World Health Organization

Malaria Policy Advisory Committee (MPAC) Draft Meeting Agenda
Dates: 12-14 March 2014. Location: Salle A, WHO HQ, Geneva

Wednesday, 12 March 2014

Time	Session	Purpose	Type
9.00 am 9.15 am 10.30 am	Session 1: Welcome Welcome from Chair, MPAC *(K Marsh)* Report from the Director, GMP - Introduction *(J Reeder)* - World Malaria Report 2013 *(R Cibulskis)* WHO recommendations on the sound management of old Long Lasting Insecticidal Nets *(A Mnzava)*	For information and discussion **For decision (recommendation)**	open
11.30 am	**coffee**		
12.00 pm	Session 2: Vector Control TEG Update (cont.) Recommendations for countries on crisis mitigation when faced with short-term gaps in Long Lasting Insecticidal Net coverage *(J Lines)*	**For decision (recommendation)**	open
1.30 pm	**lunch**		
2.30 pm	Session 3: Vector Control TEG Update (cont.) Guidance for countries on combining Indoor Residual Spraying with Long Lasting Insecticidal Nets *(I Kleinschmidt)*	**For decision (guidance)**	open
4.00 pm	**coffee**		
4.30 pm 5.10 pm	Session 4: Global Technical Strategy 2016-2025 Process to date *(P Alonso)* Setting global targets *(A Ghani)*	For information and input	open
6.00 pm	**End of day/ cocktail reception** (WHO HQ restaurant)		

Update from WHO GMP Director a.i.

MPAC meeting
WHO HQ, 12 March 2014

John Reeder
Reederj@who.int

World Health Organization

GLOBAL MALARIA PROGRAMME

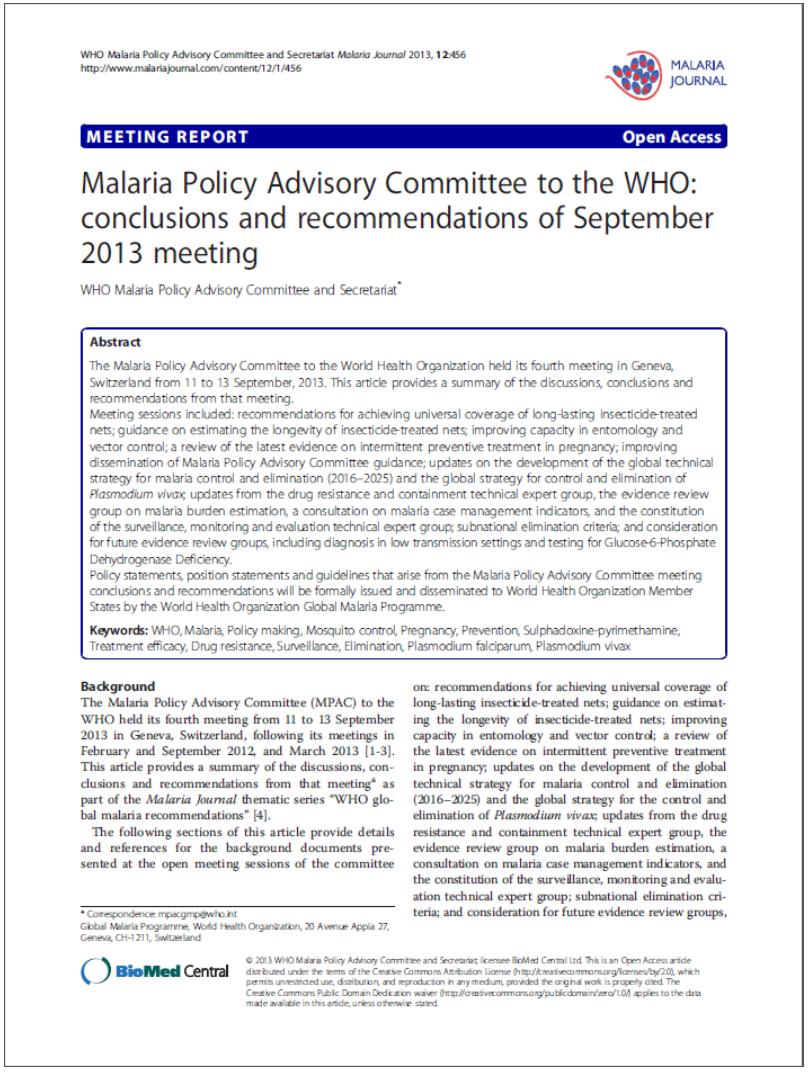
Who's that up in the front?

- Director, TDR
- Acting interim for GMP until new director is in place
- Deadline to apply was 10 March 2014
- New director expected to join within six months
- Business as usual
- Since the last MPAC meeting….

MPAC September 2014 meeting report

- Published in the *Malaria Journal* in Dec 2013
- All meeting reports published within 3 months of every MPAC meeting
- Available on MPAC website, and as part of WHO GMP's *Malaria Journal* series

http://www.malariajournal.com/series/WHO_recommendations



WHO Malaria Policy Advisory Committee and Secretariat *Malaria Journal* 2013, **12**:456
http://www.malariajournal.com/content/12/1/456

MALARIA JOURNAL

MEETING REPORT **Open Access**

Malaria Policy Advisory Committee to the WHO: conclusions and recommendations of September 2013 meeting

WHO Malaria Policy Advisory Committee and Secretariat*

Abstract

The Malaria Policy Advisory Committee to the World Health Organization held its fourth meeting in Geneva, Switzerland from 11 to 13 September, 2013. This article provides a summary of the discussions, conclusions and recommendations from that meeting.

Meeting sessions included: recommendations for achieving universal coverage of long-lasting insecticide-treated nets; guidance on estimating the longevity of insecticide-treated nets; improving capacity in entomology and vector control; a review of the latest evidence on intermittent preventive treatment in pregnancy; improving dissemination of Malaria Policy Advisory Committee guidance; updates on the development of the global technical strategy for malaria control and elimination (2016–2025) and the global strategy for control and elimination of *Plasmodium vivax*; updates from the drug resistance and containment technical expert group, the evidence review group on malaria burden estimation, a consultation on malaria case management indicators, and the constitution of the surveillance, monitoring and evaluation technical expert group; subnational elimination criteria; and consideration for future evidence review groups, including diagnosis in low transmission settings and testing for Glucose-6-Phosphate Dehydrogenase Deficiency.

Policy statements, position statements and guidelines that arise from the Malaria Policy Advisory Committee meeting conclusions and recommendations will be formally issued and disseminated to World Health Organization Member States by the World Health Organization Global Malaria Programme.

Keywords: WHO, Malaria, Policy making, Mosquito control, Pregnancy, Prevention, Sulphadoxine-pyrimethamine, Treatment efficacy, Drug resistance, Surveillance, Elimination, Plasmodium falciparum, Plasmodium vivax

Background

The Malaria Policy Advisory Committee (MPAC) to the WHO held its fourth meeting from 11 to 13 September 2013 in Geneva, Switzerland, following its meetings in February and September 2012, and March 2013 [1-3]. This article provides a summary of the discussions, conclusions and recommendations from that meeting* as part of the *Malaria Journal* thematic series "WHO global malaria recommendations" [4].

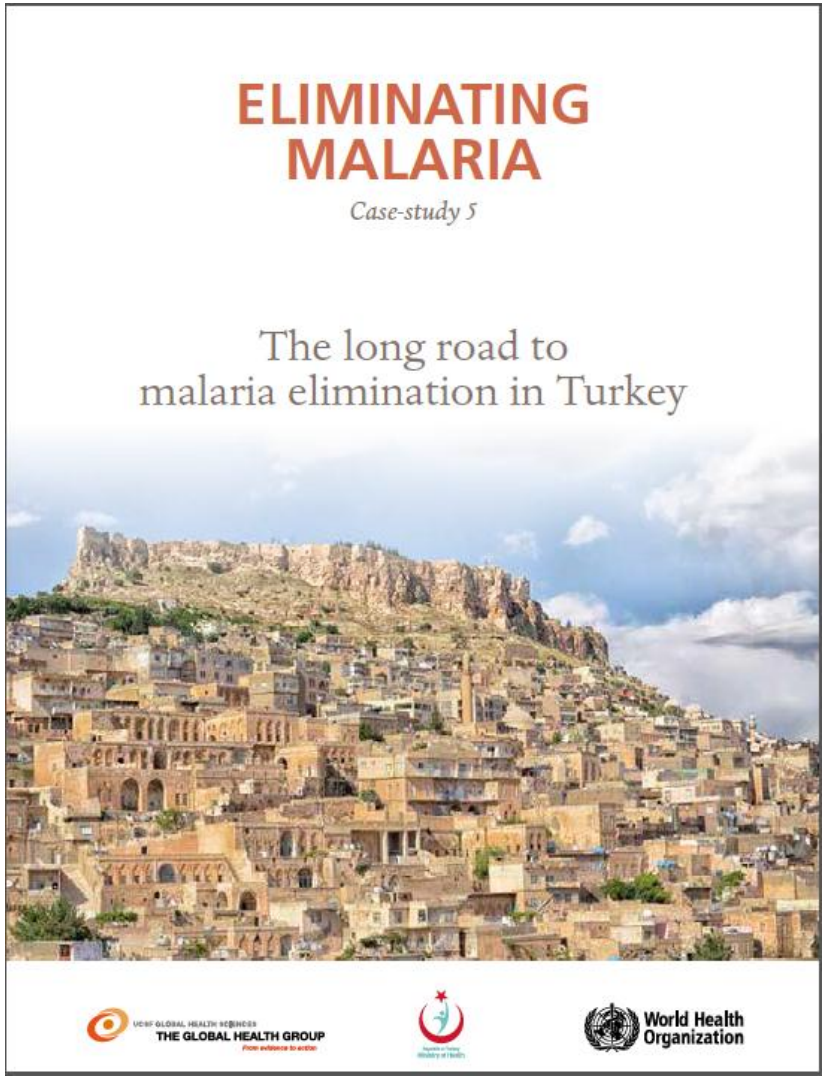
The following sections of this article provide details and references for the background documents presented at the open meeting sessions of the committee on: recommendations for achieving universal coverage of long-lasting insecticide-treated nets; guidance on estimating the longevity of insecticide-treated nets; improving capacity in entomology and vector control; a review of the latest evidence on intermittent preventive treatment in pregnancy; updates on the development of the global technical strategy for malaria control and elimination (2016–2025) and the global strategy for the control and elimination of *Plasmodium vivax*; updates from the drug resistance and containment technical expert group, the evidence review group on malaria burden estimation, a consultation on malaria case management indicators, and the constitution of the surveillance, monitoring and evaluation technical expert group; subnational elimination criteria; and consideration for future evidence review groups,

* Correspondence: mpacgmp@who.int
Global Malaria Programme, World Health Organization, 20 Avenue Appia 27, Geneva, CH-1211, Switzerland

Eliminating Malaria Case Study - Turkey

- Published Nov 2013
- 5th in series
- All case studies (Cape Verde, Mauritius, Sri Lanka, Turkmenistan and Turkey) can be found on

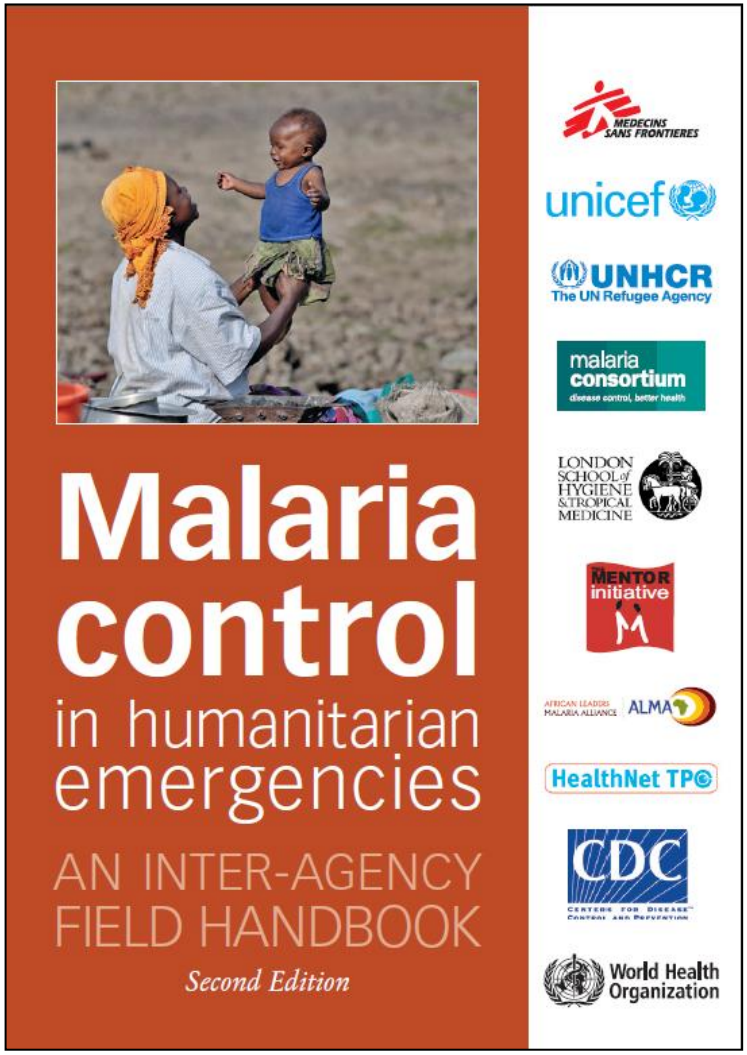
http://www.who.int/malaria/areas/elimination/casestudies/en/



Malaria in Emergencies – Interagency Field Handbook

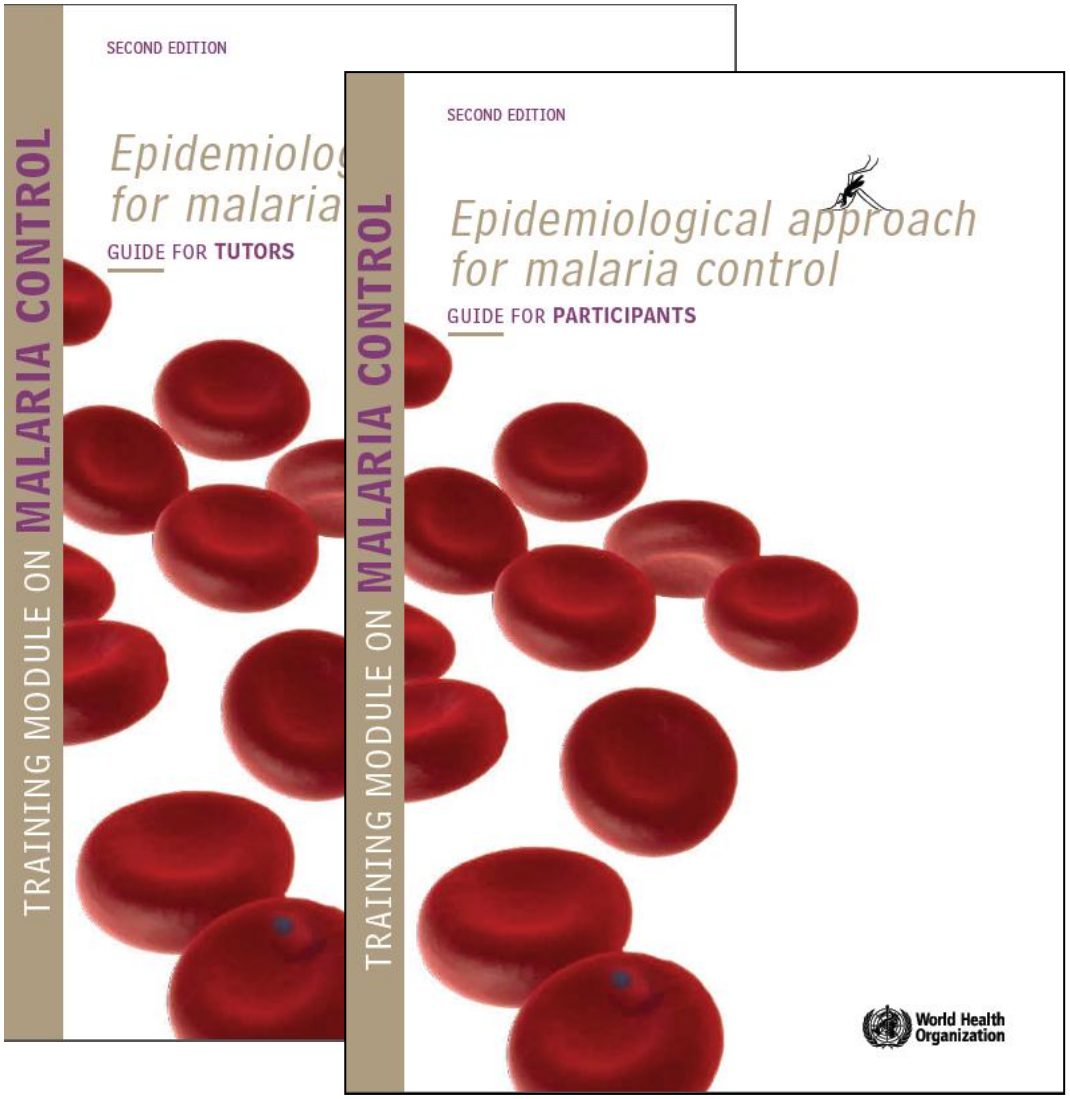
- 2nd ed. published Oct 2013
- All chapters have been revised to reflect
  - changes in best practices
  - improvements in technologies
  - availability of new tools
  - changes in WHO recommendations
- Available for download on

http://www.who.int/malaria/publications/atoz/9789241548656/en/



Training module for malaria control

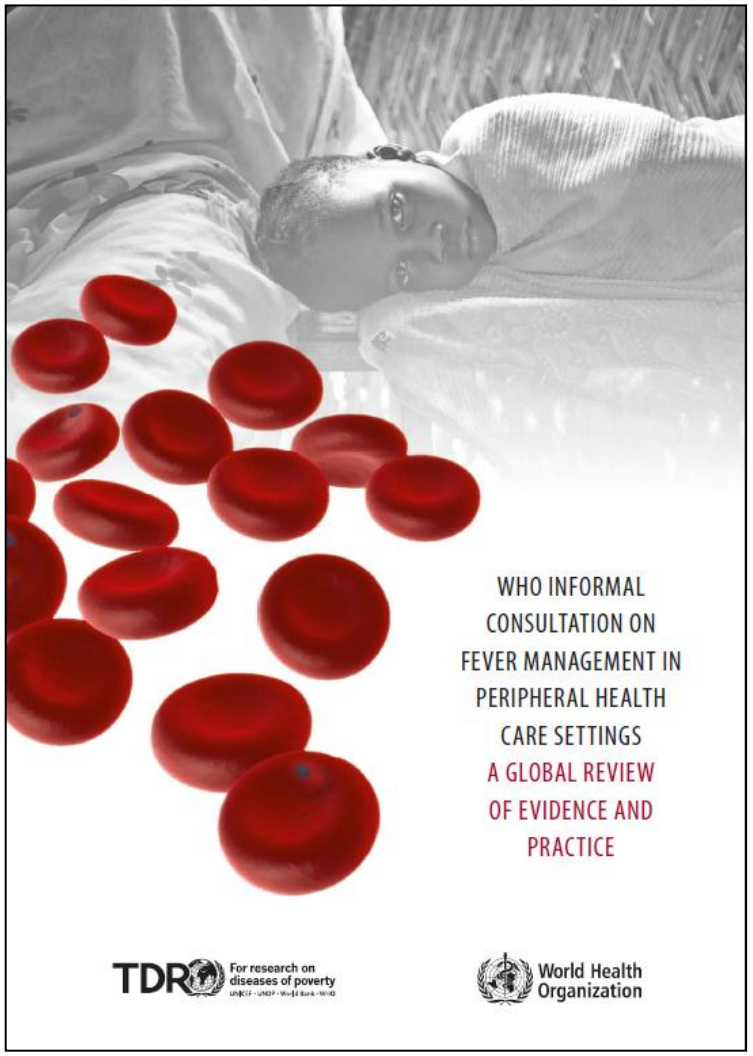
- Published Dec 2013
- Guide for both tutors and participants
- Developed to improve the capacity of NMCPs on the key determinants of malaria epidemiology, and their interactions, as the basis for the selection of appropriate prevention and control interventions.
- Available for download on http://www.who.int/malaria/publications/atoz/9789241506014/en/



Report from the WHO informal consultation on fever management

- Published Nov 2013
- Conclusions of a technical consultation convened in January 2013 by GMP and TDR to:
  - review evidence and operational experiences on the correct management of febrile illnesses in primary health care facilities and at the community level
  - consider existing WHO guidance on the issue, as well as research priorities.
- Available for download on

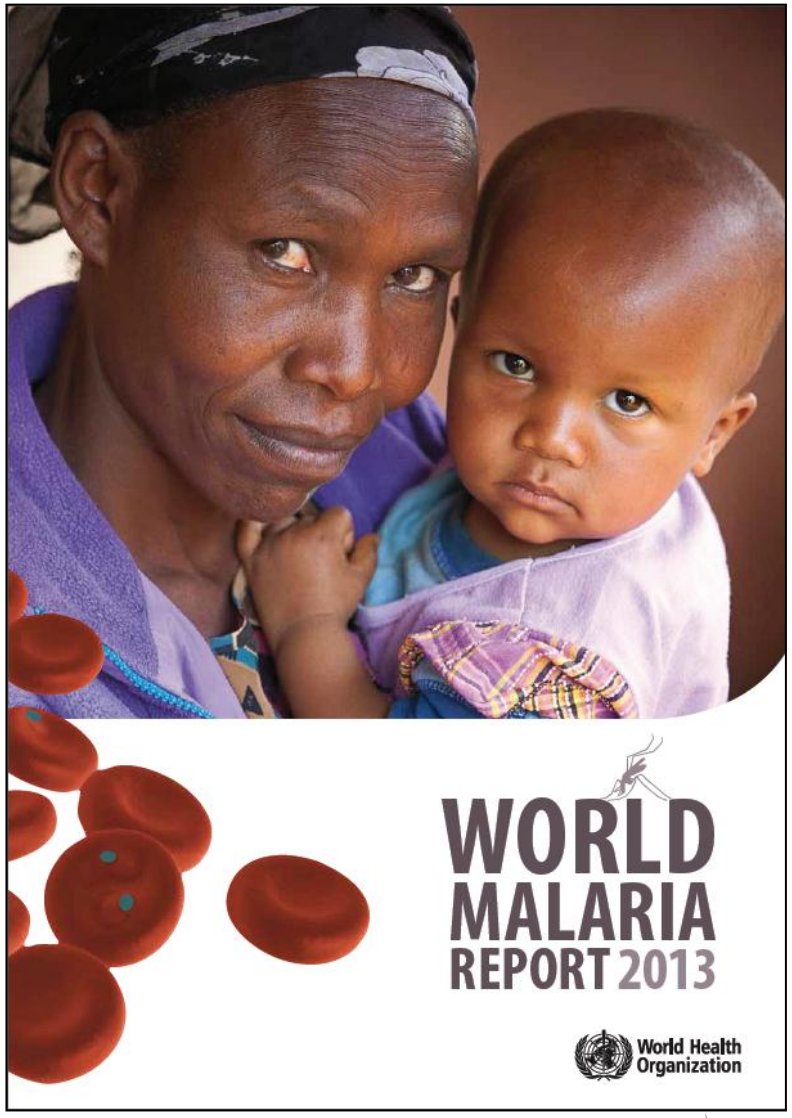
http://www.who.int/malaria/publications/atoz/9789241506489/en/



World Malaria Report 2013

- Launched Dec 2013 in Washington DC
- Summarizes information received from malaria-endemic countries and other sources, and updates the analyses presented in the 2012 report.
- Highlights the progress made towards global malaria targets set for 2015 (Richard to tell you more shortly)
- Available for download on

http://www.who.int/malaria/publications/world_malaria_report_2013/report/en/



Other WHO GMP news

- Recent GMP dissemination events – MIM 2013 and ASTMH 2013 – both symposia well received
- Draft meeting report – operational research on malaria elimination (Tab 9)
- Draft MPAC stakeholder survey – please make note of any suggestions (Tab 10) and give/email Bianca (dsouzabi@who.int)
- Recent and upcoming meetings
  - **ERG on diagnostics in low transmission** – 16 to 18 Dec 2013 – Recommendations for decision in session 10
  - **Vector Control TEG** – 24 to 26 Feb 2014 – Recommendations for decision in sessions 1, 2, and 3
  - **Drug Resistance & Containment TEG** – 28 to 30 April 2014
  - **Surveillance Monitoring & Evaluation TEG** – 14 to 16 May 2014
  - **Malaria Chemotherapy TEG** – TBC June 2014

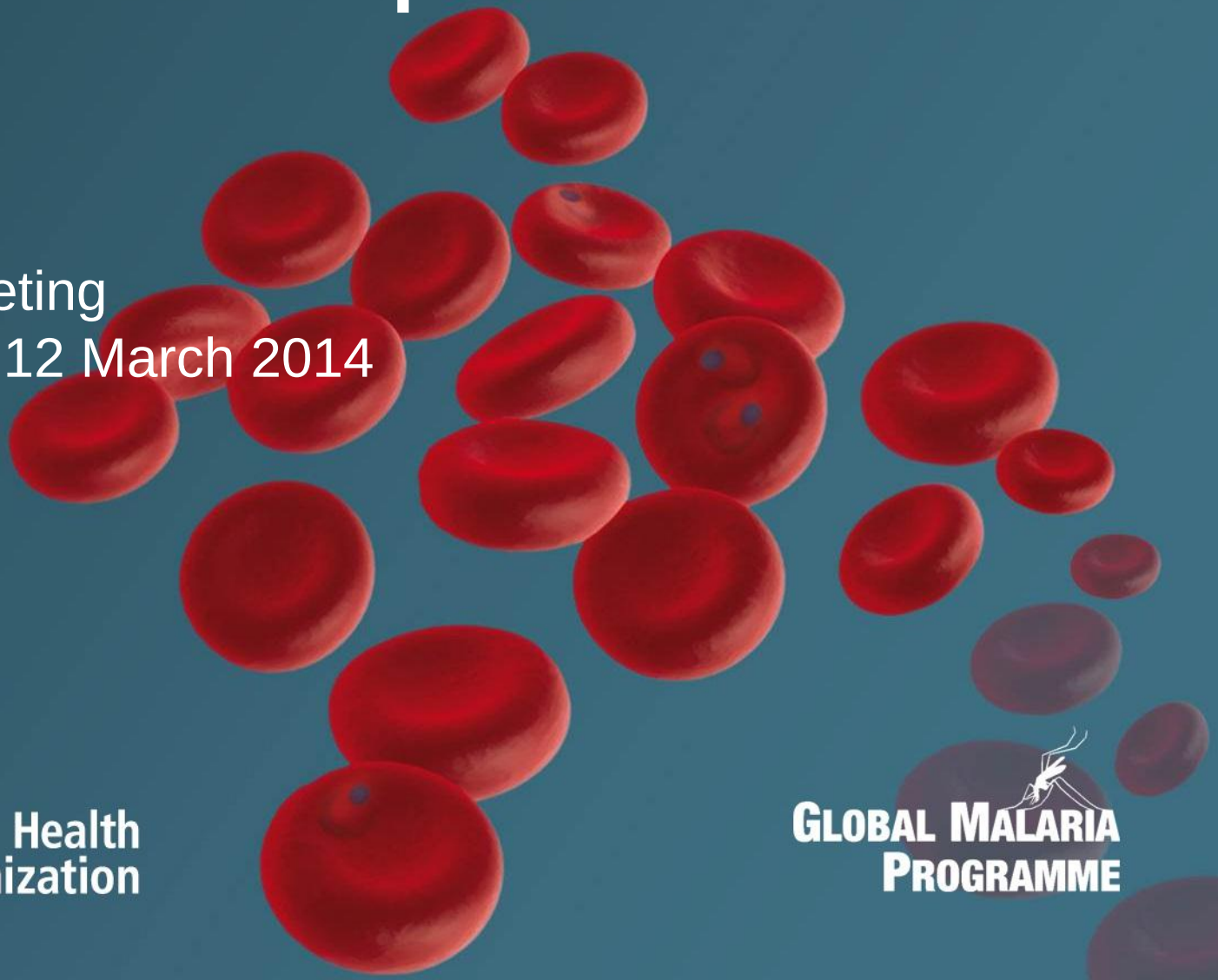
Other WHO GMP news (2)

- WHO GMP now publishes an electronic newsletter which contains a summary of all news updates and document releases
- Please sign up on our website http://www.who.int/malaria/en/
- Previous issues can be found on http://www.who.int/malaria/media/newsletter/en/

- Other GMP activities and updates will be covered during the course of the MPAC meeting
- Look out for Elimination Scenario Planning Tool, to be launched on World Malaria Day 2014

Thank you for listening! Questions following the WMR update from Richard

World Malaria Report 2013



MPAC meeting
WHO HQ, 12 March 2014

WMR team

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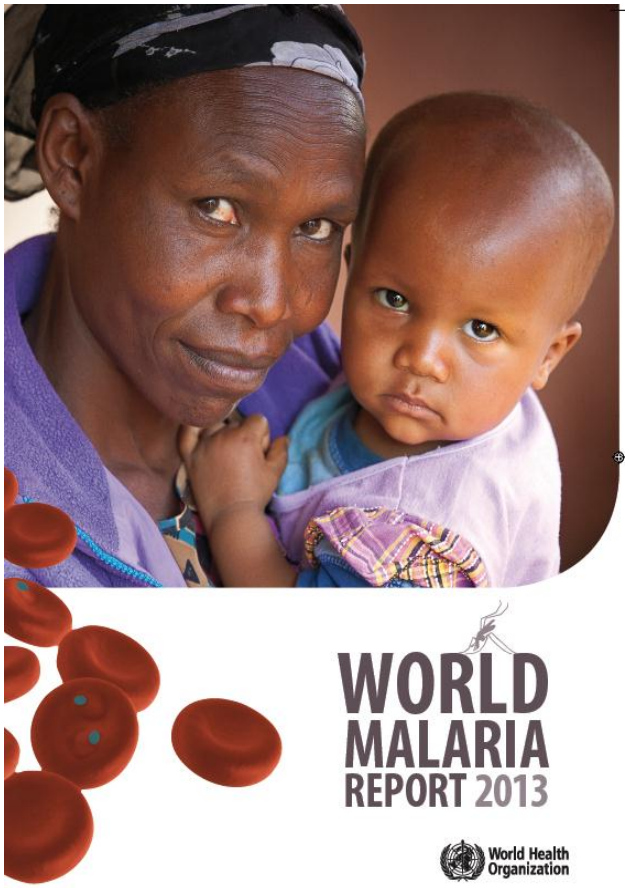
World Malaria Report 2013



- Released on 11 December 2013
- Annual reference on the status of global malaria control & elimination.
- Principal data source is national malaria control programs with support from: WHO Regional offices, AMFm, ALMA, CDC, DHS/ Measure, FIND, GHG UCSF, Global Fund, IHME, ISGlobal, JHSPH, Oxford University, RBM, Tulane University, UNICEF, UNSE, USAID.
- Data to 2012 and 2013.
- Summarizes key malaria targets & goals ana policies
- Documents trends in financing, intervention coverage and malaria cases and deaths
- Profiles for 6 WHO regions and 99 endemic countries and areas

Core Team

HQ

Kathryn Andrews/ Cristin Fergus	*Data analyst*
Maru Aregawi	*Epidemiologist*
Richard Cibulskis	*Coordinator*
Mike Lynch (from CDC)	*Epidemiologist*
Zsofia Szilagi	*Advocacy*
Mar Velarde (ISGlobal)	*Production manager*
Ryan Williams	*Data base manager*

WHO regions

Afr: Boniface Kinvi, Khoti Gausi, Spes Ntabangana, Kharchi Tfeil
Amr: Rainier Escalada, Prabjhat Singh
Emr: Ghasem Zamani
Eur: Elkhan Gasimov
Sear: Leonard Ortega
Wpr: Bayo Fatumbi

External Reviewers

Melanie Renshaw (ALMA)
Larry Slutsker (CDC)
Rob Newman
WHO Regions

Collaborators

Oxford University (MAP)

New inclusions for 2013

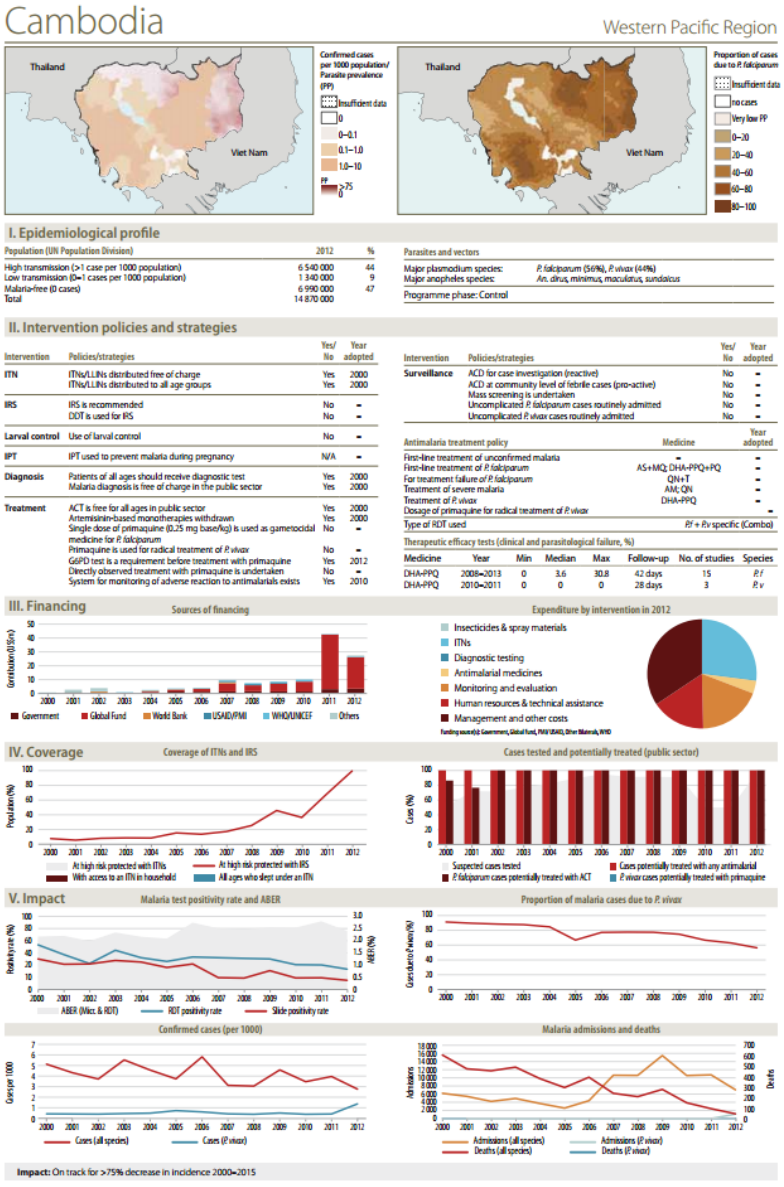
3. Financing: Domestic investment priority index (DIPI)
4. Vector control: Missed opportunities to distribute ITNs in routine deliveries (ANC, EPI).
5. Preventive therapies: Missed opportunities in ANC inc. TT
6. Diagnostic testing and treatment: Testing for *P. vivax.* Estimates of malaria treatment coverage including *P. vivax*.
7. Surveillance M&E: Completeness of death reporting, availability of household surveys.
8. Impact: Trends in *P. vivax*, burden estimates for 2012 including country consultation.
9. Country profiles: To include *P. vivax*

Translations ahead of launch event. 3 launch events.

Regional & Country Profiles & Annexes

Maps of % *P. falciparum*

P. vivax specific information for policies, therapeutic efficacy, and disease trends



Cambodia

Western Pacific Region

Thailand

Viet Nam

Confirmed cases per 1000 population/ Parasite prevalence (PP)

Insufficient data

0

0–0.1

0.1–1.0

1.0–10

PP >75

Proportion of cases due to *P. falciparum*

Insufficient data

no cases

Very low PP

0–20

20–40

40–60

60–80

80–100

I. Epidemiological profile

Population (UN Population Division)	2012	%
High transmission (>1 case per 1000 population)	6 540 000	44
Low transmission (0–1 cases per 1000 population)	1 340 000	9
Malaria-free (0 cases)	6 990 000	47
Total	14 870 000	

Parasites and vectors

Major plasmodium species: *P. falciparum* (56%), *P. vivax* (44%)

Major anopheles species: *An. dirus, minimus, maculatus, sundaicus*

Programme phase: Control

II. Intervention policies and strategies

Intervention	Policies/strategies	Yes/ No	Year adopted
ITN	ITNs/LLINs distributed free of charge	Yes	2000
	ITNs/LLINs distributed to all age groups	Yes	2000
IRS	IRS is recommended	No	-
	DDT is used for IRS	No	-
Larval control	Use of larval control	No	-
IPT	IPT used to prevent malaria during pregnancy	N/A	-
Diagnosis	Patients of all ages should receive diagnostic test	Yes	2000
	Malaria diagnosis is free of charge in the public sector	Yes	2000
Treatment	ACT is free for all ages in public sector	Yes	2000
	Artemisinin-based monotherapies withdrawn	Yes	2000
	Single dose of primaquine (0.25 mg base/kg) is used as gametocidal medicine for *P. falciparum*	No	-
	Primaquine is used for radical treatment of *P. vivax*	No	-
	G6PD test is a requirement before treatment with primaquine	Yes	2012
	Directly observed treatment with primaquine is undertaken	No	-
	System for monitoring of adverse reaction to antimalarials exists	Yes	2010

Intervention	Policies/strategies	Yes/ No	Year adopted
Surveillance	ACD for case investigation (reactive)	No	-
	ACD at community level of febrile cases (pro-active)	No	-
	Mass screening is undertaken	No	-
	Uncomplicated *P. falciparum* cases routinely admitted	No	-
	Uncomplicated *P. vivax* cases routinely admitted	No	-

Antimalaria treatment policy	Medicine	Year adopted
First-line treatment of unconfirmed malaria	-	-
First-line treatment of *P. falciparum*	AS+MQ; DHA-PPQ+PQ	-
For treatment failure of *P. falciparum*	QN+T	-
Treatment of severe malaria	AM; QN	-
Treatment of *P. vivax*	DHA-PPQ	-
Dosage of primaquine for radical treatment of *P. vivax*		-
Type of RDT used		*Pf* + *Pv* specific (Combo)

Therapeutic efficacy tests (clinical and parasitological failure, %)

Medicine	Year	Min	Median	Max	Follow-up	No. of studies	Species
DHA-PPQ	2008–2013	0	3.6	30.8	42 days	15	*P. f*
DHA-PPQ	2010–2011	0	0	0	28 days	3	*P. v*

III. Financing

Sources of financing

Contribution (US$/cap)

Government; Global Fund; World Bank; USAID/PMI; WHO/UNICEF; Others

Expenditure by intervention in 2012

Insecticides & spray materials; ITNs; Diagnostic testing; Antimalarial medicines; Monitoring and evaluation; Human resources & technical assistance; Management and other costs

IV. Coverage

Coverage of ITNs and IRS

Population (%)

At high risk protected with ITNs; At high risk protected with IRS; With access to an ITN in household; All ages who slept under an ITN

Cases tested and potentially treated (public sector)

Cases (%)

Suspected cases tested; Cases potentially treated with any antimalarial; *P. falciparum* cases potentially treated with ACT; *P. vivax* cases potentially treated with primaquine

V. Impact

Malaria test positivity rate and ABER

Parasite rate (%); ABER (%)

ABER (Micr. & RDT); RDT positivity rate; Slide positivity rate

Proportion of malaria cases due to *P. vivax*

Cases due to *P. vivax* (%)

Confirmed cases (per 1000)

Cases per 1000

Cases (all species); Cases (*P. vivax*)

Malaria admissions and deaths

Admissions; Deaths

Admissions (all species); Admissions (*P. vivax*); Deaths (all species); Deaths (*P. vivax*)

Impact: On track for >75% decrease in incidence 2000–2015

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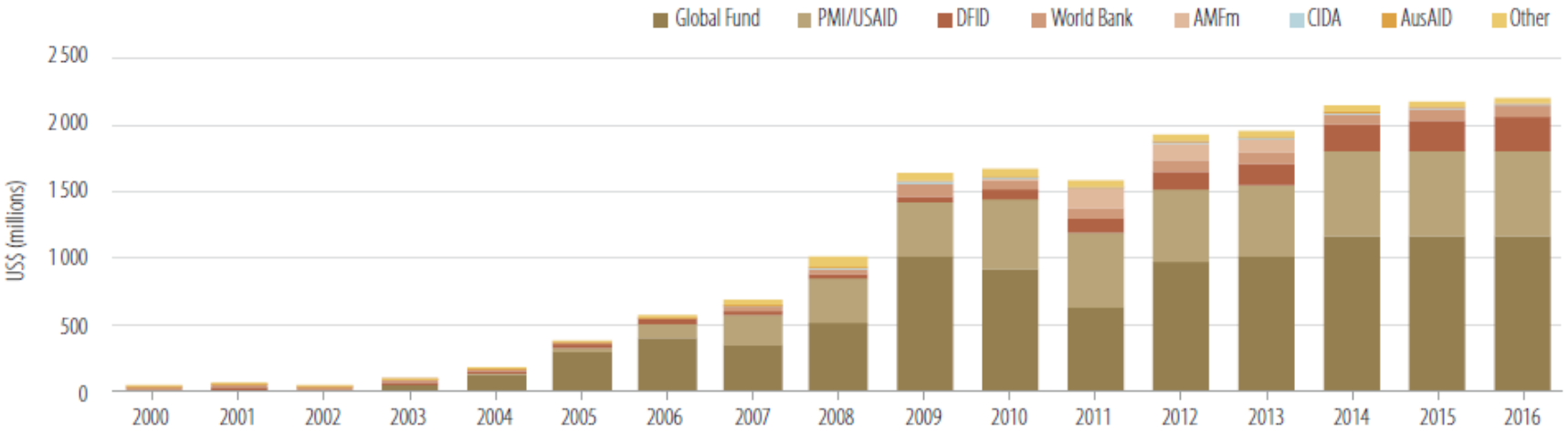
Chapter 3: International funding for malaria control, 2000-2016



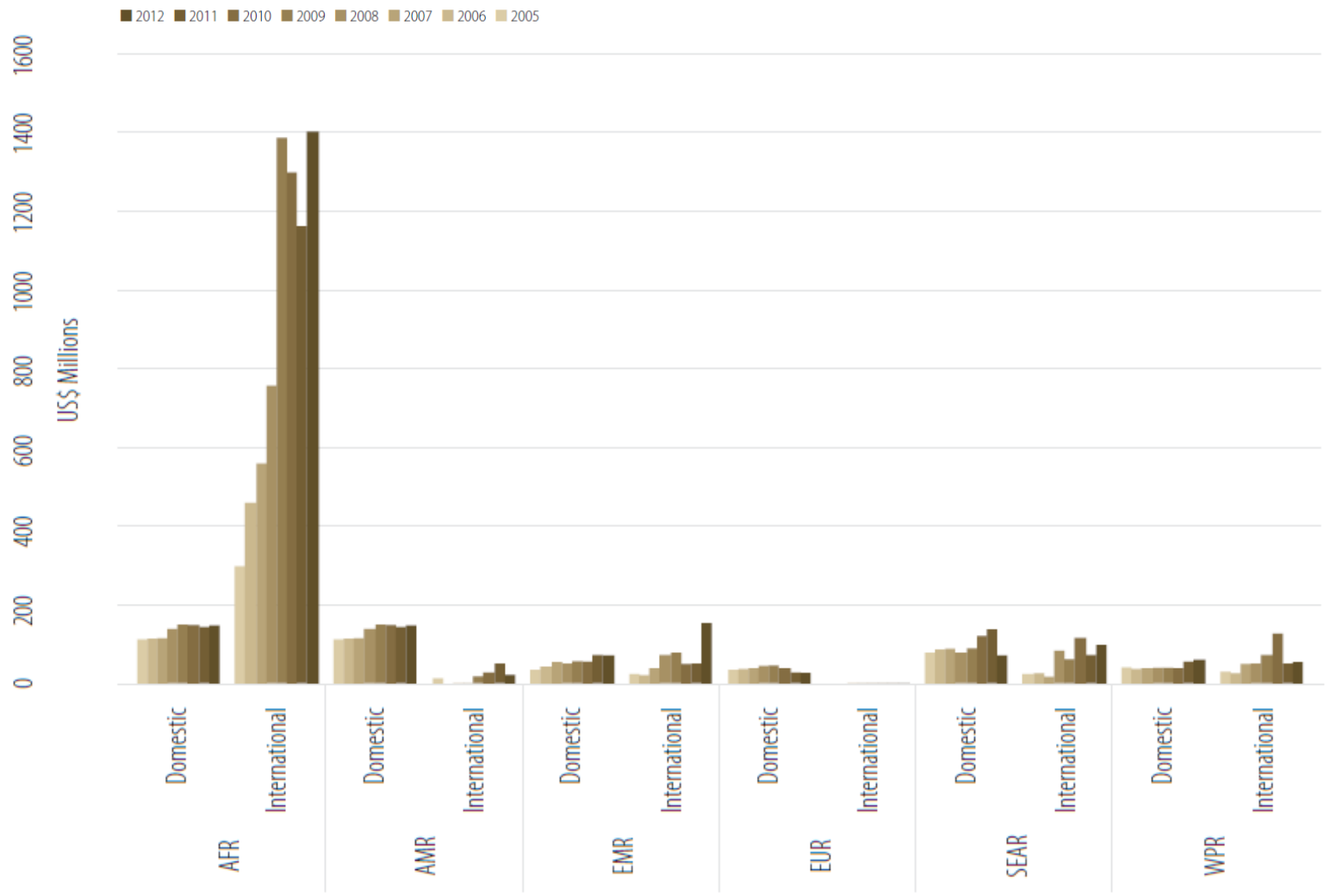
AMFm, Affordable Medicines Facility – malaria; AusAID, Australian Agency for International Development; CIDA, Canadian International Development Agency; DFID, Department for International Development; GF, Global Fund; PMI, President's Malaria Initiative; USAID, United States Agency for International Development; WB, World Bank

For the GF and PMI/USAID, funds from the last quarter of 2013 onwards are projected; for other agencies, funds from 2012 onwards are projected.

Source: *See Box 3.1*

International disbursements to malaria-endemic countries have increased, from less than US$ 100 million in 2000 to US$ 1.6 billion in 2011, and an estimated US$ 1.94 billion in 2012 and 1.97 billion in 2013.

Domestic and external disbursements 2005–2012 by WHO region, 2005-2012



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

Source: *See Box 3.1.*

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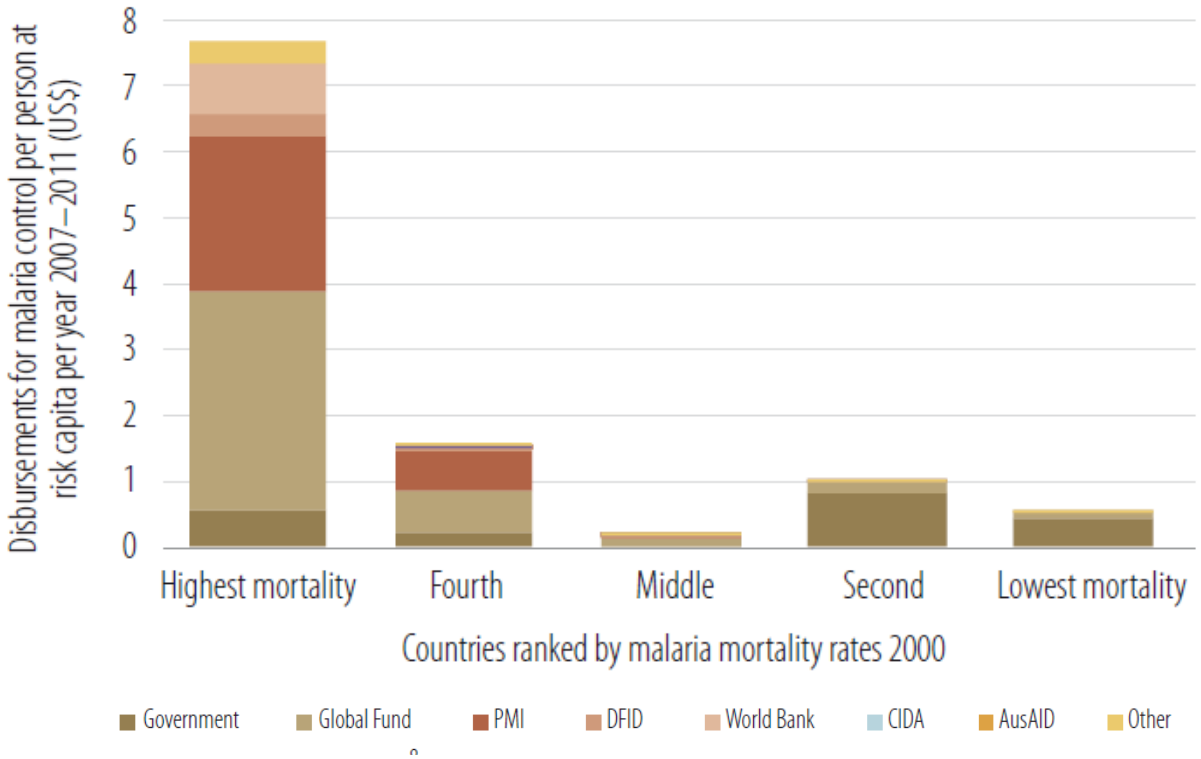
Malaria spending per person according to national income and estimated malaria mortality rates



AusAID, Australian Agency for International Development; CIDA, Canadian International Development Agency; DFID, Department for International Development; GF, Global Fund; GNI, gross national income; PMI, President's Malaria Initiative; WB, World Bank

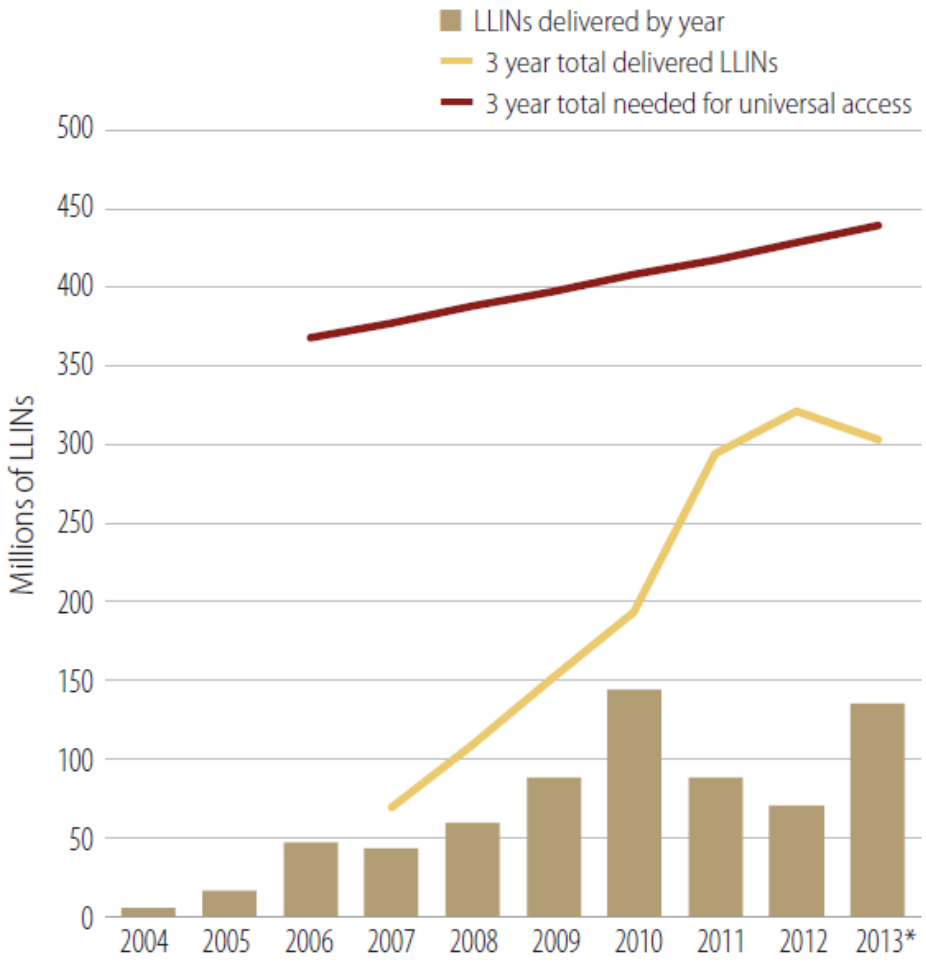
Data on international disbursements by country are available only up to 2011 for most agencies (See Box 3.1)

Source: *See Box 3.1*

GNI per capita: World Development Indicators 2013, (http://wdi.worldbank.org/tables)

Malaria mortality rates: WHO calculations.

Chapter 4: Number of LLINs delivered by manufacturers to countries in sub-Saharan Africa, 2004–2013



LLIN, long-lasting insecticidal net

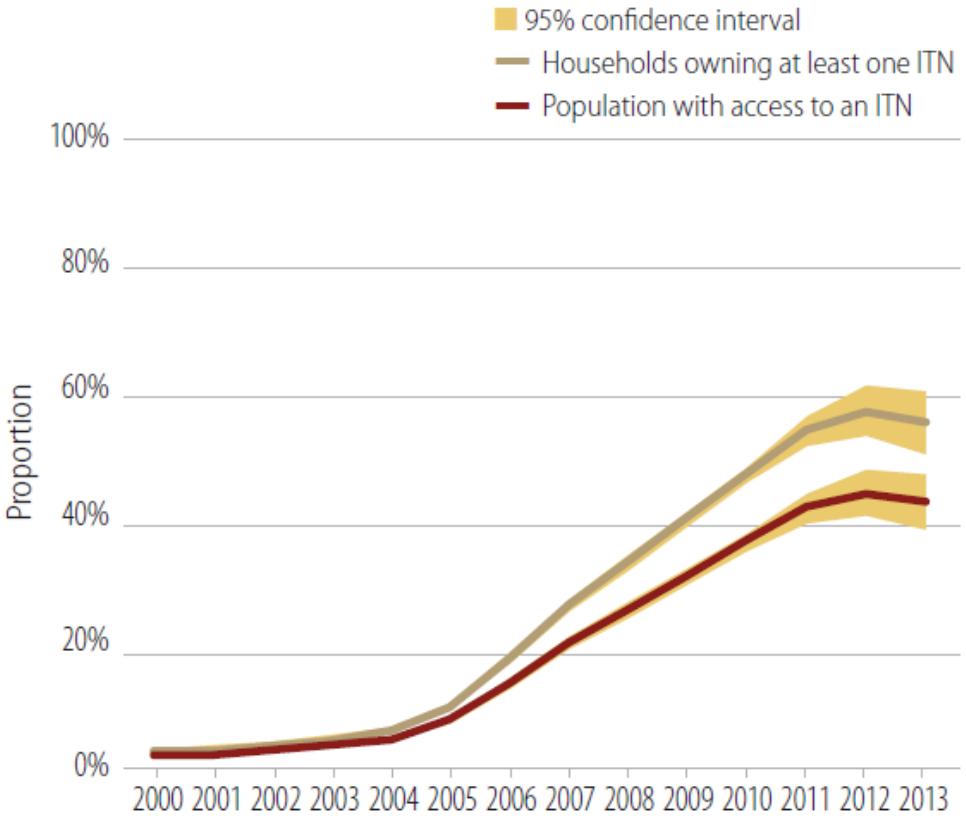
* The total number delivered for the first three quarters of 2013 has been multiplied by 4/3 to provide an annual estimate.

Source: Data from 7 WHOPES-approved manufacturers, collated by Milliner Global Associates.

Only 92 million ITNs were delivered by manufacturers in 2011, and only 70 million in 2012.

The estimated numbers of ITNs delivered in 2013 (136 million) closer to the need of 150 million.

Estimated proportion of households with at least one ITN and population with access to an ITN in sub-Saharan Africa



ITN, insecticide-treated net

Proportion population with access to an ITN derived from relationship with household ownership of at least one ITN analyzed by linear regression in 48 household surveys 2001-2012, y= 0.77x

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

The percentage of households owning at least one ITN in sub-Saharan Africa is estimated to have risen from 3% in 2000 to 56% in 2012, but declined slightly to 54% in 2013.

The proportion of the population with access to an ITN in their household increased during the same period, reaching 42% in 2013.

The proportion of the population sleeping under an ITN was estimated to be 36% in 2013.

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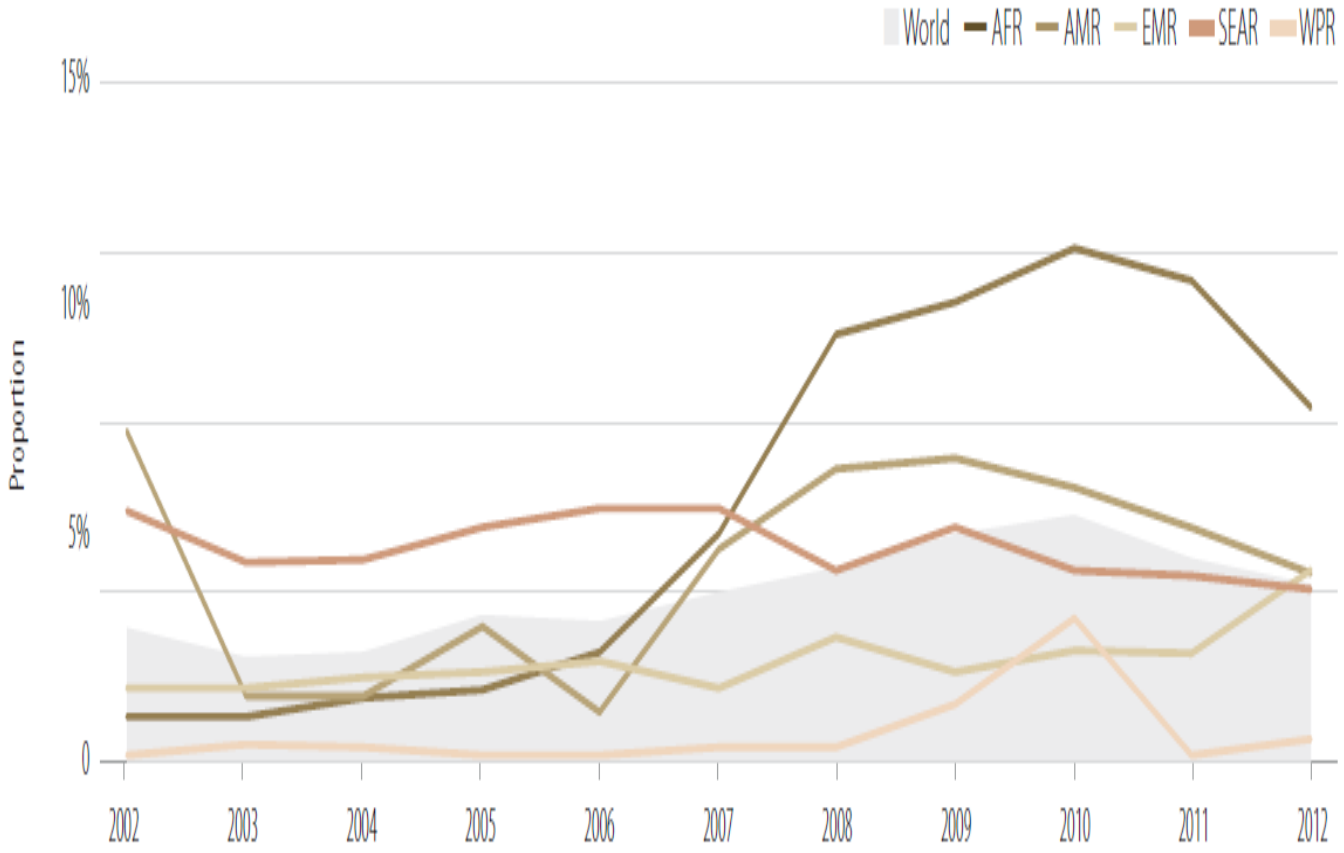
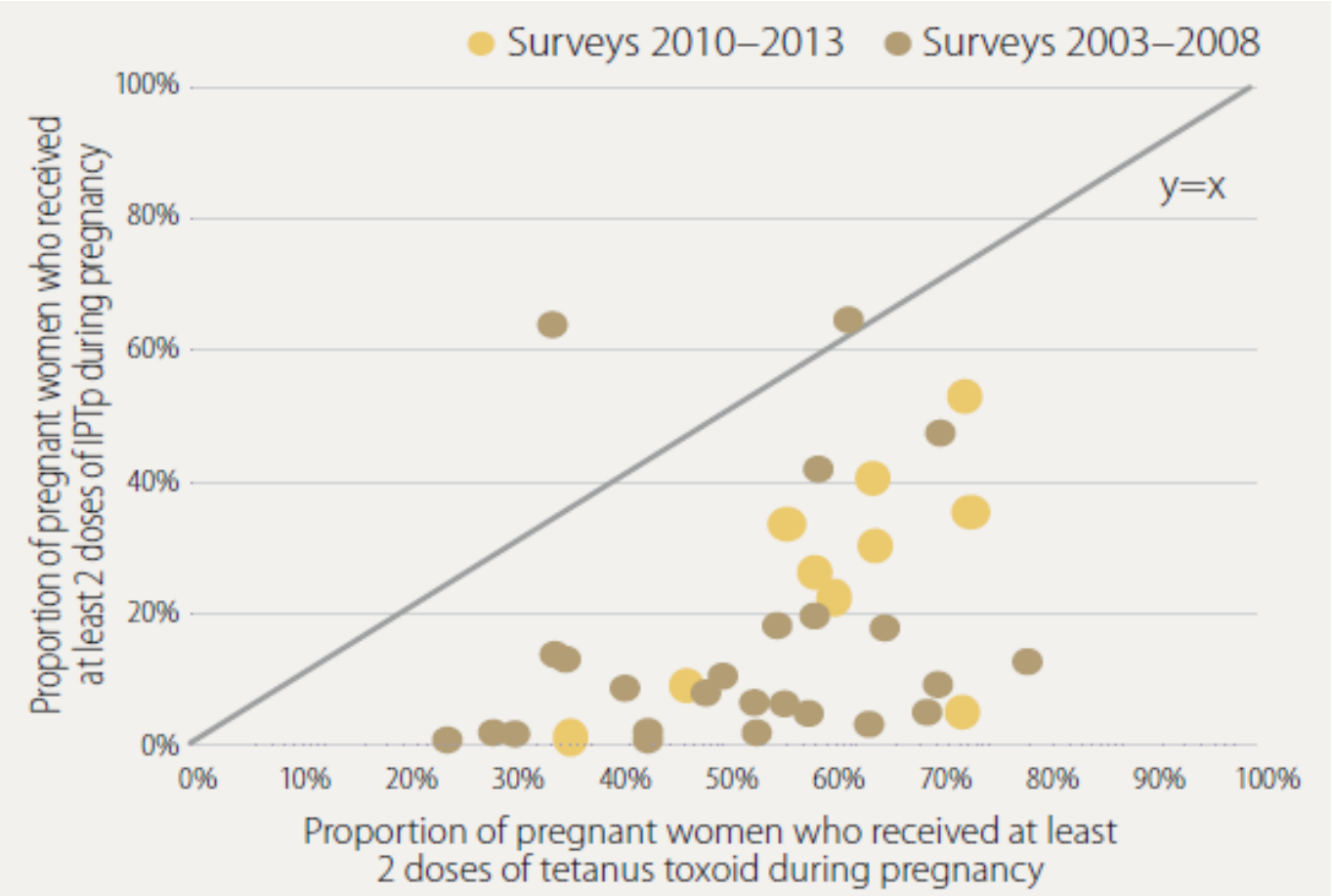
Proportion of population at malaria risk protected by IRS, by WHO Region, 2002–2012



AFR, African region; AMR, Region of the Americas; EMR, Eastern Mediterranean Region; IRS, indoor residual spraying; SEAR, South-East Asia Region; WPR, Western Pacific Region

Source: National Malaria Control Programme reports

Chapter 5: Proportion of pregnant women receiving 2+ doses of tetanus toxoid and the proportion receiving 2+ two doses of IPTp during pregnancy, 2000–2012

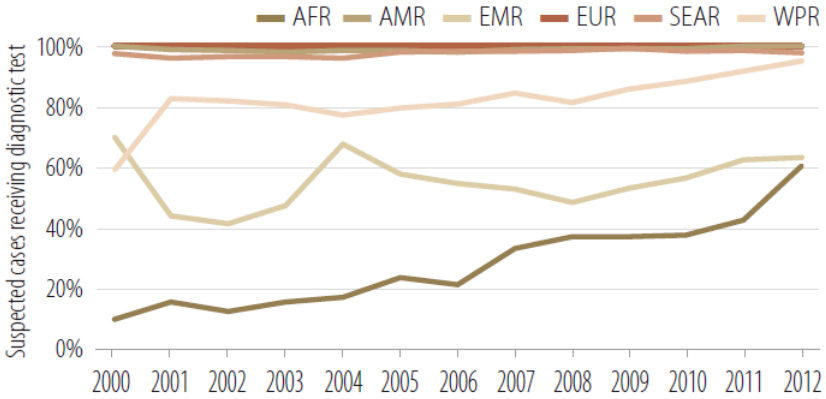


IPTp, intermittent preventive treatment in pregnancy

Source: *Household surveys*

Chapter 6: Proportion of suspected malaria cases/ febrile children receiving a diagnostic test

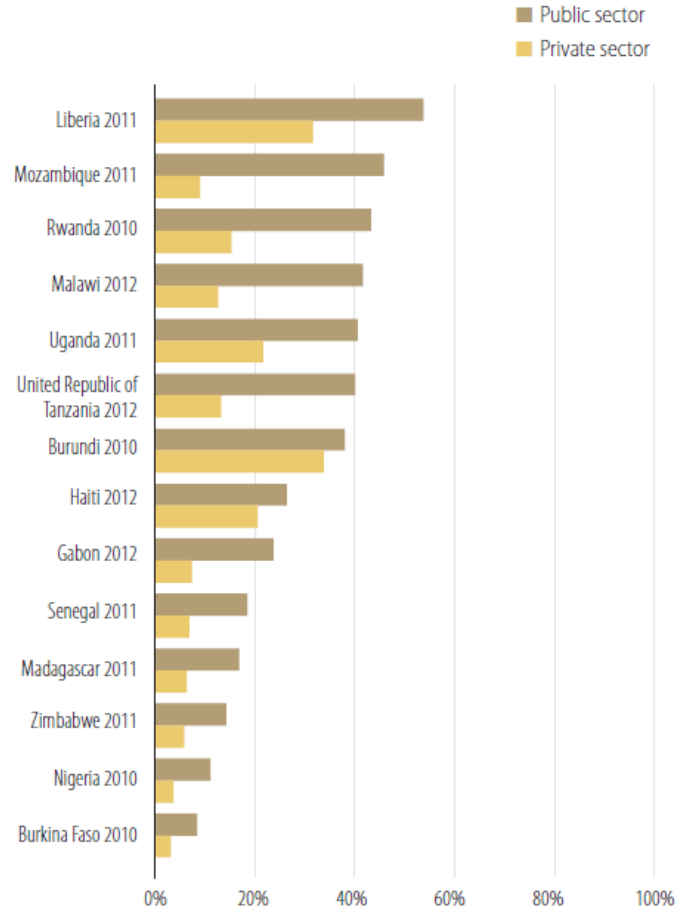
Suspected cases receiving test in public sector



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

Source: *National Malaria Control Programme reports*

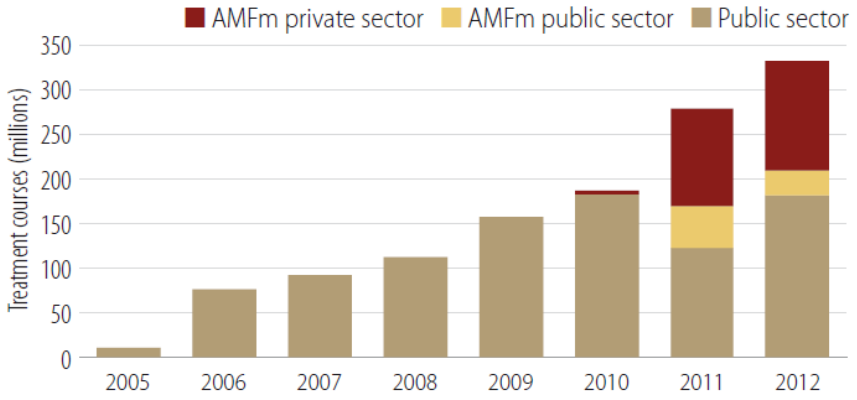
Febrile children receiving test



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

Source: *Household surveys*

ACT deliveries 2005–2012 and ratio of RDT and microscopy performed to ACTs distributed, African Region, 2006-2012

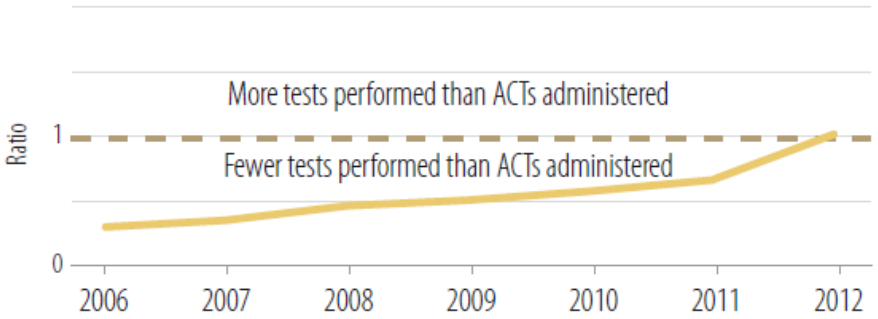


ACT, artemisinin-based combination therapy; AL, artemether-lumefantrine, AMFm, Affordable Medicine Facility – malaria; AQ, amodiaquine, AS, artesunate; Co-B, co=blistered pack; FDC, fixed-dose combination; MQ, mefloquine; SP, sulfadoxine-pyrimethamine

Source (Figures 6.6, 6.7, 6.8): *Data provided by 8 manufacturers eligible for procurement from WHO/UNICEF and AMFm reports*

Routine ACT public sector deliveries monitored 2005–2012; AMFm-facilitated public and private sector deliveries through AMFm monitored 2010–2012, in 2010 by AMFm reports and in 2011–2012 by reports of manufacturers

ACT deliveries through non-AMFm private sector channels are not monitored, but are estimated to be a small fraction (about 5–10%) compared to public sector deliveries

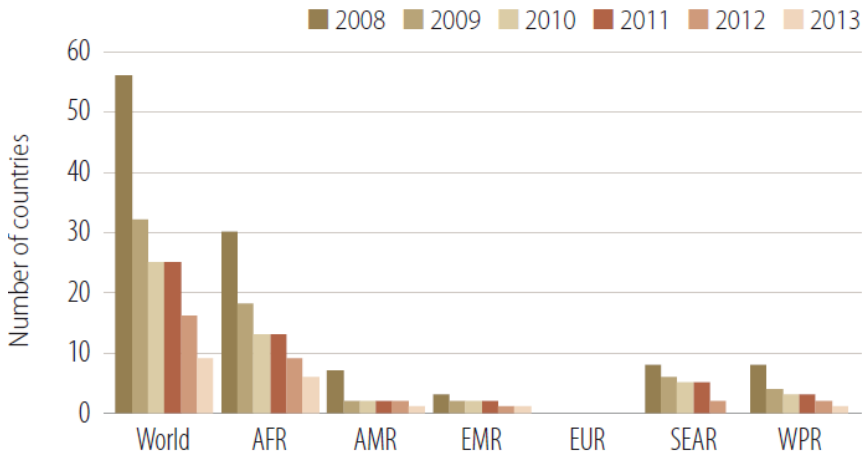


ACT, artemisinin-based combination therapy; RDT, rapid diagnostic test

Source: *National malaria control programme reports*

Number of countries allowing marketing of oral artemisinin-based monotherapies and undertaking therapeutic efficacy testing

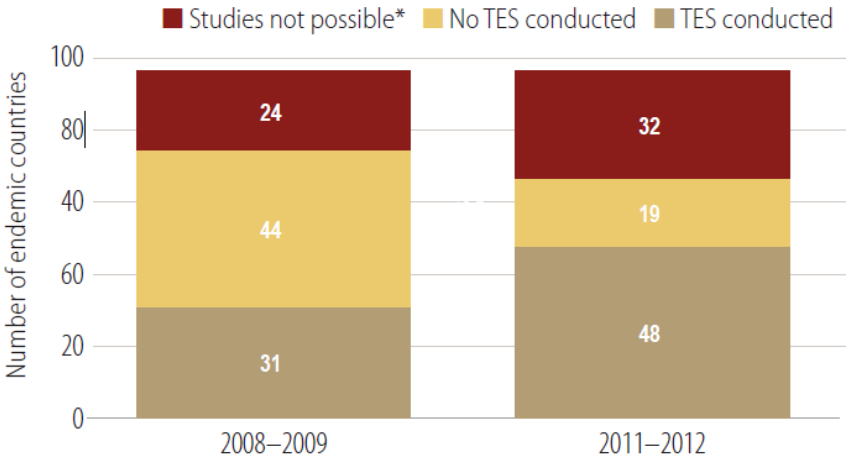
Oral artemisinin-based monotherapies



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

Source: *http://www.who.int/malaria/monotherapy_NDRAs.pdf*

Therapeutic efficacy testing

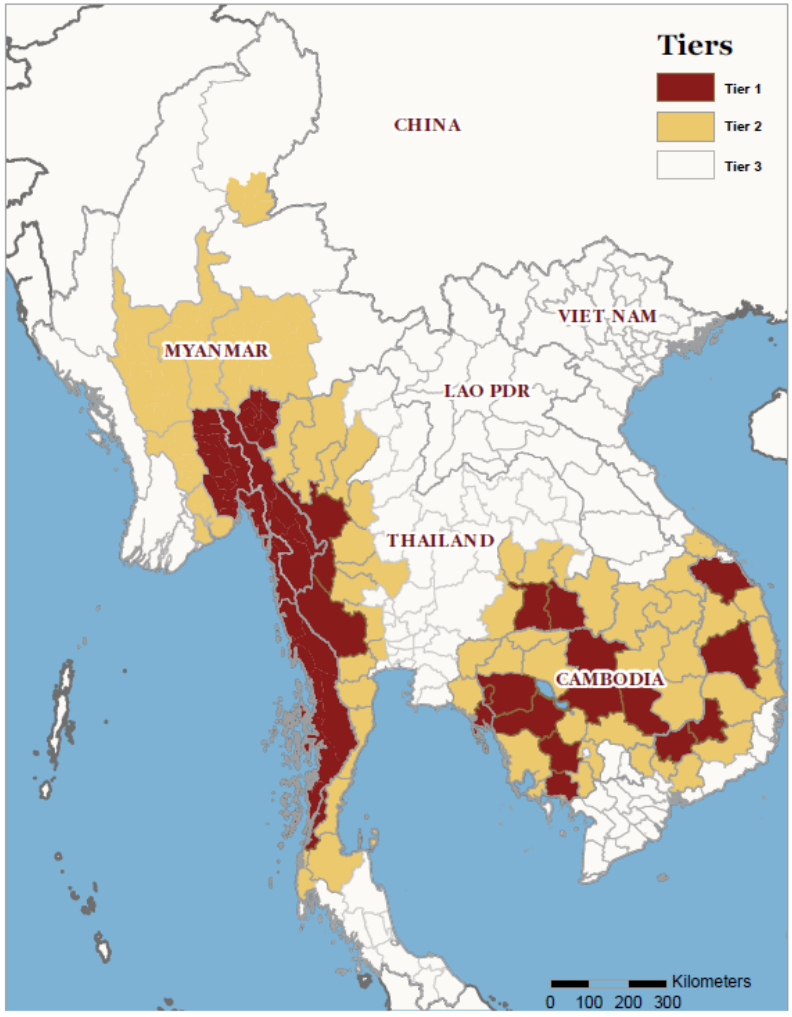


*TES studies are impractical in countries with low malaria transmission or transmission of *P. vivax* only

TES, therapeutic efficacy study

Source: *WHO Global Malaria Program database on antimalarial therapeutic efficacy monitoring by country, November, 2013*

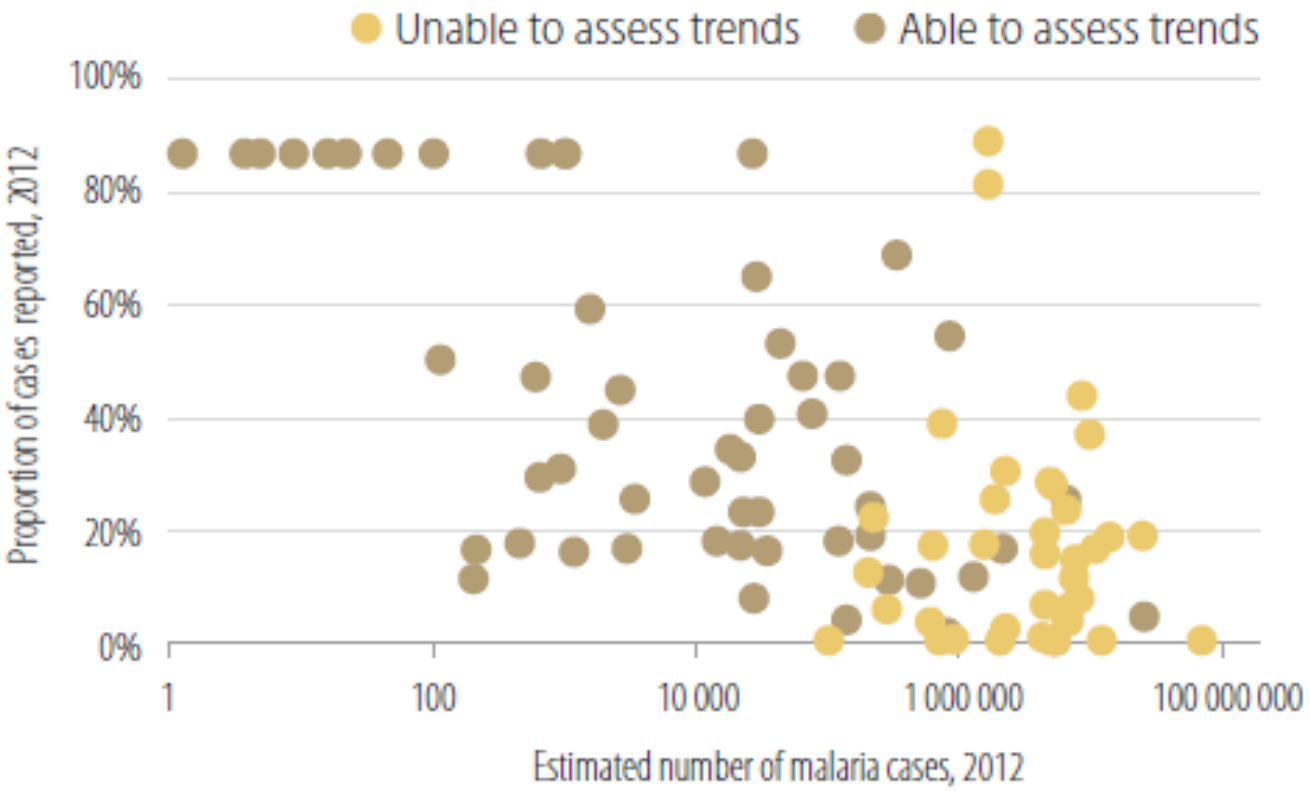
Prioritized areas for artemisinin resistance containment activities, Greater Mekong subregion, 2013.



Tier I are areas where there is credible evidence of artemisinin resistance; tier II are areas with significant inflows of people from Tier I areas, including those immediately bordering Tier I; Tier III are areas with no evidence of artemisinin resistance and limited contact with Tier I areas

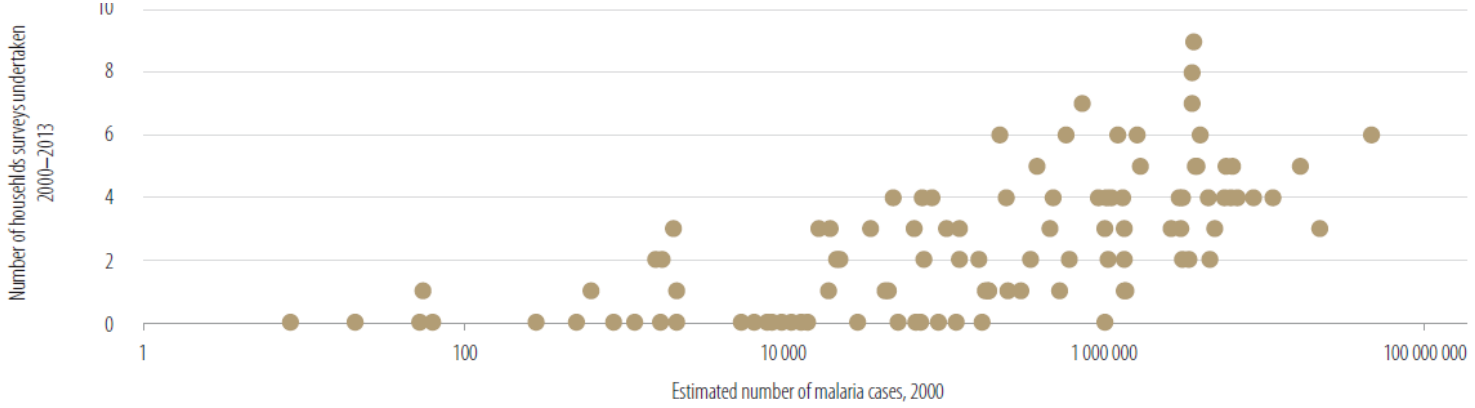
Source: *Global Malaria Programme, WHO, November, 2013*

Chapter 7: Proportion of all cases and deaths cases captured by health-facility reports

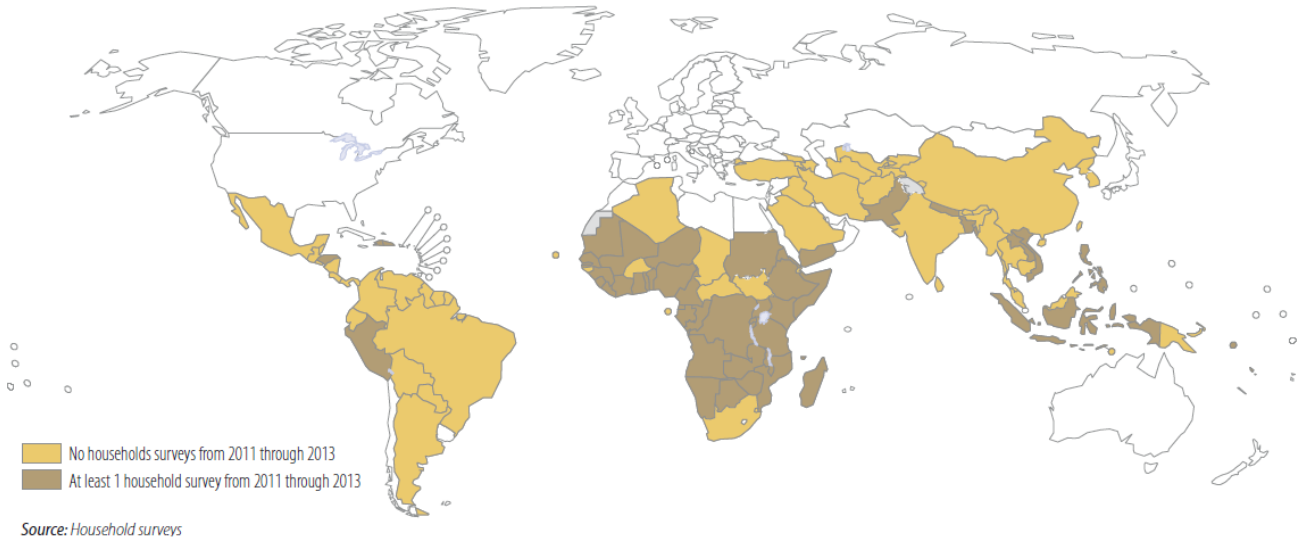


Source: *National malaria control programme data, WHO estimates*

Household surveys conducted, 2000–2012 and in the past 3 years (2010–2012)



Source: *Household surveys, WHO estimates*



Source: *Household surveys*

Proportion of surveys in which key indicators were measured

For calculation of proportions the denominator for malaria specific indicators is the number of surveys with malaria specific questions. For all-cause under-5 mortality rate the denominator is total surveys undertaken.

	2000–2013		2011–2013	
	Number	Proportion	Number	Proportion
Proportion of population with access to an ITN within their household	209	83%	61	97%
Proportion of population who slept under an ITN the previous night	188	75%	60	95%
Proportion of households with at least one ITN for every two people and/or sprayed by IRS within the past 12 months	58	23%	26	41%
Proportion of women who received three ore more doses of IPTp during ANC visits during their last pregnancy	194	77%	54	86%
Proportion of children under 5 years old with fever in the past 2 weeks who had a finger prick or heel stick	42	17%	16	25%
Proportion receiving first line treatment among children under five years years of age with fever in the past two weeks who received any antimalarial drugs	209	83%	57	90%
Parasite prevalence: proportion of children aged 6–59 months with malaria infection	88	35%	31	49%
Surveys with malaria specifc questions	**252**		**63**	
All-cause under 5-mortality rate (5q0)	288	89%	77	95%
Total surveys	**323**		**81**	

ACT, artemisinin-based combination therapy, ANC, antenatal clinic; IRS, indoor residual spraying; IPTp, intermittent preventative treatment in pregnancy; ITN insecticide-treated net

Source: *Household surveys*

Chapter 8: Decreases in reported malaria case incidence rates, 2000–2012, by WHO region

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

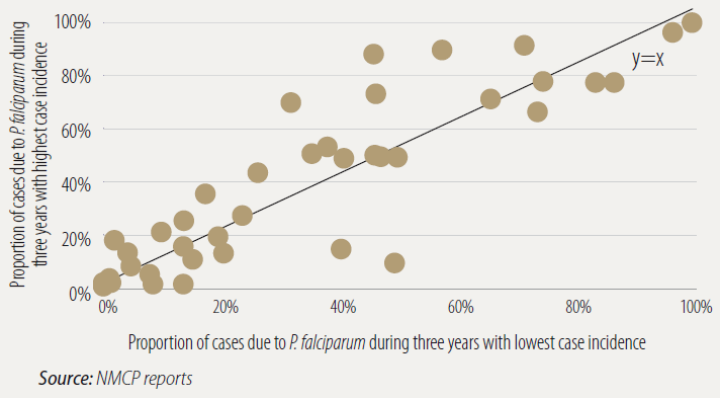
Source: National Malaria Control Programme Data

59 out of 103 countries that had ongoing malaria transmission in 2000 are meeting the MDG target of reversing the incidence of malaria.

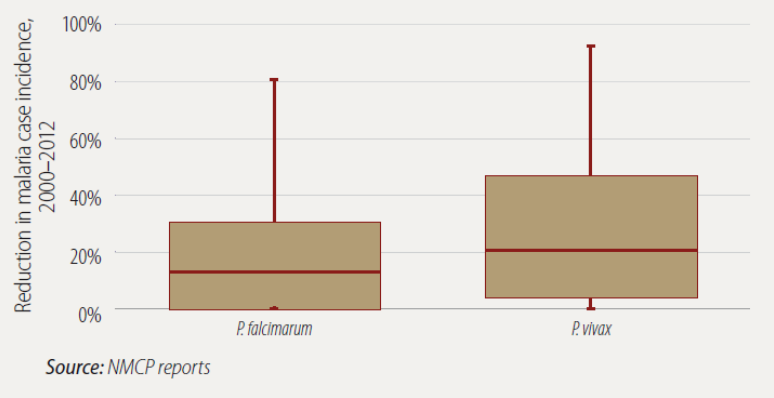
Of these, 52 are on track to meet RBM and WHA targets of reducing malaria case incidence rates by 75% by 2015. These account for 4% of estimated cases in 2000.

Slower rate of decrease in *P. vivax* incidence than *P. falciparum*

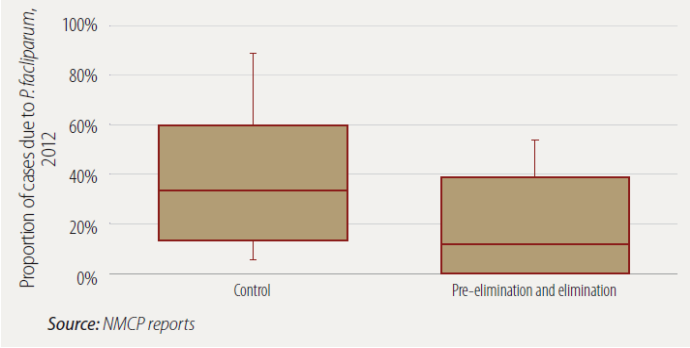
% cases due to *P. falciparum* in high vs low years



Reductions in case incidence in 58 countries showing decrease



% cases due to *P. falciparum* outside of Africa by programme phase



Estimated number of malaria cases and deaths 2012

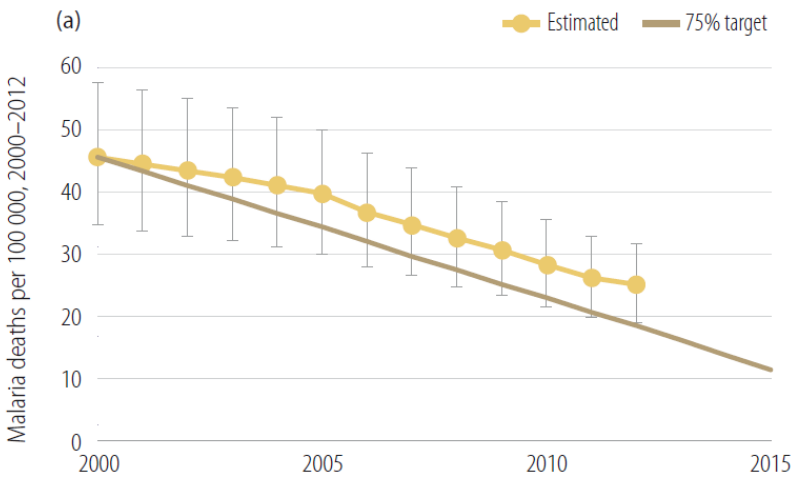
a) Region	Estimated cases ('000s)			Estimated *P. vivax* cases ('000s)			*P. vvax* as % of total cases
	Estimate	Lower	Upper	Estimate	Lower	Upper	
African	165 000	93 000	245 000	1 900	1 600	2 100	1%
Region of the Americas	800	700	1 000	500	400	600	65%
Eastern Mediterranean	13 000	10 000	18 000	3 700	3 000	4 500	28%
European	2	2	2	2	2	2	89%
South-East Asia	27 000	22 000	33 000	13 000	10 000	16 000	47%
Western Pacific	1 000	1 000	2 000	200	100	300	16%
World	**207 000**	**135 000**	**287 000**	**18 900**	**16 000**	**22 200**	**9%**
Outside sub-Saharan Africa	33 300	28 000	39 400	16 600	13 800	19 800	50%

b) Region	Estimated deaths, all ages			Estimated deaths, <5			Deaths <5 as % of total
	Estimate	Lower	Upper	Estimate	Lower	Upper	
African	562 000	410 000	722 000	462 000	386 000	534 000	82%
Region of the Americas	800	500	1 200	230	200	270	27%
Eastern Mediterranean	18 000	11 000	31 000	6 600	5 400	8 100	37%
European	0	0	0	0	0	0	22%
South-East Asia	42 000	26 000	60 000	11 000	9 000	14 000	26%
Western Pacific	3 500	2 100	5 200	1 600	900	2 400	46%
World	**627 000**	**473 000**	**789 000**	**482 000**	**408 000**	**565 000**	**77%**
Outside sub-Saharan Africa	50 000	33 000	68 000	14 000	11 000	17 000	28%

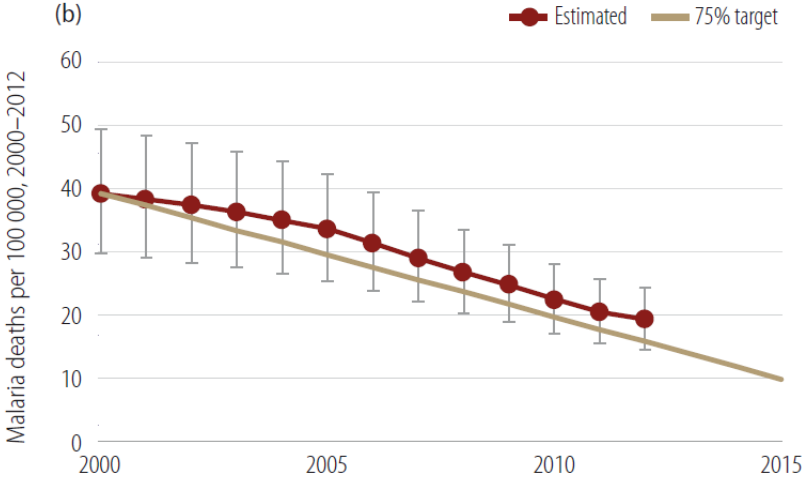
Source: WHO estimates

Trends in estimated malaria case incidence and mortality rates

Global malaria mortality rate, all ages



Global malaria mortality rate, <5



Source: WHO estimates

Worldwide, between 2000 and 2012, estimated malaria mortality rates fell by 42% in all age groups and by 48% in children under 5 years of age.

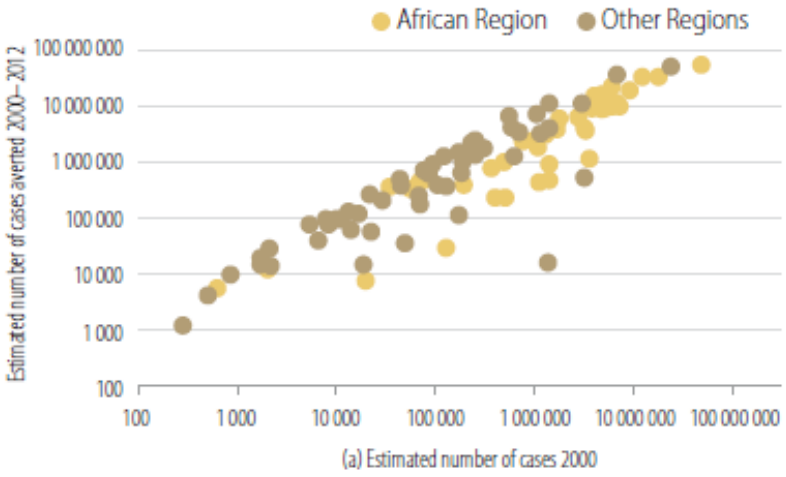
If the annual rate of decrease that has occurred over the past 12 years is maintained, then malaria mortality rates are projected to decrease by 52% in all ages, and by 60% in children under 5 years of age by 2015

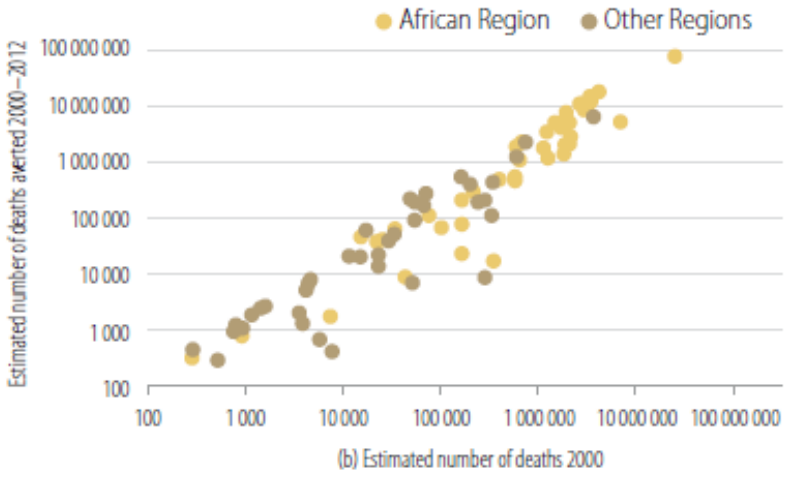
Cases and deaths averted 2001-2012

Region	Cases averted, 2001–2012 (millions)	Percentage of total	Deaths averted, 2001–2012 (millions)	Percentage of total
African	337	67%	3.08	93%
Region of the Americas	14	3%	0.01	0%
Eastern Mediterranean	66	13%	0.09	3%
European	0,4	0%	–	0%
South-East Asia	67	13%	0.11	3%
Western Pacific	15	3%	0.04	1%
World	**500**	**100%**	**3.32**	**100%**

Source: WHO estimates

Figure 8.5 Estimated numbers of (a) cases averted in 2000–2012 versus cases in 2000 and (b) number of deaths averted in 2000–2012 versus deaths in 2000





Source: WHO estimates

Conclusions

- 59 out of 103 countries that had ongoing malaria transmission in 2000 are meeting the MDG target of reversing the incidence of malaria.
- Of these, 52 are on track to meet Roll Back Malaria (RBM) and World Health Assembly targets of reducing malaria case incidence rates by 75% by 2015, including 8 countries of the WHO African Region. These countries account for 4% of total estimated cases in 2000.
- In 41 countries, which accounted for 80% of cases in 2000, it is not possible to assess trends using reported.
- Between 2000 and 2012, estimated malaria mortality rates fell by 42% globally in all age groups and by 48% in children <5.
- Malaria mortality rates are projected to decrease by 52% in all ages, and by 60% in children under 5 years of age by 2015

Conclusions

- An estimated 3.3 million malaria deaths were averted between 2001 and 2012, and that 69% of these lives saved were in the 10 countries with the highest malaria burden in 2000 - progress is being made where it matters
- About 3.2 million (96%) of the deaths averted between 2001 and 2012 are estimated to be in children under 5 years of age. These account for 20% of the 15 million child deaths that are estimated to have been averted globally since 2000 through overall reductions in child mortality rates. Thus, decreases in malaria deaths have contributed substantially to progress towards achieving the target for MDG 4.
- In 2012, financing of malaria programmes was estimated to be less than half of the estimated US$ 5.1 billion required globally.

Conclusions

- 40% of household in sub- Saharan Africa did not have access to a single ITN, millions still do not have access to diagnostic testing and artemisinin-based combination therapies (ACTs).
- As a result, an estimated 207 million cases (uncertainty interval, 135–287 million) and 627 000 malaria deaths (uncertainty interval, 473 000–789 000) are estimated to have occurred in 2012.
- There is an urgent need to increase funding for malaria control and to expand programme coverage, in order to meet international targets for reducing malaria cases and deaths.

Future priorities for WMR

Using what we have got:

1. Enhance data analysis: Combining surveys and routine data for more accurate estimation of progress
2. Enhance dissemination: short summaries, regional reports, peer review, MOOCs
3. Enhance linkages between national and international monitoring
    - take advantage of ALMA (elimination scorecard), APLMA

Enhancing what we have got:

1. Better define tools for use at country level:
    - expenditure tracking, health facility surveys, rapid impact assessments
2. Support to countries to implement guidance
    - surveillance; regular health facility surveys for T3, revising HMIS
3. More comprehensive analysis of country progress - building the data base. PMI evaluations, epidemiological profiles, GF assessments, MPRs

Draft recommendations on managing old LLINs

MPAC meeting
WHO HQ, 12 March 2014

Vector Control Unit/GMP

World Health Organization

GLOBAL MALARIA PROGRAMME

Managing old LLINs

What is the problem?

- Remarkable success in the last 10 years – deaths reduced by 42% globally and 49% in Africa
- Result of scaling-up of vector control interventions among others
- For example, between 2004-2013 – about 700 million nets distributed
- These nets and their packaging contribute significantly to plastic waste
- However, most countries do not have the resources to collect and manage their disposal

Managing old LLINs

How big is the problem?

- Approx. 133million nets are delivered to Africa annually
- Assume a net weighs 600g and plastic package 150g
- On average 1 net covers 1.5 people and is used for 2.5 years
- Based on these calculations, nets contribute a total of approx. 100,000 tones per year – approx. 200g plastic/person/year
- Using data from Ghana of 6-12kg/person/year in total, nets contribute about 2-5% of total plastic waste
- In context – 100kg/person/year in N. America and W. Europe
- Although amount of insecticide is small, plastic packaging is considered a pesticide product/container

Managing old LLINs

What happens when nets are too old to offer protection?

- Pilot studies in three countries – Kenya, Madagascar and Tanzania plus extensive review by USAID
- These are used as window screening, room dividers, crop protection, fencing for chickens, bags for seed protection, sheet beneath mattresses - because they are perceived ineffective for malaria protection
- But once they do not serve any purpose, they are generally disposed along with other household waste
- This practice could potentially cause adverse environmental /health effects especially burning these in the open
- While WHO issued recommendations to manage plastic packaging in 2011, there were none issued for old LLINs

Managing old LLINs

Who is responsible for the management of plastic waste?

- Ministries of Environment (regulatory authorities) – responsible for setting and enforcing laws/regulations to manage plastic waste broadly
- Lack data on the number of countries with regulations that include old LLINs and their packaging (Rwanda and Senegal ban the importation of plastic bags)
- Few countries though have procedures to deal with pesticide-contaminated plastics e.g. Colombia
- Unrealistic to expect NMCPs to address this problem single-handedly

Managing old LLINs

Draft recommendations for MPAC consideration

- Country programmes should not attempt to collect old LLINs unless same number or more are replaced and safe and sustainable plans are in place to manage them
- Collection of old LLINs should not divert the efforts and attention of malaria control programmes away from their core malaria control duties, including from maintaining universal coverage
- If such material is collected, it should not be burned in the open air and communities must be made aware of the potential environmental and health hazards
- Residents should be advised to continue to use an old LLIN, even if it has holes, until a replacement is available
- National control programmes should work with national environment authorities to ensure that there are regulations for the management of old nets and that such regulations are enforced

Thank you!

World Health Organization

GLOBAL MALARIA PROGRAMME

WHO recommendations on the sound management of old long-lasting insecticidal nets

March 2014

Recommendations

1. Residents should be advised through appropriate communication strategies to continue to use long-lasting insecticidal nets (LLINs) – even if they have holes – until another LLIN in better condition is available to replace it.[1] Moreover, communities should be encouraged to regularly repair their LLINs when they become damaged.

2. Residents should also be advised not to dispose of old LLINs[2] in any water body, as the residual insecticide on the net can be toxic to aquatic organisms and especially to fish.

3. National malaria control and elimination programmes should **only** collect old LLINs if it has been ensured that: (a) communities are not left uncovered i.e. new LLINs are distributed to replace old ones, and (b) there is a suitable and sustainable plan in place for safe disposal of the collected material.

4. The collection of old LLINs should **not** divert the efforts and attention of malaria programmes away from their core duties, including the task of maintaining universal coverage.

5. If LLINs and their packaging (bags and baling materials) **are** collected, the best option for disposal is high-temperature incineration. They should **not** be burned in the open air. In the absence of such facilities, the recommended method of disposal is burial. Burial should be away from water sources and preferably in non-permeable soil: see details in *WHO Recommendations on the Sound Management of Packaging for Long Lasting Insecticidal Nets.*[3]

6. National malaria control and elimination programmes should work with national environment authorities to ensure that the information and recommendations in this document are taken into consideration when formulating local guidance and regulations.

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1 While there are WHO guidelines on how to measure net durability which include rate of hole accumulation and loss of insecticide, there is no standard threshold to define when a net is 'too old to be used'. Even a net with many holes and with little or no remaining insecticide gives some degree of protection against malaria and other mosquito-borne diseases (as well as against nuisance biting) compared to sleeping with no net at all. Ultimately it is the homeowner/user of the net who will decide when a net is no longer useful although this decision can be influenced by behaviour change communication efforts.

2 Old LLINs are defined herein as those no longer used within households for the purpose of protecting individuals against malaria.

3 World Health Organization. *Recommendations on the sound management of packaging for long lasting insecticidal nets (LLINs).* Geneva, 2011. http://www.who.int/malaria/publications/atoz/recommendations_management_llin_packaging_nov11.pdf

Background

Currently, LLINs and the vast majority of their packaging (bags and baling materials) are made of non-biodegradable plastics. The large-scale deployment of LLINs has given rise to questions on the most appropriate and cost-effective way to deal with the plastic waste that results, given that most endemic countries currently do not have the resources to manage LLIN collection and waste disposal programmes.

WHO issued recommendations on the management of packaging for LLINs[3] in November 2011, though these did not address the issue of disposal of old LLINs. A pilot study was subsequently conducted to examine patterns of LLIN usage and disposal in three African countries (Kenya, Madagascar and Tanzania). Findings of this pilot study along with other background information were presented to the Technical Expert Group on Malaria Vector Control (VCTEG) in March 2014 for review. The VCTEG indicated that the conclusions from the pilot study and from other background information were sufficient to form global recommendations on best practices in relation to managing LLIN waste.

Evidence

The following are the main findings from the pilot study and other background information:

1. LLINs entering domestic use in Africa each year contribute approximately 100 000 tonnes of plastic[4] and represent a per capita rate of plastic consumption of 200 grams per year. This is substantial in absolute terms, but constitutes only approximately 1% to 5% of total plastic consumption in Africa[5] and thus is small compared to other sources of plastic and other forms of plastic consumption.

2. The plastic from LLINs is treated with a small amount of pyrethroid insecticide (less than 1% per unit mass for most products) and plastic packaging is therefore considered a pesticide product/container.

3. Old LLINs and other nets may be used for a variety of alternative purposes, usually due to perceived ineffectiveness of the net, loss of net physical integrity or presence of another net.

4. LLINs that no longer serve a purpose are generally disposed of at the community level along with other household waste by either discarding in the environment, burning in the open, or placing into pits.

5. LLIN collection was not implemented on a large scale or sustained in any of the pilot study countries. USAID found that recycling of LLINs may be feasible but is not practical or cost effective.[6,7] Specialized adaptation and upgrading of recycling facilities would be needed before insecticide-contaminated materials could be included in this process, but this is not a practical option at this time.

4 Based on the assumption of 133 million LLINs delivered to Africa per year with an average weight of plastic of 600 g of netting and 150 g of packaging per LLIN. Each LLIN is assumed to cover 1.5 people for 2.5 years.

5 Estimates for overall plastic consumption in African countries are hard to find. One observational study in Ghana in 2000 estimated average national consumption of 6 – 12kg per person per year, indicating that LLINs and their packing would have comprised 2.5% of total plastic waste. However, assuming that plastic consumption has increased substantially in line with economic development on the continent, the working estimate derived was that LLINs and their packaging currently account for 1% to 5% of total plastic consumption in Africa.

6 http://deliver.jsi.com/dlvr_content/resources/allpubs/countryreports/Mada_LLIN_Recy_Pilo.pdf

7 http://deliver.jsi.com/dlvr_content/resources/allpubs/countryreports/Mada_LLIN_Recy_PhasIII.pdf

6. Two important and potentially hazardous practices are: (a) routine removal of LLINs from bags at the point of distribution and burning of discarded bags and old LLINs, which can produce highly toxic fumes including dioxins,[8] and (b) discarding into water old LLINs and their packaging that may include high concentrations of residual insecticides that are toxic to aquatic organisms, particularly fish.

7. Insecticide-treated plastics can be incinerated safely in high-temperature furnaces[9] but suitable facilities are lacking in most countries. Burial away from water sources and preferably in non-permeable soil is an appropriate method of disposal for net bags and old LLINs in the absence of a suitable high-temperature incinerator.

8. In most countries, ministries of environment (national environment management authorities) are responsible for setting up and enforcing laws/regulations to manage plastic waste broadly. While some countries have established procedures for dealing with pesticide-contaminated plastics it is unrealistic to expect national malaria control and elimination programmes to single-handedly address the problem of managing waste from LLINs. Environmental regulations, as well as leadership and guidance from national environmental authorities, and oversight from international agencies such as the United Nations Environment Programme, are all necessary.

Conclusions

It is important to determine whether the environmental benefits outweigh the costs when identifying the best disposal option for old LLINs and their packaging. For malaria programmes in most endemic countries, there are limited options for dealing with the collection. Recycling is not currently a practical option in most malaria endemic countries (with some exceptions for countries with a well-developed plastics industry). High-temperature incineration is likely to be logistically difficult and expensive in most settings. In practice, when malaria programmes have retained or collected packaging material in the process of distributing LLINs, it has mostly been burned in the open air. This method of disposal may lead to the release of dioxins, which are harmful to human health.

If such plastic material (with packaging an issue at the point of distribution and old LLINs an intermittent issue at household level when the net is no longer in use) is left in the community, it is likely to be re-used in a variety of ways. While the insecticide-exposure entailed by this kind of re-use has not yet been fully studied, the expected negative health and environmental impacts of leaving it in the community are considered less than amassing the waste in one location and/or burning it in the open air.

Since the material from nets represents only a small proportion of total plastic consumption, it will often be more efficient for old LLINs to be dealt with as part of larger and more general solid-waste programmes. National environment management authorities have an obligation to consider and plan for what happens to old LLINs and packing materials in the environment in collaboration with other relevant partners.

8 Dioxins are produced as a result of burning the plastic material and not because of the insecticide.

9 The *Basel Convention Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal* specify that "The condition for the optimal incineration of material is: Temperature of 850°C-1100°C for hydrocarbon wastes and 1100°C-1200°C for halogenated wastes; sufficient (gas) residence time in the incinerator good turbulence; and excess of oxygen": http://www.basel.int/meetings/cop/cop6/cop6_21e.pdf. See also *Basel Convention Technical Guidelines on Incineration on Land*: http://www.basel.int/meetings/sbc/workdoc/old%20docs/tech-d10.pdf.

World Health Organization

Review of current evidence on combining indoor residual spraying and long-lasting insecticidal nets

1. Introduction

Recent reductions in malaria disease burden have coincided with the massive scale-up of malaria prevention measures, of which vector control has constituted a sizeable component particularly in sub-Saharan Africa (1). In this region the proportion of households owning at least one insecticide treated net (ITN) increased from 3% in 2000 to 56% in 2012, with the estimated proportion of the population sleeping under a net increasing from 2% in 2000 to 36% in 2013. By the end of 2013, the projected number of LLINs delivered in the region through the public sector was 136 million. The proportion of the population at risk of malaria in the African region who were protected by Indoor Residual Spraying (IRS), increased from 5% in 2005 to 11% in 2011, but fell to 8% in 2012.

In an effort to accelerate malaria transmission reduction, some countries have implemented IRS and universal distribution of ITNs in combination in recent years. Such decisions have been based on the results of a limited number of observational studies, some of which have shown that there was added protection conferred to those who received both interventions relative to those who received only one, whilst other studies showed no such effect (2). None of these studies randomized communities to receive either a) both interventions together or b) either intervention alone. These results may therefore be subject to potential confounding and bias.

Since the rollout of both interventions would require considerable additional resources, it is important that such an approach is based on good evidence of additional protective efficacy. A number of cluster randomized trials (CRTs) (3) comparing epidemiological outcomes in communities receiving IRS plus ITNs versus those receiving ITNs alone have recently been completed (although there are no trials that compare IRS plus ITNs versus IRS alone). Summaries of these trials and an interpretation of their results are given in section 2. The results of only two of these trials have been published, although all were reported at a seminar on the subject at the recent Multilateral Initiative on Malaria (MIM) conference held in Durban in 2013.[1] In section 3, results from a few observational studies are presented. Sections 4 summarizes the existing findings and section 5 summarizes conclusions that can be drawn from the evidence available thus far.

2. Evidence from randomized trials

2.1. Benin (4)

This study consisted of four study arms of 7 clusters each (28 in total): (1) targeted LLIN to pregnant women and children <6 years (TLLIN, the reference arm); (2) universal coverage of LLIN (ULLIN); (3) TLLIN plus full coverage of IRS with bendiocarb applied every 8 months (TLLIN+IRS); and (4) ULLIN plus bendiocarb-treated plastic sheeting (CTPS) to upper parts of all household walls (ULLIN+CTPS) with re-impregnation every four months. LLIN use in children under 6 years was 43% in the TLLIN arm, 58% in the ULLIN arm, 60% in the ULLIN+CTPS arm, and 43% in the TLLIN+IRS arm. The primary outcome measure of this trial was clinical incidence of malaria in children under 6 years, who were followed up in each cluster for 18 months. The results are summarized in Table 2.1.1.

1 Sixth Multilateral Initiative on Malaria Pan-African Conference, 6–11 October 2013, Abstract Book, p. 41

Table 2.1.1. Clinical incidence of malaria by study arm, Benin trial

Study arm	Incidence, per 100 child months	Incidence rate ratio (adjusted for age)	P-value
TLLIN	5.0[3.6-6.8)	1	
ULLIN	4.8 (3.4-6.6)	0.95 (0.67-1.36)	0.79
TLLIN+IRS	6.6(4.9-8.7)	1.32 (0.90-1.93)	0.15
ULLIN+CTPS	5.4(3.9-7.3)	1.05 (0.75-1.48)	0.77

One of the conclusions of the study was that there was "no significant benefit for reducing malaria morbidity, infection, and transmission" when combining LLIN+IRS with "a background of LLIN coverage".

Negative findings are always difficult to interpret since they may be the result of inadequately powered trials rather than due to the absence of a true effect. As the Benin study is currently one of only two peer-reviewed, published studies on this subject it merits closer examination. There are a number of possible interpretations of the above-mentioned conclusion:

- There is no added benefit from combining the two interventions and that is why no benefit was detected in this study. However, the intervention in the reference (baseline) arm of this study was provision of LLINs to target-groups only, not universal coverage of LLINs. It seems surprising that IRS with an effective insecticide at universal coverage was unable to provide additional protection in comparison to limited coverage with LLINs. Even universal coverage provided no added benefit compared to target-group coverage with LLINs.
- The study had only seven clusters per study arm, and it may therefore have missed an additional protective effect that was smaller than anticipated.
- The between-cluster variance was higher than expected, thereby swamping the additional effect of the IRS.
- IRS rounds were carried out eight months apart, which considerably exceeds the expected residual lifetime of bendiocarb on walls. As a result, there were likely long periods during which there was not sufficient active ingredient on walls for optimal efficacy.

2.2. Sudan (ongoing study)

140 clusters in four study areas were randomly allocated to either universal coverage of LLINs, or to universal coverage of LLINs plus IRS. The study arms were balanced on a number of criteria that were measured at baseline before randomization. Mean allelic frequency of the *kdr* genotype in *Anopheles arabiensis* samples from each cluster was one of the balance criteria to minimize potential confounding of the primary trial result by differences in pyrethroid resistance in the two study arms. The IRS insecticide used in three of the four study areas was a carbamate (bendiocarb), whilst in Galabat in Gedarif state a pyrethroid (deltamethrin) was used in 2011 and 2012 with a switch to bendiocarb in 2013. The two primary outcome measures in this ongoing study are: (1) confirmed malaria case incidence in cohorts of 200 children in each cluster; and (2) rapid diagnostic test (RDT)-based infection prevalence determined annually at the height of the malaria season in a random sample of 100 of the cohort children. *Kdr* allelic frequency is monitored annually in samples from all 140 clusters, whilst phenotypic resistance is measured in a randomly chosen subset of 66 sentinel clusters. Interim results were presented at the MIM conference, and more recent results were made available for the purpose of this report.

Spray coverage was reported at above 95% for the first two spray rounds. LLIN access met universal coverage criteria (at least one net per two persons) and self-reported usage of nets was >80% during the malaria (rainy) season.

There was no evidence of a difference in incidence between study arms in any of the study areas in 2012 (Rate Ratio (RR) IRS+LLIN vs LLIN alone for all areas combined =1.1; 95% CI 0.68-1.80). Cohort follow-up from 1 May 2013 to 30 September 2013 showed overall a lower incidence in the arm with the combined intervention compared to the LLIN only arm, although this was not statistically significant (RR = 0.83, 95% CI 0.47-1.45; Table 2.2.1). The effect was strongest, though still not significant, in Galabat which is the area of highest transmission (RR = 0.49, 95% CI 0.17-1.44).

Table 2.2.1. Incidence of cases 1st May to 30 September 2013, by study area and study arm, Sudan

Area	Study arm (number of clusters)	Cases	Incidence, cases per 1000 p.a.	Rate ratio [95% CI]; p-value
El Hoosh	LLIN(19)	52	32.5	1
	LLIN+IRS(19)	60	37.3	1.15[.33-3.97]; p=0.83
Hag Abdalla	LLIN(19)	64	38.7	1
	LLIN+IRS(19)	63	38.2	0.99[.38-2.55]; p=0.98
Galabat	LLIN(13)	63	58.5	1
	LLIN+IRS(13)	31	28.5	0.49[.17-1.44]; p=0.18
New Halfa	LLIN(19)	39	24.2	1
	LLIN+IRS(19)	25	16.1	0.67[.28-1.55]; p=0.34
All combined	LLIN(70)	218	36.7	1
	LLIN+IRS(70)	181	30.7	0.83[.47-1.45]; p=0.50

In the cross sectional survey carried out in October 2012 in a random sample of 100 children there was no evidence of a difference in infection prevalence between study arms in any of the study areas (Table 2.2.2). On the contrary, prevalence was (non-significantly) higher in the combined intervention arm, particularly in Galabat.

Table 2.2.2. Prevalence of infection by study arm and study area, Sudan, 2012

Area	Study arm (number of clusters)	Number tested	*P. falciparum* prevalence, %	Odds ratio by area (95% CI); p-value
El Hoosh	LLIN(19)	1899	0.5	1
	LLIN+IRS(19)	1883	0.6	1.23[0.32 – 4.70]; p=0.75
Hag Abdalla	LLIN(19)	1850	0.4	1
	LLIN+IRS(19)	1862	1.0	2.37 [0.47 -12.11];p=0.29
Galabat	LLIN(13)	1272	6.7	1
	LLIN+IRS(13)	1246	10.4	1.61 [0.60-4.35];p=0.33
New Halfa	LLIN(19)	1660	0.8	1
	LLIN+IRS(19)	1706	0.4	0.45[0.09 – 2.21];p=0.31
All combined	LLIN(70)	6681	1.7	1
	LLIN+IRS(70)	6697	2.5	1.44[0.61 – 3.44];p=0.41

From the cross-sectional prevalence survey carried out in October 2013, only data for the Galabat study area are currently available (Table 2.2.3). There was an indication of reduced prevalence in the IRS+LLIN arm compared to the LLIN only arm (Odds ratio (OR)=0.86; 95% CI 0.31-2.42). However, the evidence for this reduction was non-significant (p=0.77). Amongst those reporting to use nets in both study arms, the effect again was non-significant (OR=0.55; 95% CI 0.18-1.71).

Table 2.2.3. Prevalence of infection by study arm, Galabat, Sudan, 2013

Year	Study arm	% RDT positive	95% CI	Number tested	Odds ratio [95% CI]	p-value
2013 (all participants)	LLIN	4.5	2.0-9.8	1791	1	
	LLIN+IRS	3.9	2.2-7.0	1654	0.86 [.31-2.42]	0.77
2013 (ITN users only)	LLIN	5.3	2.5-10.8	1368	1	
	LLIN+IRS	3.0	1.4-6.0	1081	0.55[.18-1.71]	0.29

This study has not yet been completed but thus far there has been no significant difference in study arms in this very large CRT. In three of the four study areas malaria transmission is very low and it may be that under such circumstances there is no additional protection provided by adding IRS to a well-implemented ITN programme with high usage of nets, particularly during the main transmission season.

There is some indication that in the area of highest transmission (Galabat) there has been a reduction in prevalence in the IRS+ITN arm compared to the LLIN only arm, but only after the insecticide was switched from deltamethrin in 2012 to bendiocarb in 2013. *Anopheles arabiensis* mortality in WHO susceptibility tests ranged between 53% and 100% (median 87%) in 12 sentinel clusters in Galabat, but there has been no consistent evidence of a relationship between phenotypic resistance and malaria incidence or prevalence. It is therefore speculation at this stage whether any additional impact due to IRS was related to pyrethroid resistance.

2.3. Tanzania (5, 6)

In a trial conducted in Muleba, Tanzania during 2011 and 2012, fifty study clusters were randomly assigned to either IRS plus universal coverage of ITNs or to universal coverage of ITNs alone. Randomization was restricted to ensure balance between study arms based on a number of variables related to the primary outcome, including prevalence of *P. falciparum* infection in children 6 months to under 15 years old. In the IRS+LLIN arm two rounds of bendiocarb were sprayed approximately four months apart.

Phenotypic resistance and *kdr* target-site mutations were detected in *Anopheles gambiae,* the primary vector in the study area. The outcome was assessed by means of three cross-sectional surveys in all study clusters: survey A took place one month after the first spray round, survey B took place one month after the second spray round, and survey C took place approximately six months after the second spray round.

IRS coverage was around 90% in both spray rounds; ITN ownership of at least one net per household was >80%, whilst ITN usage ranged between 36% and 53%.

Table 2.3.1. Prevalence of infection with *P. falciparum* in children 6 months to <15 years by study arm, Muleba, Tanzania, 2012

	Study arm	*P. falciparum* prevalence, %, [95% CI], (N)	Odds ratio, [95% CI], p-value
Survey A	LLIN	23·6, [15·4-34·2], (2191)	1·00
	IRS+LLIN	13·6, [8·3-21·4], (2342)	0·51, [0·24-1·09], p=0·082
Survey B	LLIN	30·5, [20.2-43·4], (2033)	1·00
	IRS+LLIN	12·7, [7·4-21·0], (2204)	0·33, [0·15-0·75], p=0·009
Survey C	LLIN	24·5, [14·2-38·9], (2091)	1·00
	IRS+LLIN	13·4, [7·3-23·4], (2285)	0·48, [0·18-1·24], p=0·127
A, B and C combined	LLIN	26·1, [16·7,38·4], 6315	1·00
	IRS+LLIN	13·3, [7·9,2·.5], 6831	0·43, [0·19-0·97], p=0·043

For all three surveys combined, there was strong evidence that infection prevalence was substantially lower in the IRS+ITN arm (13.3%) than in the ITN only arm (26.1%) (OR=0.43 (95% CI 0.19-0.97; p=0.043) (Table 2.3.1). The effect differed between survey rounds, with the biggest effect in survey B, which was conducted two months after the second spray round and during the peak of the transmission season when prevalence in the ITN only arm was highest. However this variation in effect between survey rounds may have been due to sampling variation (interaction p-value=0.08). For the three surveys combined, mean haemoglobin in children under 5 years old was higher in the IRS+ITN arm (11.2 g/dL) than in the ITN only arm (10.8g/dL) with a difference of 0.37 g/dL (95% CI 0.07 to 0.68, p=0.017).

Mean monthly entomological inoculation rate (EIR) was 83% lower in the ITN+IRS arm than the ITN only arm (RR adjusted for baseline EIR =0.17 (95% CI = 0.03-1.08, p=0.059) - results not tabulated).

Whilst more than 80% of households owned at least one ITN, usage declined to 36% in the last survey (Table 2.3.2). However, per protocol analysis on data restricted to net users only in both study arms showed that IRS provided sizable and significant additional protection to using an ITN in each survey round (survey A: OR=0·39, 95% CI 0·18-0·81; survey B: OR=0·21, 95% CI 0·09-0·49; survey C: OR=0·27, 95% CI 0·10-0·73).

In the study area high levels of pyrethroid resistance were detected from susceptibility tests using permethrin and deltamethrin (7).

This study therefore presents strong evidence that combining IRS with ITNs gives significant additional protection, particularly during the peak of the transmission season, and during the residual period of the insecticide. However, the added protection due to IRS is likely to be lower in situations where ITN usage is at sufficiently high levels to generate a substantial mass effect in addition to the personal protection provided by ITNs.

Table 2.3.2. Reported LLIN coverage by study arm, Muleba, Tanzania, 2012

	Survey	Study arm	
		LLIN	LLIN+IRS
Households owning ≥ 1 LLIN, %	**A**	86	89
	B	83	88
	C	78	84

Households with enough LLINs, %	**A**	52	57
	B	52	57
	C	53	57
LLIN use, %	**A**	47	53
	B	41	44
	C	36	36

2.4. The Gambia (8)

This trial was completed in 2012, but the results have not yet been published. In a two arm cluster randomized trial, 70 clusters consisting of a village or groups of villages in rural Gambia were allocated to receive either high coverage of LLINs or high coverage of LLINs plus IRS using dichloro-diphenyl-trichloroethane (DDT). Randomization was restricted to ensure balance between study arms using baseline data. The outcome indicator was clinical incidence of malaria over two malaria seasons in children 6 months to 13 years of age by passive case detection. In addition, children were surveyed at the end of each transmission season to estimate prevalence of *P. falciparum* infection and prevalence of anaemia.

The results were presented at the American Society of Tropical Medicine and Hygiene 61st Annual Meeting in 2012 and the sixth Multilateral Initiative on Malaria Pan-African Conference in October 2013. Malaria incidence in both study arms was identical with no evidence of any additional protection provided by the combination of IRS and LLINs versus LLINs alone. Reported LLIN usage was very high (>95%). The study reported susceptibility of the main vector to DDT and permethrin. However, there was evidence of reduced susceptibility to DDT in samples of *Anopheles gambiae s.l.* collected in the Basse area in the Gambia in 2013 (Opondo, Weetman and Donnelly, unpublished).

This was a large, well-conducted trial which found no evidence that combining LLIN with IRS using DDT produced an advantage over very high usage of LLIN alone, if vectors are susceptible to the LLIN insecticide.

3. Evidence from observational studies

A number of observational studies have evaluated whether combined use of IRS and LLINs is superior to using either LLINs or IRS alone. As with trials, these studies have produced conflicting results, some showing evidence of additional protection due to the combination, some showing no such effect.

An unpublished systematic review of published literature identified 23 studies that had reported results with epidemiological outcomes comparing either communities or individuals protected by both interventions with those who were protected by only one of the two (P.West, PhD thesis in preparation, 2014). Of these, four were mathematical models, one was the Benin trial reported above, one was a cluster randomized trial in an area of very low prevalence of infection and 17 were predominantly cross-sectional or ecological observational studies. Three of the four models predicted that the combination of IRS and LLINs would provide additional protection. The trial in the very low transmission area (9) showed no additional benefit of using IRS in addition to LLINs. Of the 17 observational studies, some were inconclusive, with the remainder were fairly evenly divided between those that showed an additional protective effect and those that did not. Since these studies did not use robust experimental designs, the evidence produced is of a lower quality than that of trials, primarily because confounding cannot be ruled out in such study designs.

Lack of evidence of additional protection due to the combined use of the two methods does not constitute evidence that there is no added effect – it just means there was no evidence against the null hypothesis of no difference between study arms. Studies which set out to show superiority but failed to show evidence of an effect are therefore harder to interpret: did they show no effect because there is no effect, or did they show no effect because the effect was smaller than the study was able to demonstrate, or because the amount of variation (noise) was large leading to large standard errors?

Only a few examples of non-randomized studies are discussed below; of these, two found evidence of an added effect whilst one showed no effect. These are by no means representative of all the observational studies that have been reported, but rather they are indicative of the conflicting evidence that is available.

3.1. Equatorial Guinea (2, 10)

The Bioko Island Malaria Control Project (BIMCP) has used IRS as its primary vector control intervention since 2004. Apart from an initial round of deltamethrin IRS, bendiocarb was sprayed biennially from 2005 to 2012. IRS coverage has varied between 70% and 90%. In 2007 a mass distribution of deltamethrin-impregnated LLINs was carried out, providing one net per sleeping space. Initially, reported LLIN usage was high (76% in 2008) but ownership and hence usage subsequently declined with only 14% of children 2 to <15 years reported to have used an LLIN the night before the survey in 2013 (I. Kleinschmidt, personal communication).

Comparing net users whose houses were sprayed versus those not using a net whose houses had been sprayed has consistently shown that those sleeping under a net were at lower risk of infection, even after allowing for socio-economic status of the household (Table 3.1.1) (2, 10, 11). LLINs provided added protection during periods of high as well as periods of low overall net usage.

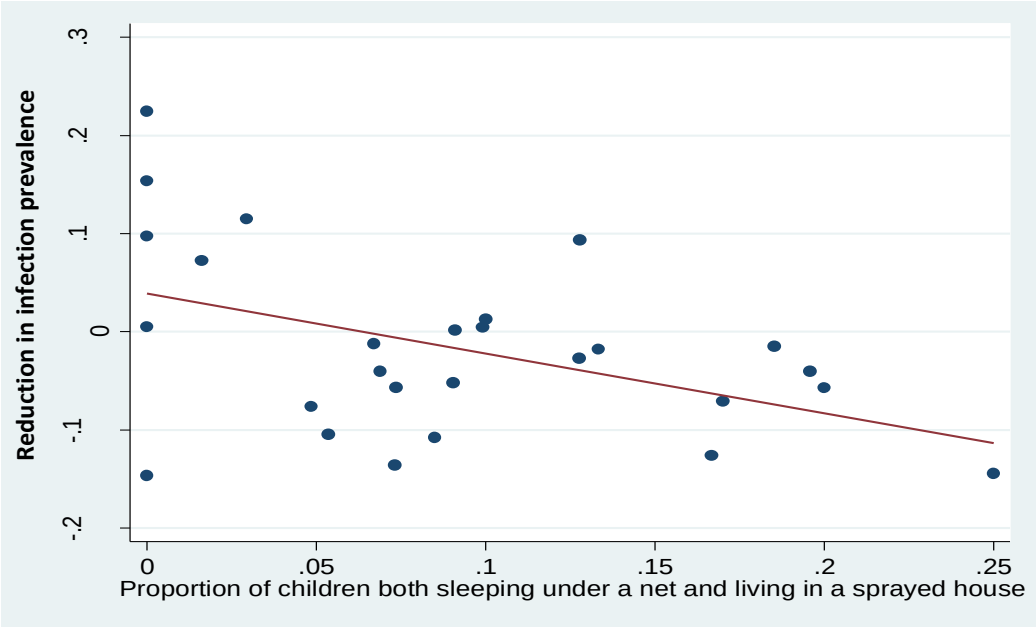
Table 3.1.1. Prevalence of infection in children 2 to 15 years and status of sleeping under a mosquito net, Bioko, Equatorial Guinea, 2012

	P. falciparum **prevalence in children 2 to <15 years, % (N)**	**Adjusted[1] Odds Ratio [95% CI], p-value**
Slept under net		
no	21.2 (2846)	1
yes	15.1 (800)	0.7 [0.6 to 0.9], p=0.008

[1] Adjusted for seroconversion rate of area, socio-economic status of household, time since IRS, age of child.

At a community level, there is evidence from cross-sectional surveys that after allowing for baseline differences in transmission, the reduction in prevalence of infection in children is greatest in communities that had the largest proportion of children protected by both IRS and LLINs compared to those where relatively few were protected by both interventions (Figure 3.1.1). According to the statistical regression model, a 1% increase in children sleeping in a sprayed house and under a net corresponded to a 0.6% decrease in infection prevalence (95% CI 0.12- 1.06, p=0.016).

Figure 3.1.1. Proportion of children living in a sprayed house and sleeping under a net and reduction in infection prevalence between 2011 and 2013, Bioko Island, Equatorial Guinea



Due to perennial malarial transmission in Bioko, IRS has been implemented twice yearly from 2005 to 2012. However, the residual effect of bendiocarb has been shown to diminish after 3–4 months leading to decreased mosquito mortality in bioassays conducted on sprayed walls, and increased prevalence of infection in children in relation to the time since the last spray round in the neighbourhood in which they live (10). With 12 months of transmission per year and two spray round with an insecticide lasting less than six months, there are periods during which the IRS insecticide is no longer fully effective. It is plausible, however, that children who sleep under LLINs are protected during the insecticide 'gap' between spray rounds which contrasts with those who benefit from IRS only. Another explanation may be that IRS coverage has at times been inadequate in Bioko, resulting in a loss of mass effect even for those whose houses are sprayed; the added protection of nets would again compensate for deficiencies of the IRS. The third possibility for the added impact of nets in communities and individuals in Bioko is that the combination of these two interventions genuinely provides added protection against malarial infection.

3.2. Kenya (12)

A non-randomized prospective cohort study was conducted in Western Kenya in 2008 comparing parasitaemia incidence in Rachuonyo District where only ITNs were used, with Nyando District, where IRS using lambda-cyhalothrin and alpha-cypermethrin was introduced in addition to ITNs.

Prevalence of infection was similar in the two districts at baseline. Cohorts of approximately 900 persons per district were recruited in a randomly-selected sample of households in the vicinities of three health facilities in each district. All cohort members were cleared of parasites by providing them with a treatment course of artemether-lumefantrine, and tested monthly by RDT and microscopy for a duration of nine months. The cohort in the district that had received IRS (Nyando) had substantially lower infection incidence than the cohort in Rachuonyo where ITNs only were used (incidence RR =0.41 [95% CI 0.31-0.56) (Table 3.2.1). Reported ITN use was 72% in the ITN+IRS group, and 98% in the ITN only group.

Table 3.2.1. Parasitaemia incidence rates in cohorts in Rachuonyo and Nyando districts, Western Kenya, 2008

Intervention	Events (all ages)	Person years	Rate per 100 person years	Rate ratio [95% Confidence Interval]
ITN	251	570	44	1
IRS plus ITN	114	627	18	0.41 [0.31-0.56][1]

[1] Adjusted RR = 0.38 [95% CI 0.28-0.50]

This study showed convincing evidence of the benefits of ITNs and IRS compared to ITNs only. Its main weakness was that it compared one district with another, and therefore other district-specific factors in addition to IRS may have played a part in causing the difference in infection incidence that was observed.

More recent unpublished data from the same area from a study on the implications of insecticide resistance suggest that the areas with combined use of IRS and LLIN are still seeing lower prevalence of infection than the areas with LLIN alone, but that this additional benefit is restricted to locations where deltamethrin resistance is low (I. Kleinschmidt, personal communication).

3.3. Burundi (13)

The study area consisted of four demarcated zones in the highland area of Karuzi. Two zones were comprised of hilltops and two were made up of valleys. In one of the valley zones and one of the hilltop zones, IRS with a pyrethroid insecticide was introduced whilst the other two zones were used as controls. In all four zones deltamethrin-impregnated LLINs were distributed, with coverage of two per house. Impact was monitored through a series of cross-sectional surveys. Children 1–9 years old in valleys had a significantly lower risk of malaria infection in the intervention zones after IRS was implemented compared to children in the control zones (OR =0.55; 95% CI 0.42 -0.72, p<0.001).

In the hilltop zones there was no difference in infection prevalence between intervention and control zones. There was no evidence of lower infection risk amongst children sleeping under an LLIN in sprayed houses compared to those not sleeping under a net in sprayed houses. The authors concluded that due to the high coverage of effective IRS (>90%), transmission was reduced to such low levels that sleeping under an LLIN had no detectable additional impact. It is not clear whether the nets on their own, i.e. those used in control zones, were effective or not.

The findings of this study cast doubt over any added protection that LLINs may provide in the presence of high coverage of IRS. The limitations of this study are the non-randomized design and the very small number of comparison units. No adjustment for confounders was reported in the assessment of the effect of LLINs on infection risk. Confounding and random error can therefore have played a part in obscuring any effect that the nets may have had in addition to IRS. As with other studies, the design was not intended to demonstrate non-inferiority and therefore a type 2 error (not demonstrating a true difference which does exist) cannot be ruled out.

4. Discussion

Given the conflicting results of the trials and other studies that have investigated the effect of combining IRS and LLINs, it is not possible to draw firm conclusions on whether the combination is generally beneficial in comparison to providing a single intervention. A previous review, which preceded the randomized trials that have recently been conducted was similarly unable to come to definitive conclusions [2]. The trials, which represent the highest quality of available evidence, can currently not be fully assessed since two out of four of these have not yet been published and

therefore have not undergone peer-review. One of the two trials that were published [4] was underpowered with seven clusters per intervention with the second published trial [6] having 25 clusters versus 35 and 70 in the unpublished Gambia and Sudan trials, respectively.

Based on the findings of the two published trials and results from the other two that have been available for the compilation of this report, there is a majority of three against one showing no significant added benefit when combining IRS and LLINs versus LLINs alone. However, none of the trials were non-inferiority trials and therefore it would be false to claim that there is evidence that LLINs alone are non-inferior to IRS plus LLINs. These trials merely failed to dispel the null hypothesis that IRS plus LLINs and LLINs alone are equivalent.

Given evidence from the Tanzania trial [6] of an added benefit of the combination, albeit in a setting of low ITN use, and programmatic studies that demonstrated added effect, it is likely that there is not a 'one size fits all' answer that the combination would always be beneficial, or that it would never produce added protection. Differences and similarities between the various trials and non-experimental studies discussed in this report are summarized below in Table 4.1.

In studies where added benefit of the combination has been evident, the IRS insecticide was bendiocarb. This restricts the period of added protection to the relatively short residual duration of this insecticide on walls [7]; multiple IRS rounds would be required if the transmission season exceeds this residual duration. There are currently no data on the added protection the combination might offer if other non-pyrethroids (apart from DDT) were used.

Insecticide resistance is undoubtedly a factor in whether the combination provides effective additional protection or not, but there are currently not enough data to determine the impact of resistance on the combined use of IRS and ITNs. In areas of high pyrethroid resistance it may be particularly beneficial to add non-pyrethroid IRS to areas with high coverage of ITN in order to provide protection against biting by pyrethroid resistant mosquitoes, particularly when nets have already acquired holes. There is some indication that this is the case in the Galabat area of Sudan. Combined use of IRS and ITNs may be particularly ineffective if there is resistance to the insecticide used for IRS.

At least three new trials will investigate the question of combined use of LLINs plus IRS versus one of these interventions alone:

- A trial in Muleba, Tanzania planned to commence in 2014 will compare (a) high coverage with permethrin-impregnated LLINs, (b) high coverage with permethrin+synergist-impregnated LLIN, (c) high coverage of permethrin-impregnated LLINs and IRS with pirimiphos-methyl capsule suspension (CS) and (d) high coverage of permethrin+synergist-impregnated LLIN and IRS with pirimiphos-methyl.[2]
- A cluster randomized trial in Ethiopia will compare IRS plus LLINs with LLINs only and with IRS only.[3]
- A two arm cluster randomized trial in Chhattisgarh, India, will compare combined use of LLINs and IRS with IRS alone.

This report has not attempted to address the question of whether there is evidence that the deployment of IRS and ITNs together is an effective insecticide resistance management strategy, as discussed in the *Global plan for insecticide resistance management in malaria vectors* (14).

2 Joint Global Health Trials. Evaluation of a novel long lasting insecticidal net and indoor residual spray product, separately and together, against malaria transmitted by pyrethroid resistant mosquitoes

3 MalTrials: *Combining indoor residual spraying and long-lasting insecticidal nets for preventing malaria: Cluster randomised trial in Ethiopia*. http://malaria.b.uib.no/maltrials/

Table 4.1. Summary of trials and selected non-trial studies investigating whether the combination of IRS and ITNs provides additional protection against malaria infection or disease

Comparison	IRS insecticide	Number of clusters/arm	Main vector	Reported LLIN usage	Reported IRS coverage	Mortality from susceptibility tests on LLIN insecticide, % main vector	*PfPR*$_{2-10}$ endemcity class[§]	Result
Benin								
IRS+TLLIN vs TLLIN	Bendiocarb	7	*An. gambiae s.s.*	Target groups only	>90%	97	High, *PfPR*$_{2-10}$ >40%	No effect
Sudan								
IRS+LLIN vs LLIN	Bendiocarb/ Deltamethrin	70	*An. arabiensis*	Very high	>95%	Range 43-100	Low, 0% <*PfPR*$_{2-10}$ ≤5%	No significant effect
The Gambia								
IRS+LLIN vs LLIN	DDT	35	*An. gambiae s.s. & An. arabiensis*	Very high	Very high	high	Intermediate, 5% <*PfPR*$_{2-10}$ ≤40%	No effect
Muleba, Tanzania								
IRS+ LLIN vs LLIN	Bendiocarb	25	*An. gambiae s.s., An. arabiensis & An. funestus*	Modest	~90%	Permethrin 11; Deltamethrin (range) 28-70	Intermediate, 5% <*PfPR*$_{2-10}$ ≤40%	Strong effect
Bioko, Equatorial Guinea								
IRS+LLIN vs IRS	Bendiocarb	No randomization	*An. gambiae s.s. An. melas*	Low	~80%	Not reported	Intermediate, 5% <*PfPR*$_{2-10}$ ≤40%	Strong effect
Western Kenya								
IRS+LLIN vs LLIN	Pyrethroid	No randomization	*An. gambiae s.s., An. arabiensis & An. funestus*	Modest	74%	Not reported	High, *PfPR*$_{2-10}$ >40%	Strong effect
Karuzi, Burundi								
IRS+LLIN vs IRS	Pyrethroid	No randomization	*An. gambiae s.s. & An. funestus*	High	>90%	Not reported	Intermediate, 5% <*PfPR*$_{2-10}$ ≤40%	No effect

[§] *PfPR*$_{2-10}$ is the proportion of 2-10 year olds in the general population that are infected with *P. falciparum*, averaged over the 12 months of 2010 as estimated by Malaria Atlas Project (15) (http://www.map.ox.ac.uk/browse-resources/endemicity/Pf_class)

5. Summary of current evidence

1. One trial that compared LLINs alone versus LLINs plus IRS using bendiocarb showed significant added protection against malaria infection of the combination. This was in a setting of intermediate transmission intensity, high pyrethroid resistance and modest LLIN usage.
2. Two trials that compared LLINs alone versus LLINs plus IRS using bendiocarb showed no additional protection due to the combination. One of these had low power and targeted LLIN coverage only, while the other was in a setting of very low transmission intensity but high LLIN coverage.
3. There is therefore limited generalizable evidence from trials that combining LLINs and IRS with bendiocarb may give added protection.
4. One large trial that compared LLINs alone with LLINs plus IRS using DDT found no evidence of additional protection against malaria due to the combination.
5. There is evidence from several non-randomized observational studies and from mathematical models that the combined use of LLINs and IRS offers added protection versus LLINs alone. Findings from observational studies may be subject to confounding, and those from models are clearly sensitive to the assumptions upon which the models are based.
6. A number of non-randomized observational studies have shown no added protection resulting from the combination of IRS and LLINs.
7. The negative findings do not constitute proof of no effect, but may indicate that, if present, the effect is small.
8. At least three additional cluster randomized trials investigating the combined use of LLINs plus IRS versus one intervention alone are in progress.

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World Health Organization

GLOBAL MALARIA PROGRAMME

WHO guidance for countries on combining indoor residual spraying and long-lasting insecticidal nets

March 2014

Summary

1. In settings where there is high coverage with long-lasting insecticidal nets (LLINs) and LLINs remain effective, indoor residual spraying (IRS) may have limited utility in reducing malaria morbidity and mortality. However, IRS may be implemented in areas where there are LLINs as part of an insecticide resistance management strategy.[1]

2. If LLINs and IRS are to be deployed together in the same geographical location, the IRS should use non-pyrethroid insecticides.

3. Malaria control and elimination programmes should prioritize delivering either LLINs or IRS at high coverage and to a high standard rather than introducing the second intervention as a means of compensating for deficiencies in the implementation of the first.

4. Evidence is needed to determine the effectiveness of combining IRS and LLIN in malaria transmission foci, including in low transmission settings. Evidence is also needed from different eco-epidemiological settings outside of Africa.

5. All programmes in any transmission setting that invest in the combined use of LLINs and IRS should include a rigorous programme of monitoring and evaluation (e.g. a stepped wedged introduction of the combination) to confirm whether the additional inputs have the desired impact. Countries that are already using both interventions should similarly undertake an evaluation of the effectiveness of combining versus either LLINs or IRS alone.

Background

The reduction in disease burden of malaria in recent years has in large part been attributed to the massive scale up of the two main vector control interventions, LLINs and IRS, particularly in Africa south of the Sahara. A number of countries have deployed the two interventions in combination in an attempt to further reduce transmission.

The evidence for enhanced protection against malaria resulting from the combination of IRS and ITNs is currently not clear even though several trials and observational studies have attempted to answer this question. Cluster randomized trials, which provide the best evidence for the effectiveness of an intervention, have been conducted in Benin, Tanzania, The Gambia and Sudan. All but one (Benin) are currently unpublished. However, the results

[1] World Health Organization. *Global plan for insecticide resistance management in malaria vectors*. Geneva, 2012. http://www.who.int/malaria/publications/atoz/gpirm/en/

of the other three trials have been presented at international conferences, and detailed data of two of the unpublished trials have been accessible for the purpose of this technical review.

The Benin trial[2] showed no evidence of added protection from the combination of IRS and LLINs, compared to LLINs alone. However, this trial does not provide adequate guidance on this question since: (a) it had low statistical power with only seven clusters per study arm (compared to 25, 35 and 70 in the Tanzania, Gambia and Sudan trials, respectively); (b) its reference arm had ITNs for targeted groups only, instead of universal coverage; and (c) spraying was conducted at intervals considerably longer than the residual life of the insecticide used (bendiocarb). The trial in The Gambia (completed but unpublished) compared LLINs in combination with IRS using DDT versus LLINs alone, and showed no evidence that the IRS offered increased protection compared to the use of LLINs alone. The Sudan study (ongoing) is being conducted in a setting of very low transmission; results to date show some additional protection in the combination arm, but the evidence for this is very weak (non-significant).

The Tanzania study[3] showed significant additional protection provided by the combined use of LLINs and IRS, but the generalizability of this result is complicated by the fact that LLIN usage was modest (between 53% and 36%). However, per protocol analysis of the trial data showed a large additional reduction in prevalence in the subgroup that used LLINs and also received IRS, compared to those who were protected by LLINs alone. Whether this additional benefit would have been seen if net use had been at universal coverage level, is unknown. Furthermore, available data suggest some level of resistance in local vector populations to the insecticide used on nets.

Overall, therefore, the trial evidence so far remains inconclusive. It should be noted that none of the trials were non-inferiority studies attempting to show equivalence of LLIN only versus LLIN plus IRS combined interventions. Observational studies have similarly given contradictory results. However, the benefit of adding LLINs to IRS has been consistently shown in Bioko over several years where the effective coverage of IRS was less than complete for the full transmission period.

Insecticide resistance is undoubtedly an additional factor that may determine whether the combined use of IRS and LLINs provides additional protection, but there are currently not enough data to determine the impact of resistance on the effectiveness of such combinations. In areas of high pyrethroid resistance it may be particularly beneficial to add IRS with non-pyrethroids to areas with high coverage of LLINs , to (a) provide protection against biting by pyrethroid-resistant mosquitoes, particularly when nets have already acquired holes, and (b) for resistance management purposes.

IRS may also have some utility in areas with low resistance as part of an overall resistance management strategy aimed at preserving the effectiveness of pyrethroids.

[2] Corbel V, Akogbeto M, Damien GB, Djenontin A, Chandre F, Rogier C, Moiroux N, Chabi J, Banganna B, Padonou GG, Henry MC. *Combination of malaria vector control interventions in pyrethroid resistance area in Benin: a cluster randomised controlled trial.* Lancet Infect Dis. 2012 Aug;12(8):617-26.

[3] West PA, Protopopoff N, Wright A, Kivaju Z, Tigererwa R, Mosha F, Kisinza W, Rowland M, Kleinschmidt I. *Indoor residual house spraying in combination with insecticide treated nets compared to insecticide treated nets alone for protection against malaria: Results of a cluster randomised trial in Tanzania.* PLOS Medicine. 2014. (*In Press*)

Current evidence

1. Three trials have compared LLINs alone versus LLINs plus IRS with bendiocarb:
    - One showed significant added protection of the combination against malaria infection; this was in a setting of intermediate transmission intensity, high pyrethroid resistance and modest LLIN use.

    - Two showed no additional protection of the combination. One of these had low power and targeted LLIN coverage only, while the other was in a setting of very low transmission intensity but high LLIN coverage.

2. One large trial that compared LLINs alone versus LLINs plus IRS using DDT found no evidence of additional protection of the combination against malaria.

3. There is evidence from several non-randomized observational studies and from mathematical models that the combined use of LLINs and IRS offers added protection versus LLINs alone. Findings from observational studies may be subject to confounding, and those from models are clearly sensitive to the assumptions upon which the models are based.

4. A number of non-randomized observational studies have shown no added protection resulting from the combination of IRS and LLINs. Negative findings do not constitute proof of no effect, but may indicate that, if present, the effect is small.

5. At least three additional cluster randomized trials investigating the combined use of LLINs plus IRS versus one alone are in progress.

Conclusions

1. In settings where there was high LLIN use and susceptibility of vectors to pyrethroids, there was no evidence that adding IRS would provide additional protection against malaria.

2. In settings of high pyrethroid resistance there is limited evidence that combining LLINs and IRS with bendiocarb may give added protection.

3. All studies that have investigated the question of added protection due to combined use of LLINs and IRS were performed in Africa. The above conclusions may therefore not be applicable in other regions.

Further information

Vector Control Technical Expert Group. *Guidance for countries on combining IRS and LLINs*. Report to MPAC March 2014. [Withheld temporarily pending publication of West et al. (*In press*)].

World Health Organization

GLOBAL MALARIA PROGRAMME

Malaria 2025: Accelerate to Eliminate

The Global Technical Strategy for Malaria: 2016 - 2025

Process to date and structure

Pedro Alonso, GTS Steering Committee Chair

Geneva, 12 March 2014

Audience and purpose of the Global Technical Strategy

What is its purpose?

- The GTS describes the global acceleration of malaria reduction and elimination over the next decade and articulates a comprehensive plan that references existing WHO recommended strategies and guidance
- The GTS will also be the technical foundation for the Roll Back Malaria Global Malaria Action Plan2

Who is it for?

- The broader community of malaria stakeholders are the target audience of the GTS
  - WHO Member States, agencies of the United Nations system, donors, global health and development organizations, the private sector and others
- Balance is needed between technical guidelines, contextual information and advocacy

Strong alignment between GTS and GMAP2

- Global Malaria Programme and Roll Back Malaria Partnership are working together to align the development of GTS and GMAP2
- Joint launch planned in 2015 after WHA endorsement (GTS) and RBM Board adoption (GMAP2)
- Overlapping Steering Committee and GMAP2 Taskforce membership: 3 members + Ex officio membership overlap

Global Technical Strategy (GTS) – Steering Committee

Name	Institution
Pedro Alonso - Chair	ISGlobal, Barcelona Institute for Global Health, Spain
Abdisalan Noor	KEMRI-Wellcome Trust Research Programme, Kenya
Ana Carolina Santelli*	Coordenação Geral do Programa Nacional de Controle da Malária (CGPNCM), Brazil
Azra Ghani	Chair in Infectious Disease Epidemiology, Imperial College, London
Ciro de Quadros	Sabin Vaccine Institute, Washington DC
Corine Karema*	National Malaria Control Programme, TRACPlus, Rwanda
Gao Qi	Jiangsu Institute of Parasitic Diseases, China
Kevin Baird	US Naval Medical Research Unit, Jakarta, Indonesia
Lesong Conteh	Centre for Health Policy, Imperial College , London
Margret Gyapong	Dodowa Health Research Centre; Ghana
Sandii Lwin	Myanmar Health & Development Consortium
Tom Burkot	School of Public Health, James Cook University, Australia
Wichai Satimai*	Former Director, Bureau of Vector Borne Disease, Ministry of Public Health, Thailand
Zulfiqar Bhutta	AGA KHAN UNIVERSITY, Pakistan
David Brandling-Bennett (ex officio)	Bill & Melinda Gates Foundation
Bernard Nahlen (ex officio)	U.S. President's Malaria Initiative
Fatoumata Nafo-Traore (ex officio)	Roll Back Malaria Partnership Secretariat
John Reeder (ex officio)	WHO Global Malaria Programme

Global Technical Strategy – Process to date

- GMP requested to develop GTS by MPAC in September 2012
- WHO Member States expressed support for the GTS development at WHA in May 2013
- MPAC chair presented the GTS plan at the RBM Board meeting in May 2013
- Steering Committee constituted in July 2013; monthly teleconference
- GTS Malaria Typology/Steering Committee mtg followed by GMAP2 Taskforce mtg in October 2013
- First draft of GTS circulated to Steering Committee December 2013
- GTS Steering Committee review of first draft and GMAP 2 Taskforce meeting January 2014
- GTS reviewed by MPAC March 2014

Global Technical Strategy – Next steps

- March – June: 7 Regional Consultations
  - 18-19 March: AFRO in Brazzaville, Congo (Francophone)
  - 1-2 April: PAHO in Panama City, Panama
  - 8-9 April: AFRO in Harare, Zimbabwe (Anglophone)
  - 15-16 April: EMRO in Casablanca, Morocco
  - 28-29 April: SEARO in New Delhi, India
  - 10-11 June: EURO in Copenhagen, Denmark
  - 10-11 June: WPRO in Manila, Philippines
- May – June: Online web consultation
- June – July: Consolidation of input into revised draft
- July 28-29: GTS Steering Committee meeting (tentative)
- August: MPAC and external review (electronic)
- September: Submission to Executive Board
- March 2015: Submission to World Health Assembly

Regional Consultations are central to GTS development

Why a regional consultation?

- Regional GTS Expert Consultations are central to developing the GTS
- One of the core values of the GTS is country and community leadership in the development and implementation of the Strategy
- Regional and Country input and ownership is critical in the success of this work

Who is joining?

- Malaria experts
- Country Programme representatives
- International partner organization representatives
- GTS Steering Committee members
- WHO HQ, Regional and Country staff

What is expected from participants?

- Discussion and feedback on the proposed global goals
- Input on how the draft GTS can be improved to support country programmes whether the country goal is reduction of malaria burden or elimination

Overview of GTS consultation website

عربي 中文 English Français Русский Español

World Health Organization

Health topics | Data | Media centre | Publications | Countries | Programmes | About WHO | Search

Malaria

- Malaria
- Areas of work
- Data and statistics
- Document centre
- Malaria Policy Advisory Committee
- Information for travellers
- Media centre
- About us

Global Technical Strategy for Malaria Control and Elimination 2016-2025

The WHO Global Malaria Programme is coordinating the development of a Global Technical Strategy for Malaria Control and Elimination (GTS) for the 2016-2025 period. It will articulate the vision and goals for malaria over the next decade and bring together current policy recommendations in a comprehensive, evidence-based strategy for WHO Member States to use in developing their own strategies, wherever they are along the pathway to elimination.

The consultation process

The Global Technical Strategy is being developed through an inclusive, country-driven approach. Based on a foundation of existing strategies, it will include input from consultations with WHO Regions, international experts and country programmes. A series of regional consultations will be held between March and May 2014 and coincide with a public web consultation.

The public web consultation will begin in March 2014 and links will be made available on this web site to submit comments. The consultation process is led by a Steering Committee composed of 14 leading malaria technical experts, scientists and representatives of endemic countries.

Purpose of the Global Technical Strategy

The Strategy will help Member States address serious threats to progress in the next ten years, including artemisinin resistance, anopheline insecticide resistance, weak health systems and inadequate human resources. It will also help them

Related links

Steering Committee
Current Steering Committee Members
Meetings and documentations

Latest news on the GTS

WHO holds first country consultation on Global Technical Strategy 2016-2025
16 October 2013

Contact the GTS team

Global Malaria Programme
World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland
Tel: +41 22 791 2533
Fax: +41 22 791 4824
E-mail: gtsgmp@who.int

Attendees can provide additional input directly on the GTS website

Overview of document structure

Draft document structure	Section titles
Introduction	• List of Abbreviations • Foreword (to be developed) • Strategy at a Glance (to be developed) • Executive Summary (to be developed)
Core concepts	• The need for a new Global Technical Strategy for Malaria • Global Progress to Date • Challenges • Core Values • Vision, Strategic Directions, and Goals • Malaria Pathway to Elimination
Strategic directions	• Surveillance and Response • Preventing Cases and Reducing Transmission • T3: Test, Treat, Track • Innovation and Implementation Research • Development and Health Systems Strengthening
Conclusion	• Call to Action • Glossary • Annexes (to be developed)

Aligned Vision for Malaria

A single vision for the Global Technical Strategy and the Global Malaria Action Plan2

Long-term Vision	**A world free of malaria**
Vision	**To accelerate progress to a world free of malaria**

World Health Organization

GLOBAL MALARIA PROGRAMME

Malaria 2025: Accelerate to Eliminate

The Global Technical Strategy for Malaria: 2016 - 2025

Setting global targets

Azra Ghani, GTS Steering Committee

Geneva, 12 March 2014

Vision and Goals

Purpose of Vision and Goals section

- This section is core to the GTS, by setting the direction and providing concrete targets that the malaria community should aim for in the coming decade
- Vision and Goals provide the strategic frame to regional and local level programmes when developing their own strategies

Key questions

- Are the proposed vision / goals sufficiently aggressive and ambitious to drive change and accelerate impact in the coming decade?
- Is the overall strategic frame clear, consistent, and comprehensive?

Vision and Goals

Long-term Vision

A single vision: *a world free of malaria*

GTS Vision

To accelerate progress to a world free of malaria

Goals

Goal 1 – to reduce malaria mortality rates globally by 75% compared to 2015

Goal 2 – to reduce malaria case incidence globally by 75% compared to 2015

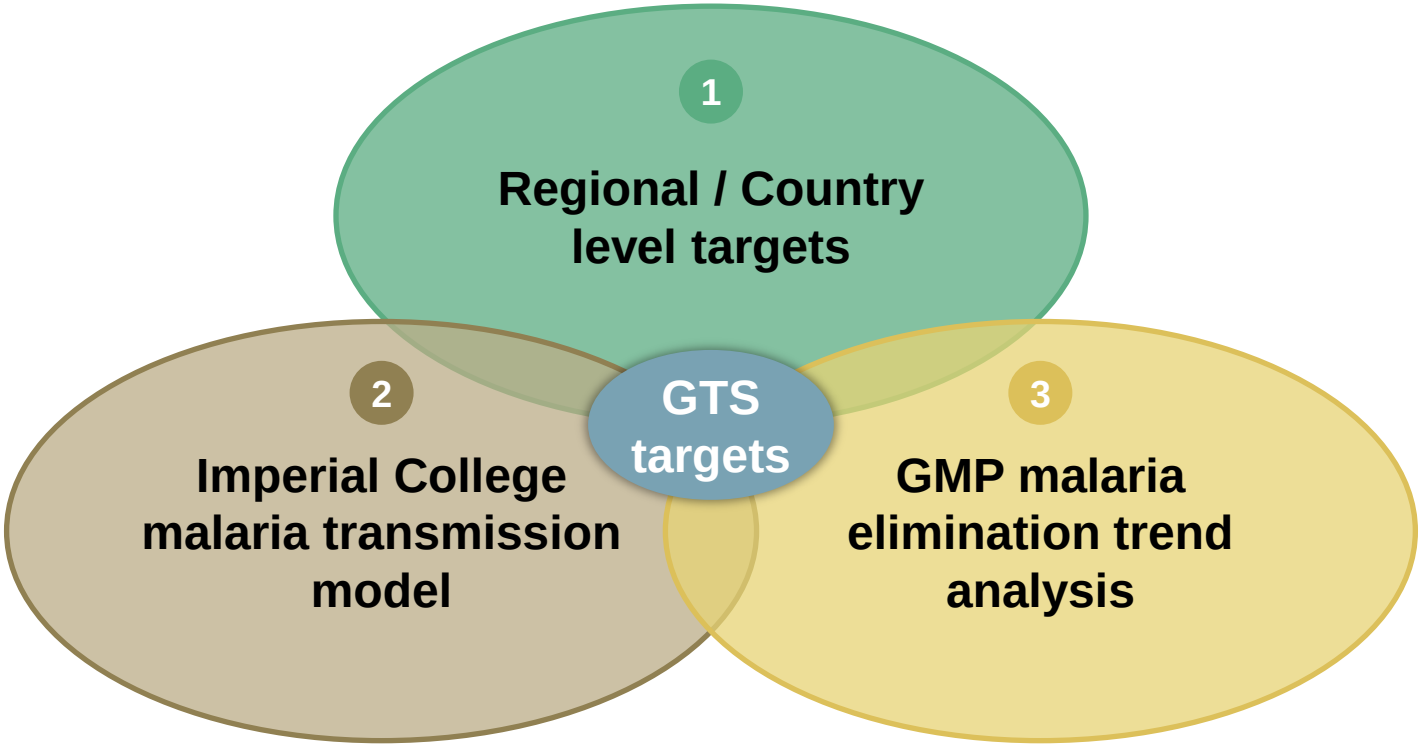
Goal 3 – to eliminate* malaria from 20 countries that had ongoing transmission of malaria in 2015**

*eliminate refers to no indigenous transmission of malaria; not certification

** 20 countries to be confirmed

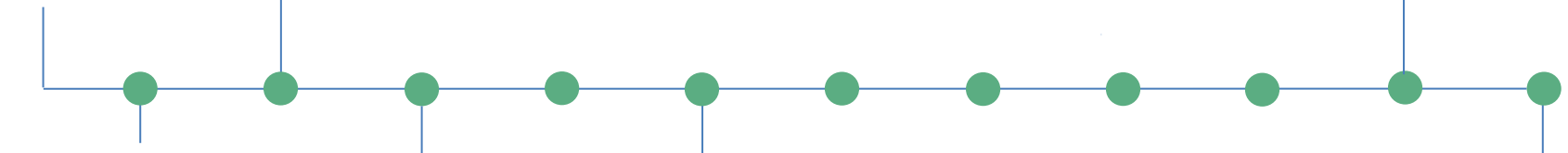
Focus on malaria targets

Three combined approaches to define appropriate target levels



Target setting methodology to be detailed in a separate Annex of the GTS document

Elimination goals & targets 2016-2030 as stated by countries



2015
Zero indigenous cases:
Botswana
Swaziland
Indonesia (337 districts)
Ethiopia (specific geographical areas)

2016
Zero indigenous cases:
Bhutan
Thailand (60% of districts)
Solomon Islands (Temotu Province)
Vanuatu (1 Province)

2017
Zero indigenous cases:
China
Zanzibar

2018:
Zero indigenous cases:
South Africa

2020:
Zero indigenous cases:
China
Djibouti
Malaysia
Suriname
Yemen
Philippines (post 2020)
Thailand (80% of districts)
Indonesia (459 districts)

2025:
Zero indigenous cases:
Cambodia
Iran
India (5-10 States)

2026:
Zero indigenous cases in Nepal

2030:
Zero indigenous cases in Indonesia

Trend Analysis

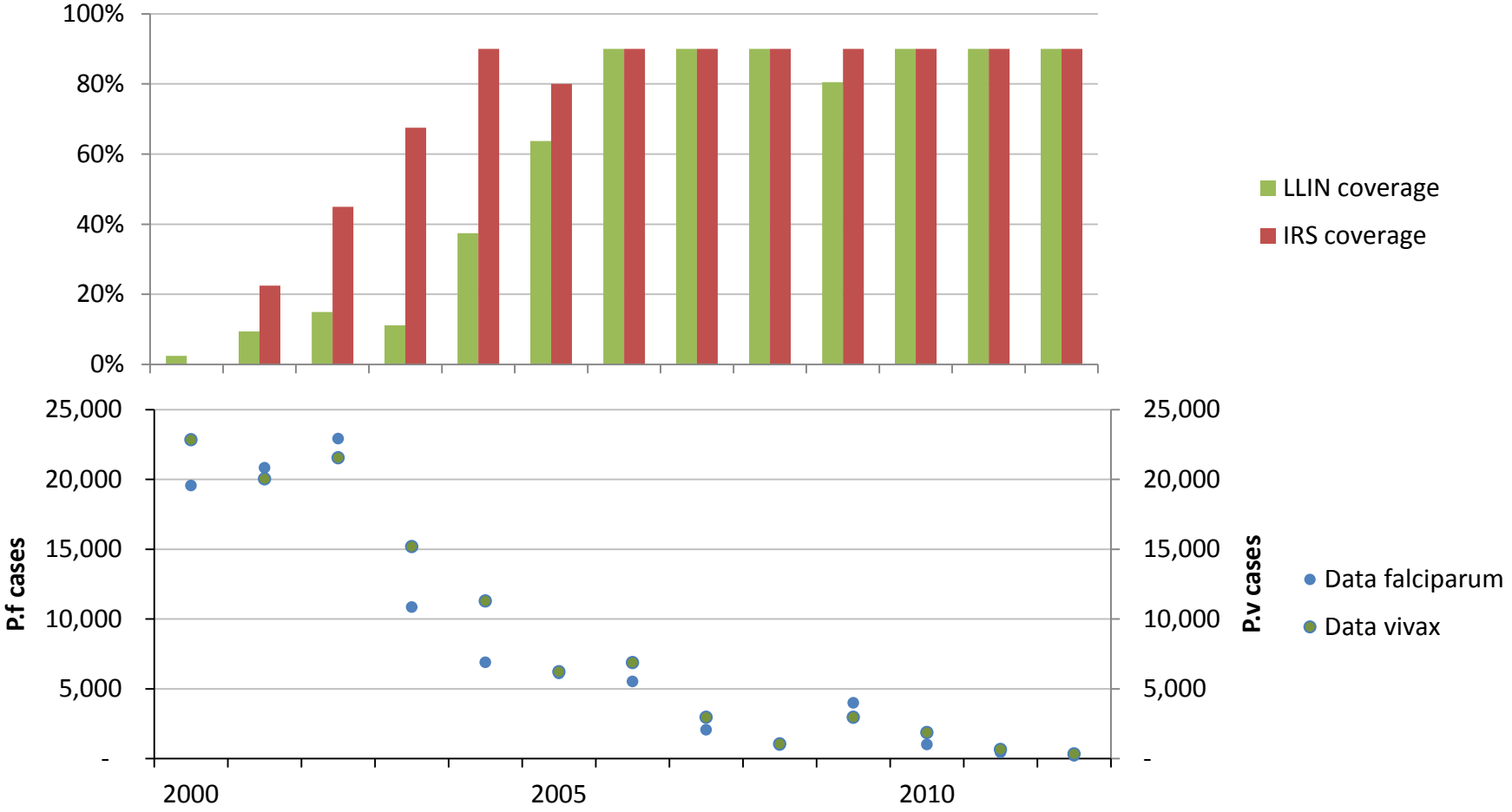
- What have countries achieved to date?
- How does this match the resources that have been input?

- Data compiled from 2013 World Malaria Report
  - Trends in *P.falciparum* and *P.vivax* case reports from 2000 onwards
  - Changing coverage of LLINs and IRS
  - Increase in access to first-line treatment with ACTs

- Predictions for 2016-2025:
  - Statistical trend extrapolation (all cases)
  - Mathematical model fitting (*P.falciparum* only)

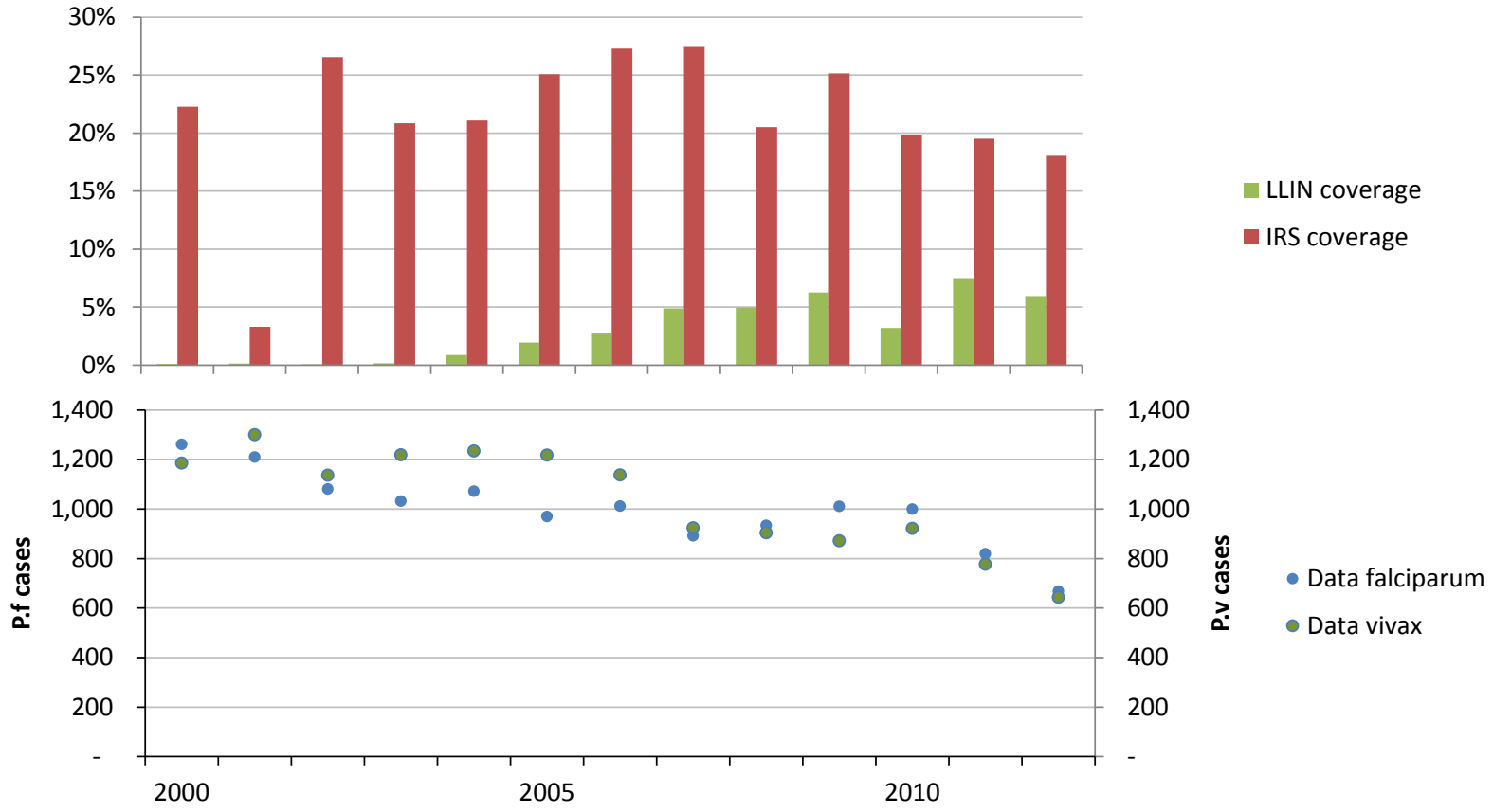
Example Trends: Bhutan

- Program Goals: To achieve zero indigenous case of malaria in Bhutan by 2016



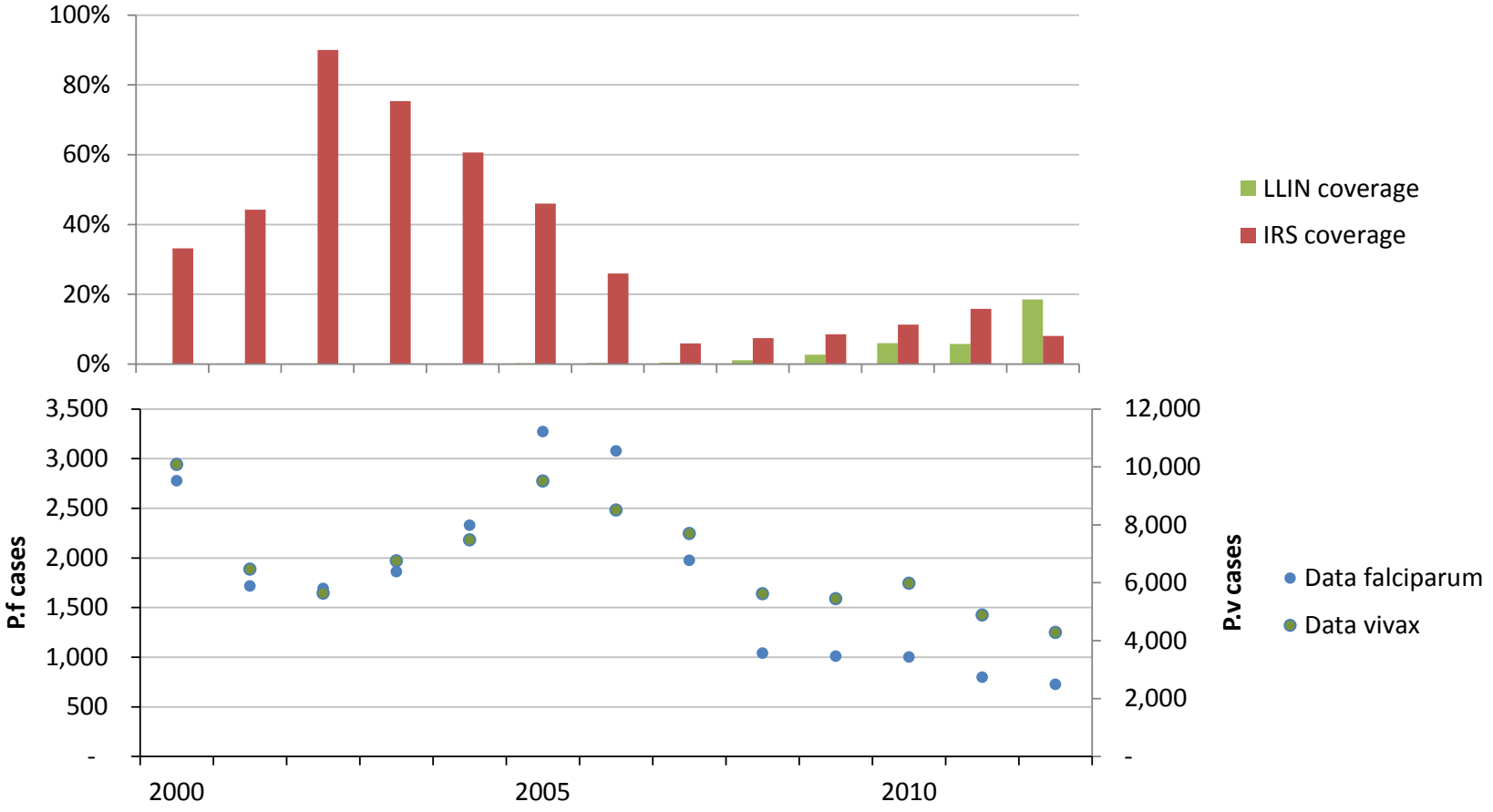
Example Trends: India

- Program Goals: substantial and sustained reduction in the burden of malaria in the near and mid-term; elimination of malaria in the long term



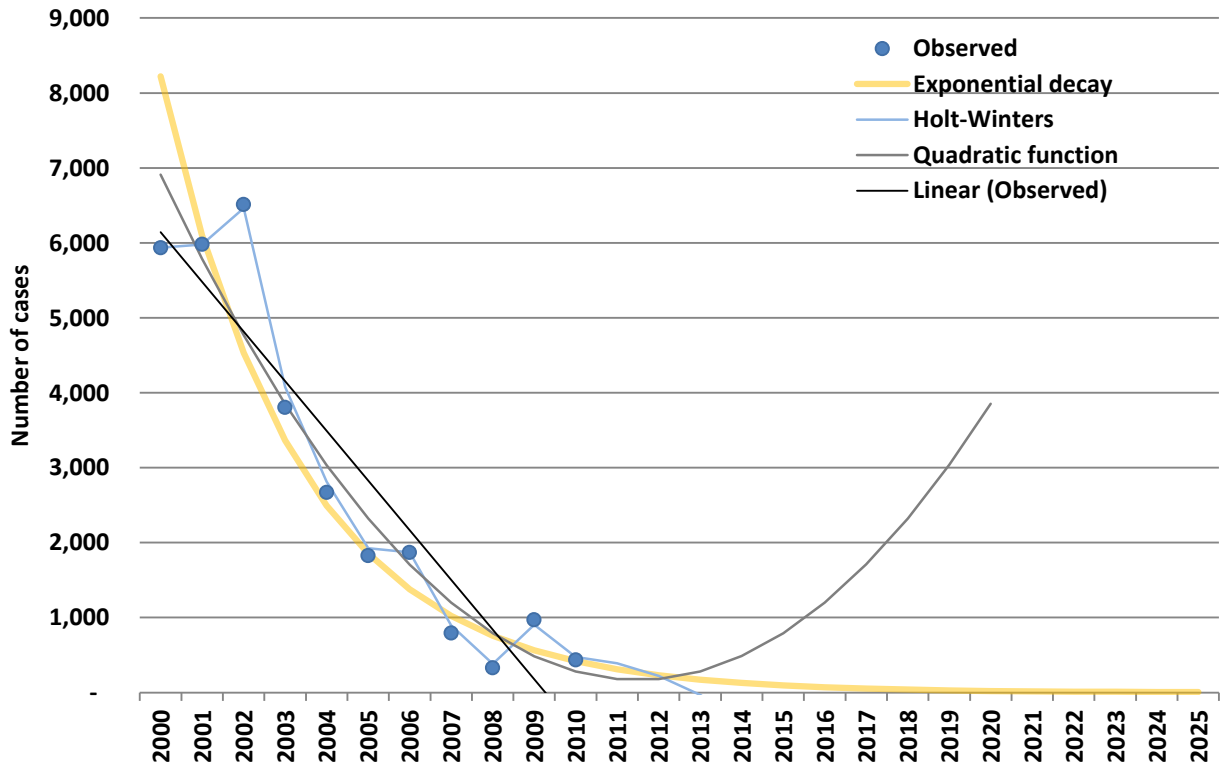
Example Trends: Brazil

- Program Goals: Reduction in mortality, cases and transmission



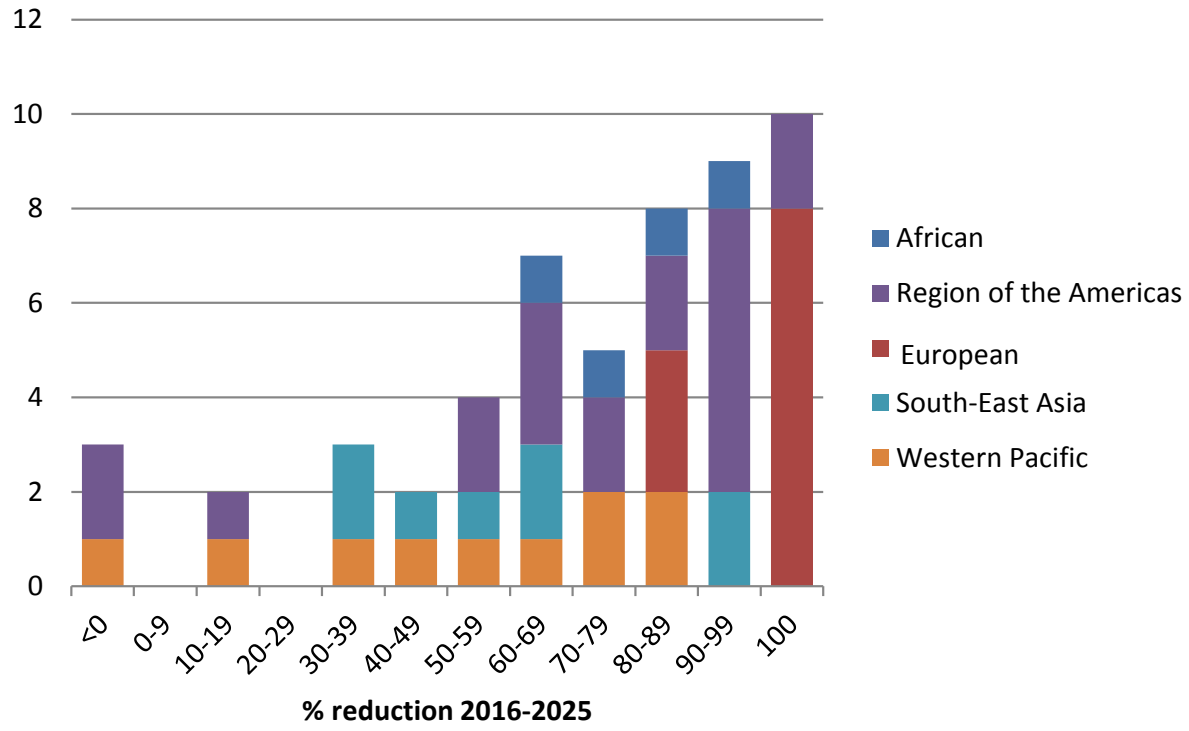
Projecting Forwards: Statistical Models

- Statistical models assume a continued trend
- Difficult to know which function is most appropriate
- Different functions give very different predictions



(Bhutan)

Projected decreases for countries in which it is possible to assess trends

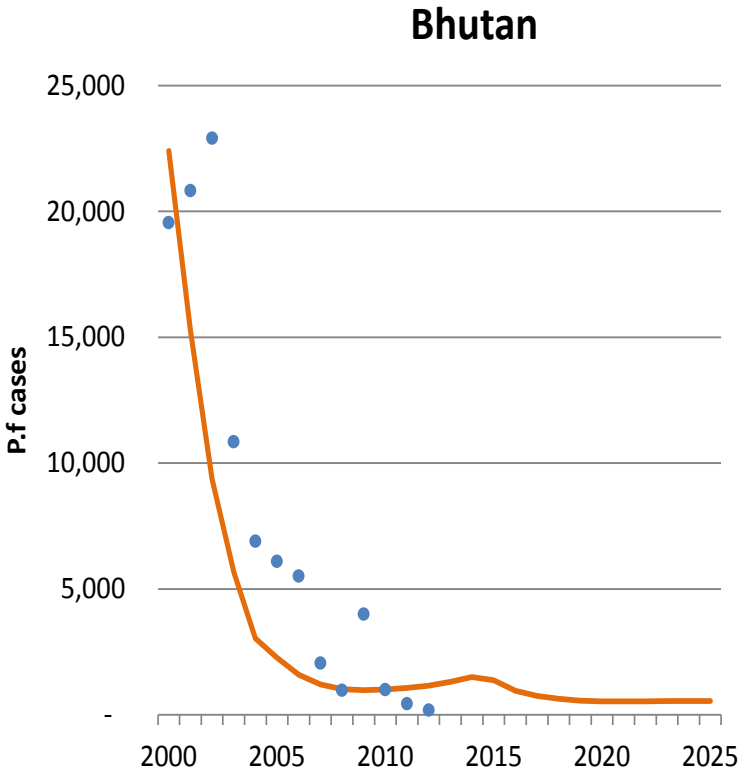


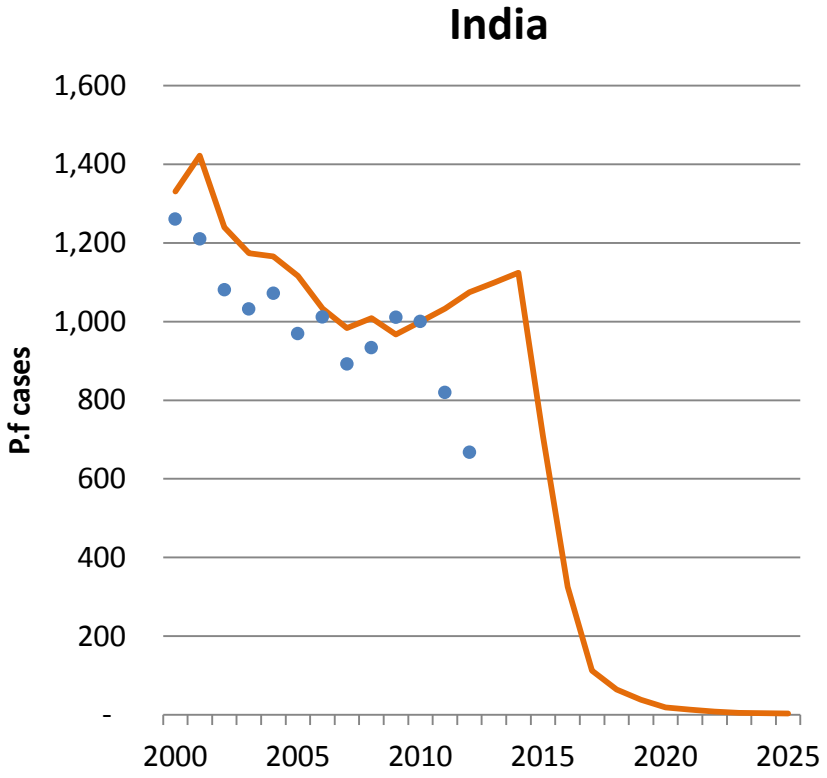
Median decrease 82% (IQR 59%-99%)

or 73% (IQR 55%-89%) excluding European Region

Projecting Forwards: Mathematical Models

- Can predict varied trends depending on coverage of interventions
- Less easy to match past trends
- *P.falciparum* only





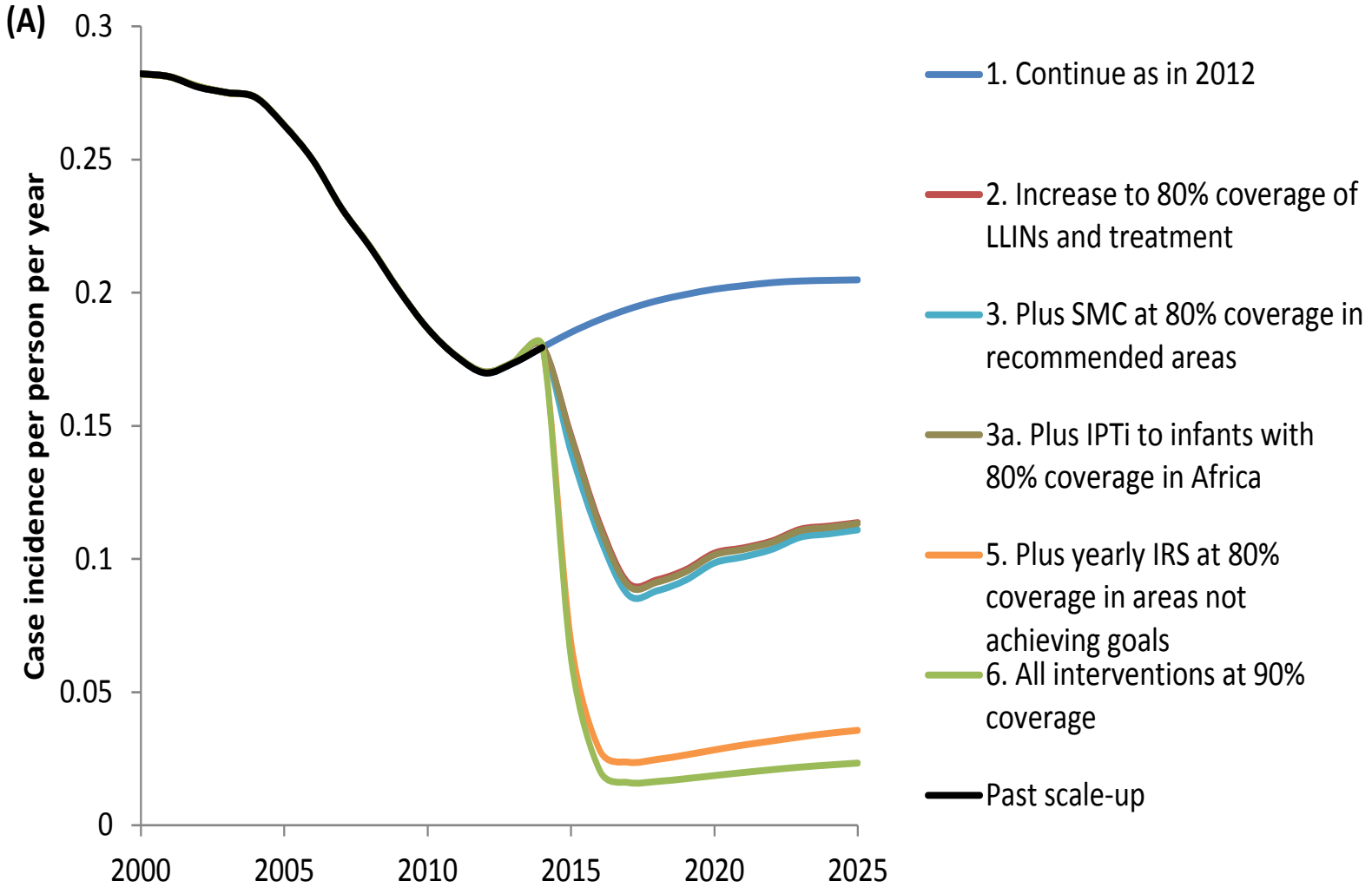
Modelling scenarios for *P.falciparum* *(Work in Progress)*

- Aim to use mathematical model of malaria transmission to assess what impact combinations of currently recommended interventions could have if implemented between 2016 and 2025
- Model inputs:
  - Endemicity in 2010 *(MAP prevalence and WMR 2013 case reports)*
  - Coverage of interventions (treatment, ACT use, LLINs and IRS) up to 2012 *(WMR 2013 & DHS/MIS surveys)*
  - Vector species & their bionomics for 3 most commonly reported species in a country *(MAP estimates)*
- Model outputs:
  - Estimates of percentage change in cases and deaths between 2016 and 2025
  - Proportion of countries achieving different reduction thresholds
  - Proportion of countries moved into pre-elimination status (<1 case per 1000 population per year)

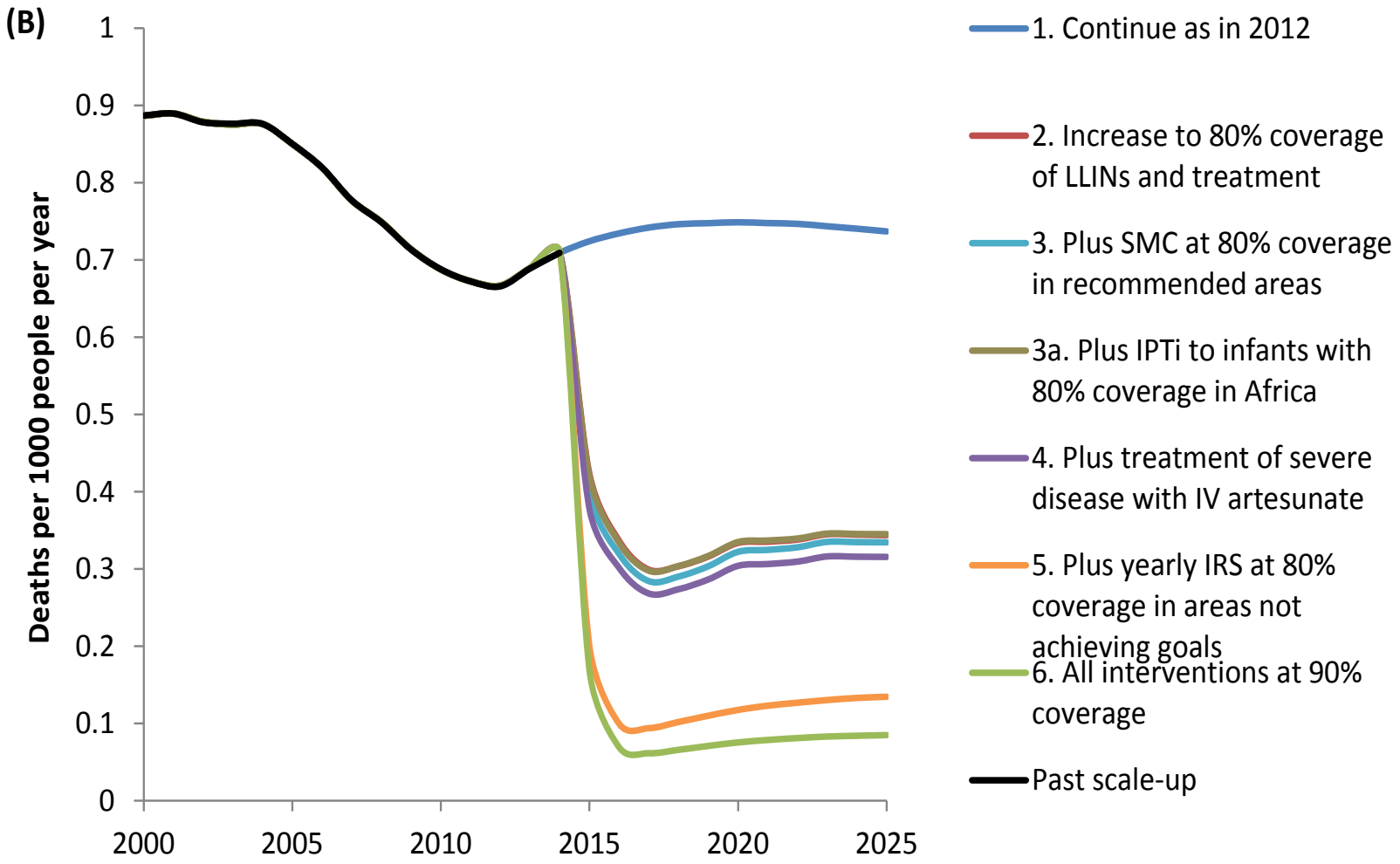
Scenarios

Scenario	Description
1	Continue the current coverage of LLINs, IRS and access to treatment
2	Increase universal coverage of LLINs to 80%, access to treatment to 80% of all cases (or existing country levels if greater), all cases accessing care are treated with an appropriate ACT
3	Scenario 2 plus SMC to children aged 3 months to 5 years with SP plus amodiaquine in recommended areas in the Sahel region of Africa at 80% coverage
3a	Scenario 2 plus IPTi to infants with SP in Africa at 80% coverage where the EIR is above 10 ibpppy
4	Scenario 3 plus treatment of severe disease with IV artesunate (assumed to reduce mortality in cases who reach hospital by a further 20%)
5	Scenario 4 plus yearly IRS with DDT (at 80% coverage) in those countries in which a 90% reduction in cases or a mortality rate less than 1 death per 1000 population per year was not achievable by 2025 with Scenario 4
6	Scenario 5 with increased coverage of LLINs to 90%, access to treatment to 90% of all cases, all cases accessing care are treated with an appropriate ACT

Global Projections: Cases



Global Projections: Deaths



Predicted Global Reductions to 2025

Scenario	% Reduction in Cases	% Reduction in Deaths
2. Increase to 80%	44.6%	53.4%
3. Scenario 2 plus SMC	45.7%	54.6%
3a. Scenario 2 plus IPTi	44.6%	53.4%
4. Scenario 3 plus treatment of severe disease with IV artesunate	45.7%	57.2%
5. Scenario 4 plus yearly IRS (currently with DDT at 80% coverage)	82.5%	81.7%
6. Scenario 5 with increased coverage to 90%	88.6%	88.5%

- 38 out of 80 countries predicted >90% reduction in cases under Scenario 5
- Substantial regional variations:
  - >95% reduction in cases and deaths under Scenario 5 in EMRO, SEARO and PAHO
- 27 countries at pre-elimination by 2025 under current coverage
- Additional 16 countries predicted to reach this under Scenario 5

Resource Needs

- Model tracks resources utilised, taking into account population distributions in at-risk areas and population growth
- Includes intervention resources and healthcare utility (assuming no change in health-seeking behaviour)
- DHS/MIS surveys used to estimate rates of NMFI in children under 5 to calculate RDT resources (other methods will be considered)
- IPTp costs not currently incorporated (but can be)
- Financial and programme costs based on recent reviews
- Additional malaria control program costs (training/communication, CHWs, operational research/M&E, infrastructure/institutional strengthening) currently added using previous GMAP methodology

Resource Costs

	Cost (USD 2010)*	GMAP assumptions
LLIN (per net)	$7.03	$6.41
IRS (per person)	$3.60	$7.50
SMC (per course)	$1.50	-
ACT treatment for uncomplicated malaria at health centre / outpatient	$1.00 (ACT cost) $0.60 (RDT cost) $1.40 (healthcare visit cost)	$1.08 (paediatric) $2.025 (adult)
Non-ACT treatment for uncomplicated malaria at health centre / outpatient	$0.30 (drug cost) $0.60 (RDT cost) $1.40 (healthcare visit cost)	$0.30
RDTs used for NMFI (per fever)	$0.60	$0.78
Hospital costs associated with treatment of severe disease (assumed to be the same for quinine and artesunate)	$30.26	$29.50

Preliminary Estimates

Scenario	Estimated Cost per Year (2010 US$) including healthcare costs	Estimated Cost per Year (2010 US$) excluding healthcare costs
1. Remain at current levels	2.0 billion	1.7 billion
2. Increase to 80%	3.1 billion	2.7 billion
3. Scenario 2 plus SMC	3.2 billion	2.9 billion
4. Scenario 3 plus treatment of severe disease with IV artesunate	3.2 billion	2.9 billion
5. Scenario 4 plus yearly IRS with DDT (at 80% coverage)	5.5 billion	5.4 billion
6. Scenario 5 with increased coverage to 90%	6.1 billion	6.0 billion

- Comparative Figures:
  - 2013 international disbursements: US$ 1.97 billion (WMR 2013)
  - 2012 domestic spend: US$ 522 million (WMR 2013)
  - Original GMAP estimates:* $5.1 billion per year from 2011 to 2020

*Includes LLINs, IRS, IPTp and treatment and management of cases assuming 100% coverage

Summary

Goals

Goal 1 – to reduce malaria mortality rates globally by 75% compared to 2015

National Plan Review: 50%, 70%, 75%, 90% reductions
Modelling: 55%-90% reduction

Goal 2 – to reduce malaria case incidence globally by 75% compared to 2015

National Plan Review: 50%, 70%, 75%, 90% reductions or threshold incidence
Trend Analysis: 73% / 82% reduction
Modelling: 45%-88% reduction

Goal 3 – to eliminate* malaria from 20 countries that had ongoing transmission of malaria in 2015**

National Plan Review: 15 countries have complete or partial elimination currently in plan
Modelling: 27 countries at pre-elimination threshold by 2025, additional 16 could reach this with intensive scenario