

Evaluation of the Impact of Malaria Interventions on Mortality in Children in Ethiopia

Part 2: Annexes



Table of Contents

Annex 1: General Survey Information and Data Availability for Ethiopia 2000-2011	5
A.1.1: Data Sources	5
A.1.2: DHS/MIS Survey Characteristics	8
A.1.3 Summary of RBM malaria control indicators	12
A.1.4. Adjustments made to DHS and MIS Surveys of Ethiopia.....	13
A.1.5 Data and Indicators on ITN coverage	13
A.1.6 Data and Indicators on IRS.....	16
A.1.7 Data and Indicators on Malaria in Pregnancy (IPTp and ITN use)	16
A.1.8 Data and Indicators on Case Management	18
A.1.9 Data and Indicators on Malaria Morbidity	20
A.1.10 Data and Indicators on Under-five Mortality	22
Annex 2: Additional Background Information	23
A.2.1: Ethiopia Health Tier System	23
A.2.2: Organizational Structure of FMOH as of 2011	24
A.2.3: Partial List of Partners Working in Malaria.....	25
A.2.4: Estimated Resource Needs for Health Sector Development Plan (HSDP IV) under the Base Case Scenario (US\$ Million).....	28
Annex 3: LiST Model Details.....	29

A.3.1 Methods - Lives Saved Tool (LiST Model)	29
LiST Model.....	29
Mortality & Cause-Specific Mortality Profile	29
Intervention Coverage	29
Malaria Control Intervention Coverage	29
Malaria Intervention Protective Efficacy	29
Uncertainty Limits.....	30
A.3.2 LiST Model Outputs	30
Annex 4: Data Tables	33
A.4.1 DHS Data Tables (Table A.4.1.1-Table A.4.1.14).....	33
Annex 5: Contextual Factors	47
A.5.1 Contextual Factors from National Survey Data, 2000-2011	47
A.5.2 Fundamental Determinants.....	48
Socioeconomic factors	48
Mother’s Education and Marital Status.....	50
A.5.3 Proximate Determinants	51
Maternal health	51
Child health	52
Breastfeeding practices and under-nutrition in children and women	54
HIV/AIDS among children and women	58
Annex 6: Health Management Information System (HMIS)	60
A.6.1 Malaria Morbidity Estimates	60
Annex 7: Outbreaks.....	61
A.7.1 History of Malaria Outbreaks in Ethiopia	61
Early 20th Century Outbreaks.....	61
Malaria Epidemiology and Outbreaks between 1959 and 1999	62
Malaria Outbreak of 2003–2004.....	63
Outbreak Data from 10 Sentinel Sites in Oromia Regional State	63
Severe Focal Malaria Epidemic, Wenberma District, Amhara Region, November, 2012	64
Annex 8: Oromia Region Case Study.....	66
Malaria Intervention Coverage in Oromia Region	66
Trends in Malaria Morbidity and Mortality	68

Oromia Regional State Case Study Summary	73
Annex 9: Detailed Calculations for Estimated Malaria Mortality in Ethiopia, 2000 through 2013	77
Annex 10: Additional Topics	87
A.10.1 Fever	87
Annex References	89

Annex 1: General Survey Information and Data Availability for Ethiopia 2000-2011

A.1.1: Data Sources

Due to differences in sampling design, data from each MIS and DHS were adjusted to make the surveys as comparable as possible over time. Most notably, adjustments were made to restrict all DHS clusters to less than 2,500 meters (m) in altitude, to match the MIS where all clusters sampled were below 2,500m. In addition, since the 2011 MIS was predominantly a rural survey, the 2000, 2005, 2011 DHS, and 2007 MIS were restricted to only rural clusters to make them comparable to the 2011 MIS. Additional stratification was conducted to differentiate DHS survey clusters at elevations less than 2,000m and those between 2,000m and 2,500m, as most malaria transmission occurs in the lower elevations.

Basic health indicators were obtained from the Health and Health Related Indicators reports ranging from 2000-2001 to 2011-2012. Of note, source documents are Ethiopian reports that generally use the Ethiopian Fiscal Year (EFY), which is seven to eight years apart from the Gregorian calendar and goes from July to June of each year; Table 2 provides the conversion table to use as a reference. When possible, the EFY is formatted to the Gregorian calendar and the July to June time period is indicated in most of the data presented in this report. The source of data for these indicators is the HMIS. Completeness of reporting of the HMIS varied from year to year [1], but by 2011 achieved over 80% reporting completeness from hospitals and health centers, and therefore are now considered to be capable of detecting the majority of the public sector malaria inpatient cases and deaths. Outpatient malaria reporting is not as complete in the HMIS, since few rural health posts reported to the system as of 2011, and approximately half of malaria outpatients were diagnosed and treated at these rural posts in that year [2]. These HMIS reports contain further data on health sector indicators such as maternal and child health services, health infrastructure, human resources, and disease statistics.

The IDSR is a passive surveillance system, which reports on 20 priority diseases or conditions (including malaria) from all hospitals and health centers in Ethiopia. Prior to 2010, IDSR reports were reported separately within the annual FMOH Health and Health Related Indicators reports that also contain HMIS data. In 2010, the IDSR system that previously had only about 85 hospitals and health centers based in cities and large towns reporting was rolled into the widely expanded PHEM system with the goal of weekly electronic reporting from 16,792 public health facilities, including hospitals, health centers, and rural health posts. The IDSR data are now reported by each district officer who reports weekly to their respective Regional Health Bureaus, who then submit the information to the EPHI point person responsible for the PHEM system database; some of these data are also reported separately to HMIS. A recent publication discusses issues related to the transition of the IDSR to the PHEM system [3]. According to the July 2011–June 2012 Annual Performance Review Report, by June 2012, PHEM had achieved more than 80% reporting completeness from the public health facilities, an improvement from 40% in 2009. Information from both the Health and Health Related Indicator reports (of the HMIS surveillance data) and the IDSR data further enhance malaria-related and contextual factor data obtained from the DHS and MIS reports.

Since 2009, PMI has supported UNICEF, the Regional Health Bureaus, and FMOH to jointly conduct annual micro-planning surveys that collect malaria morbidity data to use for predicting annual malaria commodity consumption and future requirements (i.e., ITNs, ACTs, RDTs, etc.) for each village from the designated malaria district health official. These annual micro-plan surveys are based upon data that are not derived directly from HMIS or PHEM reports, but are generally reported annually by the same district officials or from the same local offices that also report their data to HMIS or PHEM systems at weekly or quarterly intervals. The micro-plan data and reports include malaria outpatient visits from rural health posts, and although only collected annually, are reported by malaria control officers at almost every district and have been consistent since 2009. For these reasons, the micro-plan surveys provide additional information that overlap with both HMIS and PHEM data, and as reporting improves triangulation with the HMIS and PHEM reports have provided increasing confidence in all of these surveillance systems.

Other data that provide a more in-depth assessment of trends in malaria-specific mortality were also incorporated. These include data from the PMI-supported Ethiopia Malaria Epidemic Detection and Sentinel Surveillance Project as well as other research projects across the country. A special study by the Malaria Consortium of nearly all surveillance data from the Oromia Regional State health facilities from 2006–2010 are included in the analysis [4]. Since April 2010, the sentinel surveillance project has collected malaria data in 10 districts in Oromia from 10 epidemic detection sites which consist of 10 health centers and 73 satellite health posts located. These 10 health centers and 73 satellite health posts make up primary health care units (PHCUs) and in total serve approximately 450,000 people [1]. Ethiopia also has four demographic surveillance system (DSS) sites located throughout the country and run by local universities that collect health surveillance data and periodically conduct verbal autopsies on defined populations, such as children less than five years of age. The Butajira DSS site, located in Southern Nations, Nationalities and People's Regions (SNNPR), was the first DDS site in Ethiopia and data from this site include long term morbidity and mortality trends [5]. Data from the various DSS sites were included to further examine the subnational impact of malaria control interventions [6] and the results from the verbal autopsy studies are cited in other reports, including the 2012 WHO World Health Statistics report [7, 8]. Data from the Prevalence and Risk Factors for Malaria and Trachoma in Ethiopia survey conducted by The Carter Center further added information on malaria prevalence and LLIN coverage in the Amhara, Oromia, and SNNP Regional States [9]. Programmatic data such as district level ITN distribution data, IRS program data, and ACT commodity availability data, and microscopy coverage data were included as were made available for Global Fund documents and working documents from various malaria partners within Ethiopia.

Estimates of malaria cases, testing rates, incidence and malaria mortality rates are also available from the WHO World Malaria Reports.

From the 2014 World Malaria Report:

For countries outside the WHO African Region and low-transmission countries in Africa: estimates of the number of cases were made by adjusting the number of reported malaria cases for completeness of reporting, the likelihood that cases are parasite-positive and the extent of health-service use. The procedure, which is described in the World malaria report 2008 ([10, 11]), combines data reported by NMCPs (reported cases, reporting completeness, likelihood that cases are parasite positive) with those

obtained from nationally representative household surveys on health-service use For countries in the WHO African Region: for some African countries, the quality of surveillance data did not permit a convincing estimate to be made from the number of reported cases. For these countries, an estimate of the number of malaria cases was derived from an estimate of the number of people living at high, low or no risk of malaria. Malaria incidence rates for these populations were inferred from longitudinal studies of malaria incidence recorded in the published literature. Incidence rates were adjusted downwards for populations living in urban settings, and for the expected impact of ITN and IRS programmes. The procedure was initially developed by the RBM MERG in 2004 [12] and also described in the World Malaria Report 2008.

For countries in the WHO African Region: child malaria deaths were estimated using a verbal autopsy multi-cause model developed by the WHO Child Health Epidemiology Reference Group to estimate causes of death for children aged 1–59 months in countries with less than 80% of vital registration coverage ([13-15]). A total of 128 data points from 95 verbal autopsy studies and 37 countries that met the inclusion criteria were included. Among them, 47 data points were either new or updated from the previous estimates of malaria deaths published in the World malaria report 2012. Mortality estimates were derived for seven causes of post-neonatal death (pneumonia, diarrhoea, malaria, meningitis, injuries, pertussis and other disorders), causes arising in the neonatal period (prematurity, birth asphyxia and trauma, sepsis, and other conditions of the neonate) and other causes (e.g. malnutrition). Deaths due to measles, unknown causes and HIV/AIDS were estimated separately. The resulting cause-specific estimates were adjusted country by country to fit the estimated 1–59 month mortality envelopes (excluding HIV and measles deaths) for corresponding years. Estimates were then further adjusted for intervention coverage; that is, pneumonia and meningitis estimates were adjusted for the use of Haemophilus influenzae type b vaccine, and malaria estimates were adjusted for the use of ITNs. The bootstrap method was employed to estimate uncertainty intervals by re-sampling from the study-level data to in turn estimate the distribution of the predicted percentage of deaths due to each cause. Deaths in those above the age of 5 years were inferred from a relationship between levels of malaria mortality in different age groups and the intensity of malaria transmission ([16]); thus, the estimated malaria mortality rate in children aged under 5 years was used to infer malaria-specific mortality in older age groups. Malaria incidence and mortality rates were estimated using “total population at risk for malaria” as a denominator. Projections to 2015 were based on a linear extrapolation of the trend in incidence and mortality rates from 2000 to 2013.

A.1.2: DHS/MIS Survey Characteristics

	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
Notes				(no malaria section)	EXCLUDES areas >2500m, urban areas & inaccessible areas in Somali region
Sampling frame	1994 Population and Housing Census	1994 Population and Housing Census	2007 Population and Housing Census	2007 Population and Housing Census	2007 Population and Housing Census
Sampling distribution	Two-stage 1. EAs 2. HH within EAs	Two-stage 1. EAs 2. HH within EAs	Two-stage 1. EAs 2. HH within EAs All EAs in the country in kebeles (villages) with a mean altitude below 2,500m were stratified into <1,500m, ≥1,500m, and ≤2,500m altitude categories.	Two-stage 1. EAs 2. HH within EAs	Two-stage 1. EAs 2. HH within EAs All EAs in the country in kebeles (villages) with a mean altitude below 2,500m were stratified into ≤2,000m and ≤2,500m altitude categories.
Number of cluster (census enumeration areas/sampling points)	539 clusters PPS by urban/rural and region Systematic (random) sampling	540 clusters PPS by urban/rural and region Systematic (random) sampling	319 clusters PPS by urban/rural and region Systematic (random) sampling	642 clusters PPS by urban/rural and region Systematic (random) sampling	432 clusters PPS by regional and altitude domains Systematic (random) sampling
Number of household/cluster	27 HHS/cluster	24-32 HHS/cluster	25 HHS/cluster	30 HHS/cluster	25 HHS/cluster
Sample weights					
Sampling errors/Design effect	See Final Report Appendix B	See Final Report Appendix B	See Final Report Appendix B	See Final Report Appendix B	See Final Report Appendix B
Representativeness (designed to provide estimates for)	<ul style="list-style-type: none"> National Urban and rural areas By region 9 regions and two 	<ul style="list-style-type: none"> National regions and two Administrative Urban and rural areas By region 9 Councils 	<ul style="list-style-type: none"> National: Urban for altitude range of ≥1,500m ≤2,500m National: Rural for altitude range of 	<ul style="list-style-type: none"> National Urban and rural areas By region 9 regions and two 	<ul style="list-style-type: none"> National Urban and rural areas for altitudes <2000m National for

	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
	Administrative Councils (key variables)	(key variables)	<p>≥1,500m ≤2,500m</p> <ul style="list-style-type: none"> National: For altitude range of <1,500m Zone for Amhara (except Bahir Dar and Argoba special zones) Regional State for Oromiya 	Administrative Councils (key variables)	<p>altitude <2,500m</p> <ul style="list-style-type: none"> By region for Amhara, Oromia, SNNP and Tigray, Afar/Somali combined and Benishangul-Gumuz/Gambella combined
Month(s) survey conducted	February 2000- May 2000	November 2004-January 2005	October 2007-December 2007	December 2010-June 2011	October 2011-December 2011
Biomarkers	N/a	Hemoglobin (1/2 subsample)	<p>Hemoglobin</p> <ul style="list-style-type: none"> Blood samples were taken from all children <5 years of age Blood samples were taken from all members of every fourth household 	<p>Hemoglobin</p> <ul style="list-style-type: none"> Blood samples were taken from all children 6-59 months, women age 15-49, and men age 15-59 who voluntarily consented to testing 	<p>Hemoglobin</p> <ul style="list-style-type: none"> Blood samples were taken from all children <5 years of age Blood samples were taken from all members of every fourth household
Malaria microscopy	N/a	N/a	<p>Thick and thin: Blood samples were taken from all children <5 years of age. Blood samples were taken from all members of every fourth household.</p>	N/a	<p>Thick and thin: Blood samples were taken from all children <5 years of age. Blood samples were taken from all members of every fourth household.</p>
Rapid Malaria Diagnosis (brand of RDT)	N/a	N/a	Used ParaScreen	N/a	CareStart™
Hemoglobin values (brand of Hemocue)	N/a	Children 6-59 months and women 15-49 were	Children <5 years of age were eligible for anemia	Children 6-59 months, women 15-	Children <5 years of age were eligible for

	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
/cuvettes)		eligible for anemia testing. (HemoCue system)	testing. (HemoCue Hb 201 analyzers)	49, and men 15-59 were eligible for anemia testing. (HemoCue system)	anemia testing. (HemoCue Hb 201 analyzers)
Under-five mortality estimate	Direct method (complete birth history)	Direct method (complete birth history)	Not calculated (Incomplete birth history – 6 years)	Direct method (complete birth history)	Not calculated
ITN ownership	Possession of bednets by household and among households with bednets the percentage that were impregnated	Complete net roster is included. We know number of nets, whether each is a long lasting insecticidal net (LLIN) or pretreated, treatment history of nets, timing since treatment, duration of ownership <3 yrs of each net.	Complete net roster is included. We know number of nets, whether each is a long lasting insecticidal net (LLIN) or pretreated, treatment history of nets, timing since treatment, duration of ownership <3 yrs of each net, and current condition of the net	N/a	Complete net roster is included. Current condition of net is also observed.
ITN use	N/a	Complete net roster allows us to estimate this.	Complete net roster allows us to estimate this.	N/a	Complete net roster allows us to estimate this.
IRS	N/a	Available	Selected villages within the malarious areas	N/a	Available

	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
Wealth Index	Electricity, Radio, Television, Refrigerator, Bicycle, Motorcycle/scooter, Car/Truck, Telephone, Electric Mitad, Kerosene lamp/pressure lamp, bed/table, Own house, crop land, cattle/camels, horse/mule/donkey, sheep/goats, cash crops, own land, drinking water supply, toilet facility, flooring material, roofing material, cooking fuel	Water source, toilet type, electricity, radio, TV, fridge, bicycle, car, mobile/non-mobile telephone, watch, table, chair, bed, electric mitad, lamp, windows with glass, animal drawn cart, bank account, floor type, roofing materials, wall materials, cooking fuel, waste management, cattle, bulls, horses, camels, goats, sheep, fowl	Do not have access to data set		Do not have access to data set
Survey Response Rate					
Households sampled	14,642	14,645	N/a	17,817	N/a
Households occupied	14,167	13,928	N/a	17,018	N/a
Households interviewed	14,072	13,721	32,380	16,702	10,444
Household response rate	99.3	98.5	N/a	98.1	N/a
Individual interviews:					
Number of women	15,716	14,717	N/a	17,385	N/a
Number of women interviewed	15,367	14,070	16,181	16,515	8,764
Eligible woman rate	97.8	95.6	N/a	95.0	N/a

A.1.3 Summary of RBM malaria control indicators

Intervention	Indicator Description
Prevention	
Vector Control via ITN and IRS	1. Proportion of households with at least one ITN
	2. Proportion of households with at least one ITN for every two people (NEW)
	3. Proportion of population with access to an ITN within their household (NEW)
	4. Proportion of population who slept under an ITN the previous night
	5. Proportion of children under 5 years old who slept under an ITN the previous night
	6. Proportion of pregnant women who slept under an ITN the previous night
	7. Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months
Intermittent Preventive Treatment	8. Proportion of women who received intermittent preventive treatment for malaria during ANC visits during their last pregnancy
Case Management	
Diagnosis	9. Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick
Treatment	10. Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought (NEW)
	11. Proportion receiving first line treatment, among children under five years old with fever in the last two weeks who received any antimalarial drugs (NEW)
Impact Measure	Indicator Description
Mortality Indicator	12. All-cause under 5 mortality rate (5q0).
Morbidity Indicators	13. Parasitemia Prevalence: proportion of children aged 6-59 months with malaria infection.
	14. Anemia Prevalence: proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL

A.1.4. Adjustments made to DHS and MIS Surveys of Ethiopia

Survey	Adjustment
DHS 2000	Dropped households that were greater than 2,500 meters in elevation Restricted estimates to only rural households
DHS 2005	Dropped households that were greater than 2,500 meters in elevation Restricted estimates to only rural households
MIS 2007	Only used national rural estimates
DHS 2011	Dropped households that were greater than 2,500 meters in elevation Restricted estimates to only rural households
MIS 2011	No adjustments made

A.1.5 Data and Indicators on ITN coverage

Standard RBM indicators were used to estimate coverage of vector control interventions for each survey year as well as changes in coverage over the study period. These indicators are outlined below.

RBM Intervention	Indicator Description	Numerator	Denominator	Data Availability*
Insecticide-treated nets (ITNs)	1. Proportion of households with at least one ITN.	Number of households surveyed with at least one ITN	Total number of households surveyed	DHS 2000* DHS 2005 MIS 2007 MIS 2011
	4. Proportion of population who slept under an ITN the previous night.	Number of individuals who slept under an ITN the previous night	Total number of individuals who slept in surveyed households the previous night	DHS 2005 MIS 2007 MIS 2011
	5. Proportion of children under 5 years old who slept under an ITN the previous night.	Number of children under 5 who slept under an ITN the previous night	Total number of children under 5 who spent the previous night in surveyed households	DHS 2005 MIS 2007 MIS 2011
Prevention and control of malaria in pregnant women	7. Proportion of pregnant women who slept under an ITN the previous night.	Number of pregnant women aged 15-49 who slept under an ITN the previous night	Total number of pregnant women aged 15-49 who spent the previous night in surveyed households	DHS 2005 MIS 2007 MIS 2011

In addition, several supplemental ITN indicators were calculated.

Supplemental RBM Intervention	Indicator Description	Numerator	Denominator	Data Availability*
Insecticide-treated nets (ITNs)	S1. Proportion of children under five years old sleeping in households with ITNs who slept under an ITN the previous night	Number of children under 5 who slept under an ITN the previous night	Total number of children under 5 who spent the previous night in surveyed households owning at least one ITN	DHS 2005 MIS 2007 MIS 2011
Prevention and control of malaria in pregnant women	S3. Proportion of pregnant women sleeping in households with ITNs who slept under an ITN the previous night.	Number of pregnant women aged 15-49 who slept under an ITN the previous night	Total number of pregnant women aged 15-49 who spent the previous night in surveyed households owning at least one ITN	DHS 2005 MIS 2007 MIS 2011

Calculating Indicators

Data used to produce estimates of ITN ownership and use come from DHS and MIS surveys. The specific questions and methods used to calculate the indicators are outlined in the table and text below. Although more recently, attempts have been made to standardize questionnaires across surveys, the questions and methods required to calculate ITN indicators vary somewhat between these surveys.

In the 2000 DHS, questions on household ownership of bednets were asked as was a question about whether nets were ever treated with a product to kill mosquitoes. Thus, a rough estimate of household ownership of ITNs can be calculated from these data but a precise estimate, as would be generated from a full net roster, cannot. Use of bednets by children, women and men were not included in the women's and men's questionnaires. Thus, ITN use cannot be determined.

In the subsequent DHS and MIS surveys, data on bednet ownership and use were collected in a different format. Respondents reporting ownership of any nets were asked to provide specific treatment information about each net and were then asked which household members slept under each net the night prior to the interview. This "bednet roster" allows estimation of standard ITN indicators including the proportion of households with ITNs, the proportion of target populations (children under five, pregnant women) using ITNs, as well as non-standard indicators such as proportion of the total population using ITNs, average number of ITNs per household, average duration of net ownership, etc.

The 2007 and 2011 MIS also included questions on the source, cost and condition of nets.

Available Information on Nets					
	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
Brand	N/a	Permanent Net Permanet 2 Pretreated Net Siam Dutch Thailand Untreated Net A to Z Tanzania Other Unsure	Permanent Net Permanet Olyset Safenite Other/Don't Know Pretreated Net Salam Enkilfe KO Nets Other/Don't Know Other Don't Know Brand	N/a	Permanent Net Permanet Olyset Safenite Other/Don't Know Pretreated Net Salam Enkilfe KO Nets Other/Don't Know Other Don't Know Brand
Duration of ownership	N/a	Monthly 0-35 months OR 36 + months	Monthly 0-35 months OR 36 + months	N/a	Monthly 0-35 months OR 36 + months
Treated/dipped with insecticide since it was obtained	N/a	Yes	Yes	N/a	Not asked
Timing of last treatment	N/a	Monthly 0-23 months OR 24 + months	Monthly 0-23 months OR 24 + months	N/a	Not asked

Potential Biases

Some limitations may affect the validity of the indicators to correctly measure parameters of interest. Correct specification of a net as an ITN requires information on the kind of net owned or used which might not be accurately reported if interviewers were not allowed to view the net. It also requires information on treatment of nets (the timing and the substance used to treat) which is subject to recall bias. The true protection offered by ITNs requires proper use: The timing of sleep under an ITN, the condition of the net (without holes, etc), and proper net installation, are all important factors that were not measured in these surveys. For more information on RBM indicators including calculations, strengths and limitations see the "Household Survey Indicators for Malaria Control, June 2013" [17].

A.1.6 Data and Indicators on IRS

Standard RBM indicators on use of indoor residual spraying for the prevention and control of malaria were used in this report. The standard vector control coverage indicator is outlined below.

RBM Intervention	Indicator Description	Numerator	Denominator	Data Availability*
Indoor Residual Spraying (IRS)	7. Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months.	Number of households with at least one ITN and/or sprayed by IRS in the last 12 months.	Total number of households surveyed.	DHS 2005 MIS 2007 MIS 2011

A.1.7 Data and Indicators on Malaria in Pregnancy (IPTp and ITN use)

Standard RBM indicators on use of interventions to prevent and control malaria in pregnant women were used in this report. These indicators are outlined below.

RBM Intervention	Indicator Description	Numerator	Denominator	Data Availability*
Prevention and control of malaria in pregnant women	6. Proportion of pregnant women who slept under an ITN the previous night.	Number of pregnant women who slept under an ITN the previous night	Total number of pregnant women within surveyed households	2005 DHS 2007 MIS 2011 MIS
	8. Proportion of women who received intermittent preventive treatment for malaria during ANC visits during their last pregnancy.	Number of women who received 2 or more doses of SP to prevent malaria at least one during ANC visit during her last pregnancy that led to a live birth in the last 2 years	Total number of women surveyed who delivered a live baby within the last 2 years	2005 DHS

*2000 DHS and 2007 and 2011 MIS did not ask about receiving SP during an ANC visit. IPTp was discontinued as a national malaria control policy after the 2005 DHS.

Calculating Indicators

Data used to estimate these indicators come from the DHS and MIS. In these surveys, all women aged 15-49 from selected households were asked to participate in an interview. In the course of this interview each woman was asked if she was pregnant. This information along with the responses from the household questionnaire on ITN ownership and use was used to estimate the proportion of

pregnant women who slept under an ITN the previous night. As mentioned in the previous section, the ITN questions were somewhat different across surveys.

Typically in a DHS or MIS, interviewed women reporting a live birth in the two years prior to interview are also asked to provide information about use of antenatal care (ANC) services and other malaria prevention behaviors. This information was used to estimate the proportion of these women who received at least two doses of SP for prevention of malaria during her last pregnancy which led to a live birth, at least one of which was received during an ANC visit. In the 2000 DHS, women were asked if during their pregnancy they were given or bought drugs in order to prevent getting malaria, and if so, which drug they took. Dosage was not recorded. The 2011 DHS and the 2007 and 2011 MIS did not include questions about IPTp as this was no longer a national policy.

Potential Biases

The IPTp indicator is dependent on recall by interviewed women over the two year period preceding the survey. Women were asked to remember not only whether or not they took medication for malaria prevention but also the type of medication, the number of doses and the source of these doses. Accurate information for all of these parameters is necessary for construction of the IPTp indicator. In addition, these questions were asked only of women whose most recent pregnancy ended in a live birth in the two years preceding the survey. This excludes stillbirths and miscarriages. As birth outcomes are known to be affected by malaria and IPTp is known to reduce the risk of malaria, the results may not be representative of the general population and may bias the observed relationships. In addition, the data for this indicator come from interviews with live women: Women that died in childbirth or from malaria acquired during pregnancy are not included. Thus, the indicator may not be truly representative of the population as some selection bias may be present.

A.1.8 Data and Indicators on Case Management

The following RBM indicators measuring case management of malaria were used in this report:

RBM Intervention	Supplemental Indicator Description	Numerator	Denominator	Data Availability
Diagnostics	8. Proportion of children under 5 years old with fever in last 2 weeks who received a finger or heel stick.	Number of children under 5 years old with fever in last 2 weeks who received a finger or heel stick.	Total number of children under 5 who had a fever in previous 2 weeks	MIS 2007 MIS 2011
Treatment	9. Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought	Number of children under 5 who had a fever in previous 2 weeks who sought advice or treatment	Total number of children under 5 who had a fever in previous 2 weeks	DHS 2005 MIS 2007 MIS 2011
	10. Proportion receiving first line treatment, among children under five years old with fever in the last two weeks who received any antimalarial drugs	Number of children under 5 who had a fever in previous 2 weeks who received first-line antimalarials.	Total number of children under 5 who had a fever in previous 2 weeks who received any antimalarial.	DHS 2005 MIS 2007 MIS 2011

In addition, several supplemental case management indicators were calculated. These are historical case management indicators which have been replaced by the RBM-MERG. Due to the retrospective nature of the evaluation, these historical indicators were referenced.

RBM Intervention	Indicator Description	Numerator	Denominator	Data Availability*
Treatment	11. Proportion of children under 5 years old with fever in last 2 weeks who received any antimalarial treatment.	Number of children under 5 who had a fever in previous 2 weeks who received any antimalarial treatment	Total number of children under 5 who had a fever in previous 2 weeks	2005 DHS 2007 MIS 2011 MIS
	12. Proportion of children under 5 years old with fever in last 2 weeks who received antimalarial treatment according to national policy within 24	Number of children under 5 who had a fever in previous 2 weeks who received recommended antimalarial	Total number of children under 5 who had a fever in previous 2 weeks	2007 MIS 2011 MIS

	hours from onset of fever.	treatment according to national policy <24 hours from fever onset		
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Calculating Indicators

Data used to calculate these indicators came from DHS and MIS surveys from 2000-2011. Mothers were asked whether or not they sought treatment for their child's fever and, if so, where care was sought and what treatments were received. The timing of this treatment in relation to onset of fever was also asked in all but the 2000 DHS. None of the questions about antimalarials were included in the 2011 DHS as the malaria module was excluded from this survey. Interpretation of trends in these indicators is challenging as the treatment options and the recommended treatments changed over the course of the evaluation period. The treatment options included in each survey are summarized in the table below.

National first-line treatment policy for uncomplicated malaria and fever treatment across survey years					
Survey Type/Year	DHS 2000	DHS 2005	MIS 2007	DHS 2011	MIS 2011
First-line treatment policy for uncomplicated malaria at time of data collection	Sulphadoxine- pyrimethamine (SP) is used as first line drug where lab diagnosis is not available while SP is used for lab-confirmed <i>P. falciparum</i> infections. Chloroquine was used for lab confirmed <i>P. vivax</i>	Artemether-Lumefantrine (AL)	Coartem	Coartem	Coartem
Treatment response options in survey	Fansidar Chloroquine Quinine	SP/Fansidar Chloroquine Artemether-Lumefantrine Quinine Other anti-malarial	Coartem Chloroquine Quinine Other anti-malarial	SP/Fansidar Chloroquine Artemether-Lumefantrine (Coartem/Artefan) Quinine Other anti-malarial	Coartem Chloroquine Quinine Other anti-malarial

Current treatment policy recommends AL as the first-line drug for the treatment of uncomplicated *falciparum* malaria and chloroquine for the treatment of *vivax* malaria. Quinine is recommended for treatment failure of *P. falciparum* and for treatment of severe malaria only when IV artesunate is unavailable.

July 2004, the first line antimalarial drug for uncomplicated *falciparum* malaria was changed from Sulfadoxine-pyrimethamine (SP) to artemisinin-based combination therapy (ACT) with the then only currently available fixed combination therapy: Artemether-Lumefantrine (AL). Coartem is a trade name for a brand of AL and the terms are often used interchangeably.

One potentially useful indicator that is less affected by changing drug recommendations is the proportion of all antimalarial treatments that are first-line. This gives an indication of whether or not the recommended antimalarials are being dispensed.

To determine whether or not the antimalarial medication given to children with fever was “prompt” mothers were asked when the child first took the medication. Responses of “Same Day” or “Next Day” following fever onset were considered “prompt” and were included in the calculation of the second treatment indicator.

The more recent surveys included a question whether or not a child with fever had a finger or heel stick. This was used to estimate the proportion of children with fever who were given diagnostic tests for malaria.

Additional data on cost of medications were collected in the 2007 MIS and the 2011 MIS.

Potential Biases

A potential bias is introduced by the nature of data collection for these surveys. Data were collected on biological children of interviewed women. Children whose mothers were deceased at the time of interview are not included in this estimate. This may introduce bias if the children with deceased mothers are more likely than others to have fever or if they have different treatment seeking patterns. Another potential issue is the non-specificity of the denominator. Coverage of appropriate antimalarial treatment is only relevant if a child is actually infected with *Plasmodium* spp. parasites. In this case, an assumption is made that any child with fever is likely to have malaria, without the requirement of official clinical diagnosis. However, many interviewed households do not have access to facilities that provide diagnostic testing for malaria, or do not have the resources needed to access these services, so limiting the denominator of this indicator to diagnosed cases is not currently practical. Following WHO recommendations, many national malaria control programs have changed standards to require diagnostic testing (by RDT or microscopy) before administering malaria treatment. Until widespread implementation of these standards has occurred, the current treatment indicator remains the most practical. The new indicator on diagnosis represents a proxy measure of the prevalence of diagnostic testing of children with fever. It can be used to gauge when transition to using a more specific denominator of confirmed malaria cases might be possible.

Another potential problem with this indicator is the necessity of recall of types of medications. Errors in the specification of medications taken could reduce the validity of these estimates. Additionally, proper dosage is not verified.

A.1.9 Data and Indicators on Malaria Morbidity

Morbidity indicators measured for this report include parasitemia and severe anemia prevalence in children under five years. The details of these indicators are outlined below.

RBM Impact Measures	Indicator Description	Numerator	Denominator	Data Availability
Morbidity Indicator	10. Parasitemia Prevalence: proportion of	Number of children 6-59 months with	Total number of children aged 6-59 months	*MIS 2007 MIS 2011

	children aged 6-59 months with malaria infection.	malaria infection detected by microscopy	tested for malaria parasites by microscopy	
	11. Anemia Prevalence: proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL.	Number of children 6-59 months with a hemoglobin measurement of <8g/dL	Total number of children 6-59 months who had hemoglobin measurements obtained during household survey	DHS 2005 MIS 2007 DHS 2011 MIS 2011

* RDT and microscopy results are available for both surveys.

Calculating Indicators

The data used to calculate these indicators come from the DHS and the MIS. In the DHS these biomarkers were measured for all children older than 6 months and less than 60 months of age, for whom permission was granted, in selected households. In the MIS, biomarker data were collected for all children less than five years of age and for all other age groups in every fourth household. Parasitemia was measured using both microscopy and rapid diagnostic tests (RDT).

Parasitemia

Infection with *Plasmodium falciparum* and *Plasmodium vivax* parasites was measured in all children aged less than 60 months who slept in a selected household the night before the survey, for whom parental permission was granted, and for all household members in every fourth household. Blood was taken from a finger or heel stick using a cuvette. Thick and thin blood smears were prepared for microscopy. A rapid diagnostic blood test for *Plasmodium falciparum* antigens was then performed (using ParaScreen in the 2007 MIS and CareStart™ in the 2011 MIS). Parasitemia is defined as a positive result for any *Plasmodium* species via microscopy for the purposes of these analyses.

Severe Anemia

Severe anemia, defined as less than 8 grams of hemoglobin per deciliter of blood, in children aged 6-59 months who slept in a selected household the night before the survey is another outcome of interest. Hemoglobin levels were measured using the HemoCue® system (a light photometer) and samples of capillary blood from finger or heel sticks. Hemoglobin quantities resulting from this test were adjusted for altitude according to the standard methodology used by the DHS.

The adjustment is made with the following formulas:

$$\text{adjust} = -0.032 \cdot \text{alt} + 0.022 \cdot \text{alt}^2$$

$$\text{adjHg} = \text{Hg} - \text{adjust (for adjust > 0)},$$

where *adjust* is the amount of the adjustment, *alt* is altitude in feet (convert from meters by multiplying by 3.3), *adjHg* is the adjusted hemoglobin level, and *Hg* is the measured hemoglobin level in grams per deciliter. No adjustment is made for altitudes below 1,000 meters.

Potential Biases

Measuring parasitemia for use in comparative studies can be challenging as parasite prevalence in the population is influenced by a multitude of factors including temperature and rainfall. Thus the timing of data collection plays an important role in ensuring comparability of data, especially in areas with seasonal patterns of malaria transmission. The analyses presented in this report only include parasitemia data from high transmission season during two survey years (2007 and 2011). Another measurement issue arises due to the different methods available for diagnosing *Plasmodium* spp. infection. The current RBM recommendation is to report microscopy results; however, obtaining good quality microscopy data is often challenging due to logistic constraints. In this case, diagnosis was determined via microscopy and rapid diagnostic tests. Comparing RDT results with those obtained via microscopy may not produce valid results as RDTs measure parasite antigens whereas microscopy measures actual parasites. RDTs have been shown to have lower sensitivity than high quality microscopy in areas of low parasitemia. False positive RDT results can also occur when parasites have recently been cleared from the body via effective treatment.

Severe anemia is not a very specific proxy for malaria as there are many other potential etiologies. Anemia data are dependent on valid hemoglobin readings from the HemoCue® machine which can be affected by the skill of the technician drawing blood and on the number of blood tests being conducted with the same sample. This varied by survey. Severe anemia prevalence is also subject to seasonal variation to the extent that it is a result of malaria infection or other time-varying factors.

A.1.10 Data and Indicators on Under-five Mortality

All-cause mortality in children under five is the outcome variable of greatest interest in this report.

RBM Impact Measures	Indicator Description
Mortality Indicator	9. All-cause under 5 mortality rate (5q0).

Calculating Indicators

Estimates of mortality require significant amounts of data, as death is a fairly rare event; thus, mortality rates for Ethiopia were estimated using data from the birth histories from DHS interviews. The DHS calculates these estimates using information collected from birth histories of each interviewed woman. Women are asked the dates of each live birth, regardless of the current survival status of the child. For any death, child age at death is recorded. There is no time limit on this birth history, so every live birth a woman ever had during her lifetime should be recorded. With this information, 5-year mortality rates, approximating a point estimate of mortality rates approximately 2.5 years before the survey, are calculated using a synthetic cohort life table approach similar to that described in detail in the “DHS Guide to Statistics” [18]. Mortality rates are calculated for ages 0 months, 1-2, 3-5, 6-11, 12-23, 24-35, 36-47, and 48-60 months using a Stata program. Each rate is calculated with a generalized linear model with binomial error, log link, and an appropriate offset for risk. Adjustments are made for the survey design using the ‘svyset’ command in Stata. Stata produces robust standard errors and 95% confidence intervals for the log of each rate. These confidence intervals are mapped onto confidence intervals for

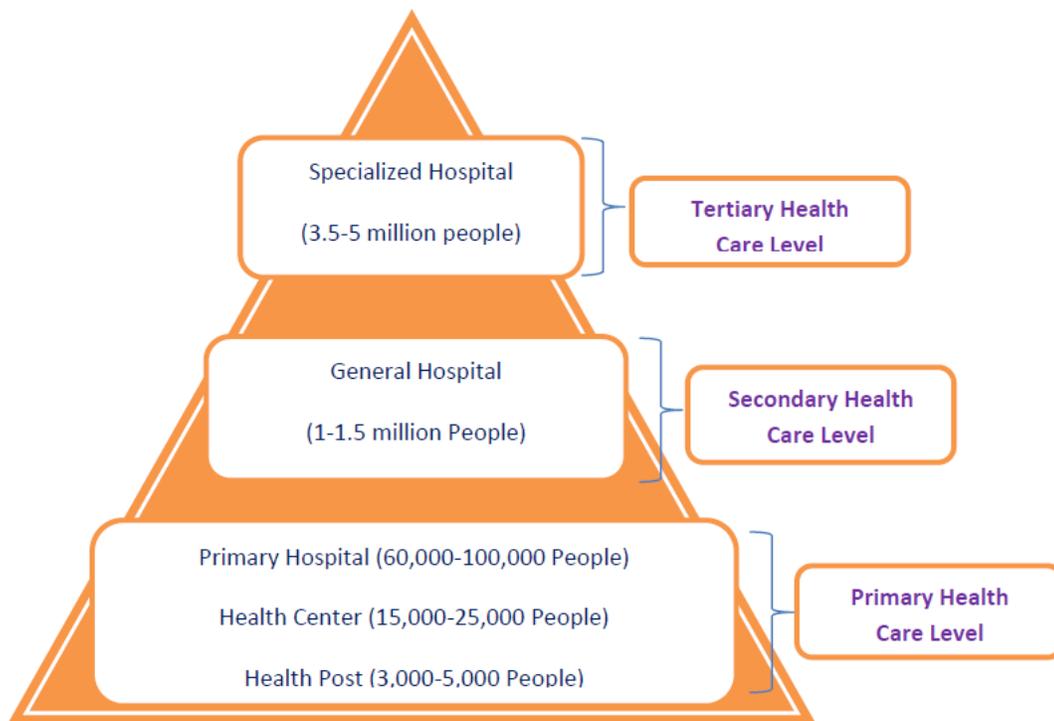
the standard set of under-five mortality rates. The rates agree exactly with the CPro program used by DHS and the confidence intervals differ only slightly from the results of the jackknife procedure used by DHS.

Potential Biases

As birth history information was collected from interviewed women in the DHS, the mortality of children whose mothers have died is missing from the estimate. Children whose mothers have died are known to have worse survival, which may lead to mortality being underestimated. Other potential biases include under-reporting of deaths and misreported age at death. These issues and the measures taken to avoid erroneous data are discussed in depth in the Guide to DHS Statistics [18].

Annex 2: Additional Background Information

A.2.1: Ethiopia Health Tier System



A.2.3: Partial List of Partners Working in Malaria

Name of organization	Activity	Project areas
<p>AED/C-Change</p> <p>African Medical Research Foundation (AMREF)</p> <p>Amhara Development Association</p>	<p>Communication on malaria prevention and control</p> <p>Family planning services, HIV/AIDs, Trachoma and malaria prevention and control programs</p> <p>Development and health programs including malaria prevention and control programs</p>	<p>Oromia and Amhara</p> <p>Addis Ababa, Afara, and SNNPRs Regions</p> <p>Amhara Region</p>
<p>Angrereb PLC</p>	<p>Import and Export and Commission Agent for LLINs/permanent</p>	<p>National level</p>
<p>Health Development and Anti Malaria Association</p>	<p>HIV, Malaria prevention and control activities</p>	<p>Amhara Region</p>
<p>CARE Ethiopia</p>	<p>Awariness creation through community Health workers and ITN distribution</p>	<p>Addis Ababa, Oromia, Afar, and Amhara Regions</p>
<p>The Carter Center (TCC)</p> <p>Catholic Relief Services (CRS)</p> <p>Center for National Health Development in Ethiopia (CNHDE)</p>	<p>Malaria, Onchocerciasis and trachoma control, Lymphatic filariasis Elimination and Guinea Worm Eradication</p> <p>Working through local partners, integrated management, Community based Health care, malaria mitigation through environmental sanitation, promotion of ITNs, Education on prevention and treatment</p> <p>Malaria, Health Extension, Millenium project, and Neglected Tropical Diseases</p>	<p>SNNPRS, Amhara, Oromia, Gambella, and Benshangule-Gumuz Regions</p> <p>National Level</p> <p>National level</p>
<p>Christian Relief and Development Association (CRDA)</p>	<p>Technical and financial assistance to CSOs/NGOs and coordination of health related activities including Malaria</p>	<p>National</p>
<p>Clinton Foundation HIV/AIDS Initiative</p>	<p>HIV/AIDs-pediatric care and ART; and Malaria prevention and control programs</p>	<p>Amhara, Addis Ababa, Tigray, and Oromia Regions</p>
<p>Coalition of Media against malaria in Ethiopia (CMAME)</p>	<p>National level policy-advocacy work, information sharing, resource</p>	<p>National level</p>

	mobilization and capacity building of members	
Consortium for integration of population health Environment Association (CIPHA)	PHE related advocacy, research and capacity building and communication activities	Nation wide
EHNRI	Laboratory strengthening and Surveillance (PHEM)	National level
Ethiopian Malaria Control professional association Ethiopian Orthodox Church Development and inter church Aid Commission FAYYAA Integrated Development Association Goal Ethiopia Health Unlimited	Community based malaria control activities Integrated rural development program, including health Integrated Humanitarian Development ITNs distribution, community mobilization, case management , support for IRS operation, IEC and training for health workers, workshop and community health workshop and environmental management Working through local partners on awareness and prevention education, promotion of ITNs, study of traditional malaria prevention and treatment methods in pastoralist areas.	East , West Shoa Zones, Oromia National level Oromia, Somali, Addis Ababa, SNNPR SNNPR and Oromia Region SNNPR and Oromia
International center for AIDs Care and Treatment programs (ICAP) Ethiopia , Columbia University Lambadina institute health and development communication Malaria Control and Evaluation Partnership in Africa (MACEPA/PATH)	Malaria program: Provide technical, strategic managerial and operational support to implement and strengthen malaria laboratory diagnosis and monitoring activities in Oromia. Health and cross cutting Issues such as Reproductive health, population and development; and malaria prevention and control Initiatives in schools Supporting the national control program to conduct the serial malaria indicator	Dire-Dawa, Harari, Oromia, and Somali Regional States National level National level

	surveys, support on planning and implementation of global fund, etc	
Malaria Consortium	Health systems strengthening and provision of technical support at national level; and coordination role	SNNPR and national level
Medical Emergency Relief international (MERLIN)	Primary health care including malaria prevention and control program	Somali and Oromia Regions
Plan Ethiopia	Child survival	Addis Ababa, Oromia, Amhara, and SNNPR Regions
Population Services international	Social Marketing (Malaria, Child survival, HIV/AIDS)	National Level
Save the Children USA	Child survival	Oromia, SNNPR, Addis Ababa, Dire Dawa, Tigray, and Somalia
Addis Ababa University School of Public Health	Teaching and research	National level
UNICEF	Child Health, Education, WASH, HIV and protection	National level
United States Agency for International Development (USAID)	Funding and Technical Support in global health and development; works closely with the Centers for Disease Control and Prevention (CDC) through the President's Malaria Initiative (PMI) to help support malaria control programs in Ethiopia and many other countries	National level
World Health Organization (WHO)	Technical and financial support for malaria prevention and control, establish best practices	National level

A.2.4: Estimated Resource Needs for Health Sector Development Plan (HSDP IV) under the Base Case Scenario (US\$ Million)

Program Areas		Baseline 2009/10	Estimated Resource needs	
			Average Annual	5 year
1. Leadership and Governance		33.85	272.452	1362.26
1.1	Community Empowerment	6.78	31.93	159.65
1.2	Monitoring & Evaluation (M&E) and Operational Research	7.36	27.77	138.85
1.3	System Strengthening & Capacity Development	19.71	212.75	1063.76
2. Strengthening Service Delivery		626.12	838.94	4194.7
2.1	Maternal-Newborn & RH-Adolescent Health	31.27	94.32	471.62
2.2	Child Health	25.06	45.14	225.7
2.3	Nutrition	6.38	21.65	108.27
2.4	Hygiene Environmental Health	7.87	31.84	159.21
2.5	Prevention and Control of Malaria	111.45	160.87	804.36
2.6	Prevention and Control of HIV/AIDS	276.25	233.59	1167.98
2.7	Prevention and Control of TB & Leprosy	152.72	141.51	707.53
2.8	Prevention and Control of Other Communicable Dis.	0.24	35.92	179.6
2.9	Prevention and Control of Non-Communicable Dis.	0.27	47.18	235.89
2.10	Public Health Emergency Management	0.45	7.19	35.97
2.11	Public Health/Nutrition Research & Quality Ass.	14.16	19.71	98.57
3. Expansion and Strengthening of health infrastructure and resources		223.09	653.91	3269.54
3.1	Expansion of PHC facilities	39.48	94.74	473.69
3.2	Hospital Infrastructure	30.11	226.97	1134.86
3.3	HR Salaries and Training	54.33	191.60	958.01
3.4	Pharmaceuticals and Medical Equipment	97.00	130.94	654.71
3.5	Health care Financing	2.17	9.65	48.27
TOTAL		883.06	1765.3	8826.5

Source: Based on HSDP IV Program Document Page 75 and Page 72 [19];
World Bank Program Appraisal Document for Ethiopia [20].

Annex 3: LiST Model Details

A.3.1 Methods - Lives Saved Tool (LiST Model)

LiST Model

The Lives Saved Tool (LiST model) is a computer-projection model that runs through the Spectrum demographic program developed by the Futures Institute [21]. The Spectrum program links together the LiST module containing maternal and child health interventions, the family planning module that accounts for changes in fertility and the AIDS Impact Module (AIM) that provides information on HIV/AIDS prevalence and interventions [21]. The LiST model projections and information are available from www.jhsph.edu/dept/ih/IIP/list/. The analysis was performed with Spectrum version 5.03. Unless otherwise indicated, the values in the standard projection available on the website for Ethiopia were used.

Mortality & Cause-Specific Mortality Profile

The cause-specific mortality profile for children 1-59 months old was obtained from the standard projection, with the exception that the malaria-specific mortality value from Rowe *et al.* [22, 23] was applied. Rowe shows 6.1% (5.5 – 6.6%) of under-five mortality (including neonates) in 2000 was due to malaria. According to Bryce *et al.* [24] 26% of the under-five mortality occurs in the neonatal period in Africa. Therefore we removed neonatal mortality by adjusting the 6.1% by 26%, resulting in 8.24% (7.43 – 8.92%) of mortality in 1–59 month old children being due to malaria. The LiST model calculates AIDS mortality directly (5.4%). Holding the malaria and AIDS mortality values fixed, the cause-specific mortality values from the standard projection were adjusted proportionally to total 100%.

Intervention Coverage

The intervention coverage levels for indicators were obtained from the Ethiopia DHS 2000, 2005, 2011 and MIS 2007 and 2011. For the years between surveys, the values were linearly interpolated. Several of the interventions are currently in the model as place holders until the ideal indicators are developed and the model is updated.

Malaria Control Intervention Coverage

The combined ITN/IRS indicator (% of households owning an ITN or sprayed with IRS within the last 12 months) was used to fully capture the coverage with vector control interventions. The LiST model has one indicator representing use of IPTp by pregnant women or the use of ITNs the night before the survey by pregnant women. Given that IPTp is not policy in Ethiopia, the ITN use indicator was used.

Malaria Intervention Protective Efficacy

The protective effect of vector control methods (household ownership of ITNs or IRS) for preventing deaths in children 1–59 months due to malaria is estimated to be 55% (ranging from 49–60%) based on a review of trials and studies [25]. The protective effect of malaria control measures (ITN use by pregnant women or use of IPTp) during pregnancy is estimated to be 35% (95% confidence interval (CI) 23–45%) during the first two pregnancies based on a review of related trials [25]. The effect of

preventing malaria in pregnancy is thought to be through decreasing low birth weight by preventing IUGR and therefore can affect deaths of children 0–59 months of age [25].

Uncertainty Limits

The uncertainty bounds around the number of malaria deaths prevented are based on the uncertainty surrounding the three primary model parameters: percentage of deaths due to malaria [22, 23], the estimated protective effect of the malaria control interventions [25] and the malaria intervention coverage estimates from the DHS and MIS survey data sets.

A.3.2 LiST Model Outputs

Given the evidence shown in this report of a decline in all-cause mortality in children under five years of age, we estimated the potential impact malaria control interventions could have had on malaria mortality through modeling. The Lives Saved Tool (LiST) was used to estimate the deaths prevented due to the scale-up of malaria control interventions in the context of a complex set of maternal and child health interventions. The LiST model is not used here to provide evidence of a malaria-specific mortality decline; instead it is a modeling exercise to examine what the potential impact of malaria control intervention scale-up could look like.

One of the primary malaria prevention measures in Ethiopia has been the use of vector control interventions such as ITNs and IRS. Figure A.3.2.1 shows the deaths averted due to the scale-up of household ownership of ITNs and/or household coverage by IRS in Ethiopia from 2005–2011. The midline estimate is shown with uncertainty bounds. It is estimated that over the six years of ITN and IRS scale-up, approximately 37,500 (25,300–50,600) deaths were prevented in children 0–59 months, compared to what would have happened if no vector control scale-up had occurred since 2005 coverage levels (Table A.3.2.1). The number of deaths prevented per year increased from 2005 to 2007, then remained relatively steady from 2007 to 2011.

Figure A.3.2.1: Deaths prevented by ITN/IRS scale-up, children 0–59 months, 2005–2011

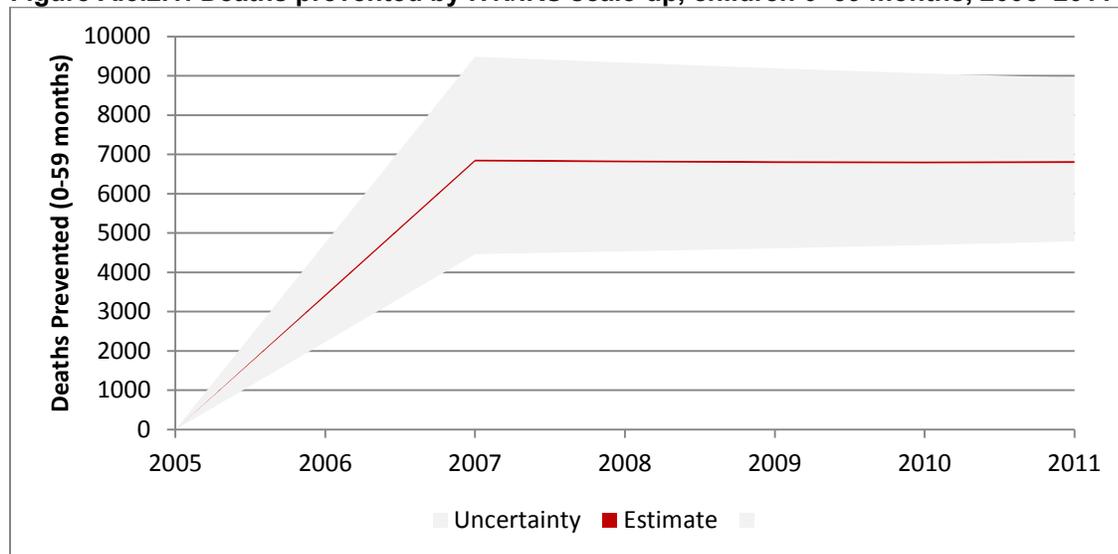


Table A.3.2.1: Annual deaths prevented* by ITN scale-up, children 0–59 months, 2005–2011

	Malaria Deaths	Estimated deaths prevented (0–59 months)							
		2005	2006	2007	2008	2009	2010	2011	Total
Lower		0	2,229	4,464	4,535	4,610	4,694	4,789	25,321
Midline	23,830	0	3,419	6,847	6,824	6,806	6,799	6,808	37,503
Upper		0	4,723	9,460	9,310	9,166	9,035	8,924	50,618

*Deaths prevented are relative to 2005 coverage levels.

Under-five child mortality (specifically neonatal and post-neonatal mortality) is also affected by interventions to control malaria in pregnancy, including ITN use by pregnant women. The LiST model estimated 2900 (range: 2300–3600) deaths in children 0–59 months were averted due to the scale-up of ITN use by pregnant women in Ethiopia from 2005 to 2011 (Figure A.3.2.2 and Table A.3.2.2).

Figure A.3.2.2: Deaths prevented by the scale-up of ITN use by pregnant women, children 0–59 months, 2005–2011

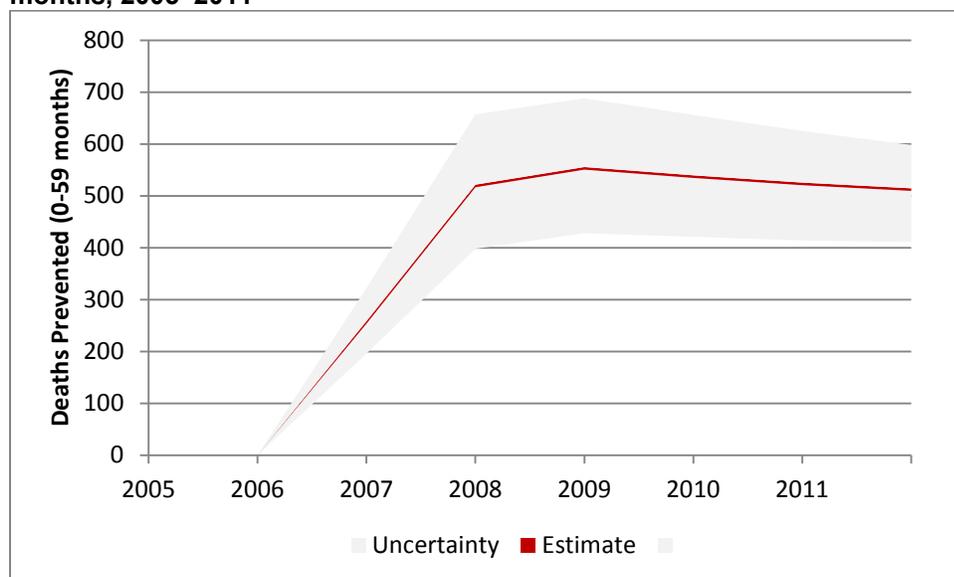


Table A.3.2.2: Annual deaths prevented by the scale-up of ITN use by pregnant women, children 0–59 months, 2005–2011

	Estimated deaths prevented (0–59 months)							
	2005	2006	2007	2008	2009	2010	2011	Total
Lower	0	196	398	428	421	414	411	2268
Midline	0	256	519	553	537	523	512	2900
Upper	0	327	662	693	661	630	603	3576

The LiST analysis presented here models the potential direct effect of malaria interventions on reducing malaria-specific mortality. This estimate is likely an underestimate of the effect of malaria interventions given the conservative nature of the LiST model. Calculations using the LiST model conservatively estimate that the scale-up of ITN/IRS household ownership/coverage and ITN use by pregnant women prevented 40,400 (range: 27,600–54,200) deaths in children 0–59 months in Ethiopia from 2005 to 2011.

Annex 4: Data Tables

A.4.1 DHS Data Tables (Table A.4.1.1-Table A.4.1.14)

Table A.4.1.1: Household possession of insecticide-treated nets

Percentage of households with at least one insecticide-treated net (ITN)** by background characteristics and survey year, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Region												
Tigray	628	12	5.9	23	277	69.3	44.3	94.3	642	60.1	47.3	72.8
Afar ¥	112	3	1	8.4	101	86.1	74.4	97.8	863	45.5	34.2	56.8
Amhara	2,295	1.5	0.6	3.4	2110	76.7	68.4	84.9	2479	69.7	64.3	75.0
Oromiya	3,582	1.3	0.6	3	1934	44.1	33.6	54.6	3793	33.1	27.9	38.2
Somali ¥	462	3.1	1.2	7.8	247	37.8	3.7	71.8	863	45.5	34.2	56.8
Benishangul-Gumuz ±	118	3.4	1.7	6.8	349	75.3	63.6	87.0	487	69.0	59.9	78.1
SNNP	2,038	8.4	4.3	15.6	819	51.5	32.5	70.4	2041	37.5	29.5	45.5
Gambella ±	41	7.6	4	14.1	267	75.0	61.0	89.1	487	69.0	59.9	78.1
Harari	-	-	-	-	-	-	-	-	49	47.8	38.4	57.1
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	21	26.9	15.7	42.1	-	-	-	-	45	78.9	60.8	97.0
Wealth Quintile												
Lowest	2,368	3.4	2.1	5.3	1536	56.9	48.0	65.9	1,337	44.2	38.3	50.1
Second	2,226	2.7	1.8	4	1539	53.6	43.2	64.0	1,266	52.4	46.9	57.8
Middle	1,992	3.8	2.1	6.9	1339	54.2	45.6	62.8	1,090	54.6	48.9	60.3
Fourth	1,864	4.4	2.4	7.9	1306	59.8	51.3	68.4	1,033	61.2	55.6	66.7
Highest	869	7	4.3	11.2	434	59.3	49.0	69.7	1,093	66.4	61.7	71.1
Altitude Strata												
Rural and Elevation <2000m	5,609	5.3	3.5	8	4160	67.4	60.4	74.5	5,819	54.8	50.9	58.8
Rural and Elevation >2000m and <2500m	3,710	1.7	0.7	3.8	1994	29.8	19.9	39.8	4,625	37.6	32.5	42.6
Total Rural and Elevation<2500m	9,319	3.8	2.6	5.6	6,154	56.2	49.5	62.9	10,444	46.9	43.8	50.0
Elevation <2500m Total	10,975	4.2	3.1	5.7	7,621	53.3	47.4	59.2	10,444	46.9	43.8	50.0

* WN = Weighted number of cases (denominator)

**An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

Table A.4.1.2: Universal Access of ITNs

Percentage of persons with “access” to an insecticide-treated net (ITN)** defined as the proportion of the population who could have used an ITN the previous night assuming that one ITN covers up to two persons within a household, by background characteristics and survey year, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Region												
Tigray	3,024	5.5	1.8	9.2	1,135	51.3	31.7	70.9	2,787	43.9	34.0	53.7
Afar	610	1.3	-0.1	2.6	431	60.0	47.9	72.1	3,608	27.1	19.5	34.6
Amhara	10,679	0.7	0.1	1.2	8,832	58.3	51.8	64.8	10,558	47.7	43.5	52.0
Oromiya	18,996	0.5	0.1	0.9	8,568	29.9	20.6	39.3	18,024	19.3	16.1	22.6
Somali	2,393	1.3	0.1	2.4	1,109	28.3	-0.6	57.2	3,608	27.1	19.5	34.6
Benishangul-Gumuz	546	1.6	0.2	3	1,362	57.7	45.6	69.8	1,920	51.6	44.3	58.9
SNNP	10,842	3.1	1.1	5.1	3,524	33.5	19.0	47.9	9,755	22.5	17.4	27.7
Gambela	174	4.5	1.1	7.9	1,143	65.2	52.3	78.2	1,920	51.6	44.3	58.9
Harari	69	0.3	0	0.7	118	50.0	50.0	50.0	222	25.2	18.1	32.4
Addis Ababa	37	0.5	-0.6	1.6	-	-	-	-	167	9.4	7.7	11.0
Dire Dawa	106	10.6	5.2	16.1	125	63.2	63.2	63.2	207	47.3	25.2	69.4
Wealth Quintile												
Lowest	11,649	1.5	0.8	2.1	6,028	41.7	34.5	49.0	9,449	22.8	19.7	26.0
Second	10,579	1.2	0.7	1.6	6,466	37.7	29.3	46.2	9,429	26.3	23.4	29.1
Middle	10,245	1.5	0.6	2.4	5,947	37.8	30.8	44.8	9,410	29.7	26.6	32.9
Fourth	10,114	1.6	0.7	2.5	5,920	41.2	32.7	49.7	9,564	33.6	30.5	36.7
Highest	4,888	2.7	1.4	4	1,862	40.2	31.6	48.8	9,396	35.7	32.4	38.9
Altitude Strata												
>2000 and <2500	28,554	2.1	1.3	3	17,597	48.3	41.9	54.8	21,026	23.5	20.1	27.0
<2000	18,922	0.7	0.1	1.2	8,750	19.7	12.7	26.7	26,222	34.7	31.9	37.5
Rural and Elevation<2500m	47,476	1.6	1	2.1	26,347	39.4	33.7	45.1	47,248	29.6	27.4	31.8
Total												

* WN = Weighted number of cases (denominator)

**An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

Table A.4.1.3: Use of insecticide-treated nets by children

Percentage of children under five years of age who slept under an insecticide-treated net (ITN)** the night before interview, by background characteristics and survey year, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Age (in years)												
<1	1,694	1.9	1.1	3.1	674	37.3	28.4	46.1	1,020	31.4	27.4	35.5
1	1,440	1.8	1.0	3.4	868	33.6	27.3	39.9	1,110	32.0	28.3	35.7
2	1,477	0.8	0.4	1.5	1,026	30.3	24.3	36.3	1,553	32.9	29.2	36.6
3	1,661	1.7	1.0	3.0	1,011	30.8	24.5	37.1	1,640	27.1	23.9	30.3
4	1,700	2.0	1.1	3.7	990	32.8	26.2	39.5	2,202	28.8	25.8	31.8
Sex												
Male	2,028	1.6	0.9	2.6	2,320	33.0	27.1	38.9	3,832	30.0	27.1	33.0
Female	1,918	1.5	0.9	2.5	2,249	32.3	26.6	37.9	3,693	30.2	27.3	33.1
Region												
Tigray	508	1.9	0.7	5.0	196	37.1	21.1	53.1	443	39.0	28.6	49.3
Afar ሄ	88	1.2	0.3	5.2	102	38.9	10.9	67.0	786	41.7	28.1	55.3
Oromiya	3,391	0.4	0.1	1.0	1,568	25.1	16.6	33.6	3,013	19.1	15.3	22.9
SNNP	1,833	4.1	2.1	7.7	600	28.0	12.8	43.1	1,482	27.5	20.6	34.4
Somali ሄ	406	2.7	0.8	9.1	242	27.8	1.7	54.0	786	41.7	28.1	55.3
Amhara	1,586	0.9	0.3	2.5	1,358	48.6	41.7	55.5	1,397	44.7	39.8	49.7
Benishangul-Gumuz ±	95	0.8	0.3	2.6	260	53.2	44.7	61.6	331	60.6	54.9	66.4
Gambella ±	26	1.9	0.7	5.0	197	80.5	66.2	94.7	331	60.6	54.9	66.4
Harari	-	-	-	-	-	-	-	-	-	-	-	-
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	-	-	-	-	-	-
Wealth Quintile												
Lowest	2,064	1.5	0.8	3.1	1,045	34.9	24.9	44.9	1,678	23.7	19.2	28.1
Second	1,796	1.0	0.5	2.0	1,239	32.7	23.7	41.8	1,501	27.9	23.5	32.2
Middle	1,770	1.5	0.6	3.4	1,025	28.7	21.5	35.8	1,430	29.3	25.2	33.5
Fourth	1,610	2.1	1.1	3.8	971	34.0	26.8	41.1	1,451	34.1	29.9	38.3
Highest	733	2.7	1.3	5.7	289	33.7	22.5	44.9	1,465	37.2	32.7	41.6
Altitude Strata												
Rural <2000	4,868	2.2	1.4	3.6	3,184	40.8	34.2	47.4	4,522	38.0	34.3	41.7
Rural >2000 and <2500	3,104	0.7	0.3	1.6	1,385	12.7	7.1	18.3	3,003	19.0	15.6	22.5
Rural and Elevation<2500m Total	7,972	1.6	1.1	2.5	4,569	32.6	27.13	38.1	7,525	30.1	27.4	32.8
Elevation <2500m Total	8,634	1.8	1.3	2.7	5,225	33.1	27.9	38.2	7,525	30.1	27.4	32.8

* WN = Weighted number of cases (denominator)

**An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

Table A.4.1.4: Household vector control measures

Percentage of households with at least one insecticide-treated net** (ITN) and/or indoor residual spraying (IRS) in the last 12 months, by background characteristics for 2005, 2007 and 2011, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Region												
Tigray	628	15.8	8.9	26.7	277	75.4	55.0	95.8	642	72.6	61.0	84.3
Afar ሄ	112	5.8	2.1	14.9	101	86.1	74.4	97.8	863	46.9	34.9	59.0
Amhara	2,295	9.2	4.9	16.5	2,110	77.9	69.4	86.4	2,479	75.2	69.7	80.7
Oromiya	3,582	6.0	3.2	10.9	1,934	47.1	36.3	57.9	3,793	44.8	38.5	51.1
Somali ሄ	462	3.1	1.2	7.8	247	37.8	3.7	71.8	863	46.9	34.9	59.0
Benishangul-Gumuz ±	118	13.3	7.1	23.6	349	77.6	65.3	89.9	487	84.3	77.8	90.8
SNNP	2,038	12.5	7.3	20.5	819	51.9	32.9	70.9	2,041	51.3	41.9	60.6
Gambella ±	41	10.6	6.1	17.8	267	77.4	62.8	91.9	487	84.3	77.8	90.8
Harari	-	-	-	-	-	-	-	-	49	64.0	54.1	74.0
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	-	-	-	-	-	-
Wealth Quintile												
Lowest	2,368	8.1	5.4	11.8	1,536	59.4	50.0	68.8	2,200	48.7	43.1	54.3
Second	2,226	7.8	5.5	11.0	1,539	54.9	44.5	65.4	2,136	54.1	49.2	58.9
Middle	1,992	8.9	6.1	12.7	1,339	55.7	47.1	64.3	2,079	56.7	52.0	61.5
Fourth	1,864	9.4	6.1	14.1	1,306	62.8	54.3	71.3	2,001	62.5	58.0	67.0
Highest	869	13.4	8.8	19.9	434	62.0	51.1	72.9	2,028	65.9	61.4	70.5
Altitude Strata												
Rural <2000	5,609	12.3	9	16.6	4,160	69.9	62.8	76.9	5,819	71.8	67.7	75.9
Rural >2000 and <2500	3,710	3.9	2.1	7.1	1,994	31.1	20.8	41.3	4,625	40.7	35.5	45.9
Rural and Elevation<2500m	9,319	8.9	6.7	11.8	6,154	58.3	51.52	65.02	10,444	57.3	53.8	60.9
Total Elevation <2500m	10,976	9.1	7.1	11.6	7,621	55.2	na	na	10,444	57.3	53.8	60.9
Total												

* WN = Weighted number of cases (denominator)

**An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

Table A.4.1.5: Antimalarial treatment received by children with fever

Among children under age five with fever in the two weeks preceding the survey, the percentage who received any antimalarial treatment, by background characteristics and survey year, Ethiopia

	DHS 2000				DHS 2005				MIS 2007				DHS 2011				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Age (in years)																				
<1	547	3	1.4	6.5	377	1.9	0.5	7.1	153	1.8	0.3	3.4	379	2.3	0.9	5.6	93	17.9	8.9	26.9
1	541	3.2	1.7	5.7	335	3.1	1.3	7.1	211	9.1	4.5	13.7	346	4.3	2.3	7.9	155	29.4	21.6	37.3
2	478	4.3	2.3	7.7	341	2.1	0.8	5.2	208	17.4	4.8	29.9	291	6.1	2.9	12.3	183	26.0	18.4	33.6
3	423	1.9	0.7	4.6	245	3.8	1.7	8.6	197	6.4	2.5	10.2	269	5	2.2	11.1	151	28.6	19.8	37.3
4	309	2.7	1	7	196	5.2	2.4	10.9	157	8.7	2.1	15.3	178	4.5	1.7	11.5	222	26.5	19.1	34.0
Sex																				
Male	1,184	4.2	2.7	6.4	750	3.2	1.6	6.4	482	7.6	5.0	10.2	813	4.2	2.6	6.7	434	26.5	20.9	32.0
Female	1,115	1.9	1.1	3.2	744	2.7	1.3	5.5	444	11.0	4.0	17.9	650	4.4	2.1	9.2	370	26.1	20.1	32.1
Region																				
Tigray	216	1.5	0.7	3.5	109	0.0	0.0	0.0	49	12.3	4.9	19.8	137	3.8	1.5	9	66	16.9	8.3	25.5
Afar ¥	43	6.5	3.7	11.4	14	9.8	4.1	21.8	30	13.5	6.4	20.6	21	4.3	2.2	8.3	94	29.3	15.7	43.0
Amhara	396	2.9	1.2	7	213	3.7	1.3	10.0	335	6.7	1.9	11.4	245	1.6	0.4	6.2	188	18.8	11.6	26.0
Oromiya	869	3.8	2.2	6.6	639	0.7	0.2	2.9	267	6.4	0.0	13.3	593	1.6	0.4	5.8	258	31.4	23.3	39.5
Somali ¥	25	0	0	0	54	0.0	0.0	0.0	-	-	-	-	52	1.4	0.3	5.5	94	29.3	15.7	43.0
Benishangul-Gumuz ±	30	5.4	2.4	11.4	14	3.5	1.3	8.9	71	11.1	6.6	15.6	27	11.9	8	17.3	66	38.6	23.8	53.5
SNNP	707	2.4	1.3	4.5	441	6.7	3.2	13.5	110	15.9	4.9	26.9	377	10.2	5.3	18.9	127	27.5	12.7	42.3
Gambella ±	-	-	-	-	-	-	-	-	38	44.3	24.7	63.9	-	-	-	-	66	38.6	23.8	53.5
Harari	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wealth Quintile																				
Lowest	504	1.4	0.5	3.9	392	0.6	0.1	3.5	199	13.9	0.6	27.3	389	3.1	1.7	5.6	190	23.4	15.7	31.0
Second	544	2.3	1.1	4.7	350	3.1	1.4	6.6	276	5.1	1.9	8.4	332	1.7	0.7	4.1	154	23.6	14.9	32.3
Middle	557	2.6	1.3	5.1	359	3.0	1.2	7.5	179	11.3	5.4	17.1	355	3.2	1.6	6.5	158	33.3	24.6	42.0
Fourth	519	3.7	2.1	6.3	278	3.7	1.5	8.7	208	9.4	3.2	15.6	312	6.9	2.5	17.6	165	30.8	19.7	41.9
Highest	174	9.7	4.5	19.7	116	8.5	3.8	17.9	64	4.8	0.0	10.7	74	16.1	6.4	34.9	137	20.8	11.7	30.0
Altitude Strata																				
<2000	1,364	3.9	2.6	5.8	916	4.3	2.4	7.7	669	11.5	6.5	16.5	1,066	5.3	3.2	8.8	584	32.6	26.7	38.5
>2000 and <2500	935	1.8	1	3.4	578	0.9	0.2	3.5	257	2.2	0.0	4.8	397	1.6	0.5	4.4	220	12.9	8.1	17.8
Rural and Elevation<2500m Total	2,299	3.1	2.2	4.3	1,494	3.0	1.7	5.2	926	9.2	5.3	13.1	1,463	4.3	2.7	6.9	804	26.5	21.9	31.1
Total Elevation <2500m Total	2546	3.4	2.5	4.7	1,590	3.1	1.8	5.2	1,034	9.5	5.7	13.2	1,662	4.1	2.7	6.4	804	26.5	21.9	31.1

* WN = Weighted number of cases (denominator)

± In the 2011 MIS the estimates are combined for Benishangul-Gumuz and Gambella

¥ In the 2011 MIS the estimates are combined for Afar and Somali

Dash indicates small sample size

Table A.4.1.6: Care seeking in children with fever

Among children under age five with fever in the two weeks preceding the survey, the percentage who sought treatment from a facility/health provider the same/next day of fever onset, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Age (in years)												
<1	461	3.7	1.9	7.2	153	12.2	4.9	19.4	93	40.9	28.9	52.8
1	409	3.2	1.6	6.6	211	18.7	11.3	26.2	155	50.1	41.2	59.0
2	382	2.0	0.6	6.4	208	13.1	7.0	19.1	183	44.8	36.5	53.0
3	297	1.9	0.6	5.4	197	15.7	8.2	23.3	151	42.9	33.5	52.2
4	218	1.5	0.2	8.7	157	9.9	4.2	15.5	222	50.7	40.4	60.9
Sex												
Male	875	3.7	2.3	5.9	482	12.1	8.3	16.0	434	43.7	38.1	49.4
Female	891	1.6	0.8	3.3	444	16.4	10.9	22.0	370	50.1	42.6	57.7
Region												
Tigray	122	0.0			49	4.2	0.0	10.4	66	22.2	12.4	32.0
Afar †	14	6.0	2.1	16.0	30	5.0	0.0	12.6	94	67.5	51.4	83.7
Amhara	313	0.9	0.2	3.5	335	13.4	7.3	19.5	188	31.9	23.0	40.9
Oromiya	728	4.0	2.3	7.0	267	15.5	9.9	21.1	258	54.5	45.7	63.3
Somali ‡	54	1.4	0.2	8.4	26	71.9	63.7	80.0	94	67.5	51.4	83.7
Benishangul-Gumuz ±	14	7.4	2.3	21.1	71	8.9	0.0	18.4	66	64.8	48.3	81.2
SNNP	509	2.2	1.1	4.4	110	12.8	5.3	20.3	127	47.7	32.7	62.8
Gambella ±	4	8	3	19	38	15.2	3.5	27.0	66	64.8	48.3	81.2
Harari	2	4	3	19	-	-	-	-				
Addis Ababa	1				-	-	-	-				
Dire Dawa	3	7	2	21	-	-	-	-				
Wealth Quintile												
Lowest	422	1.9	0.7	5.1	199	13.9	6.8	21.1	190	43.3	33.2	53.4
Second	413	3.1	1.5	6.4	276	8.1	3.9	12.2	154	40.0	31.5	48.5
Middle	431	3.2	1.4	7.0	179	18.7	8.8	28.6	158	48.0	38.7	57.3
Fourth	350	1.7	0.5	5.4	208	16.2	9.3	23.0	165	52.4	42.7	62.1
Highest	150	4.0	1.5	10.2	64	24.3	7.3	41.3	137	49.5	35.8	63.3
Altitude Strata												
Rural <2000m	916	2.9	1.7	5.1	669	15.1	11.1	19.0	584	51.3	45.3	57.3
Rural >2000m and <2500m	849	2.3	1.3	4.2	257	11.5	4.7	18.3	220	36.7	26.3	47.0
Rural and Elevation <2500m Total	1765	2.6	1.7	4.0	926	14.2	10.76	17.63	804	46.6	41.5	51.7
Elevation <2500m Total	1886	3.7	2.6	5.2	1,034	15.4	12.1	18.8	804	46.6	41.5	51.7

* WN = Weighted number of cases (denominator)

± In the 2011 MIS the estimates are combined for Benishangul-Gumuz and Gambella

‡ In the 2011 MIS the estimates are combined for Afar and Somali; Dash indicates small sample size

Table A.4.1.7: Diagnostic tests in children with fever

Among children under age five with fever in the two weeks preceding the survey, the percentage who had a finger or heel stick, by background characteristics and survey year, Ethiopia

	MIS 2011			
	WN*	%	LCI	UCI
Age (in years)				
<1	93	12.7	5.0	20.4
1	155	19.5	12.3	26.8
2	182	20.8	14.0	27.5
3	148	19.3	12.4	26.1
4	221	22.5	10.9	34.0
Sex				
Male	430	18.4	14.0	22.7
Female	369	21.5	13.6	29.3
Region				
Tigray	65	87.3	77.0	97.6
Afar †	93	9.5	1.9	17.2
Amhara	187	25.7	19.4	32.1
Oromiya	257	15.6	9.4	21.8
Somali †	93	9.5	1.9	17.2
Benishangul-Gumuz ±	65	34.0	18.6	49.4
SNNP	127	24.6	7.9	41.3
Gambella ±	65	34.0	18.6	49.4
Harari	-	-	-	-
Addis Ababa	-	-	-	-
Dire Dawa	-	-	-	-
Wealth Quintile				
Lowest	190	88.8	83.8	93.8
Second	154	18.0	11.0	25.1
Middle	156	27.6	19.2	36.0
Fourth	163	17.7	11.1	24.4
Highest	136	25.9	10.0	41.9
Altitude Strata				
<2000	220	26.7	16.3	37.1
>2000 and <2500	579	16.5	12.7	20.3
Rural Only Total	799	19.8	15.3	24.2
Total	799	19.8	15.3	24.2

* WN = Weighted number of cases (denominator)

This variable can also be stratified by malaria risk area (high, medium, low) and age range: Neonatal, 1-5 months, 2-23 months, 24-59 months. Additional altitude breakdowns of below/above 1600m can be used.

± In the 2011 MIS the estimates are combined for Benishangul-Gumuz and Gambella

† In the 2011 MIS the estimates are combined for Afar and Somali

Dash indicates small sample size

Table A.4.1.8: Use of insecticide-treated nets by pregnant women

Percentage of pregnant women who slept under an insecticide-treated net** (ITN) the previous night by background characteristics and survey year, Ethiopia

	DHS 2005				MIS 2007				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Region												
Tigray	66	3.4	0.5	19.9	19	43.3	10.7	75.9	34	32.3	9.9	54.8
Afar ¥	11	0.0	0.0	0.0	11	26.5	0.0	57.7	80	25.4	12.4	38.3
Amhara	168	0.0	0.0	0.0	149	48.7	36.4	60.9	123	44.4	33.8	55.1
Oromiya	376	0.0	0.0	0.0	176	30.3	17.8	42.9	213	21.1	14.1	28.2
Somali ¥	42	0.0	0.0	0.0	21	3.8	0.0	11.0	80	25.4	12.4	38.3
Benishangul-Gumuz ±	12	0.0	0.0	0.0	41	57.9	36.8	78.9	26	52.5	35.1	69.9
SNNP	218	2.7	1.0	6.8	63	30.0	11.6	48.3	116	32.2	21.9	42.5
Gambella ±												
Harari												
Addis Ababa												
Dire Dawa												
Wealth Quintile												
Lowest	212	0.9	0.2	3.7	102	41.5	27.0	56.0	135	21.1	13.9	28.3
Second	237	0.4	0.1	2.0	130	34.2	20.1	48.4	143	33.1	23.5	42.7
Middle	223	0.1	0.0	0.4	116	37.0	22.3	51.6	97	35.5	24.7	46.3
Fourth	167	1.4	0.4	5.4	123	27.4	16.7	38.0	106	24.5	15.3	33.7
Highest	62	5.3	1.4	18.5	31	42.0	19.2	64.8	118	36.1	26.2	45.9
Age Group												
10-19	61	0.0	0.0	0.0	92	34.9	20.1	49.6	70	21.6	11.5	31.7
20-29	201	0.4	0.1	2.3	281	36.7	27.5	45.9	336	30.9	25.0	36.9
30-39	152	0.6	0.1	3.1	38	31.4	18.0	44.7	178	32.4	24.8	40.0
40-49	32	4.9	0.7	28.1	16	40.5	11.6	69.5	15	14.5	0.0	32.1
Altitude Strata												
Rural <2000m	586	1.1	0.4	2.6	359	43.1	34.0	52.3	390	34.7	28.4	40.9
Rural >2000m and <2500m	314	0.8	0.1	4.7	143	17.4	5.7	29.0	209	21.4	15.4	27.4
Rural and Elevation<2500m												
Total	900	1.0	0.4	2.2	502	34.4	27.68	43.09	599	29.8	25.2	34.4
Total Elevation <2500m												
Total	948	1.3	0.7	2.5	568	35.2	27.7	43.1	599	29.8	25.2	34.4

Table A.4.1.9: Prevalence of severe anemia (Hemoglobin <8g/dl) in children

Percentage of children age 6-59 months with hemoglobin lower than 8.0 g/dL, by background characteristics and survey year, Ethiopia

	DHS 2005				MIS 2007				DHS 2011				MIS 2011			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Age																
6-11 months	310	12.1	8.1	17.9	578	6.5	4.0	8.9	830	8.8	6.1	12.5	287	14.2	9.3	19.2
12-23 months	639	11.6	8.3	16.1	826	6.4	4.1	8.7	1,486	8.8	6.6	11.5	1,038	10.1	7.7	12.5
24-35 months	663	6.5	4.5	9.3	974	9.0	5.0	13.0	1,580	8.3	5.9	11.6	1,439	10.4	7.8	13.0
36-47 months	751	5.2	3.3	8.1	953	4.2	2.5	5.8	1,927	3.7	2.6	5.3	1,522	5.7	4.4	7.0
48-59 months	737	7.6	5.4	10.5	923	3.1	1.4	4.8	1,768	2.3	1.5	3.5	2,027	3.8	2.7	4.8
Sex																
Male	1,564	9.5	7.7	11.7	2,163	6.5	4.8	8.2	3,877	6.1	4.9	7.6	3,223	7.5	6.0	9.0
Female	1,536	6.6	5.0	8.5	2,091	5.0	3.3	6.7	3,714	5.7	4.2	7.6	3,090	7.0	5.7	8.2
Region																
Tigray	218	7.4	5.0	10.9	187	4.5	2.7	6.2	515	6.0	4.3	8.4	390	2.8	1.0	4.7
Afar ሄ	28	11.2	6.3	19.3	93	9.2	0.8	17.5	80	18.2	14.5	22.6	618	17.0	8.2	25.7
Amhara	573	9.6	6.9	13.2	1,306	5.2	3.1	7.4	1,400	3.0	1.9	4.7	1,212	4.0	2.7	5.3
Oromiya	1,366	7.6	5.6	10.3	1,455	6.6	3.9	9.2	3,507	8.0	5.8	10.9	2,500	8.9	6.9	10.8
Somali ሄ	115	24.4	18.4	31.6	176	22.0	9.0	35.1	161	21.8	17.5	26.9	618	17.0	8.2	25.7
Benishangul-Gumuz ±	36	10.1	6.1	16.1	255	11.0	6.2	15.8	94	5.4	3.7	7.8	285	7.7	4.1	11.2
SNNP	738	4.8	2.5	8.8	570	1.5	0.0	3.0	1,783	1.8	1.1	2.8	1,250	4.5	3.0	6.0
Gambella ±	-	-	-	-	172	0.8	0.0	2.4	22	6.0	3.8	9.2	285	7.7	4.1	11.2
Harari	-	-	-	-												
Addis Ababa	-	-	-	-												
Dire Dawa	-	-	-	-												
Wealth Quintile																
Lowest	780	11.4	8.5	15.2	982	7.2	3.2	11.2	1,931	7.4	5.7	9.7	1,390	11.7	9.1	14.4
Second	709	8.2	5.8	11.6	1,142	5.6	3.9	7.3	1,859	6.6	4.5	9.6	1,242	7.1	5.0	9.2
Middle	702	6.4	4.4	9.1	954	6.5	4.2	8.7	1,765	5.1	3.5	7.5	1,226	6.8	5.0	8.7
Fourth	639	7.0	4.8	10.1	901	4.8	2.6	7.1	1,654	4.4	3.1	6.3	1,230	4.1	2.8	5.5
Highest	269	4.6	2.3	9.0	275	2.3	0.7	3.8	382	4.3	2.4	7.8	1,225	5.5	4.0	7.0
Altitude Strata																
Rural <2000m	1,860	8.5	6.7	10.6	2,953	6.8	5.0	8.6	4,966	5.7	4.3	7.5	3,762	9.1	7.2	10.9
Rural >2000m and <2500m	1,240	7.5	5.6	9.8	1,301	3.3	1.5	5.2	2,626	6.3	4.4	8.8	2,551	4.7	3.7	5.7
Rural and Elevation <2500m Total	3,100	8.1	6.7	9.6	4,254	5.8	4.4	7.2	7,591	5.9	4.8	7.3	6,313	7.2	6.1	8.4
Elevation <2500m Total	3,316	8.0	6.7	9.5	4,846	5.5	4.2	6.8	8,639	5.6	4.6	6.9	6,313	7.2	0.6	6.1

Table A.4.1.10: Prevalence of malaria in children

Percentage of children age 6-59 months with malaria infection, by background characteristics and survey year, Ethiopia¹

	MIS 2007								MIS 2011							
	<i>P.f.</i> positive				<i>P.v.</i> Positive				<i>P.f.</i> positive				<i>P.v.</i> positive			
	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI
Age (in years)																
0-9	5,930	0.6	0.1	1.1	5,930	0.3	0.1	0.5	7,297	0.6	0.2	0.9	7,297	0.3	0.1	0.4
10-19	912	0.7	0.0	1.6	912	0.1	0.0	0.4	1,407	0.7	0.2	1.3	1,407	0.0	0.0	0.0
20-29	758	0.7	0.0	1.5	758	0.1	0.0	0.2	1,086	0.4	0.0	0.9	1,086	0.4	0.0	0.7
30-39	551	0.2	0.0	0.4	551	-	-	-	894	0.6	0.1	1.1	894	0.0	0.0	0.0
40-49	294	0.6	0.0	1.6	294	-	-	-	478	0.2	0.0	0.5	478	0.1	0.0	0.4
50-59	294	-	-	-	294	-	-	-	412	0.8	0.0	1.6	412	0.0	0.0	0.0
60-69	164	-	-	-	164	-	-	-	203	0.0	0.0	0.0	203	0.0	0.0	0.0
70-79	78	-	-	-	78	-	-	-	106	0.0	0.0	0.0	106	0.0	0.0	0.0
80+	28	-	-	-	28	-	-	-	50	0.0	0.0	0.0	50	0.0	0.0	0.0
Sex																
Male	4,376	0.7	0.1	1.4	4,376	0.1	0.0	0.3	5,630	0.7	0.3	1.0	5,630	0.3	0.1	0.4
Female	4,633	0.4	0.1	0.6	4,633	0.3	0.0	0.5	6,303	0.4	0.1	0.7	6,303	0.1	0.0	0.2
Region																
Tigray	364	-	-	-	364	0.0	0.0	0.0	720	0.2	0.0	0.5	720	0.2	0.0	0.7
Afar ¥	165	2.6	0.0	5.3	165	-	-	-	987	0.8	0.0	1.7	987	0.0	0.0	0.0
Amhara	3,096	0.3	0.0	0.6	3,096	0.3	0.0	0.6	2,444	0.5	0.0	1.1	2,444	0.3	0.1	0.5
Oromiya	2,970	0.2	0.0	0.4	2,970	0.2	0.0	0.4	4,708	0.1	0.0	0.3	4,708	0.2	0.0	0.3
Somali ¥	262	-	-	-	262	-	-	-	987	0.8	0.0	1.7	987	0.0	0.0	0.0
Benishangul-Gumuz ±	564	9.1	1.1	17.1	564	0.1	0.0	0.2	562	1.5	0.0	3.6	562	0.0	0.0	0.0
SNNP	1,190	0.3	0.0	0.6	1,190	0.3	0.0	0.6	2,482	1.2	0.2	2.3	2,482	0.2	0.0	0.4
Gambella ±	342	1.5	0.0	3.5	342	-	-	-	562	1.5	0.0	3.6	562	0.0	0.0	0.0
Harari	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wealth Quintile																
Lowest	1,990	1.1	0.0	2.1	1,990	0.1	0.0	0.3	2,516	0.2	0.1	0.4	2,516	0.1	0.0	0.2
Second	2,370	0.6	0.1	1.2	2,370	0.2	0.0	0.4	2,333	0.3	0.0	0.7	2,333	0.1	0.0	0.3
Middle	2,044	0.4	0.0	0.8	2,044	0.2	0.0	0.5	2,330	0.8	0.3	1.2	2,330	0.2	0.0	0.4
Fourth	2,033	0.3	0.0	0.6	2,033	0.3	0.0	0.5	2,466	0.8	0.0	1.6	2,466	0.3	0.1	0.4
Highest	572	-	-	-	572	0.8	0.0	2.2	2,288	0.6	0.2	0.9	2,288	0.3	0.0	0.6
Altitude Strata																
Rural <2000m	6,122	0.8	0.2	1.3	6,122	0.3	0.1	0.5	6,697	1.0	0.4	1.5	6,697	0.3	0.1	0.5
Rural >2000m and <2500m	2,887	0.0	0.0	0.1	2,887	0.1	0.0	0.1	5,236	0.0	0.0	0.1	5,236	0.1	0.0	0.1
Rural and Elevation<2500m Total	9,009	0.6	0.2	0.9	9,009	0.2	0.1	0.4	11,933	0.5	0.25	0.82	11,933	0.2	0.1	0.3
Elevation <2500m Total	10,578	0.5	0.2	0.8	10,578	0.2	0.1	0.3	11,933	0.5	0.25	0.82	11,933	0.2	0.1	0.3

Table A.4.1.11: Age-specific childhood mortality

Age-specific all-cause mortality (per 1,000 live births) for five-year periods preceding the survey, Ethiopia

	Estimate	LCI	UCI	Estimate	LCI	UCI	Estimate	LCI	UCI
Age Group									
6-23 months	51.7	44.3	58.9	30.5	24.6	36.3	20.4	16.3	24.6
24-59 months	58.7	50.6	66.7	40.8	34.4	47.3	22.9	18.1	27.7
6-59 months	107.3	97.0	117.5	70.1	61.6	78.4	42.9	36.7	49.0
1-59 months	132.3	121.3	143.1	92.1	82.8	101.3	56.4	49.2	63.5
Neonatal (NN)	46.9	40.4	54.4	41.3	35.1	48.7	35.8	30.5	42.0
Postneonatal (PNN)	47.6	43.1	56.7	36.2	31.4	44.1	23.8	19.8	29.5
Infant (1q0)	94.5	85.1	103.7	77.5	68.5	86.4	59.6	52.3	66.8
Child (4q1)**	86.7	77.2	96.1	56.5	49.2	63.7	32.5	26.9	38.1
Under 5 mortality (5q0)	173.0	160.8	184.9	129.6	118.8	140.4	90.2	81.3	98.9

* WN = Weighted number of cases (denominator)

**Child mortality (4q1) is mortality between exact age 1 and exact age 5, per 1,000 children surviving to 12 months of age.

Table A.4.1.12: Early childhood mortality

All-cause under five mortality (per 1,000 live births) for five-year periods preceding the survey, by background characteristics and survey year, Ethiopia

	DHS 2000-2001			DHS 2005			DHS 2011		
	%	LCI	UCI	%	LCI	UCI	%	LCI	UCI
Sex									
Male	180.8	164.0	197.2	135.3	120.5	149.8	101.5	88.4	114.3
Female	164.7	149.2	180.0	123.7	109.0	138.1	78.0	66.5	89.5
Region[^]									
Tigray	144.7	119.7	169.0	82.1	58.5	105.1	88.4	67.2	109.1
Affar	221.7	188.2	253.9	146.4	105.5	185.4	102.5	80.7	123.8
Amhara	161.3	135.8	185.9	168.0	140.2	194.9	75.8	55.6	95.7
Oromiya	181.9	159.9	203.3	117.0	97.3	136.2	93.2	76.8	109.4
Somali	173.8	135.9	210.1	93.0	66.0	119.2	96.6	68.3	124.1
Benishangul-Gumuz	195.5	149.4	239.2	146.1	112.9	178.0	129.4	105.0	153.2
SNNP	171.8	147.9	195.1	137.6	117.7	157.0	92.6	76.7	108.2
Gambela	189.3	148.4	228.2	116.5	77.3	154.1	127.4	92.6	161.0
Harari	161.5	111.2	208.9	114.3	62.5	163.2	109.3	70.4	146.6
Addis Ababa				48.8	100.0	177.4			
Dire Dawa	173.4	130.6	214.2	160.2	97.5	218.5	88.5	50.5	124.9
Altitude (in meters)									
< 2000 m	178.9	161.7	195.8	128.5	114.9	141.9	87.9	77.1	98.5
2000+ m	165.1	148.2	181.7	131.4	112.9	149.5	94.6	78.4	110.6
Wealth Quintile									
1 (Poorest)	137.2	114.3	159.5	124.6	104.5	144.3	109.2	92.0	126.2
2	183.5	158.8	207.4	138.9	113.8	163.2	98.0	77.2	118.3
3	201.1	172.5	228.7	141.2	116.1	165.7	82.1	63.0	100.9
4	177.5	153.1	201.3	132.9	109.4	155.7	65.4	47.1	83.3
5 (Least Poor)	157.6	103.8	208.1	86.4	57.4	114.4	91.9	44.0	137.4
Mother's Education									
None	178.6	165.2	191.6	134.9	123.1	146.6	94.9	84.5	105.2
Primary	143.7	109.6	176.5	106.6	78.2	134.1	77.2	59.2	94.9
Secondary +	49.3	-40.6	131.4	34.4	-58.2	118.9	2.5	-0.9	5.9
Birth Order									
1	185.3	157.9	211.9	170.4	141.0	198.8	79.7	58.0	100.8
2	173.0	141.0	203.9	102.6	80.2	124.5	82.8	59.7	105.5
3+	169.0	154.8	182.9	126.3	113.3	139.1	94.8	84.4	105.1
Household Size									
<4	363.7	306.5	416.1	361.9	289.4	427.0	209.9	161.0	256.0
4 to 5	195.6	174.2	216.4	148.4	127.4	168.8	103.4	85.9	120.5
6 to 7	154.0	134.8	172.8	111.2	94.8	127.3	68.8	56.1	81.4
8 to 9	108.7	85.8	131.1	81.5	60.6	101.9	70.6	48.2	92.5
10+	99.3	63.8	133.5	60.6	28.3	91.8	63.4	19.4	105.4
Number of Household ITNs*									
0				129.1	118.0	140.0			
1+				142.1	86.1	194.8			
Total	173.0	160.8	184.9	129.6	118.8	140.4	90.2	81.3	98.9

*An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

Table A.4.1.13: Prevalence of fever in children

Percentage of children under age five (0-59 months) with fever in the two weeks preceding the survey, by background characteristics and survey year, Ethiopia

	DHS 2000				DHS 2005				MIS 2007				DHS 2011				MIS 2011			
	WN*	%	LCI	UCI																
Age (in years)																				
0	1,657	33.0	29.6	36.7	1,650	22.9	19.9	26.1	569	22.8	17.3	28.2	1,804	21.0	18.2	24.1	652	14.1	11.0	17.2
1	1,515	35.7	31.8	39.8	1,371	24.5	21.4	27.8	752	28.9	24.4	33.5	1,477	23.4	20.2	27.0	724	19.5	15.9	23.0
2	1,514	31.6	28.1	35.4	1,424	23.9	20.8	27.4	882	22.0	17.7	26.3	1,552	18.7	15.8	22.0	982	18.5	15.4	21.6
3	1,658	25.5	22.5	28.8	1,546	15.9	13.5	18.5	846	22.2	17.7	26.8	1,834	14.7	12.4	17.3	1,014	14.3	11.6	17.0
4	1,494	20.7	17.7	24.1	1,518	12.9	10.7	15.4	788	20.1	15.7	24.5	1,745	10.2	8.3	12.6	1,319	17.7	14.0	21.4
Sex																				
Male	3,991	29.7	27.1	32.4	100	19.5	17.5	21.7	1,944	23.6	20.2	27.0	4,317	18.8	16.9	20.9	2,366	18.1	15.6	20.7
Female	3,847	29.0	26.6	31.5	100	20.3	18.1	22.8	1,893	22.5	19.4	25.5	4,095	15.9	14.1	17.8	2,325	15.7	13.3	18.2
Region																				
Tigray	540	40.1	35.4	44.9	486	22.3	18.3	26.9	172	20.7	9.1	32.2	549	25.0	21.7	28.5	280	22.7	14.5	31.0
Afar ¥	96	44.6	38.9	50.4	84	16.8	9.9	27.1	91	30.6	24.3	36.9	92	22.7	18.8	27.3	560	18.9	13.7	24.0
Amhara	1,642	24.1	19.8	29.1	1,497	14.2	10.9	18.3	1,144	26.9	21.4	32.4	1,584	15.5	12.0	19.7	1,039	18.6	15.1	22.2
Oromiya	3,338	26.0	22.4	30.0	3,208	19.9	17.0	23.2	1,367	22.1	17.5	26.7	3,852	15.4	13.0	18.1	1,914	12.6	10.4	14.8
Somali ¥	79	31.4	27.0	36.1	383	14.2	11.2	17.8	203	12.5	8.5	16.6	219	23.7	18.3	30.1	560	18.9	13.7	24.0
Benishangul-Gumuz ±	96	31.0	26.3	36.1	89	15.9	11.8	21.1	242	34.9	24.6	45.2	106	25.6	20.3	31.8	257	29.8	19.2	40.4
SNNP	2,001	35.3	31.5	39.3	1,698	25.9	22.0	30.3	496	20.4	15.9	25.0	1,945	19.4	16.2	23.0	596	19.4	12.7	26.2
Gambella ±	17	35.9	31.0	41.1	25	16.3	12.1	21.7	86	54.1	37.8	70.5	28	25.3	17.9	34.4	257	29.8	19.2	40.4
Harari	-	-	-	-	-	-	-	-	-	-	-	-	17	8.0	5.1	12.4	27	14.4	11.2	17.6
Addis Ababa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dire Dawa	-	-	-	-	-	-	-	-	-	-	-	-	20	10.2	5.1	19.2	-	-	-	-
Wealth Quintile																				
Lowest	1,881	26.8	23.6	30.3	1,950	20.1	17.8	22.7	873	21.9	16.2	27.6	2,144	18.2	15.4	21.3	1,218	13.6	10.9	16.3
Second	1,854	29.3	26.0	33.0	1,694	20.7	17.5	24.2	1,063	23.7	19.6	27.8	2,110	15.7	13.5	18.3	881	18.5	14.0	23.0
Middle	1,786	31.2	28.0	34.7	1,669	21.5	18.4	25.0	871	19.3	15.4	23.2	1,943	18.3	15.5	21.4	891	16.9	12.6	21.1
Fourth	1,738	29.9	26.4	33.6	1,495	18.6	15.2	22.5	780	27.9	23.1	32.7	1,782	17.5	14.8	20.6	893	17.6	13.6	21.6
Highest	579	30.1	24.4	36.4	701	16.5	12.8	21.0	250	22.0	13.3	30.8	434	17.1	12.8	22.6	808	19.5	14.7	24.2
Altitude Strata																				
<2000	4,494	30.3	27.3	33.5	4,597	19.9	17.8	22.2	2,663	24.6	21.2	27.9	5,568	19.1	17.1	21.4	2,950	19.7	16.8	22.5
>2000 and <2500	3,344	28.0	24.8	31.3	2,911	19.9	16.7	23.4	1,174	19.3	14.9	23.7	2,844	14.0	11.8	16.4	1,741	13.0	10.5	15.5
Rural and Elevation																				
<2500m Total	7,838	29.3	27.2	31.6	7,509	19.9	18.1	21.8	3,837	23.0	20.3	25.8	8,412	17.4	15.8	19.1	4,691	16.9	14.9	18.9
Elevation <2500m Total	8,825	28.9	26.8	31.0	10,109	19.5	17.9	21.3	4,384	22.3	19.8	24.8	9,735	17.1	15.7	18.6	4,691	16.9	14.9	18.9

* WN = Weighted number of cases (denominator)

**An insecticide-treated net (ITN) is (1) a factory-treated net that does not require any further treatment (LLIN) or (2) a pretreated net obtained within the past 12 months or (3) a net that has been soaked with insecticide within the past 12 months.

This variable can also be stratified by malaria risk area (high, medium, low) and age range: Neonatal, 1-5 months, 2-23 months, 24-59 months. Additional altitude breakdowns of below/above 1600m can be used.

±In the 2011 MIS the estimates are combined for Benishangul-Gumuz and Gambella

¥ In the 2011 MIS the estimates are combined for Afar and Somali

Dash indicates small sample size

Annex 5: Contextual Factors

A.5.1 Contextual Factors from National Survey Data, 2000-2011

Contextual Factor†										
	%	N	%	N	%	N	%	N	%	N
HOUSEHOLD CHARACTERISTICS										
Improved source of drinking water*	8.2	9,584	55.3	9,248	24.9	6,154	42.8	11,105	46.5	10,444
Drinking water <15 min round-trip	20.6	9,584	26.8	9,248	-	-	19.2	11,105	-	-
Access to improved toilet**	0.0	9,584	5.3	9,248	8.6	6,154	6.1	11,105	23.6	10,444
Household floor material not earth, sand or dung	2.1	9,584	1.8	9,248	4.0	6,154	4.5	11,105	7.4	10,444
Household has electricity	0.5	9,584	1.7	9,248	1.5	6,154	5.1	11,105	3.8	10,444
Household has telephone (landline or mobile)	0.0	9,584	0.2	9,248	0.2	6,154	13.2	11,105	6.3	10,444
*Improved water sources include: piped water into dwelling/yard/plot; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; rainwater; bottled water; as per DHS VI Standard Tab plan.										
** Improved, Not Shared Toilet Facility includes: flush/pour flush to piped sewer system; flush/pour flush to septic tank; flush/pour flush to a pit latrine; ventilated improved pit (VIP) latrine; Pit latrine with a slab; Composting toilet; does not include any toilets that are shared with other households, as per DHS VI Standard Tabs.										
IMMUNIZATION COVERAGE*										
BCG	43.4	1,515	58.9	1,361	-	-	63.2	1,475	-	-
DPT3	17.8	1,515	29.9	1,361	-	-	33.1	1,475	-	-
polio3	30.0	1,515	44.4	1,361	-	-	41.2	1,475	-	-
measles	22.0	1,515	32.2	1,361	-	-	50.8	1,475	-	-
Fully vaccinated	11.1	1,515	18.2	1,361	-	-	20.3	1,475	-	-
* Percentage of children 12-23 months with the recommended immunizations										
MICRONUTRIENTS										
Vitamin A supplementation	54.6	7,040	44.1	6,572	-	-	52.2	7,438	-	-
NUTRITIONAL STATUS										
Stunting					-	-			-	-
Underweight					-	-			-	-
Wasting					-	-			-	-
SOCIO-DEMOGRAPHIC FACTORS										
Proportion of women 15-49 with at least a primary school education	2.8	10,269	5.5	9,197	-	-	5.9	10,721	-	-
Proportion of women 15-49 literate	14.4	10,269	19.2	9,197	-	-	28.0	10,721	-	-
Proportion of women 15-49 married	68.6	10,269	70.2	9,197	-	-	67.9	10,721	-	-
FERTILITY-RELATED RISKS										
High risk birth*	64.8	8,943	69.3	8,278	-	-	65.7	9,026	-	-
Avoidable risk birth**	58.4	8,943	62.9	8,278	-	-	58.9	9,026	-	-
Unavoidable risk birth***	13.8	8,943	10.4	8,278	-	-	12.4	9,026	-	-
Birth intervals <24 months	19.7	8,943	18.5	8,278	-	-	20.6	9,026	-	-
Fourth or higher birth	52.1	8,943	54.4	8,278	-	-	52.5	9,026	-	-
Mother age <18 yrs or >34 years	25.9	8,943	26.1	8,278	-	-	22.2	9,026	-	-

*A high risk birth is defined as any birth with a birth interval <24 months, a multiple birth, birth order <3, or any birth to a woman younger than 18 or older than 34 years.										
**An avoidable high risk birth is a birth to a woman <18 or >34 years, a birth interval <24 mo, or a birth order >3										
*** An unavoidable high risk birth is a first birth born to women ages 18-34										
OTHER CHILDHOOD ILLNESS										
Diarrhea in past 2 weeks	25.7	7,838	19.4	7,461	-	-	14.1	8,393	-	-
IMCI COVERAGE*										
Oral rehydration therapy (ORT) for diarrhea**	43.3	2,015	32.9	1,445	-	-	38.2	1,186	-	-
Oral rehydration salt solution (ORS) for diarrhea	9.9	2,015	18.7	1,445	-	-	24.2	1,186	-	-
*Integrated Management of Childhood Illness (IMCI)										
**Child was given oral rehydration or recommended home solution.										
ANC COVERAGE										
Antenatal Care (≥4 visits)	6.3	5,760	8.0	5,302	-	-	14.5	5,815	-	-
At least 2 doses of tetanus toxoid during pregnancy	14.6	5,760	25.5	5,302	-	-	31.3	5,815	-	-
Postnatal vitamin A supplementation	10.4	5,760	19.2	5,302	-	-	15.5	5,815	-	-
Delivery in a health facility*	1.8	8,943	2.3	8,278	-	-	3.9	9,026	-	-
Skilled attendant at birth**	5.6	8,943	9.2	8,278	-	-	4.7	9,026	-	-
*Health facility includes all public and private place of delivery response options.										
**Skilled provider includes doctor, nurse, trained birth attendant, medical assistant, midwife.										
BREASTFEEDING										
Early initiation of breastfeeding (within 1 hr of birth)	55.9	8,635	45.5	7,927	-	-	33.9	8,719	-	-
% 6-9 mo breastfeeding and consuming complementary foods	45.5	570	54.9	554	-	-	52.7	577	-	-

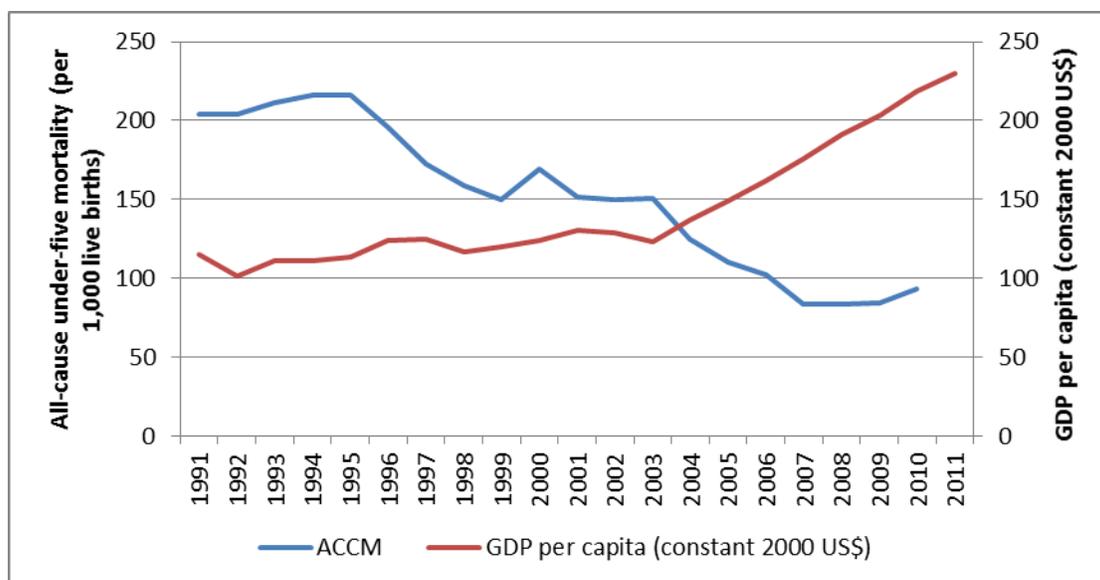
†Estimates for study population living at elevations <2000m

A.5.2 Fundamental Determinants

Socioeconomic factors

A range of socioeconomic determinants at the community, household, and individual level are associated with child survival [26-28]. Gross Domestic Product (GDP) per capita income, a measure of population wealth in a country, is considered to be a typical macroeconomic determinant of health [28]. The relationship between GDP per capita and ACCM indicate that a 1% annual increase in GDP per capita is associated with a 0.4–0.6% reduction in ACCM [29]. In Ethiopia, the GDP per capita was US\$ 123 in 2000, as compared to US\$ 230 in 2011 [30]. Trends in GDP per capita and growth in Ethiopia are shown in (Figure A.5.2.1). Levels and trends in household attributes and other proxies of socio-economic status are summarized in Table A.5.2.1.

Figure A.5.2.1: Trends in Gross Domestic Product (GDP) per capita and annual estimates of all-cause under five mortality (ACCM), Ethiopia, 1991–2011



Sources: DHS annual mortality estimates from 2000, 2005 and 2011 surveys; GDP estimates from The World Bank [30].

Safe water and sanitary facilities contribute to improved child health and survival [31]. In 2000, 12% of households surveyed reported an improved water source (i.e., protected, borehole, piped), as compared to 54% in 2011. The proportion of households with a water source within 15 minutes of the household increased from 16% to 31% from 2000 to 2011. In 2000, less than 1% of households had access to improved toilet facilities whereas 8% of households had access by 2011. During 2000–2011, access to improved water and sanitation generally improved, although a large proportion of the population remains without access. The proportion of households with electricity increased from 13% to 23% and the proportion of households with a telephone increased from 1% to 25% between 2000 and 2011. According to the World Health Statistics 2012 report, there were eight cellular phone subscribers per 100 persons in Ethiopia in 2010.

Housing construction, such as flooring and roofing material, has been used to assess household socioeconomic status, but house construction also can directly affect malaria risk [32, 33]. From 2000 to 2010, households with an improved roof (i.e., not thatch, grass, or mud) increased from 32% to 51%, while the proportion with modern floor materials (i.e., not earth, sand, or dung) rose from 7% to 15%.

Table A.5.2.1: Household attributes and asset ownership, Ethiopia, 2000–2011

	2000			2011			Relative Change	
	%	95% CI	n	%	95% CI	n	% change	Sig.
Improved water source* (protected, borehole, piped), (% households)	12.4	10.5-14.6	14072	53.7	50.0-57.3	16702	333.1	S
Time to water source <15 min, (% households)	26.3	24.2-28.5	14072	31.2	28.5-33.9	16702	18.6	S

Access to improved toilet,**(% households)	0.3	0.2-0.4	14072	8.3	7.1-9.6	16702	2666.7	S
Improved roof (not thatch/grass/mud), (% households)	32.1	29.6-34.6	14072	51.3	48.3-54.4	16702	59.8	S
Modern floor material (not earth/sand/dung), (% households)	7.4	6.3-8.9	14072	15.3	13.4-17.3	16702	106.8	S
Electricity, (% households)	12.7	11.1-14.4	14072	23.0	20.5-25.8	16702	81.1	S
Telephone (landline or mobile), (% households)	1.3	1.0-1.7	14072	25.2	23.4-27.0	16702	1838.5	S
Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant; S denotes statistically significant.								

*Improved water sources include: piped water into dwelling/yard/plot; public tap/standpipe; tubewell/borehole; protected dug well; protected spring; rainwater; bottled water.

** Improved, Not Shared Toilet Facility includes: flush/pour flush to piped sewer system; flush/pour flush to septic tank; flush/pour flush to a pit latrine; ventilated improved pit (VIP) latrine; Pit latrine with a slab; Composting toilet; does not include any toilets that are shared with other households.

Mother's Education and Marital Status

At an individual level, maternal education is an important determinant of maternal and child health [28, 34-39]. In Ethiopia, 11% of women aged 15–49 had completed primary education in 2000, as compared to 25% in 2011, and women's literacy increased from 24% in 2000 to 38% in 2011 (Table A.5.2.2).

Survivorship and health outcomes of children less than five years of age are better among married women [40-42]. The proportion of women who were married or living with a partner did not change significantly from 2000 to 2011 (63% and 62%, respectively).

Table A.5.2.2: Women's education, and marital status in Ethiopia, 2000–2011*

Indicator	2000			2011			% change	Sig.
	Estimate	95% CI	N	Estimate	95% CI	N		
Mean years of education	1.3	1.2-1.4	15,367	2.9	2.8-3.1	16,515	123.1	S
Completed primary	10.7	9.5-12.0	15,367	15.2	14.0-16.5	16,515	42.1	S

education (%)								
Literacy (%)	24.4	22.6-26.4	15,367	38.4	36.4-40.5	16,515	57.4	S
Married (%)	62.8	62.2-65.2	15,367	62.3	60.7-63.9	16,515	-0.8	NS
*Interviewed women aged 15–49 years Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant and S denotes statistically significant								

A.5.3 Proximate Determinants

Maternal health

Antenatal care visits are considered a key entry point for a continuum of care during and after pregnancy that offer timely opportunities for receiving health promotions, as well as preventive and therapeutic interventions aimed at improving maternal, fetal, and newborn survival and wellbeing [43]. Through antenatal visits, women benefit from various interventions, including counseling about healthy lifestyles, the provision of iron and folic acid supplements, and tetanus toxoid vaccinations to protect newborns against neonatal death in addition to malaria prevention interventions such as IPTp and distribution of ITNs. In Ethiopia, 10% of women attended four or more antenatal care visits (ANC4+) in 2000 as recommended by WHO, compared to 19% in 2011, a significant, although insufficient, increase over the decade (Table A.5.3.1).

Neonatal tetanus is often the result of infection from unhygienic cutting/cleaning of the umbilical cord at the time of delivery. To help prevent infection it is recommended for women who have never received the tetanus toxoid vaccine to receive a total of five doses: two doses given one month apart in the first pregnancy, then one dose in each subsequent pregnancy (or intervals of at least one year), for a total of five doses. Maternal vaccination against tetanus creates antibodies that are passed to the child *in utero* thus providing protection in the first weeks of life [44]. A conclusive reduction in neonatal tetanus mortality has been demonstrated through the scale-up in tetanus vaccination of women of childbearing age [45]. In Ethiopia, the proportion of women whose most recent births (within the last two years) were protected against neonatal tetanus (two or more doses of tetanus toxoid vaccine) increased significantly from 17% in 2000 to 34% in 2011 (Table A.5.3.1).

Childbirth at health facilities, usually by skilled attendants, can reduce the chances of maternal and newborn complications. In 2000, 5% of live births occurred in health facilities, compared with 10% in 2011. Although this change represents a significant increase there is much room for improvement. Births in women with high-risk fertility behavior can increase the risk of early childhood mortality. Mortality rates are often higher for children born to mothers who are young or old, for children born after a short birth interval, or for children born to women who have had more than three births. From 2000 to 2011, births in any high-risk fertility category did not change significantly (64% and 63% in both years).

Table A.5.3.1: Maternal health in Ethiopia, 2000–2011

Indicators	DHS 2000			DHS 2011			% change	Sig
	%	95% CI	N	%	95% CI	N		
ANC visits 4+ (% women, most recent live birth, 0-2yrs)	10.4	8.9-12.1	7978	19.1	17.2-21.0	7908	83.7	S
Tetanus toxoid 2+ (% women, most recent live births, 0-2yrs)	17.2	15.5-19.0	7978	33.8	31.4-36.2	7908	96.5	S
Delivery at a health facility (% women, live births 0-4yrs)	5.0	4.0-6.3	12260	9.9	8.3-11.9	11872	98.0	S
Births in any high-risk fertility category (%)*	64.1	62.7-65.5	12260	63.2	61.4-64.9	11872	-1.4	NS
<p>Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different change. NS denotes no statistically significant change and S denotes statistically significant change</p> <p>* Births to women <18 and >34, births <2 years apart and birth order >3</p>								

Child health

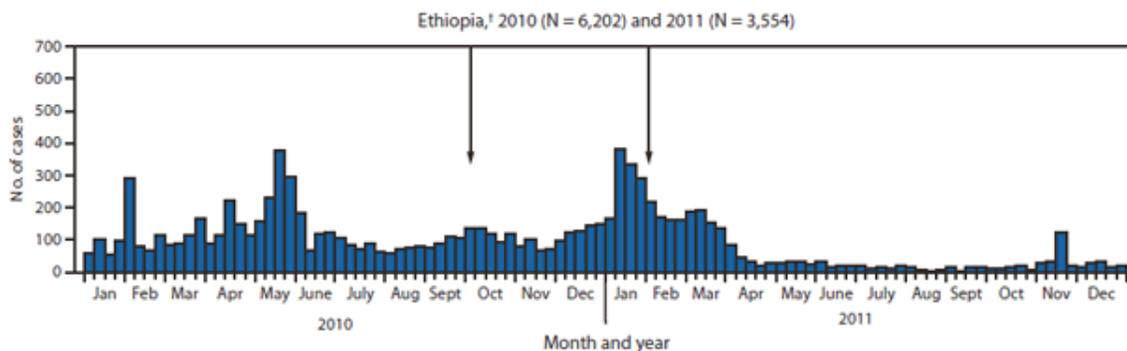
The WHO Expanded Program on Immunization (EPI) offers vaccinations against common childhood communicable diseases and is one of the most cost-effective child survival interventions [46, 47]. Effective coverage of these vaccinations contributes substantially to reductions in ACCM. Ethiopia's recommended EPI schedule for children includes immunizations to protect against TB (BCG), polio (OPV), diphtheria, pertussis, and tetanus (DPT), hepatitis B virus (HBV), *Haemophilus influenzae* (Hib), measles and pneumococcal disease (PCV). The immunization schedule calls for BCG within 14 days after birth, DPT-HBV-Hib, polio, and pneumococcal conjugate at 6, 10, and 14 weeks after birth, and measles at or soon after 9 months of age [48]. The HBV and Hib antigens were added to the DPT vaccine in 2007. Recommendations call for complete immunizations before one year of age and specify that they should be recorded on an immunization card. Coverage of each of these childhood vaccinations during 2000–2011, according to vaccination cards or mother's report during household surveys, is shown in Table A.5.3.2. In 2000, 14% of children aged 12–23 months received all of the vaccinations recommended in the EPI schedule, as compared to 24% in 2011, a significant increase but very low coverage compared to other countries in the region.

Measles vaccination, in children aged 12–23 months more than doubled from 27% in 2000 to 56% in 2011. This increase could be due, in part to a nationwide measles supplemental immunization activity

that was conducted in October 2010 and February 2011 targeting 9.1 million children between the ages of 9 and 47 months in response to a 2009-10 regional measles epidemic (Figure A.5.3.1).

According to CDC, annual reported measles incidence decreased from 75 to 42 per 1 million population during 2010-11 [49]. However, measles epidemics continue to occur periodically in Ethiopia because of sub-optimal measles vaccination coverage. According to the WHO World Health Statistics, 2012 report, measles caused an estimated 4% of all deaths among Ethiopian children less than five years of age in both 2000 and 2010.

Figure A.5.3.1: Reported measles cases by epidemiological week, horn of Africa, 2010-2011*



*Arrow represent nationwide measles supplemental immunization activities.

Source: CDC. *Morbidity and Mortality Weekly Reports* 2012;61 (34): 678-684 [49]

BCG coverage in the same age group increased from 46% to 66% over the decade, coverage with three doses of DPT increased from 21% to 37% and coverage with three doses of polio from 35% to 44%, all significant increases. Although the significant increases in immunization coverage that occurred over the decade may have contributed to decreases in ACCM, immunization coverage is still relatively low compared with standard international targets.

Acute respiratory infections (ARI) and diarrheal diseases, caused by a variety of viral and bacterial pathogens, are among the leading causes of illness and death in children less than five years of age, both globally and in Ethiopia. Interventions to control these two diseases mainly include immunizations against specific pathogens, early diagnosis and treatment, improvements in nutrition and feeding practices, and safer environments. Data on the prevalence and treatment seeking practices of these two conditions were collected during the 2000 and 2011 DHS in Ethiopia by asking mothers whether their children less than five years of age had been ill with a cough accompanied by short, rapid breathing and whether they suffered from diarrhea in the two weeks preceding the survey (Table A.5.3.2). During the two weeks preceding the survey, 24% of children less than five years had diarrhea in 2000, as compared to 13% in 2011. Thirteen percent of children with diarrhea were taken to a health provider in 2000, compared to 26% in 2011. Use of oral rehydration solution (ORS) for treatment of diarrhea increased from 13% in 2000 to 26% in 2011.

Table A.5.3.2: Child health in Ethiopia, 2000–2011

Indicators	2000			2011			% change	Sig
	%	95% CI	N	%	95% CI	N		
BCG	45.6	41.3-50.0	2,143	66.3	62.0-70.4	1,930	45.4	S
DPT3 / DPT3-HBV-Hib	20.7	17.9-24.1	2,143	36.5	62.6-40.6	1,930	76.3	S
Polio3	34.6	31.0-38.3	2,143	44.3	40.2-48.6	1,930	28.0	S
Measles	26.6	23.3-30.2	2,143	55.7	51.3-60.1	1,930	109.4	S
All (BCG, measles, DPT3, polio3)	14.3	12.0-16.8	2,143	24.3	20.9-28.0	1,930	69.9	S
Children 0-4yrs with diarrhea in previous 2 weeks	23.6	22.1-25.3	10,753	13.4	12.2-14.7	11,042	-43.2	S
Children 0-4yrs with diarrhea sought treatment	13.3	11.3-15.6	2,540	31.8	27.8-36.1	1,483	139.1	S
Children 0-4yrs with diarrhea used ORS	13.1	11.0-15.5	2,540	26.3	23.0-29.9	1,483	100.8	S
Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant and S denotes statistically significant								

Breastfeeding practices and under-nutrition in children and women

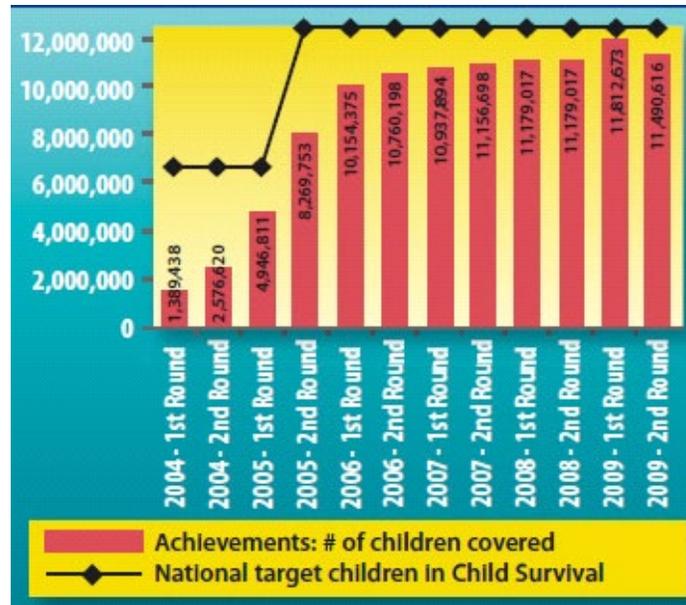
In addition to serving as a source of nutrition, breastfeeding during infancy provides protection against infectious diseases, including diarrhea and ARI, the leading causes of under-five mortality [50, 51]. Early and exclusive breastfeeding is an important child survival intervention which reduces neonatal, infant, and child mortality [52]. Currently, the WHO recommends early and exclusive breastfeeding for the first six months following birth [53]. In Ethiopia, there was no change in the percent of children less than six months of age exclusively breastfed from 2000 to 2011 (54% to 52%). In contrast, the proportion of children born in the five years prior to interview who initiated breastfeeding early (within one hour of birth) declined significantly, from 52% in 2000 to 35% in 2011.

Under-nutrition due to chronic dietary deficiency of protein, energy, essential vitamins, and minerals (collectively referred to as micronutrients) is an important determinant of maternal and child health [53]. The continuum of maternal, fetal, and child under-nutrition results in 3.5 million preventable child and maternal deaths globally, per year [54].

In children less than five years of age, the standardized anthropometric measures of under-nutrition [55] are: a) low birth weight resulting due to intrauterine growth restriction (IUGR); b) underweight, a reflection of low weight-for-age; c) stunting, a chronic restriction of growth in height indicated by a low height-for-age; and d) wasting, an acute weight loss indicated by a low weight-for-height. Under-nutrition prevalence in children less than five years of age was determined during a series of household surveys conducted in 2000 and 2011. In Ethiopia, the proportion of babies born small or very small in size (by mother's report) decreased over the study period (33% in 2000 and 29% in 2011) (Table 30). Underweight, stunting, and wasting prevalence in children less than five, was 41%, 58%, and 12%, respectively in 2000, as compared to 29%, 44%, and 10%, respectively, in 2011.

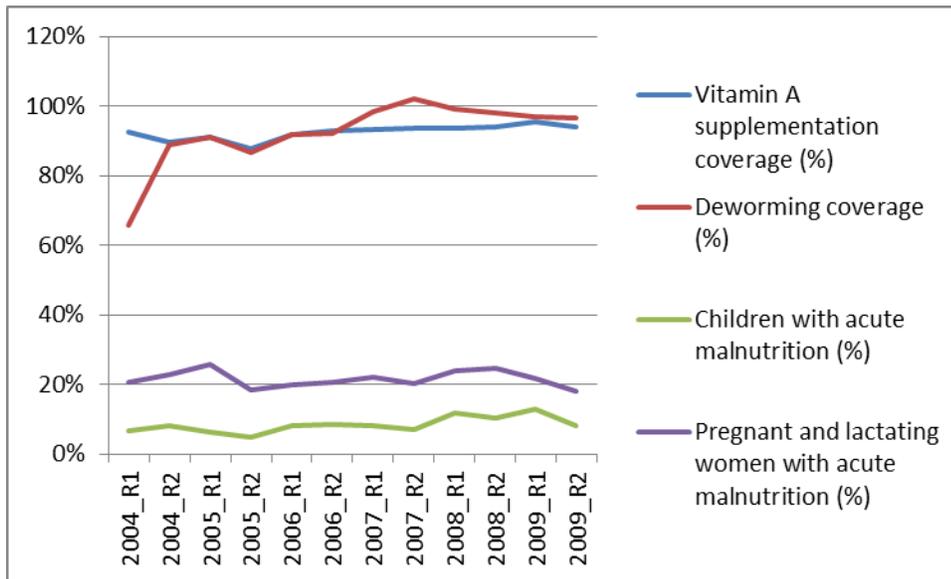
Vitamin A deficiency has been implicated in increased morbidity and mortality from infectious diseases such as, measles, diarrhea, and acute respiratory infections, and results in up to 600,000 under-five deaths annually world-wide [54]. Depletion of stored vitamin A occurs over a period of four to six months, when the diet contains too little replacement. Periodic vitamin A supplementation (i.e., every six months) in areas with prevalent pre-existing vitamin A deficiency has been shown to replenish vitamin A stores needed for essential physiological functions and to decrease ACCM by up to 23% [56, 57]. Vitamin A supplementation campaigns began in Ethiopia in 2001-02 as part of the National Immunization Days. In 2004, vitamin A distribution was paired with a new strategy called Enhanced Outreach Strategy/Targeted Supplementary Feeding (EOS/TSF) as the first national program to link community-based preventive health services with food supplementation for malnourished women and children (Figure 56). This program was established in 325 drought-prone districts following an acute famine in 2003. In 2005 the vitamin A supplementation and deworming aspects of the program were extended to the 299 remaining 'non-EOS' districts. The program includes biannual community health days during which eligible children and mothers are encouraged to come to the health post for screening and supplementation. Progress on reducing vitamin A deficiency is measured using coverage of micronutrient supplementation campaigns. According to DHS data, 60% of children aged 6–59 months received a vitamin A supplement in the six months prior to the survey in 2000 as compared to 53% in 2011 (Table 30).

Figure A.5.3.2: Children (6-59 months) reached by EOS services per year, 2004–2009, Ethiopia



Source: [58]

Figure A.5.3.3: EOS results per year and per round, 2004-2009, Ethiopia



The Economist Intelligence Unit published the Annual Global Food Security Index Rankings, 2013, with findings that Ethiopia ranked 90th out of 107 countries, with a score of 31.2 out of 100 (Range: USA 86.8, DR Congo 20.8), with Ethiopia ranking behind Kenya, Senegal, Nigeria, and Angola, but ahead of 15 other African countries and Haiti [59]. According to the US Department of Agriculture's International Food Security Assessment, 2013–2023, Ethiopia has improved its nutritional status by 15.9% between 2000 and 2009, when it had a daily intake of 2,097 kcal, achieving 100% of recommended energy input, 116% of recommended protein intake, and 52% of recommended fat intake [60]. In January to May 2008, drought affected large sections of southern, central, western, and north-eastern Ethiopia. The resulting

harvest failures left 4.6 million people needing emergency food aid and 7.5 million in drought-affected areas requiring other handouts such as additional cash or food transfers [61]. Food prices have risen significantly since 2005.

In 2013, the USDA report indicates that there are 35 million food insecure people in Ethiopia and that 282,000 tons of food are needed annually to move each income quintile to the recommended nutritional standards. Although there are and have been focal food shortages and even focal famines, the food security situation has improved over the last decade and is expected to continue to improve despite the many challenges and expected continued population growth.

Ethiopia has achieved encouraging progress in recent years in detecting and managing acute malnutrition through Extended Outreach Services and the expansion of the national Therapeutic Feeding Programs. At the same time, there is a growing understanding that it is time to invest in a more comprehensive approach at household and community levels to prevent and manage all causes of malnutrition. The Community Based Nutrition program (CBN) is the first compressive nutrition program to address some of the immediate, underlining and basic causes of malnutrition in Ethiopia. Started at the end of 2008, CBN is being implemented in 170 districts so far. Monthly growth monitoring and promotion is conducted for children less than two years, which is the most vulnerable period and when the impact of early childhood malnutrition can be reversed.

Table A.5.3.3: Breastfeeding and under-nutrition in children and women in Ethiopia, 2000–2011

Indicator	2000			2011			% change	Sig.
	%	95% CI	n	%	95% CI	n		
Early initiation of breastfeeding	51.8	48.9-54.6	11,807	35.3	33.4-37.4	11,440	-31.9	S
Exclusive breastfeeding in children <6 months of age (%)	54.4	49.8-58.9	1,075	51.9	47.4-56.5	1,256	-4.6	NS
Small/very small size at birth (mother's estimate) (%)	33.3	31.7-35.0	12,260	29.2	27.5-31.0	11,872	-12.3	S
Under-fives stunted (%) *	57.7	55.9-59.5	10,503	44.4	42.7-46.2	10,883	-23.1	S
Under-fives underweight (%) *	41.3	39.5-43.1	10,503	28.7	27.0-30.5	10,883	-30.5	S
Under-fives wasted (%)**	12.2	11.1-13.3	10,503	9.7	8.7-10.7	10,883	-20.5	S
Vitamin A supplementation	59.9	56.7-63.0	9,677	53.1	50.3-55.1	9,777	-11.4	S

within past 6 months (% children 6-59 months)								
<p>* Definitions and methods per WHO reference population.</p> <p>Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different change. NS denotes no statistically significant change and S denotes statistically significant change</p>								

HIV/AIDS among children and women

The advent of the HIV/AIDS epidemic in the 1980s threatened child survival gains made globally since the 1960s [62]. Child survival stagnated and even reversed in many countries in sub-Saharan Africa[63] and HIV/AIDS was found to be an increasingly important cause of under-five mortality in sub-Saharan Africa [64].

In Ethiopia, the first cases of HIV infection were reported in 1986 [65]. Population trends in prevalence of HIV infection in Ethiopia were monitored through the 2005 and 2011 DHS. Among women aged 15–49 years HIV prevalence did not change between 2005 and 2011, with an estimated 1.9% infected.

Data from the UNAIDS Estimation and Projection Package/Spectrum estimate that 789,900 Ethiopians are currently living with HIV/AIDS and that there are more than 950,000 Ethiopian AIDS orphans; thus, despite reductions in infection rates, the country remains highly affected by the HIV epidemic [66]. In 2012, according to the PEPFAR Fiscal Year 2013 Country Operational Plan for Ethiopia, there were an estimated 760,000 people currently living with HIV and 20,000 new HIV infections; of those about 40% of new HIV infections are the result of maternal to child transmission. Together these data suggest that in 2012, there were about 8,000 incident HIV infections among children less than five years of age.

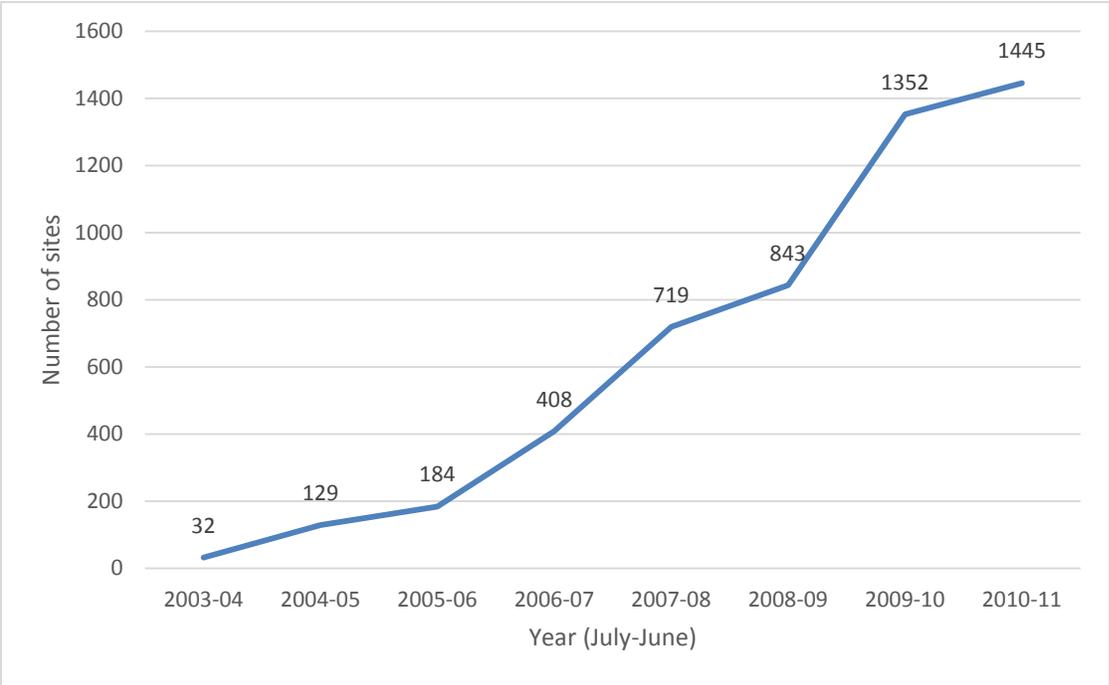
Stark variations in HIV prevalence are seen between urban and rural areas of the country as well as by region. According to the 2011 DHS, HIV prevalence among urban adults was 4.2% whereas prevalence in rural adults was 0.6%. Regionally, adult HIV prevalence ranged from 0.9% in SNNPR to 6.5% in Gambella. Despite these regional disparities in prevalence, no differential change in HIV prevalence by region was observed since 2005. In addition, regional ACCM patterns did not correlate with regional HIV prevalence patterns. This suggests that HIV prevalence over the study period is unlikely to have substantially affected or distorted trends in ACCM. The urban population proportion has increased from only 15% to 17% between 2000 and 2011. Trends of both malaria and HIV have improved over the last decade, but there should be little confounding because of a profound mutually inverse infection risk based upon urban and rural residence.

In addition to the DHS, HIV is also monitored among ANC attendees. ANC sentinel surveillance data reveal declines in HIV infection rates among women 15–24 years of age. Between 2003 and 2009 HIV infection rates halved in urban areas and declined by an even greater proportion in rural areas. New HIV infections declined by more than 25% in Ethiopia [66, 67].

Population-based estimates of HIV infection in children less than five years of age are not available; however, analyses based on national models of HIV and AIDS show that the HIV-attributable under-five mortality per 1000 live births (corrected for other competing causes of mortality) was around 5% in 2000 as compared to 2% in 2011 [8, 67]. The 2012 WHO World Health Statistics Report estimated that there were 11,130 and 5,420 HIV attributable deaths among children under the age of five years in years 2000 and 2010, respectively.

In 2011, the estimated percentage of HIV-positive pregnant women receiving anti-retrovirals (ARVs) to reduce the risk of mother-to-child transmission of HIV was 24%. The percentage of infants born to HIV-infected mothers who received virological tests for HIV within two months of birth was 11% and modeled estimates of mother-to-child transmission of HIV was 17% at six weeks (30% if breastfeeding is included). There were 1,445 facilities that provided prevention of maternal-to-child transmission of HIV (PMTCT) in 2011, an increase from 32 in 2003-04 (Figure 58). Despite this significant increase in PMTCT providers, a significant number of health facilities still do not provide this service. For example, PMTCT services were available in only 54% of facilities providing ANC and only 82% of women accessed ANC services at least once during her most recent pregnancy. Among the ANC facilities offering PMTCT services, 98% of women were counseled but only 75% were tested and 60% of those who tested positive were not provided with ARV prophylaxis for PMTCT [68]. In addition, only 20% of children with HIV receive ARVs [66].

Figure A.5.3.4: PMTCT Services Site Expansion in Ethiopia, 2003–2011 (July-June)



Source: [68, 69].

Annex 6: Health Management Information System (HMIS)

A.6.1 Malaria Morbidity Estimates

Since 2000, annual Health and Health Related Indicators reports which summarize data from the HMIS have been released. The trends in Ethiopian malaria morbidity from these reports between 2000 and 2013 are shown in Table A.5.1. Ethiopian HMIS data are only reported from public hospitals and health centers; data from the health posts and private facilities were not included until just recently. The number of reporting health facilities has doubled since 2009 (the first year for which the number of health facilities reporting is available) when there were 1,362 health facilities documented to have provided surveillance reporting data. However, it is estimated that reporting has increased 7-fold since 2000. By 2012, 93% of 125 hospitals and 80% of the total of 2,999 existing health centers were reporting surveillance data to HMIS. Due to these dramatic changes in reporting in addition to concerns about data quality over the evaluation period the HMIS data were not included in the analysis of malaria morbidity and mortality trends for this evaluation.

With the caveats about reporting rates and data quality in mind, HMIS data indicate that older age groups account for the majority of malaria cases in Ethiopia and that children less than five years of age only accounted for approximately 20% of the annual malaria admissions and outpatient visits in 2011-12. At baseline, malaria was responsible for 10% of all outpatient visits and 15% of admissions. Unfortunately, this information was not stratified by age category at baseline. Two peaks in malaria hospitalizations were observed in 2005-06 and 2010-11, both with approximately 59,000 inpatient cases reported. The most recent HMIS estimates of malaria hospitalizations are the highest with more than 80,000 inpatient cases reported in 2012-13. According to the HMIS data, in 2011-12 malaria was still accounting for 17% of the total outpatient visits and 8% of the total admissions in all age groups; pneumonia was the cause of 8% of outpatient visits and 8% of admissions for all age groups. For children aged less than five years, malaria accounted for 18% of outpatient visits and 8% of inpatient admissions, but pneumonia accounted for 16% of outpatient visits and 23% of inpatient admissions.

Table A.6.1: HMIS Malaria Morbidity Trends, Ethiopia, 2000–2014

Year July-June	HMIS OPD Malaria All Ages	HMIS OPD Malaria <5YO	HMIS IPD Malaria Admissions All Ages	HMIS IPD Malaria Admissions <5YO	No. of HF Reporting
2000-01	400,371	-	16,782	-	*492
2001-02	607,699	-	-	-	*527
2002-03	549,632	-	31,470	-	*570
2003-04	549,632	34,525	31,470	2,256	*645
2004-05	1,591,040	162,711	37,839	4,665	*738
2005-06	1,232,795	343,298	57,610	14,786	*773
2006-07	1,198,641	268,854	28,230	7,147	*839

2007-08	1,115,662	287,479	25,739	6,505	*820
2008-09	1,104,197	275,022	20,130	5,178	1,362
2009-10	1,738,682	422,543	38,387	10,548	2,141
2010-11	3,549,852	738,094	59,297	11,188	2,313
2011-12	3,384,589	762,534	44,696	8,979	2,634
2012-13	3,862,735	530,560	84,026	15,491	2,819
2013-14	2,627,182	324,203	16,326	5,103	3,338

Notes: IPD= inpatient department. OPD= Outpatient Department. Year based on Gregorian calendar. HMIS= Health Maintenance Information System. HF= Health Facility (includes Health Centers and Hospitals). <5YO= under five years of age.

*The number of health facilities reporting data to HMIS was not published prior to 2008, but the maximum number of health centers plus hospitals is provided as a proxy based upon Table 4.

Source: Health and Health Related Indicators Reports and HMIS (July-June reporting periods)

The HMIS data show significant increases in both outpatient and inpatient malaria cases from 2000 to 2013. Four hundred thousand outpatient malaria cases were reported in 2000-2001 and 3.5 million were reported in 2012-13. Inpatient cases increased from approximately 17,000 to 84,000 in the same time period. Available HMIS data span the entire evaluation period but are not representative of the larger population as health post data (covering most of the rural population) were not routinely included in HMIS until recently. HMIS data also suffer from incomplete reporting and variable reporting rates over the evaluation period. The number of facilities reporting increased from ~500 to 2800 between 2000 and 2013. While the HMIS data are likely the best source of data on hospital admissions and are growing more complete and representative as increasing numbers of facilities submit reports on a regular basis, interpretation of trends in inpatient or outpatient cases from these data are challenging.

Annex 7: Outbreaks

A.7.1 History of Malaria Outbreaks in Ethiopia

Early 20th Century Outbreaks

Periodic malaria epidemics have occurred since at least the 1930's in Ethiopia, although documentation is not widely available from the early 20th century (Table A.7.1.1). The catastrophic 1958 malaria epidemic in Ethiopia has been well described [70]. In 1958, Ethiopia's total population was estimated at 18 million, of which 10 million were at risk for malaria (based upon the distribution of the population living below 2,000m). At least 3 million acute malaria infections (30% attack rate) and 150,000 malaria deaths (5% CFR, and 1,500 deaths per 100,000 of the at risk population) were reported during this outbreak, and the majority of cases were due to *P. falciparum* infections.

Although several villages had malaria CFRs of at least 20%, typically 5–10% malaria CFRs were observed in 1958 in malarious areas. Several health facility-based case series documented that outpatient malaria morbidity in 1958 was about four to five times greater than prior non-epidemic years [71]. Although Fontaine did not specifically estimate the mortality among children less than five years of age, a reasonable estimate is that there may have been 50,000 deaths among this age group in 1958, assuming that modern HMIS trends of up to 33% of severe malaria hospitalizations and inpatient deaths are among children less than five years of age was applicable during this earlier time period. In response,

mass drug administration of CQ was conducted in several affected districts in 1958. A primary problem in 1958 was that there was not enough CQ for the clinical need, and it was difficult for health workers to reach remote rural areas because of poor roads and infrastructure. Fontaine implicated excessively rainy weather with anomalous warm temperatures and high humidity as a major factor that increased vector densities in 1958, similar to the circumstances related to malaria outbreaks that had been described earlier in India.

Malaria Epidemiology and Outbreaks between 1959 and 1999

Significant and widespread malaria epidemics were reported in Ethiopia in subsequent years as shown in Table A.7.1.1; however, none of these later epidemics had attack rates, number of affected districts, CFRs, or total malaria deaths on the same scale as the 1958 outbreak. Public health responses included IRS spraying with DDT and mass drug administration of anti-malarial drugs through the Malaria Elimination Service and later efforts [72, 73]. Multi-year periodicity of epidemics were apparent, leading Ethiopian malaria experts to conclude that widespread and severe epidemics tended to periodically occur in Ethiopia about every 5–8 years in association with weather anomalies that included atypical rain patterns. Although prior to 2009, most cases of malaria were clinically diagnosed (i.e., presumptively treated without laboratory-confirmation), the excess numbers of hospitalizations and reported malaria deaths in these epidemic years ([74]) provides plausible evidence of malaria epidemics causing higher mortality rates compared with non-epidemic years. Morbidity and mortality data trends from the 1930's through 2003-04 are summarized in Table A.7.1.1.

In the 1998 malaria epidemic, malaria caused at least 4.8 million clinical malaria illnesses and at least 14,783 malaria deaths, during which time *P. falciparum* CQ resistance was well documented, prompting a switch in primary antimalarial drugs from CQ to SP [75]. The Anti-Malaria Association (later known as the Health Development and Anti-Malaria Association (HDAMA) [76]) was formed in Ethiopia as a result of the 1998 major malaria epidemic. The epidemic occurred in highland and semi-arid areas often associated with inter-annual fluctuations in rainfall and temperature. These epidemics were particularly devastating because they occurred in areas where large portions of the population lack immunity to malaria. The HDAMA later collaborated with various researchers to study the effect of climate change on malaria and to help predict widespread epidemics [77]. After 1998, and the change of primary antimalarial treatment to SP, malaria-related morbidity, mortality, and epidemics temporarily subsided, although emerging parasite resistance to SP was detectable within several years.

Table A.7.1.1: Major Malaria Epidemic Years, Ethiopia, 1930-2013

Year	Illnesses	Deaths	Comments
1930's			Italian investigators
1953		7,000	Covell, Demba plain[78],
1958	3,000,000	150,000	Excess rain, anomalous warm temperatures, high humidity [70]
1965			Outbreak occurred, but no case data available
1973			Outbreak occurred, but no

			case data available
1981			Outbreak occurred, but no case data available
1988			Outbreak occurred, but no case data available
1991	37,189	461	
1992			Outbreak occurred, but no case data available
1998	4,800,000	14,783	Chloroquine resistance
2003	6,100,000	79,500	Midpoint SP resistance [71, 79]

Source: [71, 73, 80]

Malaria Outbreak of 2003–2004

In 2003, an outbreak affected 211 (of ~700) districts and 3,698 villages affecting a population of approximately 23 million people [71]. An urgent news posting published in *The Lancet* in December 2003 requested international emergency assistance from UNICEF, WHO, and others, suggesting that up to 15 million people could be affected, and reported that Tigray, Amhara, SNNP and Somali Regional States appeared to be the most heavily affected areas [79]; Medicins Sans Frontier investigators reported that crude mortality rates ranged from 3.5 to 11 per 10,000 people, per day (with 1 per 10,000 people per day considered as the threshold of an emergency). Emerging SP resistance was considered to be a major aggravating factor at that time along with two preceding years of drought. An intensive epidemiological investigation of 68 health facilities within 50 of the affected districts found that documented malaria cases exceeded the expected malaria caseloads in these facilities by 6-fold, during a time when *P. falciparum* SP resistance was emerging in Ethiopia [71]. An estimated 6.1 million acute malaria illnesses, and between 45,000–114,000 malaria deaths (mid-point 79,500 deaths among all age groups) occurred during that epidemic [71].

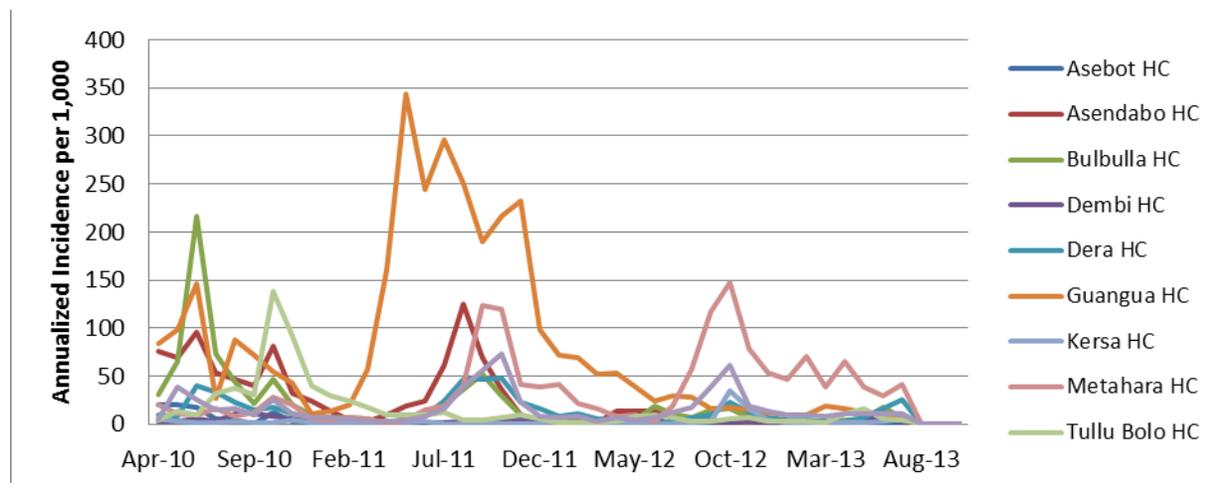
Outbreak Data from 10 Sentinel Sites in Oromia Regional State

Over 39 months of follow up from March 2010–June 2013, five out of the 10 sites sentinel sites in Oromia experienced small to moderate district-level malaria outbreaks. Of 390 possible facility-months, there were 77 facility-months with calculated epidemic conditions indicating that perceived minor epidemics were occurring approximately 20% of the time at these sentinel sites. From among these 10 sites, a single site, Guangua Health Center in Abaya district (population 35,000), experienced a sustained, predominately *P. falciparum* epidemic between April and December 2011 with outpatient malaria morbidity that was more than three times higher than previous years (3,501 *P. falciparum*, 2,913 *P. vivax*, and 161 mixed infections) with 65 malaria hospitalizations and one malaria death. This single outbreak comprised almost two-thirds of all hospitalizations (65 out of 101), and half of all deaths (1 out of 2 total deaths) experienced by the entire 10 sentinel site network over 39 months of enhanced surveillance. Monthly malaria trends for all 10 sentinel sites are provided in Figure A.7.1.2. This Guangua Health Center sentinel site recorded malaria morbidity from seven health posts in 12 affected kebeles in the Abaya district. After further investigation, two rounds of IRS spraying in 2011 appeared to be

ineffective due to suspected deltamethrin resistance, and reported ITN ownership and use was very low since the last ITN distribution had occurred more than 36 months previously.

Based on the experience of 10 sentinel sites in Oromia, greater than one malaria hospitalization per week at a health center or more than one malaria death per month within a district likely indicated a potential malaria case build up or early epidemic warning that should initiate an investigation and response. The Guangua Health Center outbreak, which was considered a small-scale outbreak compared to the other historical outbreaks mentioned above, was associated with persistent intermittent rains after the rainy season ended, combined with probable deltamethrin resistance and very low ITN availability and use. Adequate amounts of ACTs and RDTs were provided to health facilities throughout the epidemic, and there were no significant critical stock outs. In 2012, Guangua Health Center malaria rates returned to the expected baseline. Following the low transmission season in early 2012, IRS with propoxur and LLIN hang-up projects were completed. Morbidity from *P. falciparum* infections and hospitalizations were significantly lower in the Guangua Health Center catchment area after these interventions, although *P. vivax* rates remained elevated later in 2012 compared to 2010.

Figure A.7.1.2: Annual outpatient malaria incidence per 1,000 populations for all health center catchment areas, Ten Epidemic Sites, Oromia Regional State Ethiopia, 2010–2012

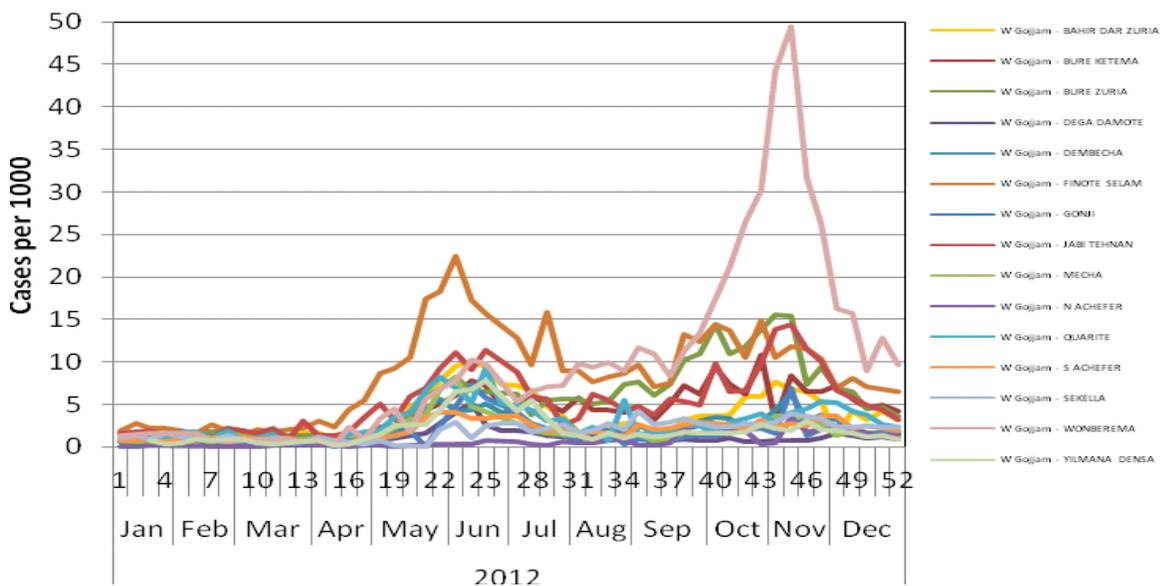


Severe Focal Malaria Epidemic, Wenberma District, Amhara Region, November, 2012

In November 2012, the FMOH responded to PHEM reports of 12 districts with significant increases in malaria cases and a possible malaria outbreak (Figure A.7.1.3). An especially severe outbreak occurred in southwestern Amhara Region in Wenberma district of West Gojjam zone that resulted in an onsite epidemic investigation by local health officials and an enhanced outbreak response by senior FMOH/PHEM officials and The Carter Center [81]. Malaria incidence from passive health facility surveillance in Wenberma peaked at 49.4 cases per 1,000 per week the second week of November 2012 (Figure A.7.1.3), with a total of 16,854 confirmed malaria cases occurring over a 4-week period in October and November. The response focused on the 14 most heavily affected kebeles, with an estimated population of about 70,000 persons. The malaria incidence fell to 8.9 cases per 1,000 per week (a decrease of 81.9%) by the second week of December following mass screen and treat activities

of the “MalTra campaign”, which is an annual mass febrile screening, RDT testing, and treatment for malaria project coupled with mass distribution of azithromycin for trachoma control that targets the entire population of the Amhara Region. In the affected areas, a total of 32,210 febrile cases were tested by RDT, of which 21,297 (66.1%) were malaria positive (79.6% *P. falciparum*; 20.4% *P. vivax*). About 1% (800 people, 1,143 malaria hospitalizations per 100,000 per year) of the affected population required hospitalization for severe malaria, and there were four deaths (inpatient CFR 0.5%, 5.7 malaria deaths per 100,000 per year). Local health providers treated severe malaria cases in the Amhara Region with rectal and IV artesunate, as per the recently updated malaria treatment guidelines. The combined effectiveness of early access to ACTs and intravenous or rectal artesunate likely contributed to the low (0.5%) mortality among hospitalized malaria cases in the 2012 Wenberma epidemic. Since most of the population was systematically reached through mass screen and treat via house-to-house enhanced active surveillance within a several week period, it is unlikely that many malaria illnesses or any malaria deaths were missed through this coordinated outbreak response effort. In addition, IRS spraying with propoxur was performed in early December 2012 to prevent further case build-ups. Also noteworthy from this outbreak response in 2012 was that mass drug administration [82] of antimalarial medications was not performed as had been the previous practice from the 1998 FMOH Malaria Epidemic Prevention and Control Guidelines; rather, the mass fever screening and treatment approach was used since RDT and microscopy resources were available, and the epidemic guidelines had been updated accordingly in early 2012.

Figure A.6.2.3: Weekly confirmed malaria incidence (per 1,000) from passive health facility surveillance in districts of West Gojjam zone, Amhara Region, 2012

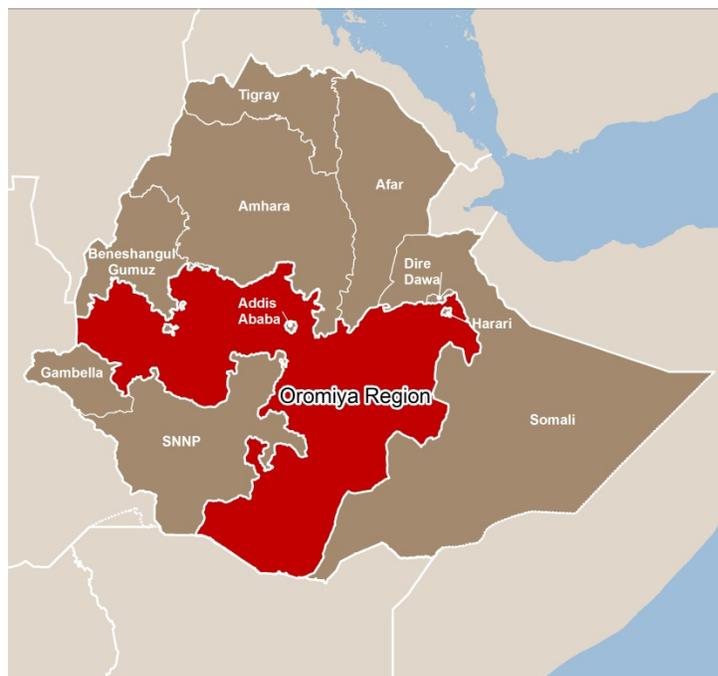


Source: ANRS/SHB/The Carter Center.

Annex 8: Oromia Region Case Study

Oromia Regional State is the largest of the 11 regional states in Ethiopia and covers approximately 298,164 square kilometers, roughly one-third of the country (Figure A.8.1) and approximately one-third of the population [83]. Malaria in Oromia, as in most other regions in the country, is a leading public health problem. In 2011-12, an estimated 1.14 million outpatient malaria cases (668,422 confirmed and 467,116 clinical) occurred in the region¹. Clinical malaria in Oromia accounts for about 30% of the total outpatient consultations and for 20–30% of the total inpatients. There has been an influx of donor support for malaria control in Oromia, especially since 2003. In addition, researchers have been studying malaria in Oromia since 2004, and are therefore able to provide additional data on malaria control activities. This case study is a subnational assessment of malaria control interventions and malaria morbidity and mortality trends in Oromia to supplement the national focus of this evaluation and is based largely on the report produced by the Malaria Consortium titled “Trends in burden of malaria at health facilities in Oromia Regional State, 2006-2010 G.C.”[4].

Figure A.8.1: Oromia Regional State, Ethiopia



Malaria Intervention Coverage in Oromia Region

Vector Control

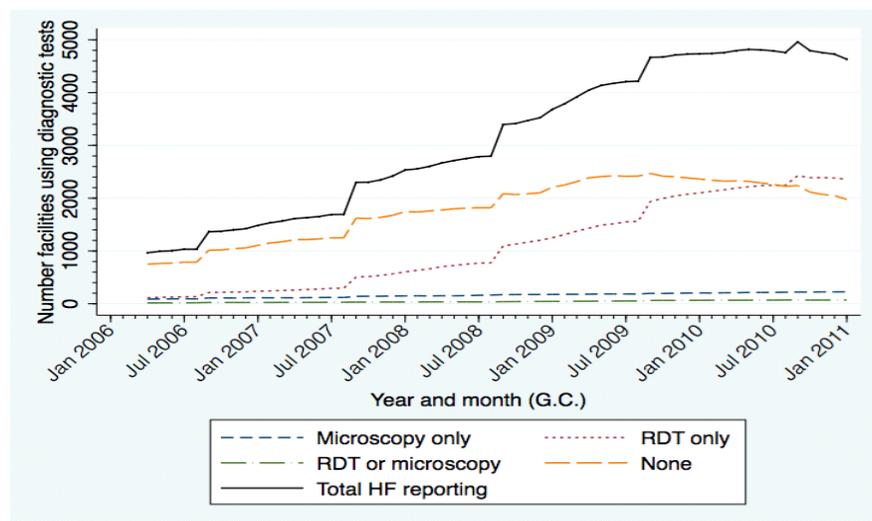
ITN household ownership was lower in Oromia Region (44% vs. 55% national) than in many of the other regions in Ethiopia. ITN use by children less than five years of age was the lowest in Oromia Region compared to other regions (27% vs. 38% national). IRS has also been applied in Oromia Region. Between 2000 and 2005, 8.7% of structures were sprayed and 12.4% of the population in Oromia Region was protected by IRS.

¹ UNICEF, unpublished malaria micro-planning data

Diagnosis

Clinically treated malaria cases decreased from 80% of reported malaria cases in 2000-01 in Oromia Region to 55% in 2011-12, with a further reduction to 23% in 2012-13 (discussed further in Figure A.8.4 below). Figure A.8.2 shows malaria diagnostic trends in Oromia Region. By January 2011, more than half of facilities were reporting laboratory confirmed malaria cases, mostly via RDTs; whereas in 2006, only a small minority of health facilities reported laboratory confirmed malaria cases in Oromia Region.

Figure A.8.2: Malaria diagnostic trends in Oromia Region, April 2006-January 2011



Source: Ruth Ashton, Malaria Consortium. Feb 2013

Case Management

Table A.8.1 shows a three-year trend in ACTs and RDTs needed and delivered in Oromia Regional State. Malaria morbidity data from 2009-10 revealed that only 1,080,922 ACTs were needed for both clinical and laboratory confirmed *P. falciparum* cases. There were 1,875,987 ACT doses available, representing a 98% excess. Clinical malaria diagnoses decreased year to year, while lab confirmed cases increased year to year over this three-year period. By 2011-12, ACTs delivered had been reduced to 731,650, while the actual ACT need was only 636,971 doses. It appeared that in all three years from 2009–2012, adequate ACTs had been delivered to meet the actual malaria morbidity burden, and an excess of RDTs in the latter two years facilitated increasing the percentage of suspect malaria cases that were laboratory tested. These results demonstrate that in Oromia there were adequate supplies of RDTs and ACTs being delivered to the Oromia Regional Health Bureau from 2009–2012.

Table A.8.1: Oromia Regional Health Bureau malaria micro-planning data trends, from 2009–2013 (July-June)

Description	2009–10	2010–11	2011–12	2012-13
Suspect malaria	1,623,393	3,050,311	2,393,910	2,839,459

Clinical malaria	892,932	1,012,333	467,116	229,265
Lab tested	730,461	2,037,978	1,926,794	2,610,194
Lab confirmed	237,849	696,396	668,422	828,975
<i>P. falciparum</i>	145,457	385,906	436,802	594,914
<i>P. vivax</i>	92,392	310,490	231,620	234,061
ACT needed	1,038,389	1,398,239	903,918	824,179
ACT delivered	1,875,987#	1,961,760*	841,770*	661,690*
RDT needed	3,682,367	3,479,000	2,574,689	3,088,147
RDT delivered	1,250,245#	2,440,500#	1,680,000#	551,000#

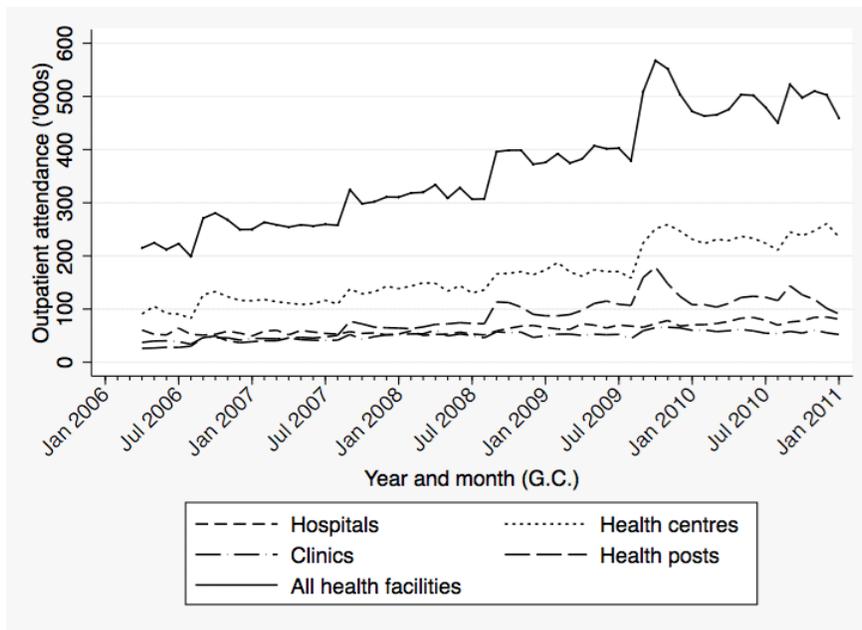
*Data Sources = UNICEF annual microplan reports (2010-2013) plus ORHB surveillance report of 2009-2010 (S. Chibsa from 2011) plus ORHB presentations to PMI of 30 December 2013 *(ACT delivered 2010-2013 and February 2013#). Since 2009, "ACT needed" included clinically treated cases (presumed) plus confirmed P. falciparum cases. *In addition to ACTs delivered through ORHB, FMOH has required contingency stocks of ACT to be available (15-25% extra) in FMOH and UNICEF warehouses in Addis Ababa for possible outbreaks, etc. " Lab tested" includes laboratory tested (examined) by either blood film microscopy or malaria RDT. See Table 13 footnote for discussion of current WHO malaria surveillance definitions. Clinical malaria has been renamed "Presumed" malaria in WMR2013. "Lab Tested" malaria was recently renamed "Laboratory Examined."*

Trends in Malaria Morbidity and Mortality

Trends in Reporting and OPD Visits

Figure A.8.3 shows the scale up of public health facility reporting of malaria in Oromia Regional State. Between April 2006 and January 2011, there was an overall increase (from 969 to 4,650) in the number of health facilities reporting data to *woreda* health offices (see Figure A.7.10 for a breakdown by facility type). Slight increases were seen in the number of hospitals (21 to 30) and clinics (204 to 252) available, but the number of health centers more than doubled (242 to 520) and the number of health posts increased by more than 7-fold (502 to 3,848) [4], similar to what was seen throughout Ethiopia. Figure A.8.3 shows the expansion of health facilities, particularly health centers and health posts, has resulted in a more than doubling of reported total outpatient visits of all ages.

Figure A.8.3: Oromia Regional State outpatient visit trends by facility type, all ages, 2006-2011

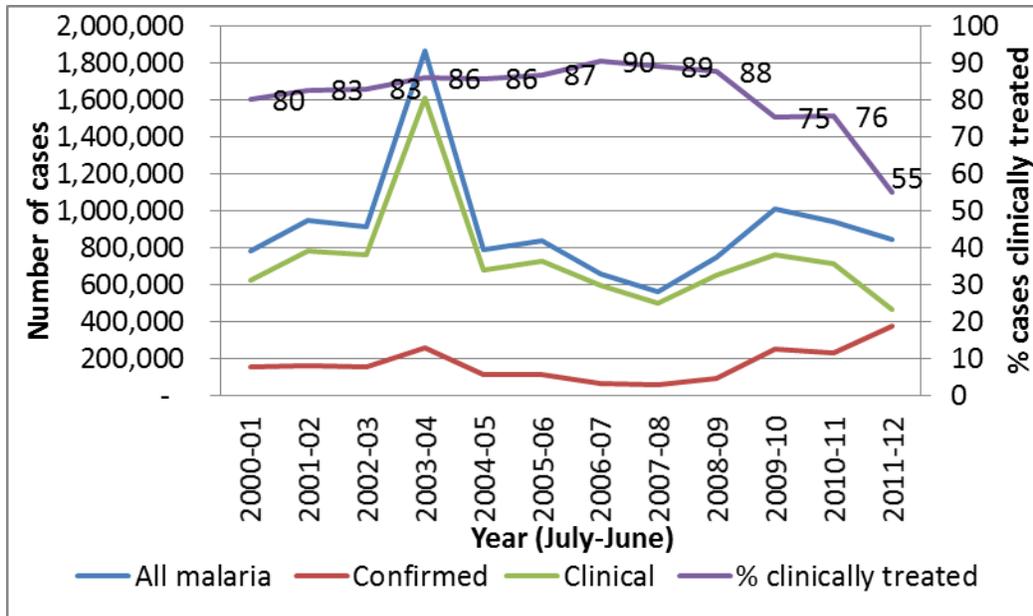


Source: Ruth Ashton, Malaria Consortium. Feb 2013

Trends in Malaria Morbidity in Oromia Regional State

The number of both confirmed and clinical malaria cases (fever cases) treated over the last twelve years (2000–2012) is shown in Figure A.8.4. The number of confirmed malaria cases showed a slight increase since 2009 but the clinical malaria cases decreased during the same period. This suggests an increase in the testing rate of all suspected or febrile malaria cases attending the health facilities. It is evident from the figure that the highest number of malaria cases was observed during the 2003-04 epidemic year. The trend in the percentage of clinically treated malaria cases in Oromia over the past 12 years (2001–2012) shows a decrease from about 80% in 2001 to 55% in 2012. The percentage of malaria cases clinically treated has continued to decline to 23% in 2012-13. This demonstrates an increase in laboratory testing, especially since 2009.

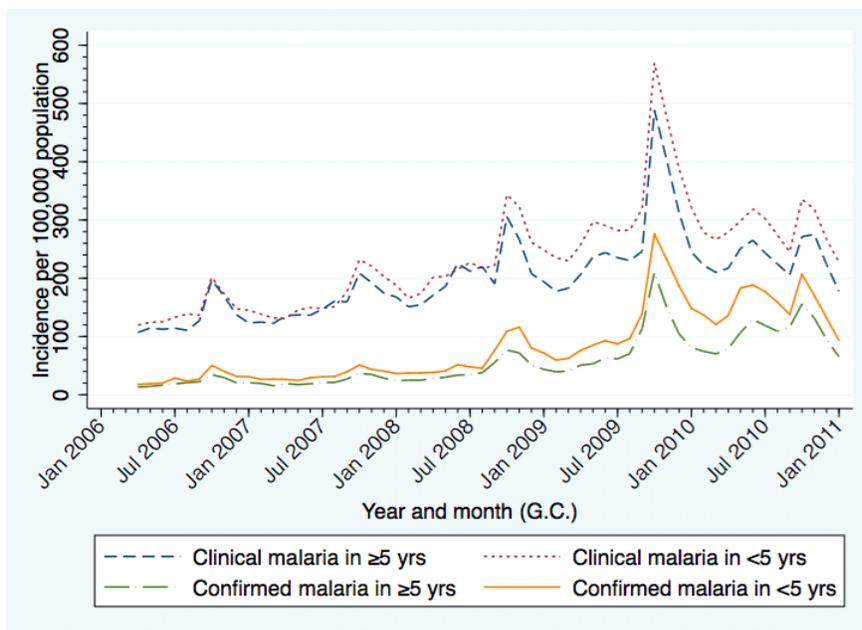
Figure A.8.4: Trends in the number of malaria cases in all ages, Oromia Regional State, 2000–2012 (July-June)



Source: Oromia Regional Health Bureau, 2012.

Clinical malaria and confirmed malaria are only slightly more frequent (200 vs. 140 per 100,000 in October 2010) in children less than five years old than in older children and adults on a population basis in Oromia (Figure A.8.5). For confirmed malaria cases by zones within Oromia see Figure A.7.12. The peak in malaria in late 2009 likely represents a focal outbreak in several districts in western Oromia due to peak seasonal malaria combined with epidemic conditions (favorable climate conditions) in October 2009 [4].

Figure A.8.5: Incidence of clinical and confirmed malaria among children less than five years, and all those aged five years and older by population, Oromia Regional State, 2006-2011



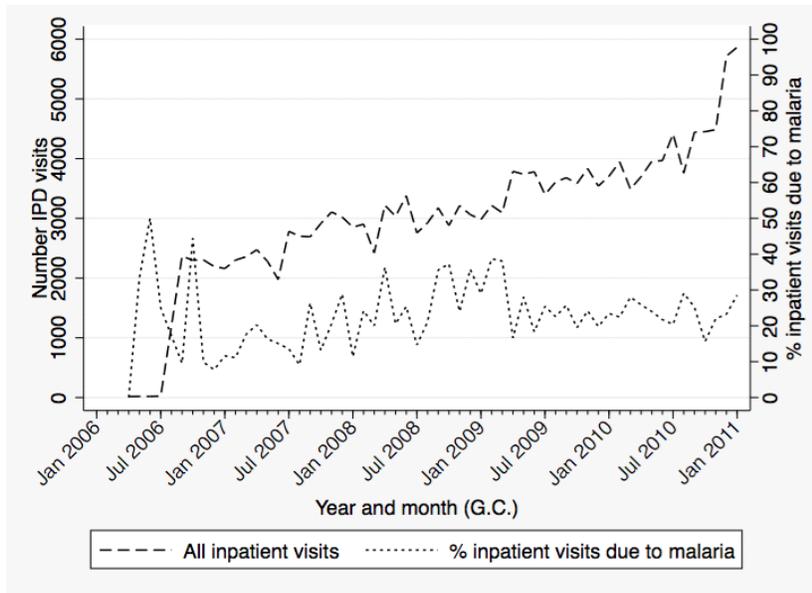
Source: Ruth Ashton, *Malaria Consortium*. Feb 2013.

For the total number of clinical malaria cases and confirmed malaria cases among children less than five years of age in Oromia, broken down by facility type, see Figure A.7.10. The increased number of clinical and confirmed malaria cases from 2006 until 2011 likely represents improved reporting and availability of health facilities (see Figure A.8.6 and Figure A.8.7), particularly health centers and health posts. The increase in confirmed cases is also likely due to the scale-up of diagnostics (RDTs) after 2009 (see Figure A.8.7).

Trends in Inpatient Malaria

Figure A.8.6 shows the increase in total inpatients in health centers and hospitals from approximately 2,000 to 6,000 for all age groups between 2006 and 2011, but the percent of admissions that were from malaria remained constant at about 20–30%, particularly from 2009 onwards. The increase in total inpatients likely represents increased availability of health facilities and increased reporting rather than an increasing trend in severe illness.

Figure A.8.6: Total number of inpatients recorded for all Oromia Regional State (left axis, dashed line), and the proportion of all inpatient visits which were due to malaria (right axis, dotted line), 2006–2011



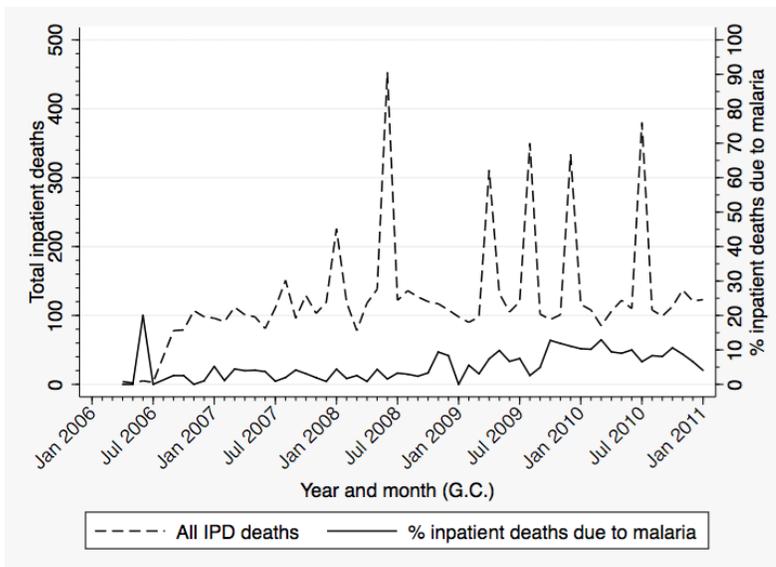
Source: Ruth Ashton, *Malaria Consortium*. Feb 2013

Inpatient malaria admissions among children less than five years of age are approximately 20–30% of the total malaria admissions, indicating that older age groups consistently represent the majority of severe malaria morbidity in Ethiopia, consistent with HMIS reports.

Trends in Malaria Mortality in Oromia Regional State

All-cause inpatient deaths remained relatively stable at 100–120 per month for the whole of Oromia Regional State, but five substantial peaks in mortality are seen in June 2008, April, August and December 2009, and July 2010 (Figure A.8.7) [4]. It is assumed that these peaks in inpatient deaths were due to sudden increases in non-malaria diseases, given the proportion of all inpatient deaths which were attributed to malaria was relatively stable throughout the study period at 5–10%.

Figure A.8.7: Trends of total monthly deaths among inpatients and of proportion of all inpatient deaths that were attributed to malaria in Oromia Regional State, 2006-2011



Source: Ruth Ashton, Malaria Consortium. Feb 2013

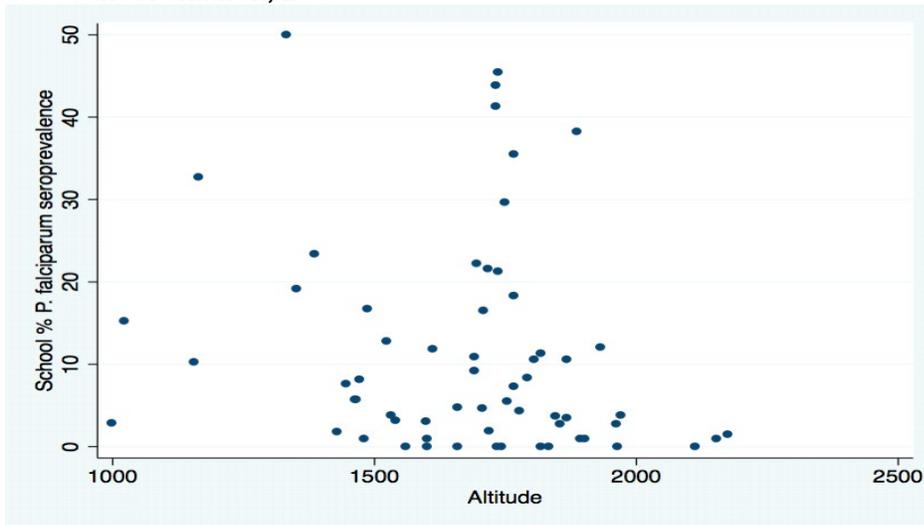
Additional data from 2010–11 and 2011–12 demonstrate an overall decline in malaria burden (malaria OPD visits, malaria IPD admissions and malaria mortality) between these two years and a shift from clinically diagnosed and treated malaria cases to confirmed and treated malaria cases.

Oromia Regional State Case Study Summary

Malaria control efforts have been scaled up in Oromia Regional State. ITN ownership and use has increased between 2005 and 2011, but still remains low compared to other regions in Ethiopia. During 2009–2012, there were adequate, even extra, RDTs and ACTs to diagnose and treat malaria. Malaria laboratory diagnosis is now near 80%, with only 55% of cases clinically diagnosed as of 2011–12, and 23% as of 2012-13. Between 2000-01 and 2011-12 there has been a fluctuation in the number of malaria cases. The greatest number of malaria cases (mostly clinically diagnosed at that time) was seen with the outbreak in 2003-04 that affected most regions of Ethiopia. The number of cases rose again in October 2009 with a focal outbreak. The number of malaria cases has declined slightly since 2009, but remains higher than during the period between the 2003-04 and 2009 outbreaks. These findings are likely confounded by an increase in the number of health facilities that have been built and are now reporting into the system, making it difficult to determine if there is a true increase in malaria cases. The proportions of inpatient admissions and deaths due to malaria have both remained relatively constant between 2006 and 2011. Similar to other regions in Ethiopia, malaria transmission is still occurring in Oromia, and additional time will be needed to see overall declines in malaria morbidity and mortality, although some decline has been seen already between 2010-11 and 2011-12.

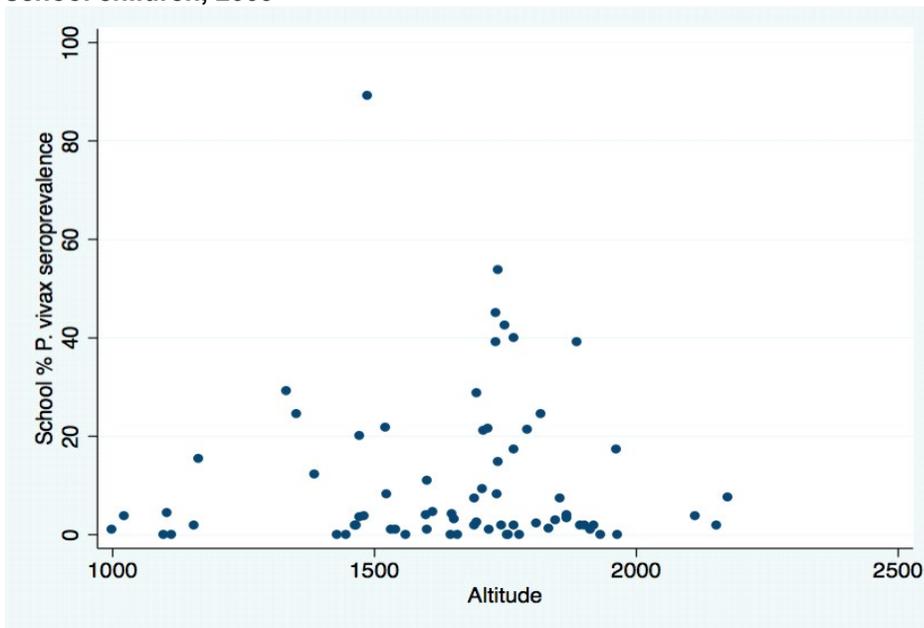
Figures A.8.8 and A.8.9 show estimates of *P. falciparum* and *P. vivax* seroprevalence, respectively, in 62 schools in Oromia Region in children aged 5-18 years (with a mean age of 11 years) in 2009.

Figure A.8.8: Scatterplot of measured *P. falciparum* seroprevalence in Oromia Region, 62 schools, 5900 school children, 2009



Source: Ruth Ashton's "Spatial epidemiology of *Plasmodium* spp. in Oromia Regional State, Ethiopia" report [84].

Figure A.8.9: Scatterplot of measured *P. vivax* seroprevalence in Oromia Region, 71 schools, 6600 school children, 2009

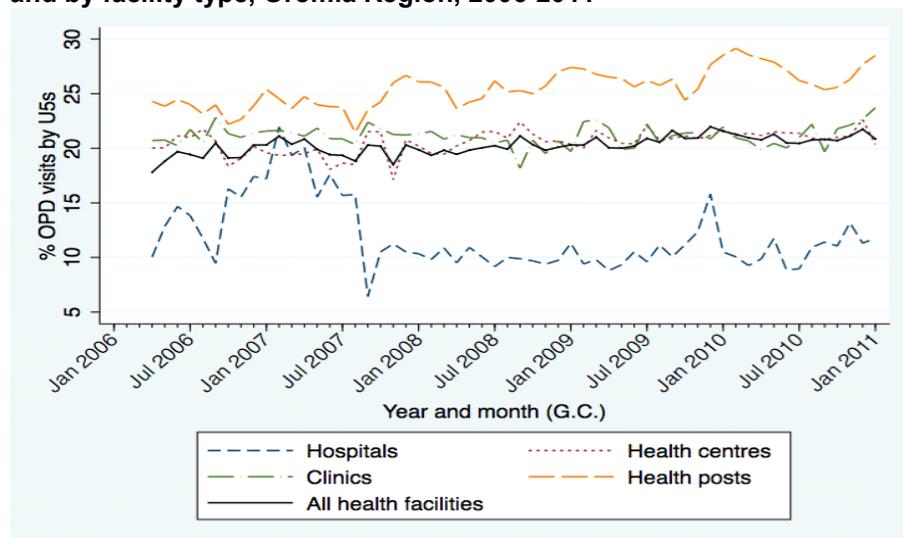


Source: Ruth Ashton's "Spatial epidemiology of *Plasmodium* spp. in Oromia Regional State, Ethiopia" report [84].

Health posts play an important role in the treatment of malaria cases in Oromia Region. Twenty-five percent of OPD visits at health posts are from children under five years of age; whereas the proportions of visits due to children under five years of age are less in other facility types (Figure A.8.10). In addition,

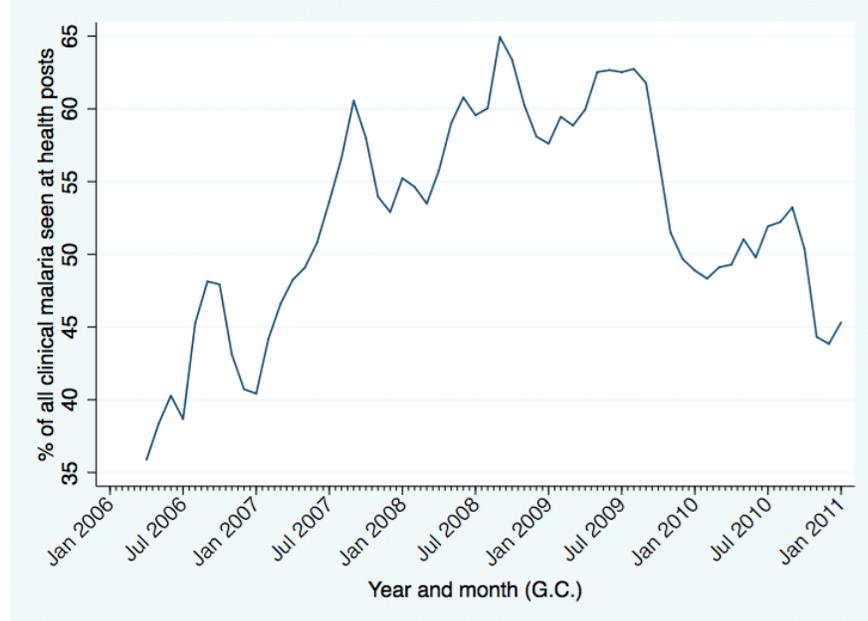
health posts see 35-65% of the clinical malaria cases (fever cases) in the government health system (Figure A.8.11).

Figure A.8.10: Proportion of outpatient attendance trends by children less than five years of age and by facility type, Oromia Region, 2006-2011



Source: Ruth Ashton’s “A retrospective analysis of routinely recorded health facility data from health post to hospital level in Oromia Regional State, 1998-2003 E.C and 2006-2010 G.C.” report [4]

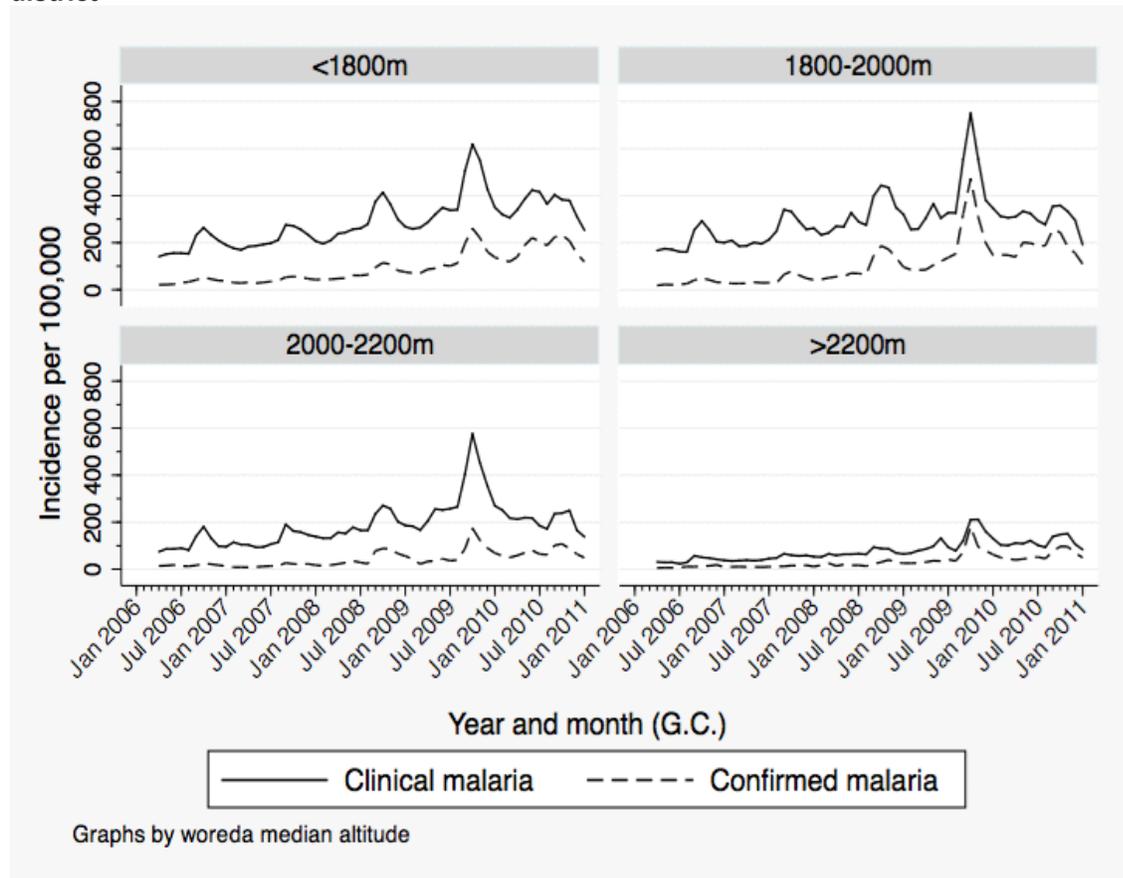
Figure A.8.11: Oromia Region outpatient malaria trends, health posts, 2006-2011



Source: Ruth Ashton’s “A retrospective analysis of routinely recorded health facility data from health post to hospital level in Oromia Regional State, 1998-2003 E.C and 2006-2010 G.C.” report [4].

There is very little malaria reported by districts with median altitude 2200m above sea level (Figure A.8.12). This is consistent with longstanding observations that most malaria transmission occurs below 2000 meters. A high percentage of the Ethiopian population lives at altitudes near 2000m, therefore risk classification can be confounded by altitude.

Figure A.8.12: Trends in Malaria, Oromia Regional Health Bureau, 2006-2011 by median altitude of district



Source: Ruth Ashton’s “A retrospective analysis of routinely recorded health facility data from health post to hospital level in Oromia Regional State, 1998-2003 E.C and 2006-2010 G.C.” report [4].

Annex 9: Detailed Calculations for Estimated Malaria Mortality in Ethiopia, 2000 through 2013

Baseline Years 2000 Through 2004

HMIS and other reporting surveillance systems were not robust enough in years 2000-2004 to base an accurate morbidity and mortality calculation since surveillance coverage data are largely unavailable and since nearly all malaria diagnosis was clinically based without laboratory confirmation at that time. Hence a review of available estimates as previously discussed in the main section of this report concerning morbidity mortality is needed. Malaria burden estimates for 2006 are summarized in Table A.9.1.

The estimate of 25,000 deaths for children less than five years and 41,000 annual deaths in all age groups was came from FMOH's input to the World Malaria Report 2008 for the year 2006. Negash's retrospective investigation of the major epidemic year (2003-2004) is a primary source of data for these estimates, but that was an outbreak investigation that included a summary of other contemporary malaria outbreak investigations, and should provide a quasi-measurement of morbidity and mortality in the major 2003-2004 epidemic year [71]. The PMI Baseline Needs Assessment report for Ethiopia in 2007 mentioned that there were widely assumed to be 70,000 annual malaria deaths among all age groups [85]. Since in most years according to HMIS and other surveillance reports, the number of total malaria deaths among all age groups is about three times the number of deaths among children less than five years in Ethiopia, we can also calculate that 25,000 annual deaths in children less than five years represent a high baseline mortality estimate for these children, that was largely applicable to the outbreak year of 2003-2004 (Table A.9.2).

Table A.9.1: Malaria Burden Estimates, Ethiopia, 2006

Estimated burden of Malaria	Age Group	Estimated cases and deaths			Estimated per 1,000		
		Number	Lower	Upper	Number	Lower	Upper
Fever suspected of being malaria	All ages	44,965,000	11,108,000	94,175,000	555	137	1,162
	< 5 years	7,514,000	1,856,000	15,737,000	559	138	1,171
Malaria cases	All ages	12,405,000	4,236,000	24,341,000	153	52	300
	< 5 years	2,073,000	708,000	4,068,000	154	53	303
Malaria deaths	All ages	41,000	14,000	75,000	0.5	0.17	0.93
	< 5 years	25,000	8,500	46,000	1.9	0.63	3.40
Malaria case fatality rate (%)	All ages	0.33					
	< 5 years						

Source: WHO, World Malaria Report 2008, page 68 [86]

Table A.9.2 Compiled Malaria Mortality Estimates, Ethiopia, 1958-2010

YEAR (GC)	AGE GROUPS	Malaria Mortality Deaths/Year			Malaria Deaths/1000/Year			SOURCE	COMMENT
		POINT	LOWER	UPPER	POINT	LOWER	UPPER		
1958	ALL	150,000			8.3			Fontaine [70]	Outbreaks Pop~18M
2000	<5YO	7420			0.56			WHS2012 [7]	Verbal autopsy
2000	<5YO	7743			0.59			Liu et al [8]	Verbal autopsy
2004	ALL	79,500	45,000	114,000	0.97	0.55	1.41	Negash et al [71]	Outbreak investigation, Major epidemics
2006	ALL	41,000	14,000	75,000	0.5	0.17	0.93	WMR2008 [86]	FMOH, pop~80M
2006	<5YO	25,000	8,500	46,000	1.9	0.63	3.4	WMR2008 [86]	FMOH
2007	ALL	70,000			0.85			PMI Baseline Survey [85]	
2010	<5YO	5,420			0.41			WHS2012 [7]	Verbal autopsy
2010	<5YO	4,514			0.34			Liu et al [8]	Verbal autopsy
2010	ALL	3,297	1,288	14,922	0.04	0.02	0.18	WMR2012 [87]	WHO modeling

Major epidemic years are especially feared because mortality increases at least 3-fold compared to non-epidemic years. If 25,000 deaths in young children represents the mortality in a severe epidemic year, then in prior non-epidemic years must have had mortality rates that were only about one-third of that amount. There are also two authoritative published studies using verbal autopsy methods including the WHO World Health Statistics (WHS) report 2012 [7], and the Lancet article [8] that both used verbal autopsy methods to estimate 7,420 and 7,743 respective deaths among children less than 5 years of age in year 2000 (Table A.9.3). If there were 7,420 deaths among under five year old children in year 2000, then there were also about twice as many persons who died in older age groups, so that the total malaria deaths among all age groups in year 2000 was estimated as 22,000 deaths as a low estimate. This low estimate for a non-epidemic year 2000 is much lower than the 70,000 total malaria deaths that were estimated by many experts at that time (i.e. the 2007 PMI Needs Assessment [85]). The 22,000 estimated malaria deaths per year among all ages compares with the 2,100 malaria deaths that were reported by Ethiopia to the World Malaria Report for the year 2003, indicating that Ethiopia's surveillance systems was detecting about 10 percent of all malaria deaths at baseline prior to RBM intervention scale up. Hence for these reasons, 7,420 is assumed to be the low baseline mortality estimate for years 2000, 2001, 2002, and 2005. For the year 2003-2004, there continue to be an estimated 25,000 deaths for children less than five years of age (Table A.9.4).

Table A.9.3: Estimates of Malaria Mortality by Verbal Autopsy, Ethiopia, 2000

WHO (WHS2012)	2000
<5Year Old ACCM	371,000
% Malaria	2
# <5Year Old Malaria deaths	7,420

Liu L , Lancet 2012	2000
<5Year Old ACCM	379,922
<5Year Old Malaria Deaths	7,743

Table A.9.4: High and Low Mortality Estimates by Year and Age group, Ethiopia, 2000-2012

	2001-2003	2004	2010-2011
Low <5YO malaria deaths	7,420**	25,000	1,000
High<5YO malaria deaths	25,000*	25,000	2,000
Low All ages Malaria Deaths	22,000	70,000	3,000
High All ages Malaria Deaths	70,000*	70,000	6,000

Sources: WHO, WMR2008* [86], WHS2012** [7], and Negash 2005 [71].

If emerging drug resistance to SP was a major cause of the major epidemic year 2003-2004, then sustained epidemics with high mortalities sustained at or exceeding 25,000 per year could have been expected were it not for developing a system to provide prompt access to diagnosis and treatment per malaria control intervention scale up. Although previously major epidemics were observed every 5-8 years, major epidemics have not been observed since 2004, and at least 25,000 additional avoided deaths from the prevented major epidemics are justified assuming that another expected major epidemic was prevented by 2010, seven years after 2003.

Estimated Malaria Mortality in Ethiopia, Years 2010 Through 2012:

In the 12 months from July 2011-June 2012, the most recent and approximately 100% complete surveillance data sets available in Ethiopia considering the population of 56 million at malaria risk reveal: 11,127,705 suspected malaria illnesses, including 9,255,139 (83%) malaria laboratory tested and 1,872,566 clinically treated (also known as “probable”) malaria illnesses without laboratory testing; from among the 9,255,139 laboratory tested cases, 5,522,462 had either clinical malaria (1,872,566 cases) or 3,649,896 laboratory-confirmed malaria infections (39.4% test positivity rate). Confirmed malaria cases were comprised of *P. falciparum* 2,475,337 (68%) and *P. vivax* 1,174,559 (32%). There were 44,696 malaria hospitalizations from that year (0.8% of total malaria diagnoses, 8/10,000 annual rate for those at risk), however, age group information is not yet available. In the HMIS data from the prior year (2010-2011), there were 59,287 hospitalizations among all ages for malaria (10.6/10,000), with 11,197 malaria hospitalizations for children less than five years of age; there were 2,307 reported inpatient malaria deaths among all age groups (4.1/100,000 per year) of which 1,757 and 550 were five years and older and less than five years, respectively. This is consistent with the multi-year trend that

malaria mortality in Ethiopia heavily affects all age groups and that the 5% inpatient case fatality for children less than five years of age is slightly higher than that for older age groups (3.7%).

The total number of malaria deaths among children less than five years of age must be somewhat higher than the 550 deaths for these reported in HMIS for the year 2010-2011, although 400 of those deaths were reported to be clinically diagnosed without laboratory confirmation, indicating that some of these might have been misclassified since they could have had other severe acute febrile illnesses (Table A.9.5). The number of HMIS reported deaths must be adjusted by 20% since HMIS completeness that year was only 80%, adding 137 deaths to these, for a sub-total of 687.5 theoretical HMIS public sector deaths (See Table A.9.6). According to 2011 MIS, only 69% of children less than five years of age sought care in the public sector, so that 687.5 is divided by 0.69, yielding 996 deaths among children to include those who may have had private sector care. Now those 996 estimated annual malaria deaths may not include an equal number of children who died at home without accessing any care or were unreported for various reasons (estimate derived from expert opinion), yielding the rounded number of 2,000 annual malaria deaths in Ethiopia among children less than five years of age as the highest possible reasonable estimate for 2011.

Table A.9.5: HMIS malaria mortality data from 2010 and 2011

HMIS 2010-2011	
Lab confirmed inpatient deaths <5 Years Old	150
Clinical Malaria Deaths <5 Years Old	400
Total Inpatient Malaria Deaths <5 Years Old	550

Table A.9.6: High and low estimates of malaria mortality 2010 and 2011

High malaria mortality estimate <5 Years		
High =150+400	550	
Complete* 1/0.8	687.5	
Private sector 1/0.69	996.3768	
Died at home 1/0.5	1992.754	~2000
Low malaria mortality estimate <5 Years		
Low = 150 + (400/3)	283.3333	
Complete* 1/0.8	354.1667	
Private sector* 1/0.69	513.285	
Died at home 1/0.5	1026.57	~1000

With the caveats previously stated, no more than approximately 2,000 malaria deaths are estimated to occur each year in Ethiopia in children less than five years of age. This estimate takes into account the fact that malaria surveillance is still imperfect, and adjusts for strengthened surveillance that now detects at least 25% of all malaria deaths in Ethiopia. Future special studies, together with rapidly improving laboratory diagnosis that is moving above 80% laboratory confirmation should be able to improve estimates of the number of children dying at home with malaria. It may be that estimates as low as 1,000 annual malaria deaths among these children could be justifiable. A similar estimate of

approximately 1,000 malaria deaths in children less than five years of age in year 2011 can be derived from HMIS data assuming that only one third of the clinical malaria deaths among inpatients would have had laboratory confirmed malaria, for a total of 283 inpatient public sector deaths; as mentioned previously, available surveillance data suggests that there are still challenges with malaria microscopy diagnosis, and many inpatients are still clinically diagnosed and treated. These estimates of 1,000 to 2,000 annual malaria deaths among children less than five years of age is also consistent with a total of between 3,000 and 6,000 malaria deaths among all age groups in 2012, including those with severe malaria who did not reach hospital and died at home, a malaria-specific mortality rate of between 5.3 to 10.7 per 100,000 per year among the population in malarious areas, and 5/100,000 among the total population of Ethiopia.

Checking these 3,000-6,000 annual malaria deaths among all age groups and this estimated malaria mortality rate of approximately 5 to 11 per 100,000 per year against recent experience and other publications: WHO's Global Health Observatory Data Repository estimates 3,297 [1,288-14,922] malaria deaths for all age groups in 2010 for Ethiopia. The PMI-supported network of ten sentinel sites in Oromia Regional State performed enhanced surveillance over three years for 450,000 people yielded only two malaria deaths (0.15/100,000/year) and 101 malaria inpatient hospitalizations (0.75/10,000). The Ethiopian IDSR study [3] documented that there was a 2.15/10,000 hospitalization rate in late 2008, and inpatient malaria mortality rate of 0.64/100,000/year. At Wembirma, Amhara Region the most intense focal malaria epidemic since year 2004 occurred affecting about 70,000 people within a district with a population of about 100,000 people; the 32,000 acute malaria illnesses resulted in 700 malaria hospitalizations (100/10,000), but only four malaria deaths (approximately 4 per 100,000 reported mortality rate in 2012). In the Wemberma epidemic, intensive house to house visits with mass screen and treat tactics ensured approximately 100% access to care and also ensured that few, if any, malaria illnesses were missed. In reality, the Wemberma epidemic was exceptionally severe, although the response was also exceptionally robust. If there were actually 5 to 10.7 malaria deaths per 100,000 per year, and given that an average malarious district has an approximately 100,000 population, and there are 700 malarious districts, many if not most of these 11 annual deaths would probably be obvious to a district health officer who is responsible for reporting all of these cases to central authorities. Therefore, 3,000-6,000 total estimated annual malaria deaths among all ages and 1,000-2,000 annual malaria deaths among children less than five years of age per year are sensitive to assumptions about how many children die at home from malaria outside of all health facility surveillance systems and also assumptions about access to medical care; it was shown by MIS 2011 that 51% of children had access to medical care within 24 hours of fever onset. If nearly all of the remaining children accessed the medical system within the subsequent several days when ill with malaria, then the number of undiagnosed and untreated children with malaria that were undetected by the health system might be a much small number than those used for our malaria mortality estimations, and the annual mortality of these children who were treated reasonably promptly with effective antimalarial medications would be expected to be very low.

The most conservative estimates (minimizing malaria program impact) are with baseline deaths at 7,420 reduced to the highest post-intervention estimate of 2,000 deaths annually that would have

cumulatively saved 32,860 lives since RBM intervention scale up. This assumes no population growth, and no credit for preventing epidemics (Table A.9.7).

Table A.9.7: Minimum estimated impact of malaria control intervention scale up based upon estimated annual malaria deaths among children less than five years of age, Ethiopia, 2000-2012

Year	Observed	Expected	O-E	Cumulative O-E
2000	7420	7420	0	0
2001	7420	7420	0	0
2002	7420	7420	0	0
2003	25000	25000	0	0
2004	7420	7420	0	0
2005	6000	7420	-1420	-1420
2006	5000	7420	-2420	-3840
2007	4000	7420	-3420	-7260
2008	3000	7420	-4420	-11680
2009	2500	7420	-4920	-16600
2010	2000	7420	-5420	-22020
2011	2000	7420	-5420	-27440
2012	2000	7420	-5420	-32860

The most optimistic scenario (regarding maximizing malaria program impact) assumes an expected 25,000 annual mortality (high baseline estimate) among children less than five years of age from unrelenting continuous epidemics since 2004 that were driven by emerging SP drug resistance, later reduced to only 1,000 annual deaths (low estimate) due to ACTs and other effective drug interventions that would have cumulatively prevented 199,080 deaths since 2004 (see Table A.9.8).

Table A.9.8: Maximum estimated impact of malaria control program scale up based upon estimated annual malaria deaths among children less than five years of age, Ethiopia, 2000-2012

Year	Observed	Expected	O-E	Cumulative O-E
2000	7420	7420	0	0
2001	7420	7420	0	0
2002	7420	7420	0	0
2003	25000	25000	0	0
2004	7420	25000	-17580	-17580
2005	5000	25000	-20000	-37580
2006	4000	25000	-21000	-58580
2007	3000	25000	-22000	-80580
2008	2000	25000	-23000	-103580
2009	1500	25000	-23500	-127080
2010	1000	25000	-24000	-151080
2011	1000	25000	-24000	-175080
2012	1000	25000	-24000	-199080

All other scenarios regarding the use of high and low estimates at baseline and post intervention intervals yield intermediate estimates of mortality, including a scenario that supposes that a major epidemic of the magnitude of 2003 was prevented only in 2010 by malaria control intervention scale up.

As shown in Table A.9.9, the prevention of only a single major epidemic saved a total of 57,560 lives since malaria control program scale up.

Table A.9.9: Intermediate estimated impact of malaria control intervention scale-up based upon estimated annual malaria deaths among children less than five years of age, Ethiopia, 2000-2012*

Year	Observed (O)	Estimated (E)	O-E	Cumulative O-E
2000	7420	7420	0	0
2001	7420	7420	0	0
2002	7420	7420	0	0
2003	25000	25000	0	0
2004	7000	7420	-420	-420
2005	5800	7420	-1620	-2040
2006	4500	7420	-2920	-4960
2007	3000	7420	-4420	-9380
2008	2000	7420	-5420	-14800
2009	1500	7420	-5920	-20720
2010	1000	25000	-24000	-44720
2011	1000	7420	-6420	-51140
2012	1000	7420	-6420	-57560

* Assumes major malaria outbreaks prevented in 2010 with scale-up, and also high mortality estimates post scale-up

Figure A.9.1 shows intermediate mortality assumptions of epidemic prevented in 2010 resulting in 57,560 cumulative lives saved through 2012 among children less than five years of age. Substantial scale up of malaria interventions began in 2005, and so no deaths were avoided until then. This intermediate assumption assumes that a major epidemic causing 25,000 malaria deaths was avoided in 2010.

Figure A.9.1: Intermediate mortality estimates of epidemic prevented in 2010

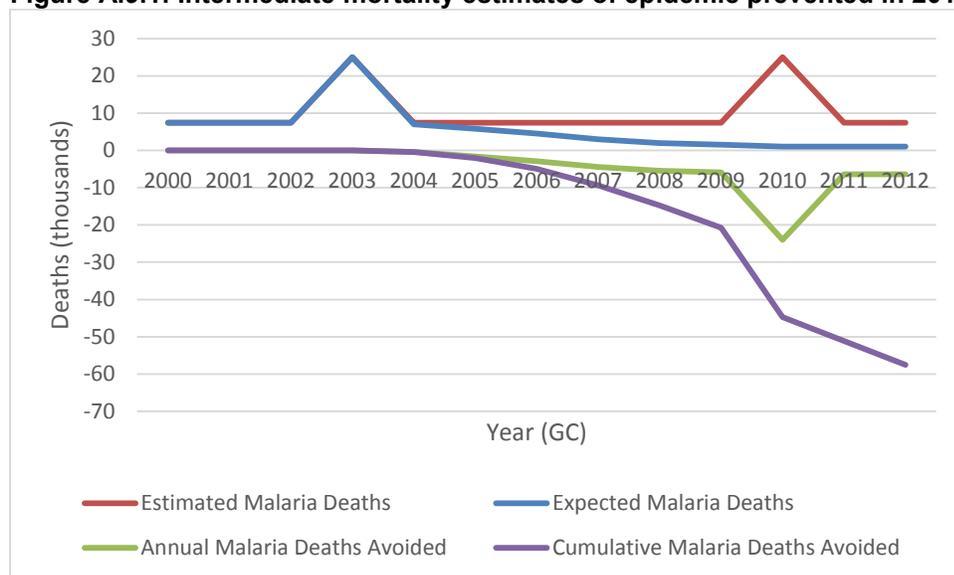
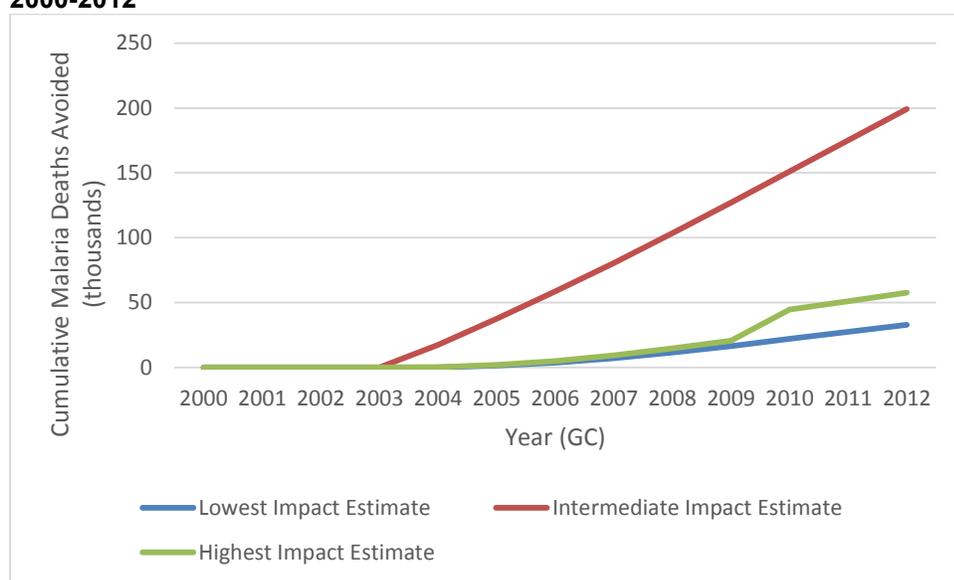


Figure A.9.2 shows cumulative malaria deaths avoided in children < 5 years of age in Ethiopia for the evaluation 12 years period. Under the highest impact scenario, unremitting epidemics at up to 24,000 deaths per year were avoided through malaria interventions since 2004. Under the lowest impact scenario, baseline mortality in 2000 was assumed to be 7420 deaths per year among children less than five years of age, and no credit was given for preventing later malaria epidemics at 5-7 years after the 2003-2004 major epidemics, and mortality in 2010 was assumed to be the highest reasonable estimate at 2,000 deaths annually. As an example of one of the intermediate or mid-impact scenarios, major epidemics were prevented during the single year of 2010, avoiding an additional 24,000 deaths that year.

Figure A.9.2: Malaria deaths cumulatively avoided in children less than five years of age, Ethiopia, 2000-2012



We have shown that using assumptions based upon the medical literature that malaria deaths among all age groups in Ethiopia are no more than 6,000 per year, as of 2011, and there might by 2012 be even lower mortalities than our lower estimate of 3,000 deaths per year (midpoint 5 malaria deaths per 100,000), resulting in between 1,000 and 2,000 deaths among children less than five years of age, annually. These annual malaria mortality estimates are an order of magnitude less than the mortality estimates from prior to 2006. Health systems strengthening including improved laboratory based surveillance, and the provision of 5-fold additional rural health facilities has ensured both the prompt access to care, and also ensured that most cases are adequately documented.

Since the scale up of malaria control interventions since 2005, there appears to have been a differential effect on malaria outpatient morbidity, hospitalizations and mortality: While malaria mortality has declined by at least 70% since baseline from 2000-2004, hospitalizations have remained stable, and reported outpatient malaria illnesses have remained stable or possibly increased slightly. Among all of the malaria control interventions, the most robust coverage has been with ACTs, which were definitely provided in sufficient number, and were combined with a much improved rural health network that enabled a 3-fold increased access to care within 24 hours. This combination of a much more effective medication compared to the SP that was used as the primary medicine prior to 2005, and the fact that this more effective medicine was provided sooner than previously through improved access to healthcare after acute illness onset would have lowered mortality dramatically, but would not have had as dramatic of an effect on the burden of malaria infection in the community, and ongoing transmission would have continued with the exception that large epidemics were being suppressed. The building of additional rural health centers with additional inpatient capacity in rural areas combined with rectal and intravenous artesunate would also serve to improve survival from severe malaria and increase hospitalizations because of improved healthcare access including the option of inpatient management for patients who on average are less severely ill with more survivable malaria infections but have had a minimal impact on the outpatient malaria burden.

The scale-up of malaria RDTs has allowed the ACT treatment doses to be targeted to those who have malaria, and RDT negative results have prompted an increasing search for other treatable infections such as pneumonia in the iCCM framework. Although it has always been the case that most acute febrile illnesses in Ethiopia have been from non-malaria causes (except during malaria outbreaks), the scale up of the Health Extension program at rural health posts has undoubtedly helped to reduce ACCM by avoiding the previous practice of empirically treating all febrile cases as malaria which inappropriately delayed definitive therapy and wasted malaria medications for most febrile children. Hence there may be a considerably higher indirect benefit on ACCM from malaria program scale up in Ethiopia than has been documented in other African countries; since year 2012, many childhood pneumonia cases have been already verified as negative for malaria by RDT.

For now, we continue to provide a conservative estimate of 1,000-2,000 annual malaria deaths among children less than five years of age, a figure that is 70% below the 7,420 estimated malaria deaths per the WHO WHS 2012 report for the non-epidemic year 2000, thus indicating significant malaria program impact by saving at least 32,000 lives among children less than five years of age since the scale up of standard malaria control interventions. At least 20,000 additional lives were saved when considering

that the periodical wide scale epidemics that were expected to occur by 2010 did not occur, and have appeared to have been successfully suppressed. By this intermediate estimate, 57,560 pediatric deaths were saved since 2004 by malaria control intervention scale-up. The malaria mortality burden in Ethiopia typically affects mostly older children and adults rather than young children. The malaria control intervention scale up has saved about three times as many total lives among all age groups from malaria deaths when considering each scenario mentioned above.

Despite accounting for only about 2% of total ACCM deaths in young children in non-epidemic years such as year 2000 according to the WHO WHS 2012, malaria remains an important cause of preventable death, rising to at least 6% of ACCM deaths in major epidemic years such as 2003-2004. Since 2010, malaria appears to be causing less than 1% of ACCM in Ethiopia, thanks to malaria control intervention scale up and to the creation of the Health Extension Program at rural health post that has enabled iCCM-trained HEWs with RDTs to quickly distinguish between malaria and other important conditions such as bacterial pneumonia. Rather than in earlier times when empirical malaria treatments were routinely given, the malaria control intervention scale up has now helped to quickly differentiate between important potentially fatal infections and focus appropriate treatment more rapidly, thus helping saving lives both from malaria and pneumonia and other important treatable diseases.

Table A.9.10: Projected Population (in '000s) Of Ethiopia by Variant and Urban Population, 2007-2037

Year	Total Population			Urban Population (Medium Variant)	
	Medium	High	Low	Population	Percentage
2007	73,845	73,845	73,845	11,874	16.1
2012	83,743	83,999	82,971	15,204	18.2
2013	85,838	86,174	84,835	15,928	18.6
2017	94,352	95,149	92,304	19,087	20.2
2022	105,162	106,906	101,486	23,795	22.6
2027	115,933	118,908	110,400	29,245	25.2
2032	126,487	130,857	119,069	35,440	28.0
2037	136,745	142,570	127,454	42,331	31.0

Source: Central Statistical Agency website (<http://www.csa.gov.et/>)

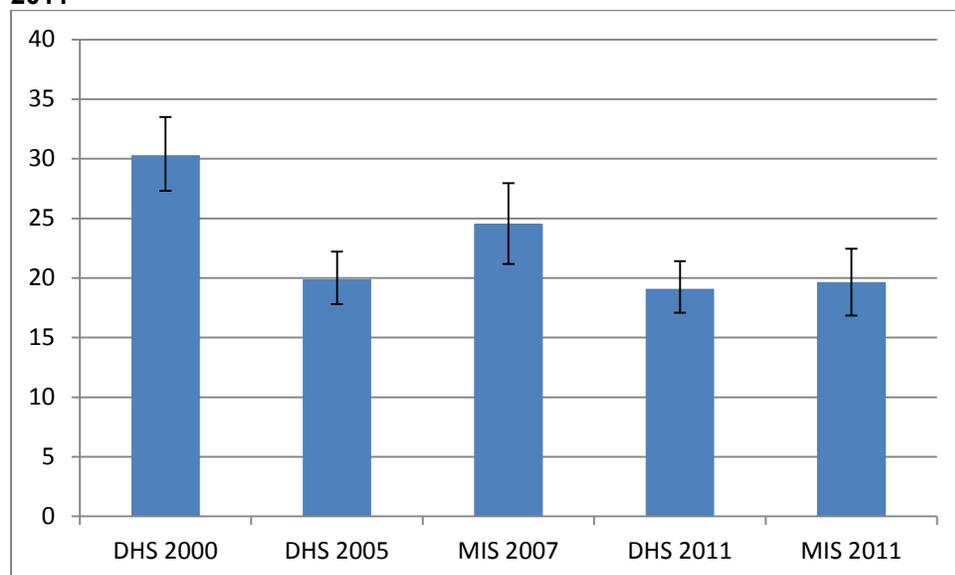
Annex 10: Additional Topics

A.10.1 Fever

In addition to the RBM-MERG morbidity indicators, this annex includes a description of trends in fever, defined as the proportion of children under five years of age whose mothers or care-takers (for the MICS survey only) reported had suffered fever within a two week period preceding the survey. The reasons for including this indicator are because an association between fever prevalence and malaria control is biologically plausible, because national trend data is available for the entire study period, and because these data can supplement analyses of facility-based measures of “presumed malaria” that are plagued with several shortcomings including incomplete reporting and lack of diagnostic confirmation.

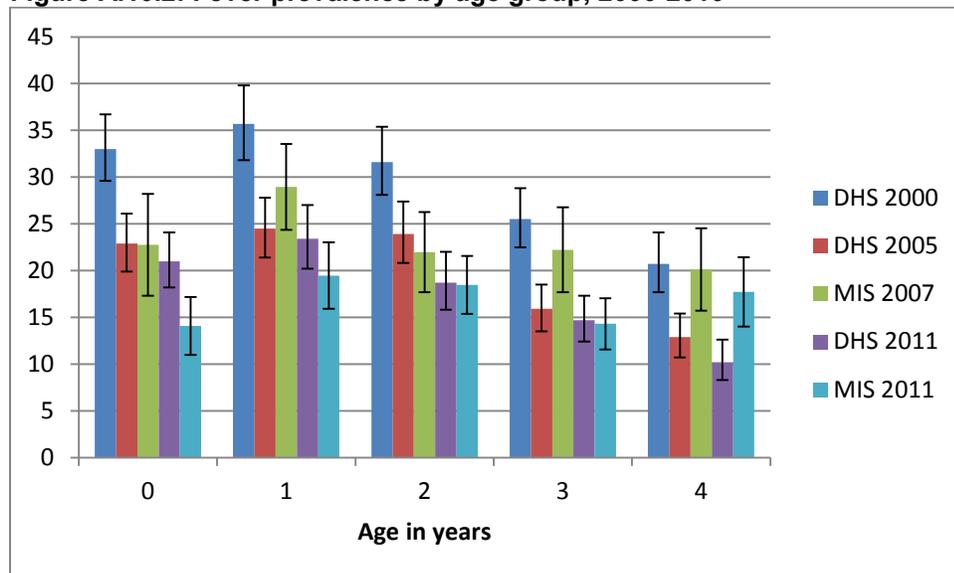
The DHS questionnaire requested mothers to report any incidence of fever among children under-five years of age, during a two-week period preceding the survey. However, it should be noted that fever is an imperfect proxy of the burden of malaria disease because malaria is not the sole cause of fever. A systematic review [88] of 39 studies across 16 countries in Sub-Saharan Africa between 2001 and 2009 found that just 22% of children (of various age groups) presenting with fever tested positive for malaria. In addition, no clinical diagnosis or testing was conducted, making the validity reliant on the accuracy of self-reported fever information. In addition, information on fever was only asked of interviewed mothers, a methodological strategy which may introduce selection bias. For analyses of correlation between the morbidity indicators, this outcome variable is limited to children aged 6-59 months.

Figure A.10.1: Fever during the two weeks prior to survey, children under-five years of age, 2000-2011



Although prevalence of recent fever in children under five has decreased over the study period, the only significant decrease occurred between 2000 and 2005 (Figure A.10.1). The trend has leveled out and remains virtually the same from 2005 to 2011. As fever has many etiologies not limited to malaria, this observed trend is challenging to interpret. It could be the case that fever prevalence has remained level despite great improvements in malaria control, due to declines in other child health interventions.

Figure A.10.2: Fever prevalence by age group, 2000-2010



Breaking down the trends in fever by age group reveals important declines in fever prevalence over the study period in all but the oldest children 48-59 months (Figure A.10.2). It is important to note that the 2007 and 2011 MIS collected data during the high malaria transmission season which is likely to affect fever prevalence.

The prevalence of fever in children under five years of age declined over the study period in children living below 2000m elevation. Between 2000 and 2011, the proportion of children with fever in the two weeks before survey fell from 30% to 20%, a relative decline of 35%. The most severe decline occurred between 2000 and 2005 after which fever prevalence did not change significantly.

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