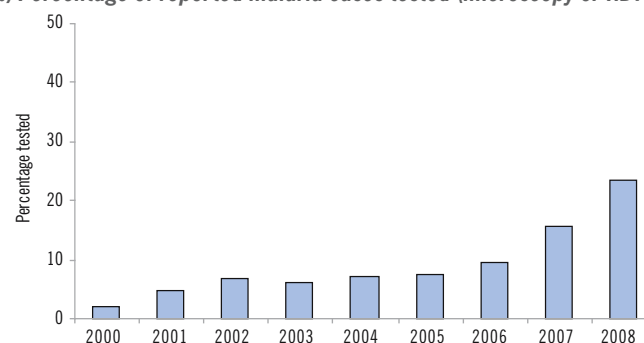


Figure 3.14 Numbers of ACT treatment courses distributed by countries, high-burden WHO African Region, 2003–2008

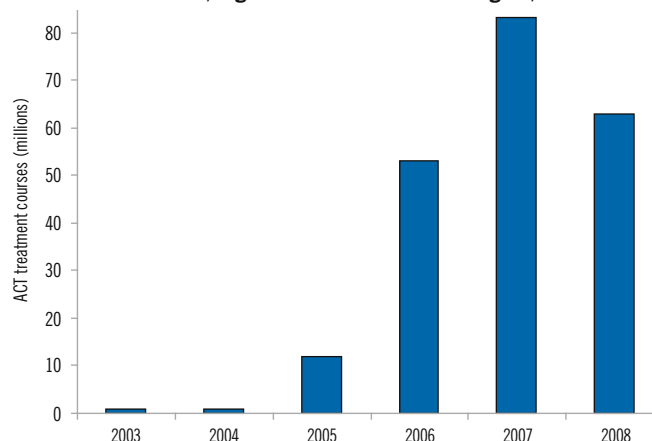


Table 3.5 Trends of household ownership and use of insecticide-treated nets (ITNs) by children < 5 years old in countries with at least two surveys after mass distribution of nets; Togo, Sierra Leone, Rwanda, and Kenya, 2004–2008

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

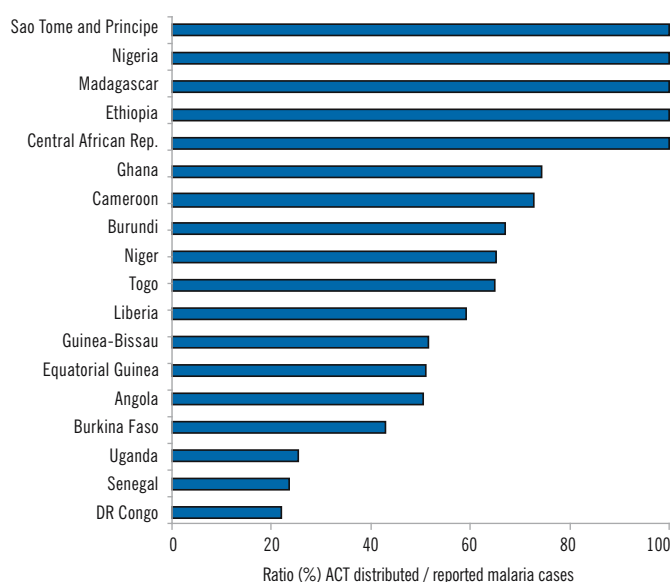
MOH = ministry of health; CDC = US Centers for Disease Control and Prevention; DHS = Demographic and Health Survey; MICS = Multiple Indicator Cluster Survey; MIS = Malaria Indicator Survey; DataDyne is a technical non-governmental organization.

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

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

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

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



Countries without data are not shown

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

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

Table 3.6 *Continued*

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

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

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

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

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

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

3.3.7 Summary of coverage with all interventions

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

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

3.4 Intervention coverage in countries outside the WHO African Region

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

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

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

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

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

* Data from only 7 countries representing 95 million persons.

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

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

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

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

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

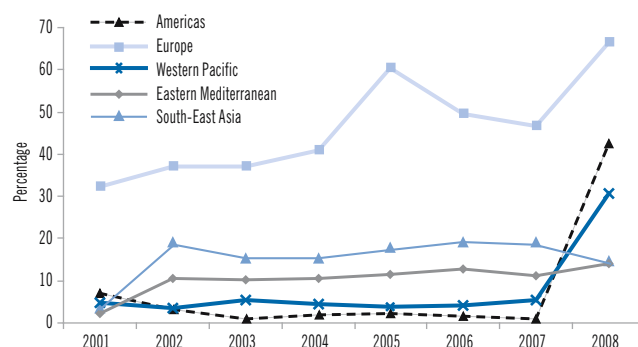


Table 3.9 Numbers of insecticide-treated nets (ITNs), artemisinin-based therapies (ACTs) and rapid diagnostic tests (RDT) reported by national programmes to have been distributed, by year, by WHO region

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

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