Evaluation of the Impact of Malaria Control Interventions on All-Cause Mortality in Children under Five Years of Age in Malawi

Malawi Malaria Impact Evaluation Group

Annexes

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Annex 1: Methodological Considerations

A.1.1 General Survey Information and Data Availability for Malawi 1996–2010

	MKAPH 1996	DHS 2000	DHS 2004	MICS 2006	MIS 2010	DHS 2010
Sampling frame	1987 Census	1998 Census	1998 Census	1998 Census?	2008 Population and Housing Census	2008 Population and Housing Census
Sampling distribution	Two-stage 1. Enumeration areas (EAs) 2. HH within EAs	Two-stage 1. EAs 2. HHs within EAs	Two-stage 1. EAs 2. HHs within EAs	Two-stage 1. EAs 2. HH within EAs	Two-stage 1. EAs 2. HH within EAs	Two-stage 1. EAs 2. HH within EAs
Number of cluster (census enumeration areas/sampling points)	106 clusters Probability proportional to size (PPS) by urban/rural and region.	560 clusters PPS by region and urban/rural and for 13 districts.	522 clusters PPS by region and oversampled for districts	1040 clusters 40 clusters per district	140 clusters PPS by region and oversampled for urban.	849 clusters Urban areas oversampled
Number of household/cluster	? HH/cluster Systematic (random) sampling	3-72 HH/cluster Systematic (random) sampling	? HH/cluster Systematic (random) sampling	30 HH/cluster Systematic (random) sampling	25 HH/cluster Systematic (random) sampling	? HH/cluster (950 hh/district) Systematic (random) sampling
Sample weights	Weighted to provide representative estimates for regions by urban/rural.	Weighted to provide representative estimates for regions by urban/rural and for 13 districts.	Weighted to provide representative estimates for regions by urban/rural and for 13 districts.	Weighted to provide representative estimates for urban/rural areas and for districts (26).	Weighted to provide representative estimates for regions (3), by urban/rural.	Weighted to provide representative estimates for regions by urban/rural and for 27 districts.
Sampling errors/Design effect	See Final Report Appendix B	See Final Report Appendix B	See Final Report Appendix B	See Final Report Appendix C	N/A	See Final Report Appendix B
Representativeness (designed to provide estimates for)	• National • Urban and Rural areas separately • Regional (3)	• National • Urban and rural areas, separately • Regional (3) • 13 Districts	• National • Urban and rural areas, separately • Regional (3) • 10 Districts	• National • Urban and rural areas, separately • Districts (26)	• National • Urban and rural areas, separately • Regional (3)	• National • Urban and rural areas, separately • Regional (3) • Districts (27)
Month(s) survey	22 June – 5	12 July 2000-	4 Oct 2004-31 Jan	July 2006-	March 2010-	June 2010-Nov

	MKAPH 1996	DHS 2000	DHS 2004	MICS 2006	MIS 2010	DHS 2010
conducted	Oct, 1996	Nov 2000	2005	Nov 2006	April 2010	2010
Biomarkers	N/A	N/A	Hemoglobin (1/3 subsample)	N/A	Hemoglobin	Hemoglobin (1/3 subsample)
Malaria microscopy	N/A	N/A	N/A	N/A	Thick and thin	N/A
Rapid Malaria Diagnosis (brand of RDT)	N/A	N/A	N/A	N/A	Bioline	N/A
Hemoglobin values (brand of Hemocue /cuvettes)	N/A	N/A	Children 6-59 months (Hemocue system) Women 15-49	N/A	Children 6-59 months (Hemocue system)	Children 6-59 months (Hemocue system) Women 15-49
Under-five mortality estimate	Not available Brass questions asked	Direct method (complete birth history)	Direct method (complete birth history)	Direct method (complete birth history)	Not calculated (Incomplete birth history (6 years))	Direct method (complete birth history)
ITN ownership	Net ownership data available but not ITN.	Net ownership data available but not ITN.	Yes, with complete net roster but no information on brand of net. Assumption that pretreated and long-lasting nets were not available. ITN = a net treated within past 12 months.	Yes, but no complete net roster	A complete net roster is included. We know number of nets, treatment of each net, who used each net the previous night and duration of ownership up to 3 years before the survey.	A complete net roster is included. We know number of nets, treatment of each net, who used each net the previous night and duration of ownership up to 3 years before the survey.
ITN use	No questions on ITN use.	Can be estimated for children under five, interviewed women and interviewed men with some assumptions.	Complete net roster allows us to estimate this.	Yes, but no complete net roster	Complete net roster allows us to estimate this.	Complete net roster allows us to estimate this.
IRS	N/A	N/A	N/A	N/A	Available	Available
Wealth Index	Water source, toilet type, electricity, radio, paraffin lamp,	Water source, toilet type, floor, cooking fuel, own land, employs domestic	Water source, toilet type, floor, cooking fuel, own land, electricity, radio, TV, fridge, bicycle,	Person's sleeping room, type of floor, roof, walls, cooking fuel,	Water source, toilet type, floor, radio, TV, telephone,	Agricultural land, # hh members per sleeping room, water source, toilet, floor, walls, roof,

	MKAPH 1996	DHS 2000	DHS 2004	MICS 2006	MIS 2010	DHS 2010
	oxcart, bicycle, motorcycle, and car.	worker, electricity, radio, TV, bicycle, motorcycle/scooter, car or truck.	motorcycle/scooter, car/truck, paraffin lamp, cell phone, landline, bed with mattress, sofa, table/chairs, number of animals owned	other assets[1].	fridge, bicycle, motorcycle, car/truck.	cooking fuel, electricity, radio, TV, fridge, bicycle, motorcycle/scooter, car/truck, landline, mobile phone, watch, bank account, paraffin lamp, koloboyi lamp, mattress, sofa, table/chair, cart
Survey Response Rate						
Households sampled	3,035	15,421	15,041	31,200	3,500	27,307
Households occupied	2,830	14,352	13,965	31,200	3,496	25,311
Households interviewed	2,798	14,213	13,664	30,553	3,478	24,825
Household response rate	98.9	99.0	97.8	97.9	99.4	98.1
Individual interviews:						
Number of women	2,737	13,538	12,229	27,073	3,237	23,748
Number of women interviewed	2,683	13,220	11,698	26,259	2,892	23,020
Eligible woman rate	98.0	97.7	95.7	97.0[2]	91.9	96.9

[1] These could include electricity, radio, TV, mobile phone, landline, refrigerator, computer, internet connection, watch, bicycle, moto/scooter, cart, car/truck, motorboat, land, animals.

[2] MICS 2006: Children eligible: 23,238; mother/caretaker interviewed: 22,994; child response rate: 98.9%

*1996 MKAPH Caretaker interviews: 2433 eligible, 2418 interviewed, 99.4%

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

Source: Household Survey Indicators for Malaria Control, June 2013.

A.1.2 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	Number of households	Total number of households	2004 DHS 2006 MICS

	one ITN.	surveyed with at least one ITN	surveyed	2010 MIS 2010 DHS
	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	2004 DHS 2010 MIS 2010 DHS
	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	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS
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	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS

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	2004 DHS 2006 MICS 2010 MIS 2010 DHS
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	2004 DHS 2006 MICS 2010 MIS 2010 DHS

Calculating Indicators

Data used to produce estimates of ITN ownership and use come from DHS, MICS 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 but the type of net and history of treatment with insecticide were not; thus, household ownership of ITNs cannot be calculated from these data. Although a full net roster was not included, use of bednets by children, women and men were included in the women's and men's questionnaires. Additional questions were asked about the nets if respondents reported use, including source, duration of ownership (up to 7 years), treatment of net, and timing of treatment. Thus, ITN use can be determined for children under five if we assume that pretreated nets were not available (an ITN is defined as a net that has been treated in the past 12 months). With the same assumption, ITN use by interviewed women, by interviewed pregnant women, and by interviewed men can be estimated.

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 2004 DHS survey did not ask about specific brands of nets, thus, as in the 2000 DHS, estimation of ITN ownership and usage depends on the assumption that pretreated nets were not available.

The 2006 MICS did not include a full bednet roster but asked follow-up questions about nets used by children under five and pregnant women. These questions included source of nets, whether or not the net was pretreated when obtained, the duration of net ownership (up to 24 months) and treatment of the most recently obtained net. Children and women are asked about net use during interview. As net treatment is only asked of the most recently obtained net, ITN ownership is likely to be underestimated from these data.

Available Information on Nets					
	2000 DHS	**2004 DHS**	**2006 MICS**	**2010 MIS***	**2010 DHS**
Brand	N/A	N/A	N/A	Permanet Olyset ICONET Fennet KO Nets Safinet Other	Duranet Olyset Lifenet Permanet Safi net Other
Duration of ownership	For nets used by children under	Monthly 0-36 months OR	For nets used by U5 and	Monthly 0-36 months	Monthly 0-36 months OR

	five, interviewed women and interviewed men (up to 84 months)	37 + months	pregnant women (up to 24 months)	OR 37 + months	37 +
Treated/dipped with insecticide since it was obtained	For nets used by children under five, interviewed women and interviewed men	Yes	For nets used by U5 and pregnant women	Yes	Yes
Timing of last treatment	For nets used by children under five, interviewed women and interviewed men (up to 84 months)	Monthly 0-36 months OR 37 + months	For nets used by U5 and pregnant women (Monthly 0-24 months OR 25+ months)	Monthly 0-24 months OR 25 + months	Monthly 0-24 months OR 25 + months

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."

In addition, the denominators are not strictly the same across surveys. Net use was asked of all persons who slept in the household the previous night in the 2004 and 2010 DHS and in the 2010 MIS but not in the 2006 MICS. Net use in the 2006 MICS was asked of all children in a household (via interview of mothers or care-givers), of interviewed women age 15-49 and of interviewed men aged 15-49.

A.1.3 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	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS

	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	2004 DHS 2010 MIS 2010 DHS

*2000 DHS and 2006 MICS did not ask about receiving SP during an ANC visit.

Calculating Indicators

Data used to estimate these indicators come from the DHS, MICS 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.

Interviewed women reporting a live birth in the two years prior to interview were 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 and the 2006 MICS women with a live birth in the past two years were not asked if they received SP during an ANC visit; thus, strictly speaking, the IPTp indicator cannot be calculated for 2000 or 2006. The difference between the proportion of women receiving 2 doses of SP and the proportion receiving 2 doses of SP, at least one of which was given at an ANC visit, is typically small. Therefore, for comparison purposes across the series of surveys, the proportion of women receiving 2 doses of SP regardless of where it was given was used in this evaluation.

Potential Biases

This 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.1.4 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	2010 MIS 2010 DHS
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	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS
	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.	2006 MICS 2010 MIS 2010 DHS

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	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS

	12. Proportion of children under 5 years old with fever in last 2 weeks who received antimalarial treatment according to national policy within 24 hours from onset of fever.	Number of children under 5 who had a fever in previous 2 weeks who received recommended antimalarial treatment according to national policy <24 hours from fever onset	Total number of children under 5 who had a fever in previous 2 weeks	2000 DHS 2004 DHS 2006 MICS 2010 MIS 2010 DHS

Calculating Indicators

Data used to calculate these indicators came from DHS, MICS and MIS surveys from 2000–2010. A slight difference in denominators exists between the MICS and the other surveys. For the MICS, the denominator is all children under five in a household who had fever in the two weeks prior to interview. In the DHS and MIS, the denominator for these indicators is biological children of interviewed women under five years of age who had fever in the two weeks prior to interview. Mothers (or caregivers) 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. 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.

Antimalarial Drugs Taken for Treatment of Fever				
2000	**2004**	**2006**	**2010 MIS**	**2010 DHS**
SP/Fansidar/Novidar Chloroquine Quinine Amodiaquine Halafan	SP/Fansidar Chloroquine Amodiaquine Quinine Artesunate Other	SP/Fansidar Chloroquine Amodiaquine Quinine ACT Other	SP/Fansidar Quinine ACT (LA) Other Antimalarial	SP/Fansidar/Novidar SP Chloroquine Amodiaquine Quinine ACT (LA Coartem) Artesunate AA/ASAQ Other Antimalarial

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.

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

Potential Biases

A potential bias is introduced by the nature of data collection for these surveys. Denominators are not exactly the same across all of the surveys. For the DHS and MIS, 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.1.5 Data and Indicators on Malaria Morbidity

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

RBM Impact Measures	Indicator Description	Numerator	Denominator	Data Availability*
Morbidity Indicator	10. Parasitemia Prevalence: proportion of children aged 6-59 months with malaria infection.	Number of children 6-59 months with malaria infection detected by microscopy	Total number of children aged 6-59 months tested for malaria parasites by microscopy	2010 MIS

	11. Severe 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	2004 DHS 2010 MIS 2010 DHS

*2010 MIS: Microscopy (thick and thin for parasite density) and RDT (*Pf*)

Calculating Indicators

The data used to calculate these indicators come from the DHS and the MIS. 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. Parasitemia was measured using both microscopy and rapid diagnostic tests (RDT), but was only measured in one national survey.

Parasitemia

Infection with *Plasmodium falciparum* parasites was measured in all children aged 6-59 months who slept in a selected household the night before the survey, for whom parental permission was granted. Blood was taken from a finger or heel stick using a cuvette. Thick and thin blood smears were prepared for microscopy. A SD Bioline Malaria Pf® rapid diagnostic blood test for *Plasmodium falciparum* antigens was then performed. Parasitemia is defined as a positive result 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:

$$\textbf{adjust} = -0.032*\textbf{alt} + 0.022*\textbf{alt}^2$$

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

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 the high transmission season during one survey year (2010), and during the low transmission season during two other survey years (2001 and 2009). 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. Finally, discrepancies between microscopy and RDT results could be partially due to the presence of single-species infection with non-*falciparum Plasmodium* parasites as a *Pf*-specific RDT was used in the 2010 MIS.

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.1.6 Data and Indicators on Under-five Mortality

All-cause mortality in children under five years of age 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 Malawi 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" (http://www.measuredhs.com/help/Datasets/index.htm). 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 svyset. 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 CSPro 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 (http://www.measuredhs.com/help/Datasets/index.htm).

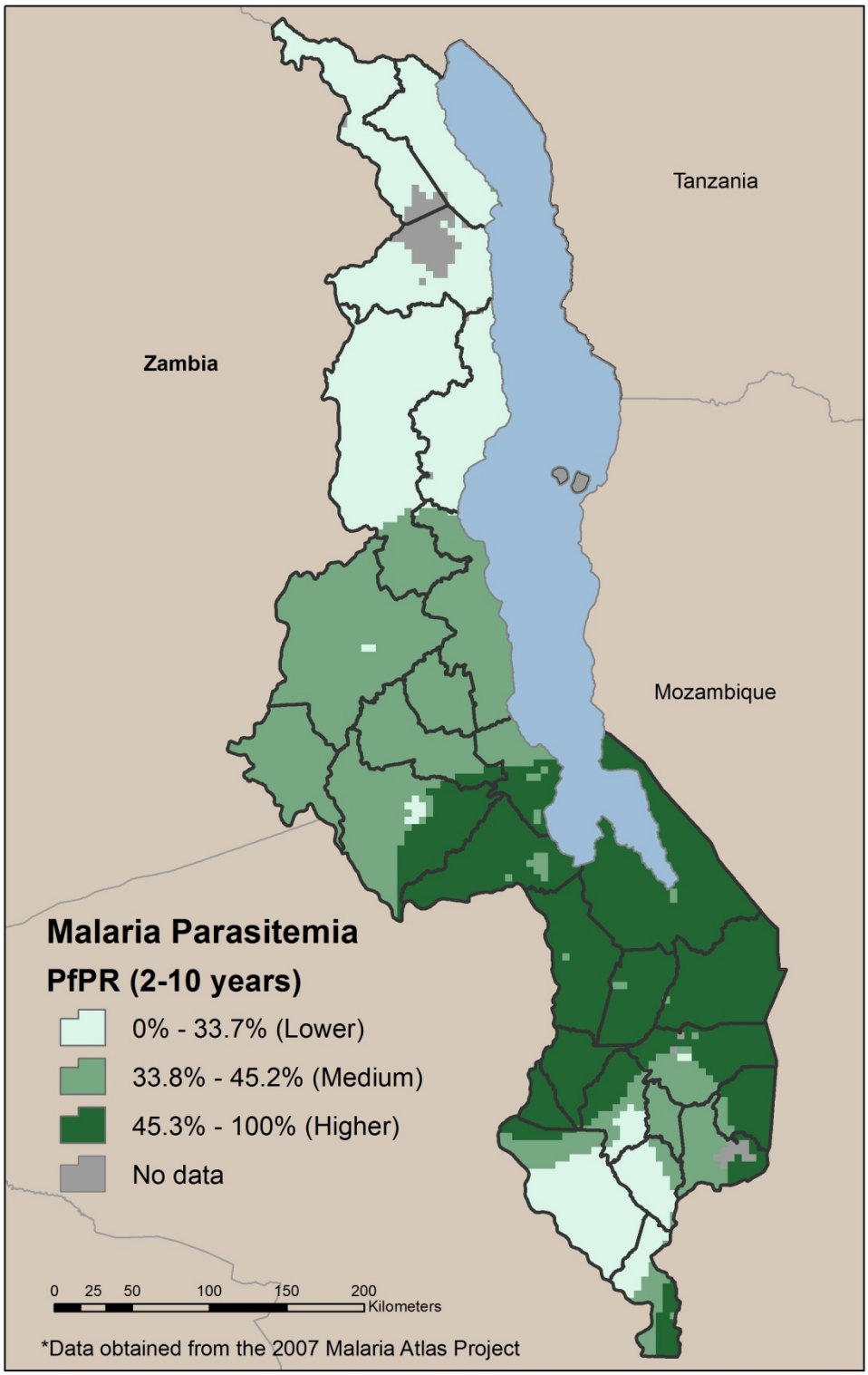
A.1.7 General Information about MAP Data and Construction of Risk Terciles

The Malaria Atlas Project (MAP) uses available data from research studies and surveys to map age-standardized *Plasmodium falciparum* parasite rates which describes the estimated proportion of 2–10 year old children ($Pf\mathrm{PR}_{2\text{-}10}$) in the general population that are infected with the parasite at any one time, averaged over the 12 months of 2007. The resulting maps have 5 km^2 resolution. For data inclusion, studies must have been conducted after 1984 with a sample size of at least 50. The samples must be random or community-based. Data from intervention studies only include pre-intervention data. Duplicate data from the same source will not be used unless there is a time window of at least 36 months. Data on numerators and denominators are required and children are the preferred age group in the African region. Microscopy data are preferred over RDT[1].

Using the available MAP 2007 data layer for Malawi, cluster points from the 2010 DHS survey were overlaid. The corresponding $Pf\mathrm{PR}_{2\text{-}10}$ value was assigned to each cluster. Clusters were then divided into terciles based on the $Pf\mathrm{PR}_{2\text{-}10}$ value, and labeled lower (0%-33.7%), medium (33.8%-45.2%) and higher (45.3%-100%). These were the risk strata used for analyses throughout the evaluation.

[1] MAP. The *Plasmodium falciparum Parasite Rate Survey Database (Pf Endemicity Data Protocol), 2010.*

Figure A.1.1: Malaria risk strata in Malawi based on 2007 MAP parasitemia data



Source: Hay, S. I., et al. (2009). "A World Malaria Map: Plasmodium falciparum Endemicity in 2007." PLoS Med **6**(3): e1000048.

A.1.8 General Information about LMIS - Stockouts

Context:

In November 2007, Malawi's national first-line treatment policy for malaria was changed from sulfadoxine-pyrimethamine (SP) to the artemisinin-based combined therapy (ACT) artemether lumefantrine (AL). Prior to November 2007, all fevers were to be treated with SP, with severe cases of malaria treated with quinine. With the change in NMCP treatment policies, all fevers were to be treated with an ACT. The most recent strategic plan (2011-2015) established a new policy of clinical diagnosis with malaria, before provision of AL. IV quinine was used for the treatment of severe malaria through 2012 and was switched to IV artesunate in 2013; oral quinine for the management of malaria in the first trimester of pregnancy; and SP for the intermittent preventive treatment of malaria in pregnancy.

As part of the 2007 launch of this new first line anti-malarial policy, PMI provided all initial stocks of AL, as well as significant technical support to build the capacity of the drug management system and train and supervise health workers. Procurement of AL was solely supported by PMI until May 2009, when the Global Fund began providing financial support for ACTs. Through the Community Case Management (CCM), the MOH is working to expand the availability of ACTs into the community, with a focus on 4,000 hard-to-reach villages. By mid-2010, nearly 3,000 of these communities had been reached.

In December 2010, a parallel supply chain (PSC) system was implemented to address misallocation of AL and weaknesses with the Central Medical Stores (CMS). The current parallel system is a push system, with re-supply of anti-malarial commodities based on historical amounts and distributed to service delivery points (SDPs) in the public sector. Both PMI-funded and GFATM-funded products are delivered through this mechanism.

Methods:

All available anti-malarial logistics data were reviewed and supplied through Supply Chain Manager (SCMgr) software first implemented in Malawi in 2005 to manage logistics management information. For 2005 and 2006, data on anti-malarials (including quinine and SP) were only available from one district (Salima) and for two months total. In 2007, anti-malarial data were available nationally, and in December 2007, data became available for AL, in addition to SP and quinine. Data were collected and reported at the facility level.

For purposes of this analysis, for the 2008–2010 time period, "percent of facilities stocked out" was defined as the number of treating facilities that reported being stocked out of all four AL weight bands, in recognition of Malawi's policy to cut or combine these AL presentations to enable treatment even when the appropriate weight band for a given patient is stocked out[2]. For 2007, "percent of facilities

[2] AL is packaged in blister packs of 1x6, 2x6, 3x6, and 4x6 tablets. Packs correspond to patient weight, and each tablet containing 20mg of artemether and 120 mg of lumefantrine. Each pack corresponds to a six-dose regimen to be given twice daily over three days.

stocked out" was the number of treating facilities that reported being stocked out of SP. A stock out was defined as 0.0 months of stock. Data were calculated by month and aggregated by district and nationally.

Facility reporting rates were also calculated, and determined as the number of treatment facilities reporting each month out of the total number of facilities listed in the LMIS each month. Since district health office (DHO) pharmacies are part of a different level of the supply chain, these health units were not included in the treatment facilities calculations.

Results:

Stock outs of anti-malarial medicines[3] appear to have increased over the 2007–2010 time period, although it should be noted that reporting rates over this period of time also substantially increased (Figure A.1.2) [4]. The periods of low reporting can be distorting, as facilities that did not report may often be those facilities that were more likely to be stocked out. Reporting rates of logistics data varied widely, both within districts over the course of the year, and between districts. The increase in reporting rates was likely due to an increased investment in system strengthening efforts, including increased funding and technical assistance for logistics reporting and accurate stock card completion.

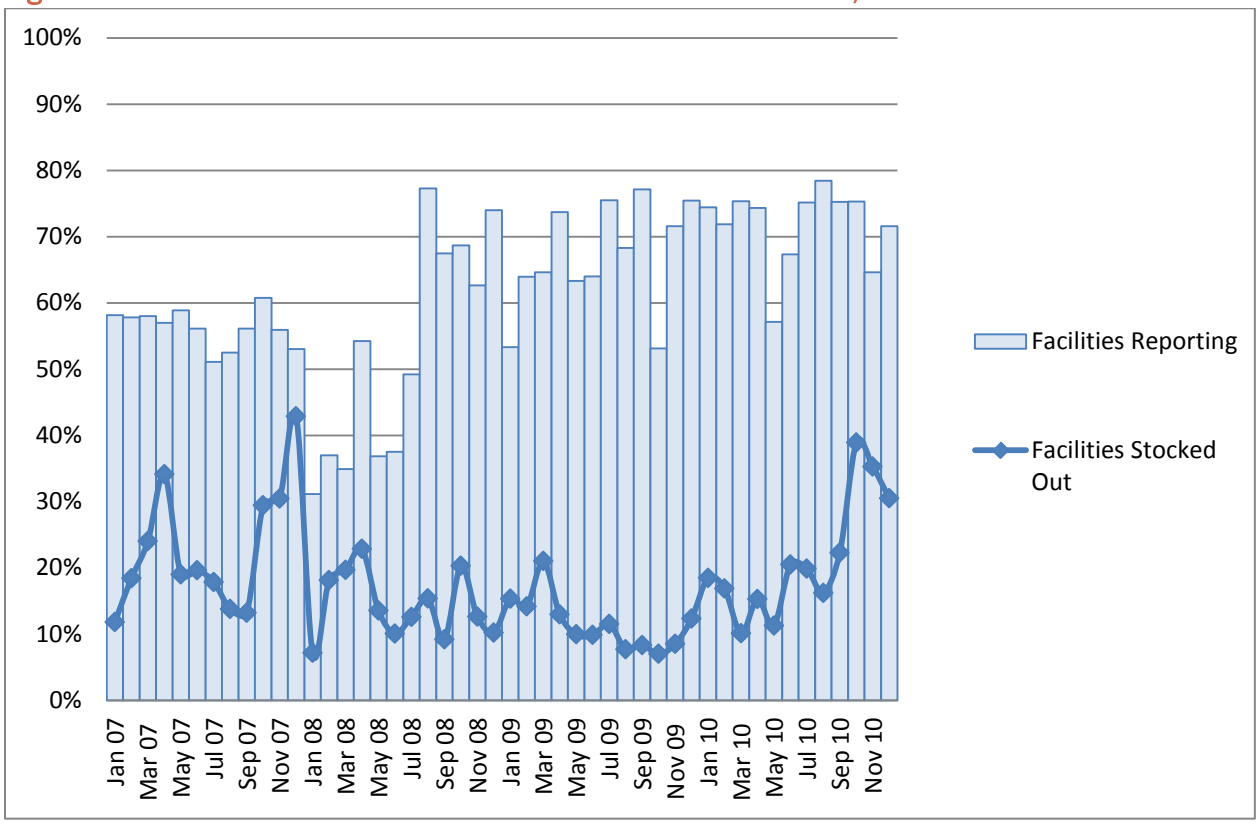
Stock outs continued to be a problem in 2010, with a limited supply of ACTs coming into the country, leading to stock outs at the central level. A Global Fund disbursement delay in October, 2010, for example, led to stock outs at the central level and a sharp increase in stock outs at facility levels as well.

Prior to 2007, the availability of SP to treat malaria at the facility level was unclear due to a dearth of reporting data. The peak in SP stock outs during the last few months of 2008 was likely due to the transition from SP to AL as the country's first-line anti-malarial.

[3] Data are reported for the first-line malaria treatment, meaning that in 2007, data are reported for sulfadoxine-pyrimethamine (SP), and from 2008 through 2010, data are reported for artemether lumefantrine (AL).

[4] The increase in reporting rates is likely due to an increased investment in system strengthening efforts, including increased funding and technical assistance for logistics reporting and accurate stock card completion.

Figure A.1.2: Percent of facilities stocked out of first line antimalarial, 2007–2010



Note: Data are reported for SP in 2007, and data are reported for AL from 2008 through 2010.

A.1.9 General Information about National Micronutrient Surveys

The National Micronutrient Surveys (NMS) in Malawi were designed to provide nationally and regionally representative data on the micronutrient status of the population, specifically, prevalence of vitamin A deficiency, anemia and iron deficiency, to name a few. Several populations were targeted, but for the purpose of this report, the target of interest was children aged 6–35 months. The 2009 NMS sampled children 6–59 months but for purposes of comparison with the 2001 data the age range was limited to 6-35 months. The national population enumerated during the 1998 Population and Housing Census was used as the sampling frame for the 2001 NMS and the 2008 Census population was used for the 2009 NMS. A two-stage cluster sampling design was employed with stratification by region. Clusters were randomly selected from 26 of the 27 districts (Likoma was excluded due to small population size in both surveys and Neno was excluded by chance in 2009). Thirty clusters per region were selected using probability proportional to size (PPS) sampling in 2001 and 40 clusters per region in 2009. Household listing was then conducted in the selected clusters and 18 households per cluster were randomly selected from the enumerated households (15 household per cluster in 2009). In each selected household all children aged 6–35 months (6–59 months in 2009) and every other woman aged 15–44 years was selected for interview and sample collection. Data were collected in September and October of 2001 and in July and August of 2009.

Hemoglobin levels were assessed via HemoCue Hemoglobin system (HemoCue AB, Angelholm, Sweden). Hemoglobin values were adjusted for altitude using standard methods (CDC, 1998). Thick smears were

made in the field for microscopic assessment of *P. falciparum* infection and were analyzed in district laboratories at the end of each day. Data entry was conducted by the NSO in Zomba using Epi-Info version 6.04d in 2001 and using CSPRO version 6.04 in 2009. Analysis was conducted by the national survey coordinator and CDC staff. Data were weighted based on population for national prevalence estimates.

	2001 NMS	**2009 NMS**
Sample design	National	National
Sampling frame	1998 Census EAs	2008 Census EAs
Sampling distribution	Two-stage within each district 1.Enumeration areas (EAs) PPS 2.HHs within EAs	Two-stage within each district 1.Enumeration areas (EAs) PPS 2.HHs within EAs
Number of cluster (census enumeration areas/sampling points)	30 EA per region for a total of 90	40 EA per region for a total of 120
Number of household/cluster	18 households per cluster	15 households per cluster
Sample weights	Available	Available (Appendix 16 in report)
Sampling errors/Design effect	N/A	Appendix 17 in MNS report
Representativeness (designed to provide estimates for)	National, Regional	National, Regional
Month(s) survey conducted	September-October 2001	July-August 2009
Biomarkers	Hemoglobin for children 6-35 months	Hemoglobin for children 6-59 months
Malaria microscopy	Thick for children 6-35 months	Thick for children 6-59 months
Rapid Malaria Diagnosis (brand of RDT)	N/A	N/A
Hemoglobin values (brand of Hemocue /cuvettes)	Hemocue Hb 201+	Hemocue Hb 201+
Under-five mortality estimate	N/A	N/A
ITN ownership	Can be indirectly calculated for households	Any net but not ITN
ITN use	Who sleeps under net in household questionnaire (father, mother, u5, other)	Who sleeps under net in household questionnaire (father, mother, u5, other)
IRS	N/A	N/A
Wealth Index	0 to 12 scale based on fuel used, water supply, toilet facility, roof, floor material, number of rooms, and assets (radio, TV, bicycle, motorcycle, oxcar and car).	0 to 14 scale based on fuel used, water supply, toilet facility, roof, floor material, number of rooms, and assets (radio, TV, bicycle, motorcycle, car/truck, mobile phone, canoe/boat). Low=0-2, moderate = 3-5, high 6-12.
Households sampled	1620	1800

Households interviewed	1619	1791
Household response rate	99.9%	100%
Number eligible children 6-35 months old	548	1124
Number children 6-35 months old with biomarker data	513 hemoglobin, 516 *Pf*	1003
Child 6-35 months old biomarker response rate	93.6% hemoglobin, 94.2% *Pf*	89.2%

A.1.10 General Information about MAC Anemia and Parasitemia Surveys

Cross-sectional surveys were conducted by the Malaria Alert Center (MAC) to measure malaria parasitemia and anemia in children 6–30 months old in six districts in 2005 and 2006 and in eight districts in 2007, 2008, and 2009. These surveys were conducted in April of each year, which represents the latter portion of the high transmission season. As a result, these surveys likely capture some of the highest parasite prevalence estimates within each year. The six districts surveyed in 2005 and 2006 included four from Southern Region (Chiradzulu, Mwanza, Phalombe, and Blantyre), and one each from Central Region (Lilongwe) and Northern Region (Rumphi). In 2007, 2008, and 2009, an additional district was sampled in both Central Region (Nkhotakhota) and Northern Region (Karonga).

The surveys used a two-stage cluster design to select 30 enumeration areas (EAs) proportional to size (PPS) in each district, and randomly sampled households within each selected EA. In 2005, complete enumeration was conducted in each EA, followed by simple random sampling of households. In all subsequent surveys, segmentation was used to select households within each EA. This process consisted of segmenting the EA into equal sized segments based upon previous census counts, and randomly selecting one segment where all households were contacted for interview. As a result, differences in sampling design may have biased comparability across survey years - a detailed chart comparing each survey year, including design effects, can be found below.

For each district, cross-tabulations of survey year with microscopy-confirmed parasitemia (thick smear) and severe anemia (Hb <8g/dL) were conducted. Cross-tabulations are presented in Annex 3 (A.3.3). Survey settings were used to adjust standard errors for the complex survey design. Wald chi-squared tests of annual differences from the earliest year surveyed (2005 or 2007, depending upon district) were conducted.

	MAC 2005	MAC 2006	MAC 2007	MAC 2008	MAC 2009
Sample design	Six districts chosen purposively	Six districts chosen purposively	Eight districts chosen purposively	Eight districts chosen purposively	Eight districts chosen purposively
Sampling frame	Census EAs for six districts	Census EAs for six districts	Census EAs for eight districts	Census EAs for eight districts	Census EAs for eight districts
Sampling distribution	Two-stage within each district 1.Enumeration areas (EAs) PPS 2.HHs within EAs	No documentation	No documentation	Modified EPI cluster survey 1.Same EAs per district as 2005 for six districts, PPS for two new 2.HHs within EAs 3. Used segmentation	Two-stage within each district 1.Enumeration areas (EAs) PPS 2.HHs within EAs selected through segmentation of 30-60 HHs
Number of clusters (census enumeration areas/sampling points)	30 EA per district for a total of 180 EAs	30 EA per district for a total of 180	230 EAs	30 EA per district for a total of 240 EAs	30 EAs per district for a total of 240 EAs
Number of household/cluster	11 households per cluster	30-60 by segmentation	~60 by segmentation	40-60 by segmentation	30-60 households per cluster
Sample weights	Available	Not available	Not available	Available	Available
Sampling errors/Design effect	Pf: 1.39 Hb<8: 1.29	Hb<8: 1.73	Pf: 2.70 Hb<8: 1.58	Pf: 1.89 Hb<8: 1.67	Pf: 1.86 Hb<8: 1.54
Representativeness (designed to provide estimates for)	Each of six sentinel districts	Each of six sentinel districts	Each of eight sentinel districts	Each of eight sentinel districts	Each of eight sentinel district
Month(s) survey conducted	April-May 2005	April-May 2006	April-May 2007	April-May 2008	April-May 2009
Biomarkers	Hemoglobin for children 6-30 months	Hemoglobin for children 6-30 months	Hemoglobin for children 6-30 months	Hemoglobin for children 6-30 months	Hemoglobin for children <5
Malaria microscopy	Thick for children 6-30 months	Thick for 6-30 months	Thick for 6-30 months	Thick for 6-30 months	Thick for <5
Rapid Malaria Diagnosis (brand of RDT)	N/A	N/A	N/A	N/A	N/A
Hemoglobin values (brand of Hemocue /cuvettes)	Hemocue Hb 201+	Hemocue Hb 201+	Hemocue Hb 201+	Hemocue Hb 201+	Hemocue Hb 201+
Under-five mortality	N/A	N/A	N/A	N/A	N/A

estimate					
ITN ownership	Net roster available	Net roster available	Net roster available	Net roster available	Net roster available
ITN use	Net use roster available	Net use roster available	Net use roster available	Net use roster available	Net use roster available
IRS	N/A	N/A	N/A	Available for Nkhotakota	Available for Nkhotakota
Wealth Index	HH Wealth scores using factor loadings from 2004 DHS	Assume same as 2005	Assume same as 2005	HH Wealth scores using factor loadings from 2004 DHS	PCA on 19 assets
Households sampled	1,980	No documentation	No documentation	Unsure/varies	Varies based upon segmentation size
Households interviewed	1,739	8,034	12,507	13,917	7,407
Household response rate	87.8	N/A	N/A	N/A	N/A
Number children <5	3,428	4,359	7,081	9,735	7,145
Number eligible children 6-30 months old	930	3532	4,285	6,580	3,079
Number children 6-30 months old with biomarker data	923	3421 with Hb No slide results in data set	4,281 with Hb	6,438	3,026
Child 6-30 months old biomarker response rate	99.2	97.0	99.9	97.8	98.3

A.1.11 General Information about Integrated Disease Surveillance Response System Data

The Integrated Disease Surveillance and Response (IDSR) system has been in operation in Malawi since 2003 to track prominent epidemic-prone infectious diseases through health facility-based reporting. IDSR data definitions are standardized by the World Health Organization (WHO). Here we consider all malaria cases, diarrhea with severe dehydration, and severe pneumonia cases in children under five years of age. The original IDSR database included records for 729 facilities out of approximately 832 public health facilities in Malawi. However, many of these facilities had poor reporting across the entire period. Facilities that did not report in at least two-thirds (50/75) of the reporting months were removed to produce a more representative dataset over time. Reporting from 2003 and 2004 was also removed as reporting was quite low during this initial period. The final database used for analyses included 554 facilities (76% of the original). Among the remaining facilities, the number of facilities reporting each month was calculated as the total number of facilities reporting a non-missing value (including 0) per region (or district) in a given time period (month). Rates per population are based upon census estimates from 1998 and 2008. Annual rates of change per district were computed to estimate population sizes for interim years. The proportion of children <5 in the population was assumed to be 17.7%, based upon 2010 MIS results.

Health facility outpatient cases in Malawi are in most cases not confirmed, and therefore may overestimate the true outpatient burden of malaria. Furthermore, variation in the quality of facility reporting and treatment-seeking behavior may affect perceived changes in malaria facility burden even in the absence of actual changes to disease rates. Inpatient cases (severe malaria based upon clinical judgment) and deaths may better reflect true malaria than outpatient cases, as inpatient facilities often have greater diagnostic capacity, but these data are still subject to reporting and selection bias.

The Poisson models described in the Further Analyses section of the evaluation used total district population as the exposure, and included a random intercept for each district. Month was added to the model as a dummy variable to control for seasonality.

A.1.12 General Information about Chikwawa rolling MIS

Since May 2010, a rolling (monthly) MIS (rMIS) has been conducted in Chikwawa District to monitor the burden of malaria in an area of 50 villages within 400 square km (population ~30,000)[5]. Chikwawa is located in Malawi's southern Rift Valley, 500 meters above sea level, and has perennial malaria transmission with seasonal peaks. In Chikwawa (and in Malawi in general), a unimodal rainfall season usually occurs between November and April with limited rainfall recorded in the remaining months and therefore the malaria season is usually considered to peak during those months each year. Chikwawa district is one of the focus districts for malaria control. Interventions have rapidly been scaled-up in this area including the distribution of long-lasting insecticide treated nets and the introduction of annual district-wide indoor residual spraying (IRS) in February 2011.

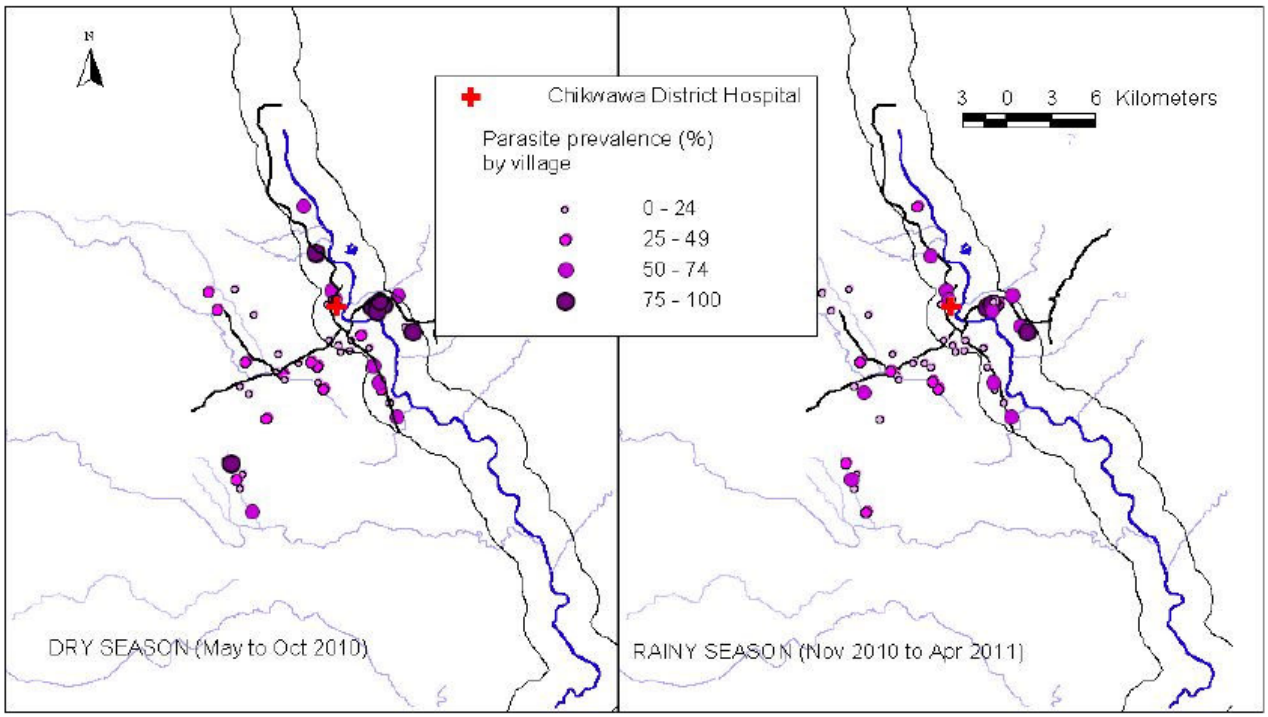
[5] Roca-Feltrer, A., et al., Short Report: Rolling Malaria Indicator Surveys (rMIS): A Potential District-Level Malaria Monitoring and Evaluation (M&E) Tool for Program Managers. *Am. J. Trop. Med. Hyg.*, 2012. **86**(1): p. 96-98.

All 50 villages (approximating census enumeration areas) were sampled once every 6 months (8 or 9 villages per month, once during the rainy season-November to April- and once during the dry season). Within each village, households were randomly selected with a probability proportional to village population size, from a sampling frame based on an enumeration conducted in 2008. An adapted version of the standard national MIS evaluation package was applied (http://rbm.who.int/merg.html#MIS) to collect malaria disease burden and coverage indicators. Monthly rainfall data was also collected from the Meteorological Department, NSO (Nchalo station, Chikwawa District). To evaluate the relationship between malaria indicators and seasonality, a logistic regression model was used. Adjusting for potential confounders (e.g. travel distance to closest health facility, distance to river, age, sex, wealth index, etc.), estimates were 'clustered' by village to adjust the standard errors to account for potential correlation between surveys from the same village.

Two survey teams, each consisting of a nurse and a field worker sampled an average of 100 (range: 60–124) households and 60 under-fives each month during both the rainy and dry months (May 2010 to April 2011). Overall, a total of 1,229 households were interviewed, with 753 under-fives. Blood samples were successfully collected from 740 of these children.

Seasonality of malaria impact indicators might be masked by heterogeneity in transmission, linked to for instance proximity to water bodies (and therefore mosquitoes breeding sites) such as rivers and swamps. The Shire River runs from Lake Malawi through southern Malawi, via Chikwawa district in the Shire Valley. The spatial distribution of malaria parasitemia shows the micro-epidemiology of the study area. The majority of the study villages (33/50) were located within 2 km from the Shire River, including an area of swamps east of the river (Figure A.1.3).

Figure A.1.3: Spatial distribution of parasitemia (RDT+) by village. Note: the two black lines represent the 2km buffer from the Shire River



A.1.13 General Information about Karonga HDSS[6]

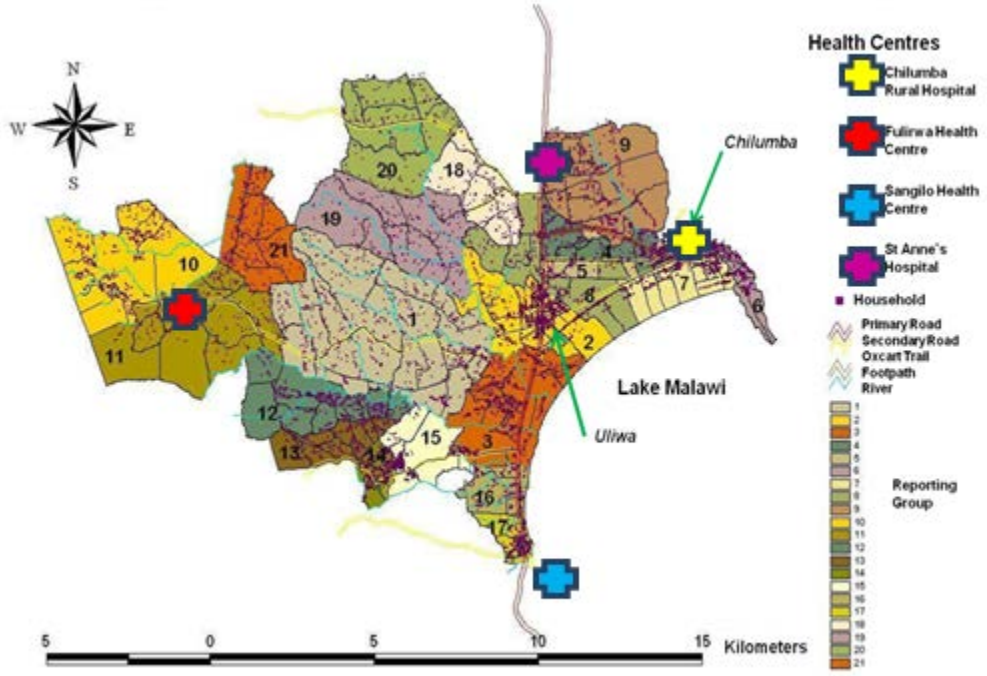
The Karonga HDSS site was originally established in 1979 as the Karonga Prevention Study, a large cohort study investigating risk factors for leprosy. In the 1980s the project was expanded to cover diagnosis and treatment of tuberculosis and a vaccine trial of the Bacillus Calmette-Guerin (BCG) and *M.leprae* vaccines. Since 1987, HIV research has also been incorporated. In 2002, the Karonga Health and Demographic Surveillance System (HDSS) was initiated in order to provide the epidemiological data necessary for studies of HIV and of impact of interventions. The Karonga HDSS is part of the INDEPTH network (http://www.indepth-network.org) and of the ALPHA network of population-based HIV/AIDS data in Africa (http://www.lshtm.ac.uk/eph/psd/alpha). The current HDSS program is still strongly focused on HIV research. One advantage of the HDSS is that population-based data are linked to health facility data from ART, ANC and pediatric clinics.

Karonga district is located in Northern Malawi and the HDSS area covers the southern part of this district, a total of 135 km^2 (Figure A.1.4). The rainy season lasts from January to May with cooler dry

[6] Crampin A, Dube A, Mboma S, Price A, Chihana M, et al. (2012) Profile: the Karonga Health and Demographic Surveillance System. Int J Epidemiol 41: 676-685.

weather from June to August and hot, dry weather from September to December. The population is predominantly rural with 15% semi-urban.

Figure A.1.4: DSS Karonga District Northern Malawi: Household and Health Centers, 2011



Source: London School of Hygiene and Tropical Medicine powerpoint entitled "Demography at KPS"

The Karonga HDSS relies on key informants to report vital events and household migrations. As of the end of 2011, these key informants provided data on 35,730 individuals from 8285 households on a monthly basis during meetings with a supervisor. Reported deaths are followed up by a medical assistant who will conduct a verbal autopsy after a brief mourning period. Annual reports are compiled of these data.

A.1.14 General Information on individual-level mortality analyses of 2010 DHS data (Cox models)

Data sources: Malawi DHS 2010, Malaria Atlas Project 2010

Methods: Household ITN ownership was determined retrospectively from household self-report on current ITN ownership, age of nets owned (in months up to 36 months), and time of retreatment, if any (in months ago). Exact matching on wealth (above/below median PCA score), urban/rural, *Pf*$PR_{2\text{-}10}$ ($\geq$40% vs <40% from MAP 2010), DPT3 coverage at PSU level (above/below median), and mother's education (secondary+, primary, none) was conducting to reduce confounding. The relationship between household ITN ownership and child mortality (1-59 months) over the 36 months preceding the survey was then assessed with Cox proportional hazards models with analysis time measured in months and

matched strata included as a shared frailty. Additional covariates controlled for in the Cox model included household wealth quintile, child age category, mother's age category, parity, PSU-level diarrhea prevalence (two weeks preceding survey), DPT3 coverage at PSU level (continuous), *Pf*PR$_{2-10}$ at PSU level (continuous), and season (high transmission season). Household improved water source and the PSU-level skilled birth attendance rate were non-significant and removed from analyses.

Results: After controlling for confounding, household ownership of at least one ITN was associated with a 25% reduction in mortality risk (HR=0.75, 95% CI 0.62 – 0.90).

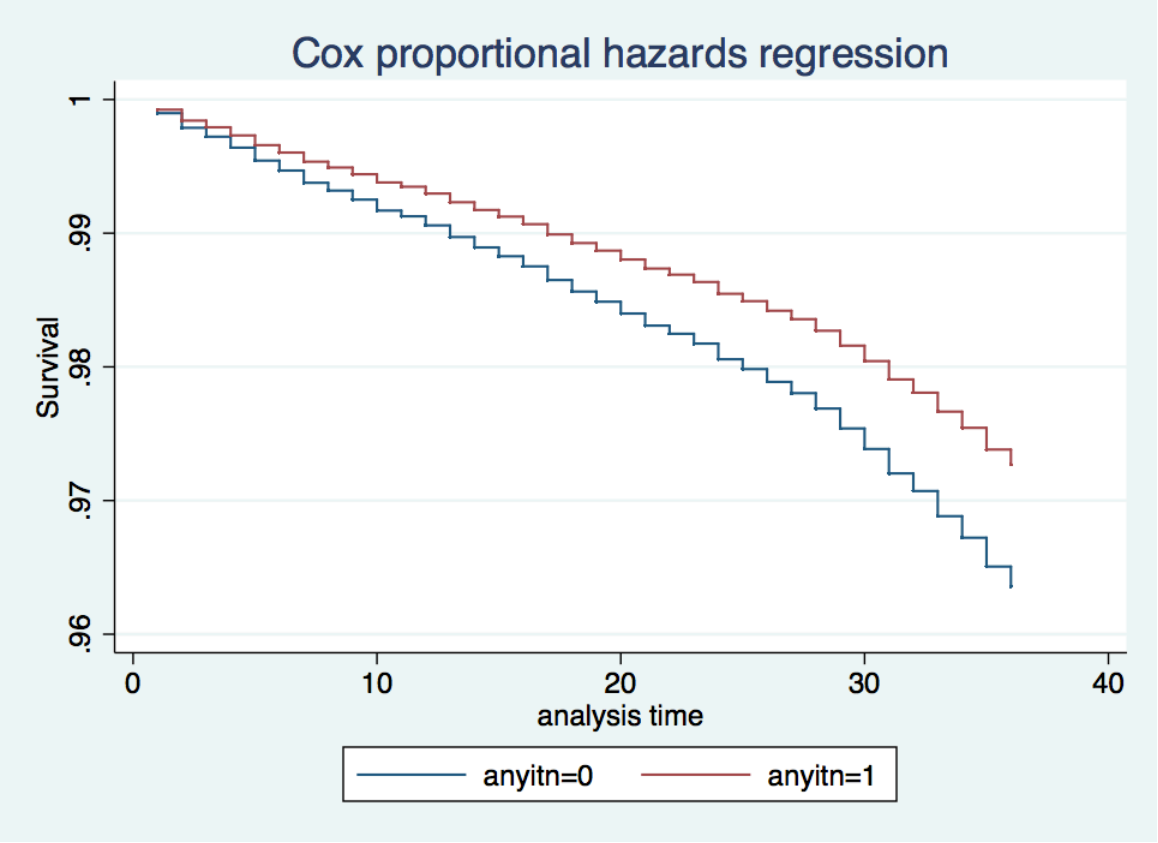
Table A.1.1: Descriptive bivariate tabulations of 1–59 month mortality by matching strata and household ITN status

Matching Strata	HH No ITN			HH ≥ 1 ITN		
	Deaths 1-59 mos.	Child-month time	Hazard rate	Deaths 1-59 mos.	Child-month time	Hazard rate
Wealth						
High	283	231,218	1.22	100	84,887	1.18
Low	347	262,745	1.32	91	73,925	1.23
Region						
Urban	62	48,067	1.29	10	15,601	0.64
Rural	568	445,896	1.27	181	143,211	1.26
*Pf*PR$_{2-10}$						
<40%	250	241,139	1.04	87	78,177	1.11
≥40%	380	252,824	1.50	104	80,635	1.29
DPT3 coverage						
High	301	246,746	1.22	97	81,377	1.19
Low	329	247,217	1.33	94	77,435	1.21
Mother's Education						
Secondary +	63	59,682	1.06	25	25,700	0.97
Primary	435	339,688	1.28	137	109,691	1.25
None	132	94,593	1.40	29	23,421	1.24
Total	630	493,963	1.28	191	158,812	1.20

Table A.1.2: Results of matched multivariable Cox regression on 1-59 month mortality, with shared frailty defined by matched strata.

Covariate	Hazard ratio	95% Confidence Interval	p-value
Wealth			
Lowest (ref)	1		
Fourth	1.07	(0.88 – 1.31)	0.503
Middle	1.10	(0.89 – 1.35)	0.377
Second	1.12	(0.90 – 1.39)	0.311
Highest	0.68	(0.51 – 0.90)	0.007
Child age			
1-5 months (ref)	1		
6-11 months	0.96	(0.79 – 1.17)	0.664
12-23 months	0.42	(0.34 – 0.52)	<0.001
24-35 months	0.29	(0.23 – 0.37)	<0.001
36-47 months	0.17	(0.13 – 0.22)	<0.001
48-59 months	0.10	(0.07 – 0.14)	<0.001
Mother's age			
15-19 years (ref)	1		
20-24 years	1.01	(0.71 – 1.44)	0.970
25-29 years	0.85	(0.58 – 1.24)	0.393
30-34 years	1.18	(0.79 – 1.78)	0.420
35-39 years	1.16	(0.73 – 1.85)	0.528
40-44 years	1.12	(0.65 – 1.95)	0.679
45-49 years	1.03	(0.52 – 2.03)	0.931
Parity	1.00	(0.95 – 1.06)	0.894
Diarrhea prevalence	1.65	(0.80 – 3.38)	0.173
DPT3 coverage (continuous)	0.58	(0.26 – 1.30)	0.184
*Pf*PR$_{2\text{-}10}$ (continuous)	1.00	(1.00 – 1.00)	0.467
Season (Dec-May)	0.90	(0.70 – 1.15)	0.395
Rainfall (lagged 2 months)	1.00	(1.00 – 1.00)	0.663
Min. temp. (lagged two months)	0.99	(0.97 – 1.02)	0.502
HH $\geq$ 1 ITN	0.75	(0.62 – 0.90)	0.002

Figure A.1.5: Hazard function by household ITN status.



A.1.15 General Information on District-Level Mortality Analyses of 2010 DHS Data

Objective: To assess the association between increases in coverage of malaria control interventions and reductions in all-cause under-five mortality controlling for changes in other variables associated with child survival using district-level data from the 2010 DHS.

Limitations:

1) Cross-sectional data on ITN ownership/use
2) Difficult to reconstruct retrospectively exposure to intervention (ITN Ownership/Use)
3) Limited or missing data for dead children
4) Limited covariates with longitudinal data

Approach: Multivariable Poisson model of child deaths by district and by year given a change in coverage of ITN household ownership or numbers of ITNs distributed.

Unit of analysis: Districts

Outcomes: Deaths in children under five years of age

Predictors: Household ITN ownership, ITNs distributed per district adjusted for mid-year population

Covariates considered for inclusion in regression models: These district-level variables were prepared for each survey and weighted averages were used to estimate values for interim years. Variables that were significantly associated with under-five deaths in univariate models were considered in multivariate models along with those that confounded the association between ITN coverage and under-five deaths. Model fit was assessed by AIC.

1) Proportion of the households per district that are urban
2) Proportion of the households per district in each wealth quintile
3) Proportion of households per district with access to improved water source
4) Proportion of households per district with access to improved sanitation
5) Proportion of women per district with no education, primary education and secondary or greater
6) Proportion of children 12-23 months per district fully vaccinated
7) Proportion of children 12-23 months per district fully vaccinated against DPT
8) Proportion of children 12-23 months per district fully vaccinated against measles
9) Proportion of children 6-59 months per district who received vitamin A supplementation in 6 months prior to survey
10) Proportion of children under five who had diarrhea in two weeks preceding the survey
11) Proportion of children under five who had symptoms of ARI in two weeks preceding the survey (note: using the old definition)
12) Proportion of children under five who had fever in two weeks preceding the survey
13) Proportion of children under five with height for age more than 2 standard deviations below the mean according to new WHO standards (stunting)
14) Proportion of children under five with weight for age more than 2 standard deviations below the mean according to new WHO standards (underweight)
15) Proportion of children under five who were very small or small at birth according to mother's report
16) Proportion of births in past five years that were assisted by a health professional
17) Proportion of women who attended at least 4 ANC visits during her most recent birth
18) Proportion of women who received at least 2 tetanus immunizations during her most recent birth
19) Proportion of children less than 6 months of age who are exclusively breastfed
20) Average annual rainfall per district per year compared to the five year district average
21) District-level *Pf*PR2-10 from MAP 2007 data as a measure of malaria risk. This value does not change by year

Methods:

The Malawi 2010 DHS is one of the few nationally-representative surveys sampled at the district level. This survey permits precise estimates of most malaria indicators at the district level. Although DHS

surveys are cross-sectional, data on women's birth histories can be used to create a longitudinal record of children's lives. Most other data collected in the DHS are only relevant for the time period of data collection or for a short period before (for example, history of fever in children under five years of age for the two weeks preceding interview). Although birth and child death data are available in a longitudinal format, data such as ITN ownership and ITN use only exist in a cross-sectional format; thus, individual-level models are not possible using these data; an individual child's ITN use cannot be reconstruct retrospectively overtime. To address these data limitations, district-level Poisson models were employed. These models use aggregated estimates of ITN ownership and other covariates at the district-level and look for associations with counts of child deaths per district. In order to take advantage of the longitudinal survival data from both the 2006 MICS and the 2010 DHS, both surveys were used for ITN ownership and other covariates. Weighted averages of district-level means for these variables were used for interim years between surveys. In addition, data on annual district-level ITN distribution were used. A decay factor was applied as per previously published methodology[7]. This decay factor accounts for some loss of ITNs per year and includes previously distributed ITNs to estimate ITN ownership.

The following steps were taken:

1. Transformed birth history datafile to a longitudinal format with multiple entries per child based on calendar year.
2. Created data file for ITN ownership in a longitudinal format by district by year with the following sources for each year:
    a. 2010: 2010 DHS
    b. 2009: weighted mean of 2010 DHS and 2006 MICS district average ITN ownership
    c. 2008: weighted mean of 2010 DHS and 2006 MICS district average ITN ownership
    d. 2007: 2006 MICS
    e. 2006: 2006 MICS
    f. 2005: no district-level estimates available
    g. 2004: no district-level estimates available
    h. <2004: no district-level estimates available

    Note: 2004 DHS data were not sampled at the district-level. While the 2006 MICS has data from 26 districts and the 2010 DHS has data from 27 districts, the 2004 DHS oversampled only 10 districts.

3. Created data file for ITN distribution in a longitudinal format by district and year using PSI ITN distribution data with the lag factor. This variable was then standardized for district-level population by using the ratio of ITNs distributed to mid-year population. Note that district-specific ITN distribution data were not available for 2010 thus the 2010 estimate is likely an underestimate.
    a. bys sdistrict: gitn_10 = 0.92*itn2009 + 0.80*itn2008 + 0.50*itn2007
    b. bys sdistrict: g itn_09 = itn2009 + 0.92*itn2008 + 0.80*itn2007 + 0.50*itn2006

[7] Otten and Lines, 2009, "Where did the LLINs go? An Analysis of Data from 7 Countries with the Most Recent Surveys (2008-2009)."

    c. bys sdistrict: g itn_08 = itn2008 + 0.92*itn2007 + 0.80*itn2006 + 0.50*itn2005
    d. bys sdistrict: g itn_07 = itn2007 + 0.92*itn2006 + 0.80*itn2005
    e. bys sdistrict: g itn_06 = itn2006 + 0.92*itn2005
    f. bys sdistrict: g itn_05 = itn2005
4. Adjusted ITN distribution data for district-level and year specific, mid-year populations to estimate ITN coverage (ITNs/person referred to as **ITN ratio**).
5. Ran fractional polynomial (FP) (Detect the best fit of the model compared to the linear model) to determine cut-points for categorizing the ITN ratio variable.
    a. g itncat = 1 if itnratio<0.25
    b. replace itncat = 2 if itnratio>=0.25 & itnratio<0.5
    c. replace itncat = 3 if itnratio>=0.5 & itnratio<1.0
    d. replace itncat = 4 if itnratio>=1.0 & itnratio<1.5
6. Created a data file for covariates in a longitudinal format by district and year using 2010 DHS and 2006 MICS data using the same methods used for estimating ITN ownership.
7. Created a data file for average rainfall per district per year containing a variable for the difference between the district-level annual estimate and the five-year average rainfall. This was to define rainfall anomalies for the five-year period preceding each survey. Rainfall anomalies were one of the variables evaluated for inclusion in regression models.
8. Created a data file for average *Plasmodium falciparum* prevalence rate for children 2-10 years of age (*Pf*PR2-10) per district from Malaria Atlas Project (MAP) 2007 data to estimate malaria risk.
9. Merged these files by district and calendar year.
10. Ran GLM models with Poisson distribution of under-five deaths, with the log of person-months at risk being the offset variable.
    a. 4 sets of models using the 4 different ITN coverage estimates were produced; household ITN ownership; ITN distribution; ITN distribution adjusted for mid-year population (ITN ratio); ITN ratio as a categorical variable.
    b. Univariate models to determine which variables were independently associated with under-five mortality.
    c. Multivariable models to adjust for potential confounding of ITN coverage – under-five mortality associations.
11. Assessed model fit using AIC values.

Results

ITN ownership increased over time from 37 percent (a conservatively high estimate) to 70 percent in 2010. Numbers of ITNs distributed (with the decay factor which adjusts for previously distributed ITNs and average decay rate) increased from 44,614 in 2005 (the first year for which district-level ITN distribution data are available) to 85,088 in 2010 (2009 distribution data are the most recently available at the district level; 2010 estimates were excluded from models for this reason, as they would likely underestimate actual numbers).

Table A.1.3: ITN ownership, ITN distribution, and ITN ratio (ITNs distributed/mid-year population) by year

	ITN ownership	ITNs distributed	Mid-year population	ITN ratio
<2004	0.367	na	na	na
2004	0.368	na	na	na
2005	0.368	44614	11,999,585	0.103
2006	0.369	85679	12,345,253	0.205
2007	0.369	103032	12,700,877	0.249
2008	0.473	135041	13,066,746	0.329
2009	0.474	124523	13,432,615	0.296
2010	0.697	na	na	na

In simple models controlling for district and calendar year the ITN ownership effect was associated with death at the alpha = 0.1 level but not at the alpha = 0.05 level. ITN coverage based on ITN distribution data was also associated with mortality at the alpha = 0.1 level. ITN ratio (ITNs distributed/mid-year population) was not significantly associated with mortality but when categorized based on results of fractional polynomial regression (<0.25, 0.25-0.49, 0.5-0.99 and 1.0-1.5), category of ITN ratio was significantly associated with reduced mortality (IRR=0.89, p=0.032).

Table A.1.4: IRR of ACCM by ITN coverage in Poisson models adjusting for district and calendar year

Variable	IRR	LCI	UCI	p
ITN ownership	0.37	0.12	1.15	0.086
ITN distribution (ITN/100000)	1.05	0.997	1.097	0.067
ITN ratio (ITNs distributed/mid-year population)	0.75	0.44	1.28	0.295
Category of ITN ratio	0.89	0.80	0.99	0.032

Covariates

In simple models controlling for district and calendar year, vaccination coverage, ARI prevalence, low weight for age, and mean *Pf*PR2-10 (a proxy for malaria risk) were associated with death at least at the alpha = 0.1 level.

Table A.1.5: IRR of under-five mortality by full vaccination status, ARI prevalence, low weight for age, and malaria risk from Poisson models adjusting for district, and calendar year.

Variable	IRR	LCI	UCI	p
Full Vaccination	0.31	0.09	1.09	0.069
ARI	0.08	0.004	1.40	0.083
Low weight for Age	0.07	0.005	0.83	0.035
Mean *Pf*PR2-10	1.49	1.08	2.07	0.015

ITN ownership

In multivariable models controlling for district, calendar year, ITN ownership, full vaccination coverage, percent urban, access to improved water, mother's educational level, diarrhea prevalence, and women with tetanus vaccination, all variables were significantly associated with under-five deaths. ITNs had a protective effect on mortality (IRR=0.55, 95%CI=0.31–0.99).

Table A.1.6: IRR of ACCM in multivariable Poisson model

	IRR	[95% Conf.	Interval]	P>z
ITN ownership	**0.55**	**0.31**	**0.99**	**0.048**
2004 (ref)	1			
2005	0.75	0.66	0.86	<0.0005
2006	0.80	0.71	0.91	0.001
2007	0.66	0.58	0.75	<0.0005
2008	0.60	0.49	0.73	<0.0005
2009	0.75	0.62	0.91	0.004
2010	0.54	0.37	0.79	0.001
Access to improved water	3.02	1.66	5.48	<0.0005
Mother's educational level	0.69	0.50	0.94	0.021
Mother's tetanus immunization	2.14	1.34	3.42	0.002
Diarrhea prevalence	5.89	2.14	16.17	0.001

ITN Ratio

In multivariable models controlling for district, calendar year, ITN ratio (number of ITNs distributed/mid-year population), access to improved water, mother's educational level, full vaccination coverage, diarrhea prevalence, proportion of children less than 6 months exclusively breastfed, and vitamin A immunization, ITN ratio was marginally significantly associated with death (IRR=0.58, 95%CI=0.31–1.10).

Table A.1.7: IRR for ACCM in multivariable Poisson models.

	IRR	[95% Conf.	Interval]	P>z
ITN ratio (# ITNs/population)	**0.58**	**0.31**	**1.10**	**0.093**
2004 (ref)	1			
2005	1.04	0.84	1.30	0.713
2006	1.16	0.94	1.43	0.17
2007	0.97	0.79	1.21	0.805
2008	0.81	0.71	0.93	0.002
2009†	1			
Access to improved water	3.52	1.74	7.15	<0.0005
Mother's educational level	0.43	0.28	0.67	<0.0005
Fully vaccinated	3.07	1.26	7.53	0.014
Diarrhea prevalence	6.97	2.01	24.19	0.002
% <6 months exclusively breastfed	0.44	0.22	0.88	0.021
Vitamin A in past 6 months	0.26	0.12	0.59	0.001

†Omitted due to collinearity

ITN Ratio as a categorical variable

In multivariable models controlling for district, calendar year, categories of ITN ratio, proportion of households with access to improved water, education of mother's, diarrhea, and vitamin A, categories of ITN ratios were significantly associated with mortality (IRR = 0.87, 95%CI=0.77–0.98). Also note that the risk of mortality decreased over time (IRR=0.82, 95%CI=0.71-0.93 for 2008 compared to 2004).

Table A.1.8: IRR for ACCM in multivariable Poisson models.

	IRR	[95% Conf.	Interval]	P>z
ITN ratio category	**0.87**	**0.77**	**0.98**	**0.018**
2004	ref			
2005	1.04	0.84	1.28	0.725
2006	1.12	0.91	1.38	0.295
2007	0.92	0.75	1.14	0.463
2008	0.82	0.71	0.93	0.003
2009†	1.00			
Access to improved water	4.13	2.05	8.30	<0.0005
Mother's educational level	0.58	0.39	0.85	0.005
Diarrhea prevalence	3.94	1.27	12.29	0.018
Vitamin A in past 6 months	0.43	0.20	0.89	0.024

†Omitted due to collinearity

In multivariable models controlling for district, calendar year, categories of ITN ratio, proportion of households with access to improved water, education of mother's, diarrhea, and vitamin A, and the variables that were independently associated with mortality (Full vaccination, ARI prevalence, low weight for age, and *Pf*PR2-10), category of ITN ratios was significantly associated with mortality (IRR = 0.87, p=0.018). Also note that risk of mortality decreased over time (IRR=0.82, p=0.003 for 2008 compared to 2004).

Table A.1.9: IRR for ACCM in multivariable Poisson models including variables independently associated with mortality in bivariate models.

	IRR	[95% Conf.	Interval]	P>z
ITN ratio category	**0.86**	**0.76**	**0.97**	**0.011**
2004	ref			
2005	1.08	0.83	1.42	0.563
2006	1.17	0.89	1.53	0.261
2007	0.96	0.74	1.26	0.794
2008	0.82	0.71	0.94	0.003
2009†	1			
Access to improved water	3.42	1.60	7.29	0.001
Mother's educational level	0.53	0.32	0.88	0.013
Diarrhea prevalence	3.19	0.81	12.60	0.098
Vitamin A in past 6 months	0.48	0.21	1.08	0.076
Fully vaccinated	2.34	1.03	5.36	0.043
Low weight for age	1.24	0.22	7.11	0.807
*Pf*PR2-10	1.16	0.61	2.20	0.649
ARI prevalence	4.66	0.75	29.12	0.1

†Omitted due to collinearity

A.1.16 Climate Data

Figure A.1.6: Monthly mean rainfall Jan – Apr in MAC survey districts, 2005–2009.

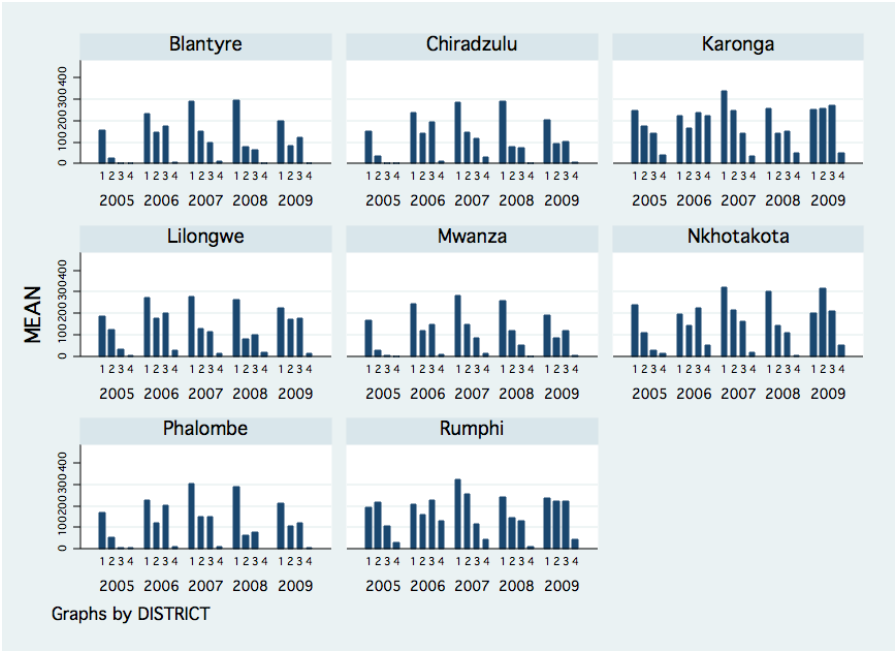
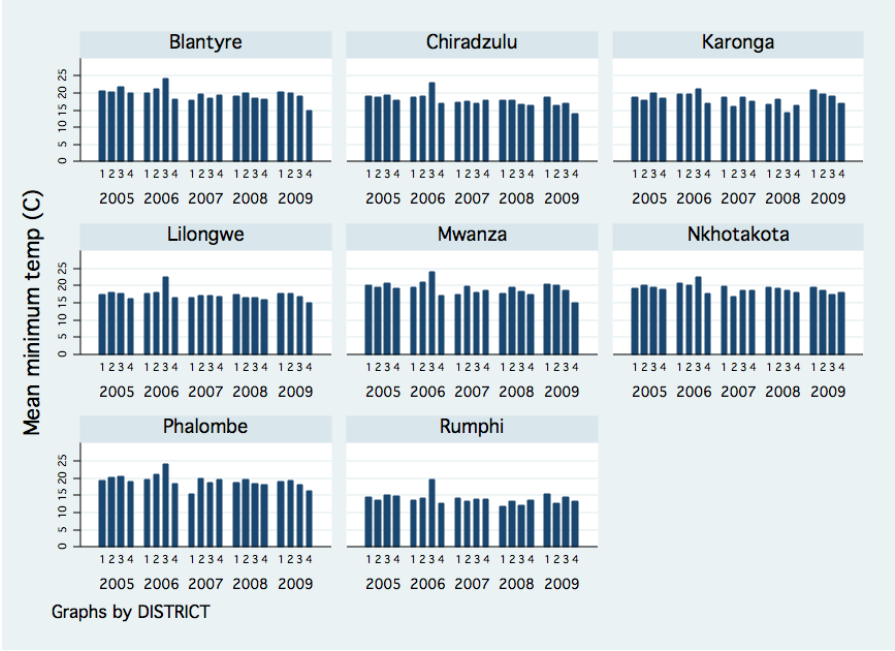


Figure A.1.7: Monthly mean minimum temperature Jan-Apr in MAC survey districts, 2005–2009



Minimum temperatures in Blantyre and the Central plains

On the whole, mean minimum temperature measured at gauge stations in Blantyre (700 meters elevation) and the Central plains (1200–1300 meters elevation) was consistent across the decade.

January-April mean minimum temperature was 20 °C between 2000–2005 and 19.9 °C from 2006–2010 in Blantyre, and 14.1 °C between 2000-2005 and 14.2 °C from 2006–2010 in the Central plains. The lowest January-April mean minimum temperatures in Blantyre occurred in 2008 (18.8 °C), and the highest occurred in 2010 (21°C). The lowest January-April mean minimum temperatures in the Central plains occurred in 2008 (13.6°C) and 2009 (13.3°C), and the highest occurred in 2010 (15.2°C).

Figure A.1.8: Monthly Mean Minimum Temperature from gauge stations in Central Plains (Mzuzu and Kasungu) and Blantyre, Malawi 2000–2010.

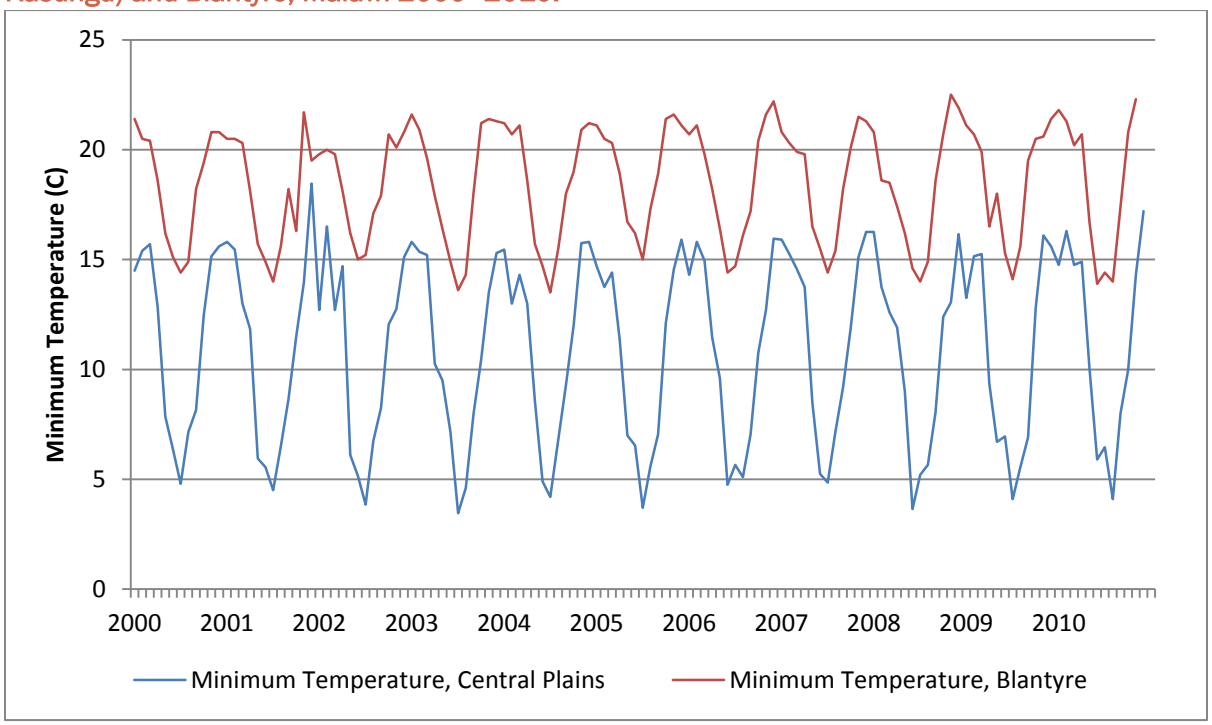


Figure A.1.9: Lowess running-mean smoothed plot of monthly rainfall compared to the *El Niño* index, Malawi, 2005–2010

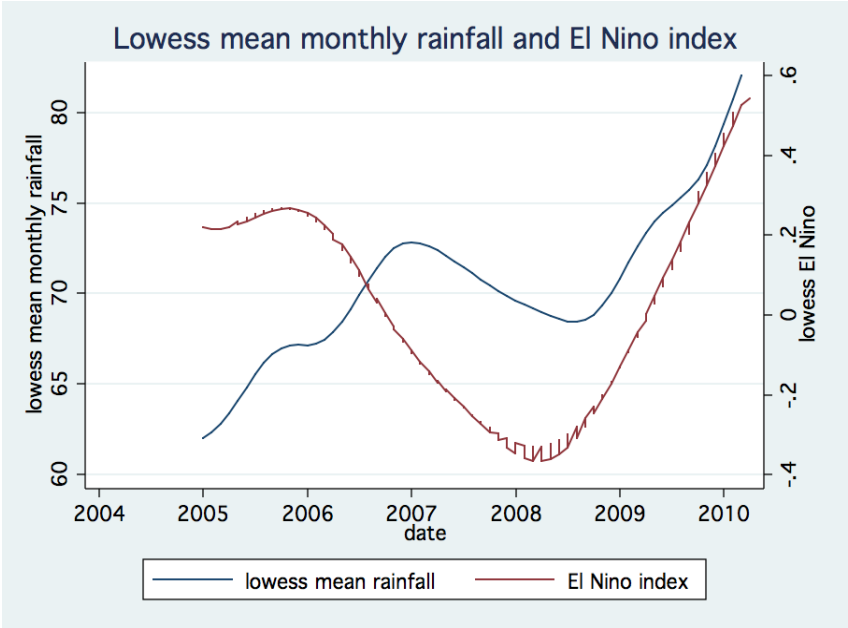
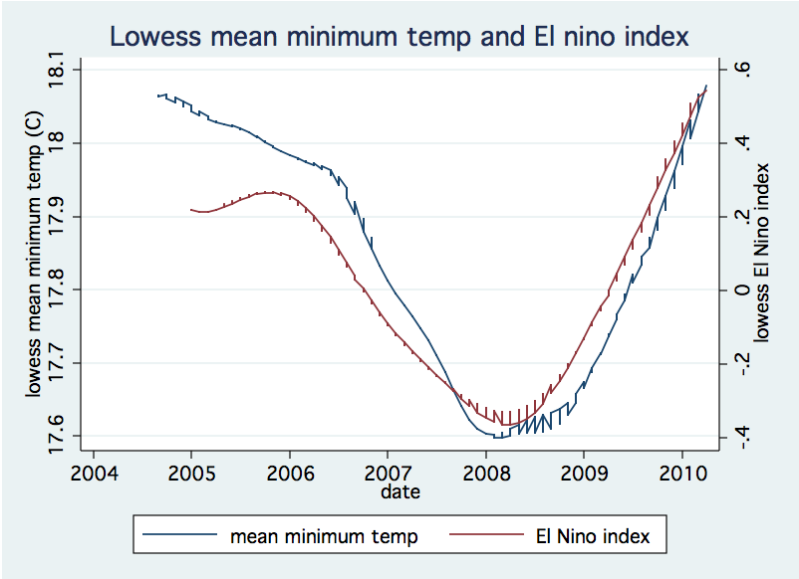


Figure A.1.10: Lowess running-mean smoothed plot of mean minimum temperature compared to the *El Niño* index

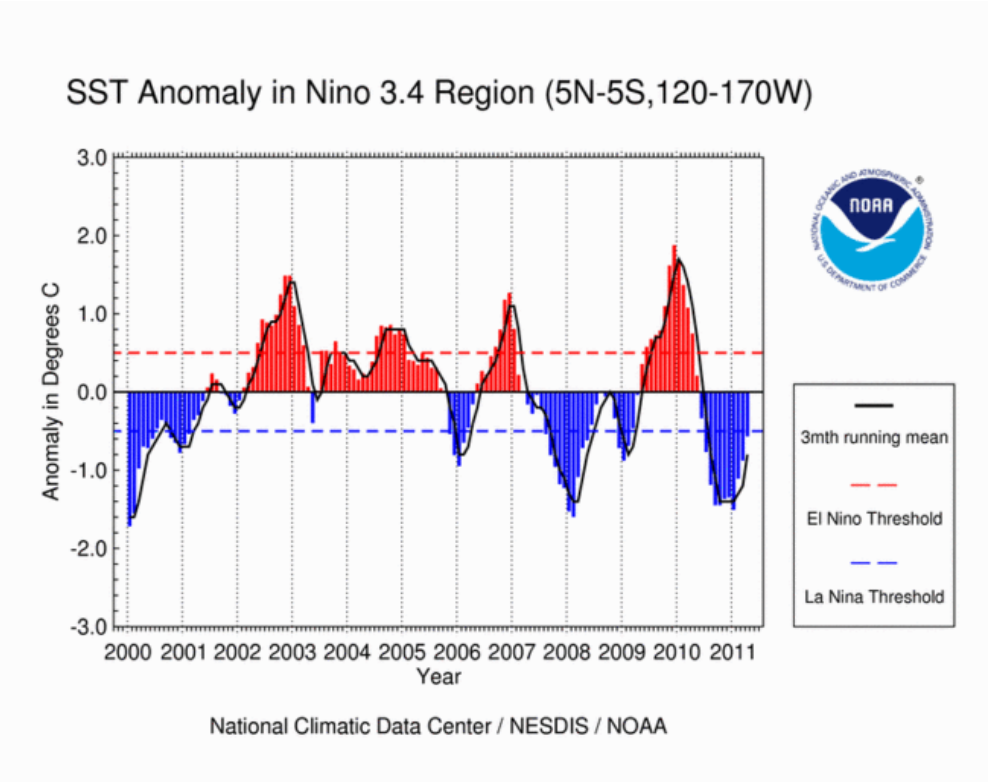


Climate Variability

The *El Niño* index (MEI) is an indicator of sea surface temperature anomalies in the southern Pacific, where positive values indicate warmer than average temperatures (*El*

Niño) and negative values indicate cooler than average temperatures (*La Niña*)[8]. The latter period of malaria control intervention scale–up was characterized by a weak *El Niño* in 2006–2007, a moderate *La Niña* in 2008, and a strong *El Niño* in 2009–2010[9] (Figure A.1.11). While the effects of these global patterns on the climate in the region vary substantially, *El Niño* patterns often bring higher rainfall to the northern part of the region, whereas *La Niña* patterns often affect the southern part of the region[10]. The 2000–2010 rainfall and temperature time series suggest that the 2008 transmission season may have been influenced by slightly lower rainfall totals and lower minimum temperatures, and the 2010 transmission season was characterized by moderate rainfall totals along with the highest minimum temperatures of the decade. Based upon 2005–2010 monthly mean rainfall alone, the largest negative rainfall anomalies nationally were observed for early 2005, early 2008, and January of 2010. Positive rainfall anomalies were observed in early 2006, early 2007, late 2007, and February of 2010 (Figure 52 in core report).

Figure A.1.11: El Niño sea-surface temperature anomalies, 2000–2010



[8] ESRL. *Multivariate ENSO Index (MEI)*. 2012; Available from: http://www.esrl.noaa.gov/psd/enso/mei/.
[9] Null, J. *El Nino and La Nina Years and Intensities*. 2012; Available from: http://ggweather.com/enso/oni.htm.
[10] Magadzire, T. and A. Chavula, *Regional Update 2009/2010 Seasonal Rainfall Outlook.* SADC Regional Training Workshop on Emergency Preparedness Planning in Southern Africa, 2009.

Annex 2: LiST Model Details

A.2.1 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 [1]. 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 [1]. The LiST model projections and information are available from www.jhsph.edu/dept/ih/IIP/list/. The analysis was performed with Spectrum version 4.43. Unless otherwise indicated, the values in the standard projection for Malawi were used.

Malawi Demographic Data

The default demographic data (from the United Nations Population Division) in the Spectrum projection for Malawi was used.

Family Planning Module

The values in the standard Malawi projection were used without change.

AIDS Impact Module (AIM)

The AIDS Impact Module (AIM) was used without change from the standard Malawi projection.

Mortality & Cause-Specific Mortality Profile

The baseline mortality values for 2000 were obtained from the IGME estimates for 2000 midyear (accessed 6/5/12). The values (deaths per 1000 live births) are infant (98.7) and under five (166.5). The WHO neonatal mortality value of 37.4 for 2000 was used [2].

The cause-specific breakdown of child mortality used here was developed by the CHERG [3]. For neonatal mortality, the cause-specific mortality profile for Malawi is diarrhea (2.8%), sepsis pneumonia (28.7%), asphyxia (22.8%), prematurity (26.9%), tetanus (5.3%), congenital anomalies (7.0%) and other (6.5%). The cause-specific mortality profile for children 1-59 months old was also obtained from the CHERG [3], with the exception that the malaria-specific mortality value from Rowe *et al.* [4,5] was applied. Rowe shows 14.2% (12.3 – 16.1%) of under-five mortality (including neonates) was due to malaria. According to Bryce *et al*. [3] 26% of the under-five mortality occurs in the neonatal period in Africa. Therefore we removed neonatal mortality by adjusting the 14.2% by 26%, resulting in 19.2% (16.6 – 21.8%) of mortality in 1–59 month old children being due to malaria. The LiST model calculates AIDS mortality directly (17.3%). Holding the malaria and AIDS mortality values fixed, the cause-specific mortality values from the CHERG [3] were adjusted proportionally to total 100%. The 1–59 month mortality envelope used here is therefore: diarrhea (22.9%), pneumonia (25.0%), meningitis (2.0%), measles (0.36%), malaria (19.2%), pertussis (3.6%), AIDS (17.3%), injury (2.1%) and other (7.54%).

Intervention Coverage

Table A.2.3.1 lists the values, definitions and data sources for the prevention and treatment interventions used in this LiST analysis. The intervention coverage levels for indicators were obtained from the Malawi DHS 2000, 2004, 2010 and MICS 2006 with a few exceptions noted below. 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. "Data not available" refers to these interventions as well as those in which data is not currently being collected/reported in the surveys.

National yearly values for coverage of tetanus toxoid (% of children protected at birth) and vaccination coverage (Hib, measles (MCV1), DPT3, polio3 and BCG) were obtained from WHO-UNICEF (http://apps.who.int/immunization_monitoring/en/globalsummary/timeseries/tswucoveragemcv.htm). The water and sanitation indicators (% of households with improved source of drinking water, % of households with water piped into the dwelling/yard/plot, and % of households with access to flush toilet/vip latrine) were obtained from the WHO/UNICEF Joint Monitoring Program for Water and Sanitation (http://www.wssinfo.org/documents-links/documents/).

Malaria Control Intervention Coverage

The 2000 DHS did not allow for calculation of the % of households owning at least one ITN. The value of 7.1% was estimated from the 2001 Micronutrient Survey as follows:

-14.4% of households report using a bednet (n=1290)
-55.5% of household that report using nets have a net that was soaked (n=217)
-82.7% of the hh that have a soaked net have a net soaked in the past 12 months (n=110)
Thus, following the calculations: 110*82.7 /1290 = 0.0705

Therefore, approximately 7.1% of households owned at least one ITN in 2000. This is in line with the 2000 DHS value of 10.1% of households owning any net, but it should be noted that the 7.1% is only calculated based on households that reported using a net, so may in fact overestimate net ownership and therefore underestimate deaths prevented in the LiST model. The ITN household ownership indicator was used for the LiST model as opposed to % of households owning at least one ITN or sprayed by IRS within the last 12 months because the later indicator was only available for 2010 and the national 2010 value (56%) was very similar to the % of households owning at least one ITN (55.4%).

The proportion of pregnant women receiving 2 doses SP/Fansidar at an ANC visit was only available from the 2004 and 2010 DHS surveys. For those two surveys the values were similar for % of pregnant women receiving 2 doses SP/Fansidar regardless of source of SP [2004: 41.7% at ANC, 45.4% regardless of source; 2010: 53.6% at ANC, 54.8% regardless of source]. In order to look at the trend in IPTp coverage the % of pregnant women receiving 2 doses SP/Fansidar regardless of source was used in the LiST model so as to obtain values from the 2000, 2004, 2006 and 2010 surveys.

It was assumed that most malaria-attributable deaths are in the rural areas, where the coverage of malaria interventions is lower than in urban areas. Therefore, the rural value for the percentage of households owning at least one ITN and the percentage of pregnant women with two doses of IPTp

were used to conservatively calculate the malaria-specific deaths prevented by vector control and malaria in pregnancy measures in all of Malawi.

Additional Health Status Data

The percent of newborns with IUGR in the baseline year 2000, was calculated from the percentage of weighed babies with low birth weight (<2500g) in the 2000 DHS, 11.06% for Malawi. Using X=11.06 in the equation from De Onis *et al.* [6] Y=-3.2452 + 0.852X, gives Y=6.19% IUGR. 88.4% of IUGR infants are estimated to weigh between 2000 and 2500g and are the IUGR infants most likely to benefit from interventions that reduce IUGR, therefore the IUGR value used was 88.4% of calculated IUGR, which was 5.47% (I. Friberg, Johns Hopkins). Wasting (-3SD) values for 2000 were obtained from the WHO Global Database on Child Growth and Malnutrition (www.who.int/nutgrowthdb/database/en/). Stunting (-2SD) was directly entered for 2000, 2004, 2006 and 2010 from the WHO Global Database on Child Growth and Malnutrition, and linearly interpolated between these years. The baseline diarrhea data in the standard projection was used and is derived from regional estimates based on the DHS data by Boschi-Pinto *et al* [7].

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 [8]. 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 [8]. 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 [8].

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 [4,5], the estimated protective effect of the malaria control interventions [8] and the malaria intervention coverage estimates from the DHS and MICS survey data sets.

A.2.2 LiST Model References

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A.2.3 Intervention Coverage Indicators & Values Used in LiST Analysis

Table A.2.3.1. Indicators Used in Malawi LiST Analysis

Intervention[a]	2000	2004	2006	2010	Data Sources/Indicator Information
Periconceptual					
All interventions	n/a	n/a	n/a	n/a	data not available
Pregnancy					
Antenatal Care	56.0	57.1	51.0	45.5	% of women with a live birth in the five years preceding the survey who had 4+ ANC visits for the most recent birth (DHS, MICS)
Tetanus toxoid	see yearly values under data sources				WHO-UNICEF[b]/% children protected at birth (pab): '00-'10: 84, 87, 85, 87, 86, 86, 88, 86, 87, 87, 87
Pregnant women protected via IPT or sleeping under an ITN	27.8	45.4	45.3	54.8	% of pregnant women receiving 2 doses SP/Fansidar, rural (DHS, MICS). Note: This is regardless of location, only have IPTp2 at ANC for 2004 (41.7) and 2010 (53.6).

Multiple Micronutrient Supplementation	11.4	17.6	n/a	32.3	% of pregnant women receiving 90+ days of iron folate (DHS)
Balanced Energy Supplementation	n/a	n/a	n/a	n/a	data not available
Case management of malaria	n/a	n/a	n/a	n/a	data not available
Childbirth					
Skilled birth attendance (SBA)	55.6	57.1	53.6	73.0	% of live births assisted by a skilled birth attendant, (DHS, MICS)
Institutional delivery (clinic and hospital)	55.3	57.2	53.8	73.2	% of live births delivered at a health facility (public, voluntary/religious, private) (DHS, MICS)
Place and level of delivery	n/a	n/a	n/a	n/a	use defaults calculated by LiST
$MgSO_4$ management of eclampsia	n/a	n/a	n/a	n/a	use defaults calculated by LiST
Neonatal resuscitation (home)	n/a	n/a	n/a	n/a	use defaults calculated by LiST
Breastfeeding					
<1 month					% distribution of youngest children under 3 years living with the mother by breastfeeding status (MICS not restricted to youngest child) (retabulated DHS, MICS) (for 6-11 months and 12-23 months all types of breastfeeding were combined to generate any breastfeeding)
Exclusive	85.9	83.0	86.1	95.6	
Predominant	8.4	8.4	9.6	2.4	
Partial	5.7	6.8	1.3	2.0	
Not	0	1.8	3.0	0	
1-5 months					
Exclusive	40.4	49.5	52.0	68.8	
Predominant	13.0	23.6	17.6	6.6	
Partial	46.6	26.4	29.0	24.0	
Not	0	0.5	1.4	0.7	
6-11 months					
Exclusive	2.0	2.1	3.0	4.0	
Predominant	3.3	12.9	5.5	4.5	
Partial	94.2	83.8	90.0	89.8	
Not	0.6	1.2	1.5	1.8	
12-23 months					
Exclusive	0.5	0.4	0.5	17.5	
Predominant	1.0	1.6	3.3	3.2	
Partial	87.9	88.3	83.7	72.2	
Not	10.6	9.6	12.5	7.1	
Preventative After Birth					

Preventative Postnatal Care	43.8	50.9	48.2	11.4	% of women whose child's first postnatal checkup was 0-2 days after delivery, denominator is births outside of health facility (DHS, MICS)
Complementary Feeding-education only	93.4	79.6	88.8	87.4	% of 6-9mo breastfeeding and consuming complementary foods (DHS, MICS)
Complementary Feeding-education & supplementation	93.4	79.6	88.8	87.4	% of 6-9mo breastfeeding and consuming complementary foods (DHS, MICS)
Vitamin A for prevention	70.6	65.4	68.5	85.5	% of 6-59 mo receiving 1 dose of vitamin A within past 6 months (DHS,MICS)
Zinc for prevention	n/a	n/a	n/a	n/a	data not available
Use of improved water source within 30 minutes	see yearly values under data sources				% households with improved source of drinking water (JMP)[c]: '00-'10: 65.7,X,68.8, 80.8,64.8,73.0,75.7,80.0,74.9,81.1,80.2
Use of water connection in the home	see yearly values under data sources				% of households with water piped into the dwelling/yard/plot (JMP)[c]: '00-'10: 7.8,x,5.3,5.6,6.3,X,6.6,X,8.8,7.2,7.6
Improved excreta disposal (latrine/toilet)	see yearly values under data sources				% of households with access to flush toilet/vip latrine (JMP)[c]: '00-'10: 74.8,X,81.6,79.0,76.9,X,82.5,X,78.9,X,82.5
Hand washing with soap	n/a	n/a	n/a	n/a	data not available
Hygienic Disposal of children's stools	75.6	n/a	82.5	n/a	% of mothers whose youngest child under five's stools are contained (DHS, MICS)
Insecticide treated materials or indoor residual spraying	7.1	24.8	34.9	55.4	% households owning at least 1 ITN, rural (MNS[d], DHS, MICS)
Vaccines					
Rotavirus	n/a	n/a	n/a	n/a	data not available
Measles	see yearly values under data sources				MCV1: WHO-UNICEF[b] '00-'10: 73, 81, 69, 77, 80, 82, 85, 83, 88, 92, 93
Hib	see yearly values under data sources				Hib3: WHO-UNICEF[b] '02-'10: 64, 84, 89, 93, 99, 87, 91, 93, 93
Pneumococcal	n/a	n/a	n/a	n/a	data not available
DPT	see yearly values under data sources				DPT3: WHO-UNICEF[b] '00-'10: 75, 90, 64, 84, 89, 93, 99, 87, 91, 93, 93
Polio	see yearly values under data sources				Polio3: WHO-UNICEF[b] '00-'10: 73, 86, 79, 85, 94, 94, 99, 88, 92, 93, 86
BCG	see yearly values under data sources				BCG: WHO-UNICEF[b] '00-'10: 83, 93, 78, 91, 97, 99, 99, 95, 97, 95, 97

Hepatitis B	see yearly values under data sources				HepB3: WHO-UNICEF[b] '02-'10: 64, 84, 89, 93, 99, 87, 91, 93, 93
Curative after birth					
Sepsis case management-basic	n/a	n/a	n/a	n/a	data not available
Sepsis case management-comprehensive	n/a	n/a	n/a	n/a	data not available
Kangaroo mother care	n/a	n/a	n/a	n/a	data not available
Oral antibiotics: case management of severe neonatal infection	n/a	n/a	n/a	n/a	data not available
Injectable antibiotics: case management of severe neonatal infection	n/a	n/a	n/a	n/a	data not available
Full supportive care: case management of severe neonatal infection	27.7	28.6	26.9	36.6	% of live births delivered at a health facility * 0.5 (DHS,MICS)
ORS	47.9	61.1	51.4	69.0	% of children with diarrhea given ORS packets (DHS,MICS)
Antibiotics for dysentery	24.0	30.6	25.7	34.5	50% of ORS (DHS)
Zinc for treatment	n/a	n/a	n/a	n/a	data not available
Case management of pneumonia (oral antibiotics)	16.0	21.9	12.5	39.2	60% of care seeking for ARI (26.7, 36.5, 20.9, 65.4) (because oral antibiotics indicator not available) (DHS, MICS)
Vitamin A for measles treatment	70.6	65.4	68.5	85.5	Percentage of 6-59 mo receiving 1 dose of vitamin A within past 6 months (DHS,MICS)
Antimalarials	n/a	n/a	n/a	n/a	not running the LiST model with this intervention (coverage and efficacy still being worked out for changing antimalarials)
Therapeutic feeding	n/a	n/a	n/a	n/a	data not available

[a]It is important to note that the LiST model calculates lives saved compared to the baseline year, therefore a *change* in intervention coverage is required to see lives saved.

[b]WHO-UNICEF (http://apps.who.int/immunization_monitoring/en/globalsummary/timeseries/tswucoveragemcv.htm)

[c]WHO/UNICEF Joint Monitoring Program for Water and Sanitation (http://www.wssinfo.org/documents-links/documents/)

[d]Malawi Micronutrient Survey 2001 was used to estimate ITN ownership in 2000.

A.2.4 LiST Model Outputs

Table A.2.4.1 Annual deaths prevented by ITN scale-up, children 1–59 months, 2000–2010

	Malaria Deaths	Estimated deaths prevented (1–59 months)											
	2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Lower		0	232	472	720	977	1,313	1,661	2,008	2,374	2,761	3,168	15,686
Midline	12,764	0	330	671	1,023	1,389	1,821	2,268	2,724	3,205	3,713	4,247	21,391
Upper		0	446	908	1,385	1,881	2,400	2,938	3,509	4,111	4,747	5,417	27,742

Table A.2.4.1 Annual deaths prevented by IPTp scale-up, children 0–59 months, 2000–2010

	Neonatal Deaths	Estimated deaths prevented (0–59 months)											
	2000	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Lower		0	2	5	8	10	11	11	13	15	17	19	111
Midline	19,445	0	4	9	14	19	19	20	23	26	30	34	198
Upper		0	7	15	23	31	32	33	37	41	45	51	315

Annex 3: Data Tables with Values, 95% Confidence Limits and Sample Sizes

A.3.1 DHS Data Tables (Table A.3.1.1-Table A.3.1.21)

Table A.3.1.1: Household possession of insecticide-treated nets

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

	DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence												
Urban	40.5	36.7	44.4	2,262	55.2	52.5	57.9	4,481	64.3	61.1	67.3	4,116
Rural	24.8	23.3	26.4	11,402	34.9	33.6	36.1	26,072	55.4	54.0	56.7	20,709
Region												
Northern	31.3	26.7	36.4	1,584	38.9	36.9	41.0	3,132	56.5	52.3	60.6	2,716
Central	24.0	21.6	26.6	5,589	38.5	36.3	40.8	13,121	54.4	52.3	56.6	10,627
Southern	29.4	27.3	31.6	6,491	37.0	35.6	38.5	14,300	59.1	57.6	60.7	11,482
Wealth Quintile												
Lowest	10.7	9.3	12.2	3,168	22.9	21.1	24.9	6,360	41.0	39.1	43.0	5,253
Second	18.5	16.5	20.6	2,748	30.6	28.7	32.6	6,297	51.3	49.2	53.4	5,128
Middle	24.8	22.6	27.0	2,622	38.3	36.4	40.3	5,976	58.3	56.4	60.2	4,869
Fourth	35.6	33.1	38.1	2,569	41.6	40.0	43.3	5,863	61.2	59.0	63.4	4,808
Highest	52.2	48.6	55.8	2,557	57.0	54.9	59.0	6,057	74.3	72.5	76.1	4,767
Number of household members												
<4	21.8	20.1	23.7	5,263	31.5	30.0	33.0	12,063	46.9	45.3	48.6	8,145
4-5	29.3	27.1	31.5	4,562	40.6	38.8	42.5	10,544	60.5	58.7	62.1	8,654
6-7	32.4	29.9	35.0	2,614	42.9	41.1	44.7	5,750	62.4	60.5	64.3	5,519
8-9	32.0	28.0	36.2	921	46.3	43.0	49.6	1,729	63.0	60.1	65.8	1,944
10+	39.8	33.2	46.7	303	46.8	41.7	52.0	467	68.7	63.5	73.5	563
Under-fives in household												
No	21.9	20.1	23.7	5,795	30.7	29.4	32.0	13,678	43.7	42.0	45.4	9,712
Yes	31.5	29.7	33.4	7,869	43.6	42.0	45.3	16,875	65.3	63.9	66.6	15,113
Total	27.4	25.9	29.0	13,664	37.8	36.7	39.1	30,553	56.8	55.6	58.1	24,825

* 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.3.1.2: Use of insecticide-treated nets by children under five years of age

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	11.5	9.2	14.2	1,358	30.2	25.5	35.4	1,420	42.3	38.4	46.3	3,366	48.4	43.6	53.2	2,634
Rural	1.5	1.1	1.9	9,201	12.4	11.1	13.8	9,119	21.6	20.5	22.8	19,628	38.0	36.5	39.5	16,785
Region																
Northern	3.5	1.6	7.4	1,166	17.4	13.3	22.5	1,350	23.7	21.1	26.5	2,315	36.5	33.4	39.8	2,312
Central	1.9	1.4	2.8	4,594	11.9	9.9	14.1	4,397	24.4	21.5	27.5	10,569	38.5	36.3	40.8	8,404
Southern	3.4	2.6	4.3	4,799	16.7	14.7	19.0	4,791	25.2	23.5	26.9	10,111	41.1	39.0	43.2	8,703
Wealth Quintile																
Lowest	0.6	0.3	1.1	2,311	6.4	4.8	8.3	2,090	14.6	13.0	16.4	5,112	28.8	26.6	31.2	4,344
Second	0.9	0.5	1.5	2,144	9.2	7.7	11.0	2,294	19.9	17.7	22.3	4,686	35.1	32.9	37.4	4,200
Middle	2.2	1.2	4.1	1,965	12.1	10.3	14.2	2,358	24.1	21.9	26.5	4,736	41.5	39.0	44.0	4,158
Fourth	2.4	1.6	3.5	2,120	16.7	14.4	19.2	2,071	25.5	23.2	28.1	4,243	42.1	39.5	44.8	3,587
Highest	8.2	6.6	10.1	2,007	33.8	29.4	38.5	1,726	41.8	38.7	45.1	4,217	54.0	50.8	57.2	3,130
Number of household members																
<4	3.0	2.1	4.3	1,762	16.0	13.6	18.9	1,461	26.2	24.1	28.4	3,954	46.0	43.3	48.8	2,208
4-5	2.4	1.7	3.2	3,895	16.2	14.3	18.3	4,169	25.6	22.9	28.4	9,808	42.4	40.4	44.5	7,341
6-7	3.2	2.3	4.5	2,800	13.7	11.9	15.9	2,967	23.9	21.9	26.1	6,239	37.0	34.9	39.1	5,985
8-9	2.6	1.7	3.9	1,345	12.4	9.9	15.4	1,322	21.9	18.8	25.3	2,209	34.6	31.7	37.7	2,722
10+	2.9	1.7	4.8	758	12.4	8.6	17.4	619	19.3	15.3	24.1	784	31.4	27.1	36.1	1,165
Sex																
Male	2.8	2.2	3.5	5,225	14.3	12.8	16.0	5,195	25.1	23.4	26.9	11,368	38.6	37.0	40.3	9,514
Female	2.7	2.1	3.6	5,334	15.2	13.6	17.0	5,344	24.2	22.6	26.0	11,626	40.2	38.5	41.9	9,905
Age in months																
0-11	3.6	2.7	4.7	2,517	15.3	13.4	17.4	2,378	28.9	25.3	23.7	5,026	47.4	45.2	49.6	3,830
12-23	2.9	2.1	4.0	2,238	15.7	13.8	17.9	2,293	25.3	23.3	27.3	5,080	42.6	40.6	44.7	3,919
24-35	2.8	2.0	4.0	2,107	15.8	13.8	18.0	1,881	23.7	21.5	26.0	5,027	37.7	35.4	40.1	3,971
36-47	2.5	1.5	4.1	2,047	14.3	12.3	16.6	1,941	22.6	20.7	24.7	4,540	34.9	32.7	37.2	3,886
48-59	1.5	1.0	2.2	1,650	12.7	10.8	14.8	2,047	21.6	19.8	23.6	3,322	34.4	32.3	36.5	3,814
Mother's education																
None	0.8	0.5	1.3	3,388	7.3	6.1	8.7	2,557	18.1	15.4	21.3	5,614	32.4	29.8	35.0	3,231
Primary	2.0	1.5	2.7	6,453	15.3	13.7	17.0	6,219	23.6	22.3	25.0	14,875	39.7	38.2	41.3	12,250
Secondary +	18.4	14.9	22.4	718	33.8	29.3	38.5	1,025	46.2	42.9	49.5	2,442	56.6	53.2	60.0	2,563
Missing					10.1	7.3	13.8	737	23.6	12.9	39.2	53	21.1	18.1	24.6	1,376
Number of ITNs per household																
0					0.0	0.0	0.0	7189					0.0	0.0	0.0	6,450
1					40.1	36.9	43.4	1848					50.6	48.7	52.5	6,531
2					53.1	48.4	57.7	989					64.0	61.8	66.2	4,276
3+					56.9	50.6	63.0	513					74.6	71.9	77.2	2,163
Total	2.8	2.2	3.4	10,559	14.8	13.4	16.3	10,539	24.7	23.1	26.3	22,994	39.4	38.0	40.8	19,420

* WN = Weighted number of cases (denominator)

Table A.3.1.3: Household vector control measures

Percentage of households with indoor residual spraying† (IRS) and percentage of households with at least one insecticide-treated net** (ITN) and/or IRS in the last 12 months, by background characteristics for 2010, Malawi

	IRS				IRS or ITN ownership			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence								
Urban	1.7	1.1	2.7	4,116	64.6	61.4	67.7	4,116
Rural	2.3	1.8	2.9	20,709	56.0	54.6	57.4	20,709
Region								
Northern	0.7	0.4	1.2	2,716	56.6	52.4	60.7	2,716
Central	4.2	3.3	5.4	10,627	55.7	53.5	57.8	10,627
Southern	0.7	0.4	1.1	11,482	59.3	57.8	60.8	11,482
Wealth Quintile								
Lowest	2.0	1.2	3.3	5,253	41.9	39.8	43.9	5,253
Second	2.2	1.6	3.1	5,128	52.0	49.9	54.1	5,128
Middle	2.1	1.6	2.6	4,869	58.7	56.8	60.6	4,869
Fourth	2.3	1.7	3.1	4,808	61.9	59.7	64.1	4,808
Highest	2.4	1.8	3.4	4,767	74.8	72.9	76.5	4,767
Number of household members								
<4	1.6	1.2	2.0	8,145	47.6	45.9	49.3	8,145
4-5	2.4	1.8	3.2	8,654	61.0	59.3	62.7	8,654
6-7	2.5	1.9	3.3	5,519	63.1	61.1	65.0	5,519
8-9	2.9	2.0	4.1	1,944	63.6	60.7	66.4	1,944
10+	3.1	1.7	5.6	563	68.9	63.7	73.7	563
Under-fives in household								
No	1.8	1.4	2.4	9,712	44.5	42.8	46.2	9,712
Yes	2.4	2.0	3.0	15,113	65.8	64.4	67.1	15,113
Total	2.2	1.8	2.7	24,825	57.5	56.2	58.7	24,825

*WN = weighted sample size

**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.

†Indoor residual spraying (IRS) is the spraying of the interior walls of a dwelling in the past 12 months with insecticide that has a long-lasting effect against mosquitoes.

Table A.3.1.4: 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, Malawi

	DHS 2000				DHS 2004				MICS 2006†				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	9.6	5.6	16.0	206	29.8	21.9	39.2	183	(40.3)	24.4	58.6	85	43.6	32.2	55.7	248
Rural	1.6	1.0	2.5	1,362	12.4	10.4	14.8	1,222	22.2	17.7	27.5	453	34.1	31.5	36.8	1,838
Region																
Northern	2.3	1.2	4.7	172	15.7	11.0	21.8	173	14.8	7.6	27.0	27	35.5	29.8	41.7	249
Central	2.1	1.2	3.6	680	11.1	8.1	15.1	578	24.2	16.1	34.7	265	32.4	28.4	36.6	860
Southern	3.2	1.9	5.5	716	17.6	14.3	21.3	655	27.2	20.7	34.8	245	37.7	33.7	41.9	977
Wealth Quintile																
Lowest	0.7	0.2	2.4	335	6.0	3.7	9.6	247	14.3	7.2	26.3	87	22.5	18.4	27.2	416
Second	0.3	0.0	1.8	288	9.6	6.8	13.5	319	16.7	9.7	27.4	141	28.6	24.2	33.6	478
Middle	2.7	1.4	5.1	309	12.6	9.3	16.8	342	16.8	9.4	28.2	120	38.1	33.2	43.3	481
Fourth	2.5	1.2	5.0	344	17.0	12.2	23.1	284	47.9	30.3	66.0	110	42.2	36.4	48.2	370
Highest	7.4	4.3	12.5	289	32.6	25.1	41.1	213	32.7	18.4	51.2	80	48.5	39.2	58.0	341
Woman's Age (years)																
15-19	2.2	1.0	4.8	289	9.9	6.5	14.8	268	27.0	14.6	44.6	61	26.0	20.9	31.9	357
20-24	3.0	1.6	5.3	515	16.7	13.1	21.1	487	26.1	19.0	34.7	206	35.3	30.6	40.3	601
25-29	2.7	1.4	5.0	351	15.4	11.5	20.3	301	19.8	12.1	30.7	123	37.8	32.8	43.0	564
30-34	3.1	1.3	7.1	209	12.6	8.6	18.0	212	20.9	11.0	35.9	82	37.5	31.3	44.1	285
35-39	3.3	1.3	8.5	124	16.1	9.2	26.7	85	(33.4)	7.6	75.4	51	40.7	32.6	49.3	211
40-44	0.0			55	20.0	9.8	36.4	42	*				34.2	21.8	49.3	52
45-49	0.0			25	34.4	9.6	72.0	10	*				40.5	18.3	67.4	16

Woman's Education																
No education	0.7	0.2	2.1	426	8.6	5.8	12.4	309	19.4	12.1	29.8	111	31.7	25.5	38.6	294
Primary	2.0	1.3	3.2	1,032	14.5	12.0	17.4	927	26.3	20.3	33.4	379	33.0	30.1	36.0	1,479
Secondary or Higher	15.9	9.2	26.0	110	26.7	19.0	36.1	169	(28.9)	14.9	48.6	47	49.3	42.4	56.1	312
Missing									*				44.2	8.8	86.6	2
Number of household members																
<4	2.8	1.6	4.7	587	17.5	13.8	22.0	536	25.1	17.4	34.8	210	37.4	32.3	42.8	583
4-5	2.9	1.7	4.9	494	14.4	11.4	18.0	483	23.3	15.9	33.0	167	35.5	31.4	39.9	756
6-7	2.5	1.2	5.1	297	12.0	8.0	17.6	251	27.9	16.1	43.8	124	36.4	31.3	41.8	462
8-9	2.8	0.9	8.7	126	11.8	5.9	22.0	90	(24.1)	8.9	50.6	34	31.4	23.8	40.0	215
10+	0.0			64	6.0	1.9	17.6	46	*				19.0	11.7	29.2	72
Number of ITNs per household																
0					0.0			1008					0.0			785
1					49.0	42.0	56.0	244					47.3	42.7	51.9	730
2					58.4	47.8	68.2	103					65.2	59.0	70.9	377
3+					53.1	38.3	67.5	51					74.3	66.3	81.0	195
Total	2.6	1.8	3.8	1,568	14.7	12.5	17.1	1,405	25.1	19.9	31.1	538	35.2	32.6	38.0	2,086

* 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.

( ) Where the number of unweighted cases was between 25-49

* Where the number of unweighted cases was <25

†Based on pregnant women who had a birth in the past 2 years. The other surveys are based on pregnant women who had a birth in the past 5 years.

Table A.3.1.5: Use of Intermittent preventive treatment during pregnancy

Percentage of women age 15-49 with a live birth in the two years preceding the survey who received Intermittent Preventive Treatment (IPTp)** for malaria during ANC visits during their last pregnancy, by background characteristics and survey year, Malawi

	DHS 2004				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence								
Urban	51.1	45.9	56.3	583	55.2	50.3	60.0	1,138
Rural	41.7	39.8	43.7	4,021	53.6	51.8	55.3	6,586
Region								
Northern	48.1	42.9	53.2	559	50.3	45.7	54.8	889
Central	41.6	38.5	44.8	1,931	59.1	56.7	61.4	3,375
Southern	42.8	40.5	45.1	2,115	49.7	47.2	52.1	3,461
Wealth Quintile								
Lowest	39.0	35.3	42.9	919	51.6	48.4	54.8	1,669
Second	37.6	34.4	40.9	1,111	53.3	50.4	56.1	1,669
Middle	43.7	40.2	47.3	1,001	55.4	52.2	58.5	1,689
Fourth	44.4	40.9	48.0	871	55.2	51.6	58.7	1,409
Highest	53.5	49.4	57.5	701	53.9	49.7	58.0	1,288
Number of household members								
<4	43.3	39.6	47.0	942	57.5	53.7	51.2	1253
4-5	42.8	40.2	45.5	1724	54.6	52.2	57.1	2841
6-7	42.2	39.0	45.4	1190	53.1	50.2	56.0	2214
8-9	41.4	36.7	46.3	497	50.8	46.7	54.9	986
10+	49.2	42.6	55.8	251	48.7	42.7	54.6	430
Woman's Age (years)								
15-19	39.6	34.7	44.7	534	52.9	48.7	57.0	813
20-24	43.1	40.3	46.0	1,641	57.1	54.5	59.7	2,410
25-29	44.4	41.0	47.8	1,109	54.7	52.0	57.4	2,001
30-34	43.4	38.9	48.0	657	50.7	47.0	54.3	1,276
35-39	44.4	38.6	50.4	422	50.5	46.1	54.9	781
40-44	39.3	31.6	47.5	181	49.8	42.7	56.8	341
45-49	35.1	22.4	50.3	60	43.9	32.7	55.8	103
Woman's Education								
No education	35.2	31.9	38.7	1,110	51.1	47.2	55.0	1,249
Primary	43.5	41.3	45.8	2,960	53.5	51.6	55.4	5,236
Secondary or Higher	55.6	50.4	60.6	534	57.8	53.9	61.7	1,239
Source of ANC								
Home	39.6	18.8	65.1	13	39.7	28.6	52.0	70
Public	47.1	45.1	49.1	3,265	55.0	53.1	56.8	5,937
Private	32.5	23.1	43.6	131	56.0	48.0	63.7	223
Religious	45.4	40.4	50.5	785	56.0	51.7	60.1	1,277

Other	14.7	9.5	22.0	149	22.3	11.1	39.6	53
Missing	4.9	2.9	8.0	261	9.9	5.6	16.9	164
Skilled ANC provider[1]								
No	0.0			324				
Yes	46.2	44.4	48.0	4,280				
Parity								
1	45.0	41.5	48.5	1026	57.3	54.0	60.6	1,539
2	44.3	40.6	48.2	947	55.7	52.5	58.8	1,535
3+	41.6	39.3	44.0	2,631	52.1	50.0	54.1	4,651
Month of pregnancy at first ANC								
1-3	55.6	49.8	61.2	351	58.8	54.2	63.3	946
4-6	46.7	44.7	48.7	3,258	56.3	54.4	58.2	5,611
7+	26.0	22.5	29.8	995	37.8	33.9	41.9	1,168
Number of ANC visits								
1	16.5	9.7	26.5	117	14.9	9.6	22.3	224
2	33.4	28.7	38.4	507	46.4	42.3	50.5	1,065
3	42.2	38.9	45.6	1,249	54.7	52.0	57.3	2,940
4	47.5	44.3	50.6	1,138	60.4	57.6	63.1	2,015
5+	45.3	42.1	48.4	1,592	54.5	51.3	57.7	1,480
Used ITN previous night								
No	40.9	39.0	42.9	3,866	51.1	48.9	53.3	4,132
Yes	53.3	49.6	57.0	738	57.0	54.7	59.2	3,593
Total	42.9	41.1	44.8	4,604	53.8	52.2	55.5	7,724

[1] doctor/clinical officer; nurse/midwife; ward attendant

* WN = Weighted number of cases (denominator)

**IPTp: Intermittent Preventive Treatment during pregnancy is preventive treatment with two or more doses of SP/Fansidar

Table A.3.1.6: Use of Intermittent preventive treatment during pregnancy

Percentage of women age 15–49 with a live birth in the two years preceding the survey who received at least two doses of SP for prevention of malaria during last pregnancy**, by background characteristics and survey year, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	31.5	27.4	35.9	644	53.8	48.8	58.7	583	55.1	50.2	59.9	1,507	55.9	51.0	60.7	1,138
Rural	27.8	26.1	29.4	4,419	45.4	43.4	47.4	4,021	45.3	43.7	47.0	9,045	54.8	53.2	56.5	6,586
Region																
Northern	26.1	22.2	30.5	564	49.4	44.2	54.6	559	39.5	36.4	42.6	1,035	51.1	46.9	55.3	889
Central	28.2	25.6	30.9	2,152	45.7	42.4	49.1	1,931	50.4	47.6	53.2	4,959	60.1	57.8	62.4	3,375
Southern	28.8	26.7	30.9	2,347	46.4	44.1	48.7	2,115	44.3	42.2	46.5	4,557	51.0	48.6	53.4	3,461
Wealth Quintile																
Lowest	25.7	22.7	29.0	1,118	42.1	38.2	46.0	919	41.8	38.4	45.2	2,442	52.7	49.5	55.8	1,669
Second	27.2	24.1	30.4	1,023	42.6	39.1	46.3	1,111	44.2	41.1	47.4	2,225	54.3	51.5	57.2	1,669
Middle	28.9	25.6	32.5	915	46.2	42.7	49.7	1,001	47.0	44.0	50.0	2,164	56.9	53.8	59.9	1,689
Fourth	29.8	26.9	32.8	1,060	47.8	44.1	51.5	871	48.1	44.2	52.0	1,899	56.2	52.8	59.6	1,409
Highest	29.9	26.5	33.4	943	57.0	52.9	61.0	701	54.6	51.0	58.1	1,822	55.1	51.0	59.1	1,288
Number of household members																
<4	27.5	24.5	30.7	1160	47.2	43.4	51.0	942	46.3	42.9	49.7	2,483	58.6	54.9	52.2	1,253
4-5	29.7	27.2	32.5	1763	45.9	43.3	48.5	1724	47.2	45.0	49.3	4,183	55.3	52.9	57.7	2,841
6-7	26.7	23.7	30.0	1197	45.8	42.5	49.1	1190	45.7	42.7	48.8	2,657	54.9	52.2	57.6	2,214
8-9	29.9	26.0	34.2	579	16.3	41.4	51.3	497	48.9	44.2	53.7	895	51.8	47.7	55.9	986
10+	25.8	21.2	30.9	365	51.6	45.0	58.2	251	46.0	39.0	53.0	333	50.3	44.4	56.3	430
Woman's Age (years)																
15-19	29.4	25.5	33.7	626	43.2	38.0	48.6	534	43.4	39.1	47.9	1,158	53.8	49.7	58.0	813
20-24	27.6	25.3	30.1	1,676	45.9	43.0	48.9	1,641	47.8	45.0	50.6	3,599	58.4	55.8	61.0	2,410

25-29	29.5	26.8	32.4	1,318	47.9	44.5	51.4	1,109	48.4	45.5	51.2	2,670	55.6	52.9	58.4	2,001
30-34	27.5	23.5	31.8	669	47.2	42.6	51.8	657	44.2	40.8	47.7	1,621	52.0	48.4	55.6	1,276
35-39	27.6	23.1	32.7	481	48.8	42.9	54.8	422	50.0	45.1	54.9	970	52.2	47.8	56.5	781
40-44	27.9	21.3	35.5	205	43.6	35.8	51.7	181	39.2	31.0	48.0	384	50.8	43.8	57.8	341
45-49	22.6	14.4	33.7	89	47.7	32.8	63.0	60	41.4	31.8	51.8	150	44.3	33.0	56.2	103
Woman's Education																
No education	25.9	23.3	28.6	1,507	39.7	36.1	43.4	1,110	39.4	36.7	42.2	2,407	52.5	48.6	56.4	1,249
Primary	28.3	26.4	30.4	3,172	47.1	44.9	49.4	2,960	46.7	44.9	48.5	6,912	54.7	52.8	56.6	5,236
Secondary or Higher	36.7	31.0	42.8	383	57.0	51.9	61.9	534	60.8	55.2	66.2	1,232	58.9	55.2	62.5	1,239
Source of ANC																
Home					54.3	29.9	76.8	13					50.4	39.8	61.0	70
Public					49.7	47.6	51.8	3,265					55.9	54.1	57.7	5,937
Private					37.7	27.6	48.9	131					57.3	48.9	65.2	223
Religious					47.7	42.7	52.7	785					56.2	52.0	60.3	1,277
Other					24.4	18.1	32.2	149					31.1	18.2	47.9	53
Missing					19.0	14.1	25.0	261					18.4	12.2	26.8	164
Skilled ANC provider[1]																
No	5.8	3.7	8.9	402	19.0	14.7	24.2	324	46.7	44.9	48.6	9,776				
Yes	30.2	28.6	31.8	4,661	48.5	46.7	50.4	4,280	46.3	41.3	51.5	776				
Parity																
1	30.7	27.4	34.2	1,178	47.8	44.2	51.4	1,026	48.4	44.3	52.7	2,331	58.2	54.9	61.4	1,539
2	27.9	25.0	31.0	997	47.4	43.6	51.2	947	48.0	44.7	51.2	2,183	56.7	53.6	59.7	1,535
3+	27.3	25.5	29.3	2,887	45.6	43.3	48.0	2,631	45.6	43.7	47.5	6,037	53.4	51.4	55.4	4,651
Month of pregnancy at first ANC																
1-3	35.7	29.9	42.0	310	59.0	53.3	64.5	351					59.2	54.6	63.7	946
4-6	31.8	29.9	33.6	3,544	49.7	47.6	51.7	3,258					57.5	55.7	59.3	5,611

7+	16.0	13.7	18.6	1,208	31.6	27.9	35.4	995					39.5	35.6	43.5	1,168
Number of ANC visits																
1	13.9	9.4	20.1	205	17.5	10.7	27.3	117	16.9	10.7	25.9	429	14.9	9.6	22.3	224
2	22.0	18.5	25.9	583	36.4	31.3	41.9	507	34.6	30.4	39.1	1,237	47.8	43.8	51.8	1,065
3	25.9	23.3	28.6	1,224	44.7	41.3	48.1	1,249	46.8	44.5	49.1	3,073	55.7	53.0	58.3	2,940
4	31.7	28.9	34.7	1,184	50.4	47.2	53.5	1,138	54.2	50.6	57.6	2,885	61.3	58.6	64.0	2,015
5+	31.1	28.6	33.8	1,867	50.4	47.3	53.5	1,592	54.0	50.7	57.2	2,499	56.3	53.1	59.5	1,480
Missing									18.5	15.0	22.5	429				
Used ITN previous night																
No	28.0	26.5	29.6	4,903	44.8	42.8	46.8	3,866	44.7	42.7	46.6	7,849	52.1	49.9	54.2	4,132
Yes	34.1	26.3	42.9	160	55.0	51.3	58.7	738	52.7	50.3	55.1	2,703	58.4	56.1	60.6	3,593
Total	28.2	26.7	29.8	5,063	46.5	44.6	48.3	4,604	46.7	45.0	48.4	10,552	55.0	53.4	56.6	7,724

[1] doctor/clinical officer; nurse/midwife; ward attendant

* WN = Weighted number of cases (denominator)

**Two or more doses of SP/Fansidar without regard to the source of SP

Table A.3.1.7: 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, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	33.7	25.8	42.6	434	42.0	36.1	48.2	401	32.1	25.5	39.5	993	42.6	34.8	50.7	786
Rural	26.3	24.6	28.1	3,961	26.7	24.7	28.8	3,230	23.9	22.4	25.5	6,997	43.5	41.5	45.5	5,428
Region																
Northern	30.7	22.9	39.9	394	38.2	31.9	44.9	351	26.3	23.6	29.2	669	46.8	40.9	52.8	626
Central	26.4	23.7	29.2	2,003	24.5	21.6	27.7	1,624	24.1	20.9	27.5	3,875	44.4	41.1	47.8	2,954
Southern	27.0	24.8	29.4	1,998	30.2	27.4	33.1	1,655	25.6	23.7	27.6	3,445	41.4	38.9	44.0	2,634
Wealth Quintile																
Lowest	24.7	21.4	28.4	1,032	23.2	19.7	27.2	757	19.7	16.9	22.8	1,899	40.8	37.5	44.3	1,397
Second	25.5	22.2	29.2	884	26.3	22.8	30.1	894	24.8	21.8	28.0	1,685	42.5	39.0	46.1	1,357
Middle	26.4	23.0	30.0	783	25.5	22.3	29.0	830	25.0	21.6	28.7	1,735	44.9	41.4	48.4	1,469
Fourth	25.8	22.5	29.4	944	33.0	28.9	37.3	676	26.5	23.5	29.8	1,530	43.6	39.7	47.6	1,127
Highest	34.7	29.6	40.2	745	39.5	34.2	45.1	474	31.4	26.8	36.4	1,141	46.1	41.1	51.1	865
Child's age (years)																
0	22.5	20.0	25.2	1,173	24.3	20.9	28.0	973	21.5	16.9	26.8	1,697	32.1	28.5	35.9	1,296
1	27.7	24.5	31.1	1,202	31.4	28.2	34.8	1,087	23.1	20.6	25.9	2,049	47.3	44.2	50.5	1,545
2	27.8	24.4	31.5	927	31.1	27.3	35.3	689	26.8	24.0	29.7	1,853	48.1	44.3	52.0	1,359
3	30.6	26.6	34.9	667	26.2	22.1	30.8	501	29.5	26.2	33.1	1,491	44.9	40.9	48.9	1,091
4	30.6	26.0	35.7	426	28.6	23.6	34.2	381	24.0	20.3	28.1	899	43.9	39.4	48.6	924
Child's sex																
Male	26.9	24.5	29.4	2,179	28.7	26.1	31.4	1,793	25.8	23.7	28.0	3,887	43.3	41.0	45.6	3,161
Female	27.2	25.0	29.5	2,215	28.2	25.5	31.0	1,837	24.1	21.8	26.5	4,102	43.5	40.7	46.3	3,053
Mother's education																

None	23.8	21.2	26.7	1,404	21.5	18.2	25.2	911	21.5	18.1	25.4	1,985	39.2	34.9	43.7	952
Primary	27.4	25.4	29.5	2,768	29.2	26.9	31.7	2,379	24.6	22.9	26.3	5,206	43.7	41.5	45.9	4,429
Secondary +	43.2	29.9	57.5	223	41.4	34.8	48.3	340	35.6	30.4	41.2	784	46.6	41.9	51.4	833
Non-standard curriculum									29.3	13.1	53.2	16				
Parity																
1	25.5	21.9	29.4	938	27.7	24.1	31.6	776					45.1	41.7	48.6	1,207
2	27.4	23.8	31.2	814	29.4	25.0	34.2	766					41.1	37.4	44.8	1,203
3+	27.5	25.4	29.7	2,643	28.4	26.0	30.9	2,087					43.6	41.1	46.1	3,804
Number of household members																
<4	26.8	23.1	30.9	832	26.3	22.1	30.9	611	23.3	20.4	26.5	1,513	47.3	43.1	51.5	823
4-5	27.0	24.6	29.7	1,563	29.9	26.9	33.0	1,461	25.5	22.4	28.8	3,338	44.0	41.2	46.7	2,411
6-7	27.0	24.1	30.1	1,129	29.0	25.7	32.5	982	25.3	22.6	28.2	2,085	41.5	38.3	44.8	1,853
8-9	26.6	22.3	31.3	544	28.2	23.1	33.9	375	24.5	20.2	29.2	766	39.6	34.9	44.6	801
10+	28.6	22.5	35.6	327	22.3	16.7	29.2	201	24.7	19.1	31.4	288	49.4	43.1	55.7	326
Where advice/treatment was sought																
No advice/treatment sought	0.0			317	0.0			228					11.0	9.0	13.3	1,690
Government facility	52.6	48.6	56.6	739	53.1	48.9	57.1	803					61.4	58.7	64.0	3,036
Private facility	60.3	51.1	68.9	178	53.1	41.1	64.7	149					67.9	62.5	72.8	557
Religious facility	21.6	19.1	24.4	1,951	19.1	16.8	21.8	1,518					50.0	41.4	58.6	369
Other	22.4	19.4	25.8	1,208	25.4	22.2	28.8	932					15.1	11.7	19.2	562
Total	27.1	25.3	28.9	4,394	28.4	26.4	30.5	3,630	24.9	23.2	26.8	7990	43.4	41.4	45.4	6,214

* WN = Weighted number of cases (denominator)

Table A.3.1.8: Among children under five with recent fever who received antimalarial treatment proportion who received recommended treatment[1]

Among children under age five with fever in the two weeks preceding the survey who also received antimalarial treatment[1], the percentage who received recommended antimalarial treatment, by background characteristics and survey year, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	81.8	71.7	88.9	146	81.7	69.2	89.8	168	78.9	71.1	85.1	319	80.8	71.3	87.8	335
Rural	86.6	83.6	89.1	1,043	82.3	79.3	84.9	864	81.5	78.8	84.0	1,671	84.3	82.0	86.3	2,362
Region																
Northern	79.7	68.5	87.6	121	74.2	64.3	82.0	134	83.4	76.8	88.4	176	71.4	64.9	77.1	293
Central	83.7	78.6	87.7	528	81.2	75.1	86.1	398	80.4	76.2	84.0	933	84.6	80.8	87.7	1,313
Southern	89.7	86.3	92.3	540	85.1	81.6	88.1	500	81.4	77.8	84.6	881	86.4	83.3	88.9	1,091
Wealth Quintile																
Lowest	88.8	81.2	93.6	255	83.6	75.6	89.4	176	83.2	75.6	88.8	374	86.0	81.8	89.4	571
Second	90.4	85.5	93.8	226	85.0	78.9	89.5	235	83.1	78.5	86.9	417	87.7	84.0	90.7	577
Middle	83.0	76.5	88.0	206	79.6	73.4	84.6	211	81.0	74.5	86.1	434	86.3	82.6	89.3	659
Fourth	91.5	86.6	94.7	243	83.9	77.3	88.8	223	79.8	72.5	85.6	406	80.7	75.5	84.9	492
Highest	76.5	69.3	82.4	258	78.3	69.6	85.1	187	78.3	72.3	83.3	359	75.1	69.2	80.3	399
Child's age (years)																
0	82.3	75.5	87.6	264	82.9	77.0	87.5	236	79.5	72.8	84.8	364	81.8	76.7	86.0	415
1	87.2	82.4	90.8	333	83.0	77.7	87.2	341	76.7	71.5	81.3	474	84.5	80.8	87.6	731
2	84.0	78.4	88.3	258	81.1	73.9	86.6	214	82.4	77.6	86.3	496	84.7	80.7	88.0	654
3	84.8	77.9	89.9	204	77.0	68.1	83.9	131	81.7	75.4	86.7	440	83.9	79.1	87.8	490
4	96.1	91.4	98.3	130	86.8	78.1	92.3	109	89.4	84.4	92.9	216	83.5	78.9	87.2	406
Child's sex																
Male	84.6	80.5	87.9	586	83.7	79.8	87.0	515	79.0	75.2	82.3	1,003	81.8	78.8	84.4	1,369
Female	87.4	83.9	90.2	603	80.7	76.1	84.5	517	83.3	80.0	86.2	987	86.0	83.1	88.5	1,328
Mother's education																

None	88.1	82.1	92.3	335	82.6	76.1	87.7	196	82.4	74.4	88.3	427	84.6	78.8	89.0	373
Primary	85.9	82.4	88.8	758	83.2	79.7	86.2	695	81.4	78.1	84.2	1,279	85.1	82.7	87.1	1,935
Secondary +	79.1	62.8	89.4	96	76.5	67.4	83.7	141	78.2	69.5	84.9	279	77.2	70.2	83.0	388
Non-standard curriculum	na				na				71.7	29.5	93.9	5	na			
Parity																
1	86.6	79.8	91.3	239	79.7	72.3	85.6	215					82.3	77.5	86.3	544
2	85.8	78.4	91.0	223	83.3	75.8	88.8	225					82.2	77.4	86.1	494
3+	85.8	82.7	88.5	727	82.7	78.8	85.9	592					84.9	82.2	87.2	1,658
Number of household members																
<4	85.1	76.5	90.9	223	83.3	75.1	89.1	161	80.9	75.4	85.5	353	86.6	81.8	90.3	389
4-5	88.0	83.9	91.2	423	80.4	75.7	84.5	436	82.7	78.1	86.5	851	81.7	77.8	85.1	1,060
6-7	83.5	77.8	87.9	305	84.5	79.3	88.6	285	79.6	72.4	85.3	528	84.4	80.7	87.5	769
8-9	89.6	83.4	93.7	145	79.4	69.0	86.9	106	78.9	71.3	84.9	187	88.9	84.4	92.2	317
10+	81.6	71.6	88.6	93	87.4	74.2	94.4	45	80.3	67.6	88.9	71	79.0	71.6	84.9	161
Where advice/treatment was sought																
No advice/treatment sought	90.3	86.6	93.1	389	87.3	83.3	90.4	426					90.1	88.2	91.7	1,864
Government facility	84.4	74.9	90.8	108	63.9	52.7	73.8	79					74.4	67.0	80.7	378
Private facility	82.8	77.4	87.1	422	72.9	65.9	78.9	291					57.2	44.8	68.8	184
Religious facility	85.3	78.5	90.2	271	90.7	86.0	93.9	236					77.2	64.3	86.4	85
Other	na												69.7	60.9	77.3	186
Total	86.0	83.2	88.4	1,189	82.2	79.1	84.9	1,032	81.1	78.6	83.4	1990	83.9	81.7	85.9	2,696

[1] SP was the recommended antimalarial in 2000, 2004 and 2006; ACT in 2010.

* WN = Weighted number of cases (denominator)

Table A.3.1.9: Timing of 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 antimalarial treatment according to national policy within 24 hours from onset of fever, by background characteristics and survey year, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	25.0	17.2	34.9	434	30.7	24.0	38.2	401	21.7	15.7	29.3	993	19.8	15.5	24.8	786
Rural	18.7	17.2	20.4	3,961	17.3	15.7	19.0	3,230	16.7	15.4	18.1	6,997	24.7	23.0	26.5	5,428
Region																
Northern	20.6	12.7	31.7	394	22.7	17.6	28.8	351	16.3	14.1	18.7	669	23.3	19.6	27.4	626
Central	16.9	14.7	19.5	2,003	16.4	13.7	19.6	1,624	17.4	14.9	20.4	3,875	24.6	22.1	27.4	2,954
Southern	21.5	19.4	23.8	1,998	20.2	17.9	22.7	1,655	17.4	15.8	19.2	3,445	23.6	21.3	25.9	2,634
Wealth Quintile																
Lowest	17.2	14.4	20.5	1,032	12.7	10.2	15.8	757	14.8	12.2	17.8	1,899	24.2	21.1	27.5	1,397
Second	19.4	16.3	23.0	884	18.9	15.7	22.5	894	17.8	14.9	21.1	1,685	23.5	20.6	26.7	1,357
Middle	18.5	15.6	22.0	783	16.0	13.2	19.2	830	17.0	13.7	20.9	1,735	24.0	21.0	27.3	1,469
Fourth	18.9	16.2	21.9	944	23.2	19.6	27.2	676	17.4	15.1	19.9	1,530	25.8	22.6	29.3	1,127
Highest	23.9	19.1	29.6	745	26.8	21.9	32.2	474	21.4	17.6	25.7	1,141	22.4	18.7	26.7	865
Child's age (years)																
0	15.3	13.2	17.8	1,173	16.0	13.2	19.3	973	15.8	12.5	19.8	1,697	16.9	14.4	19.7	1,296
1	20.6	17.6	24.0	1,202	20.6	17.7	23.8	1,087	15.2	13.2	17.4	2,049	26.6	23.8	29.7	1,545
2	18.9	16.3	21.8	927	21.1	17.5	25.3	689	18.4	15.8	21.3	1,853	26.2	23.2	29.5	1,359
3	20.8	17.3	24.7	667	16.1	12.8	20.1	501	20.0	16.9	23.5	1,491	26.1	22.7	29.9	1,091
4	25.7	21.3	30.6	426	19.7	15.4	24.9	381	18.6	15.4	22.4	899	24.1	20.7	27.9	924
Child's sex																
Male	18.7	16.6	20.9	2,179	19.7	17.4	22.2	1,793	17.4	15.8	19.1	3,887	23.7	21.7	25.8	3,161
Female	20.0	18.0	22.3	2,215	17.9	15.5	20.5	1,837	17.3	15.3	19.6	4,102	24.4	22.4	26.5	3,053
Mother's education																
None	17.8	15.4	20.6	1,404	13.6	11.0	16.7	911	15.0	12.4	18.1	1,985	21.0	17.6	24.9	952
Primary	19.2	17.5	21.1	2,768	19.4	17.3	21.7	2,379	17.2	15.6	18.9	5,206	24.3	22.4	26.3	4,429
Secondary +	30.9	17.7	48.2	223	28.1	22.4	34.5	340	24.1	18.5	30.8	784	26.0	22.0	30.4	833
Non-standard curriculum	19.4	17.7	21.2	4,394	18.8	17.0	20.6	3,620	10.2	3.7	25.1	16	24.1	22.5	25.7	6,214

Parity																
1	18.3	15.1	21.9	938	17.9	14.7	21.6	776					24.3	21.3	27.6	1,207
2	20.7	17.7	24.0	814	19.3	15.3	24.1	766					22.7	19.8	26.0	1,203
3+	19.3	17.4	21.4	2,643	18.9	16.8	21.2	2,087					24.4	22.4	26.5	3,804
Number of household members																
<4	19.6	16.1	23.8	832	18.0	14.2	22.6	611					28.6	24.8	32.8	823
4-5	20.5	18.1	23.0	1,563	19.2	16.7	21.8	1,461					23.6	21.2	26.2	2,411
6-7	18.4	15.9	21.3	1,129	19.0	16.2	22.2	982					23.5	20.9	26.3	1,853
8-9	18.8	15.0	23.4	544	18.8	14.7	23.7	375					23.2	19.5	27.2	801
10+	17.4	12.8	23.3	327	17.0	12.1	23.5	201					20.8	16.5	25.8	326
Where advice/treatment was sought																
No advice/treatment sought	6.6	5.0	8.7	1,145	7.6	5.6	10.2	811					5.2	3.9	6.9	1,690
Government facility	43.4	39.4	47.5	850	41.6	37.5	45.8	910					36.4	34.0	38.9	3,036
Private facility	43.1	34.4	52.3	204	28.7	20.5	38.6	167					33.4	28.3	39.0	557
Religious facility	14.6	12.5	17.0	2,109	10.5	8.8	12.5	1,628					18.2	13.4	24.3	369
Other	11.9	6.4	21.0	87	18.8	12.5	27.2	114					8.4	5.8	12.0	562
Total	19.4	17.7	21.2	4,394	18.8	17.0	20.6	3,630	17.3	15.9	18.9	7,990	24.1	22.5	25.7	6,214

* WN = Weighted number of cases (denominator)

Table A.3.1.10: Care seeking in children with fever

Among children under age five with fever in the two weeks preceding the survey, the percentage who sought advice or treatment[1], by background characteristics and survey year, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	45.8	38.1	53.6	434	56.8	50.4	63.1	401	54.6	48.0	61.1	993	69.2	64.3	73.7	786
Rural	34.1	31.9	36.4	3,961	39.4	36.9	41.8	3,230	41.3	39.6	43.0	6,997	64.8	63.0	66.6	5,428
Region																
Northern	41.7	34.3	49.4	394	41.5	34.8	48.5	351	45.1	40.7	49.6	669	73.6	68.1	78.5	626
Central	34.5	31.1	37.9	2,003	39.1	35.3	43.1	1,624	42.1	38.7	45.6	3,875	63.4	61.0	65.8	2,954
Southern	34.8	31.8	38.0	1,998	43.4	40.0	46.8	1,655	43.4	41.3	45.6	3,445	65.6	63.0	68.1	2,634
Wealth Quintile																
Lowest	33.9	30.1	37.9	1,032	35.7	31.5	40.1	757	40.3	36.2	44.4	1,899	61.1	57.6	64.5	1,397
Second	34.3	30.6	38.2	884	41.0	36.6	45.5	894	42.8	39.3	46.3	1,685	61.7	58.2	65.1	1,357
Middle	34.4	30.4	38.6	783	38.7	34.7	43.0	830	40.0	37.0	43.1	1,735	69.0	65.9	71.9	1,469
Fourth	31.7	27.8	35.9	944	44.7	40.2	49.3	676	45.2	41.9	48.4	1,530	64.8	60.9	68.4	1,127
Highest	44.2	38.6	49.8	745	50.4	44.5	56.3	474	49.2	44.8	53.7	1,141	72.7	68.0	77.0	865
Child's age (years)																
0	39.1	35.8	42.5	1,173	47.0	42.9	51.1	973	47.6	44.5	50.7	1,697	66.1	62.7	69.4	1,296
1	36.9	33.3	40.6	1,202	44.4	40.3	48.5	1,087	44.2	41.2	47.2	2,049	67.9	65.0	70.7	1,545
2	33.6	30.1	37.3	927	41.2	36.4	46.2	689	42.5	38.3	46.7	1,853	66.0	62.5	69.3	1,359
3	31.9	28.0	36.1	667	30.4	25.8	35.4	501	40.4	36.5	44.4	1,491	62.5	58.5	66.3	1,091
4	29.1	24.2	34.6	426	32.4	27.0	38.3	381	36.7	32.1	41.4	899	62.6	58.6	66.5	924
Child's sex																
Male	34.8	32.2	37.6	2,179	42.6	39.7	45.5	1,793	43.4	41.1	45.8	3,887	65.4	63.0	67.7	3,161
Female	35.7	33.1	38.4	2,215	40.0	37.0	43.2	1,837	42.5	40.0	45.0	4,102	65.3	63.2	67.4	3,053

Mother's education																
None	30.5	27.3	33.9	1,404	34.5	31.0	38.2	911	40.8	36.4	45.3	1,985	59.5	55.3	63.6	952
Primary	36.0	33.5	38.7	2,768	42.0	39.3	44.9	2,379	41.7	39.9	43.4	5,206	65.2	63.2	67.2	4,429
Secondary +	56.0	44.0	67.3	223	54.1	46.8	61.2	340	57.1	50.5	63.4	784	73.0	68.5	77.1	833
Non-standard curriculum									42.5	21.5	66.6	16				
Total	35.3	33.1	37.5	4,394	41.3	38.9	43.7	3,630	43.0	41.0	44.9	7,990	65.4	63.6	67.1	6,214

[1] Excludes shop and traditional healer

* WN = Weighted number of cases (denominator)

Table A.3.1.11: 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, Malawi

	DHS 2010			
	%	LCI	UCI	WN*
Residence				
Urban	28.8	22.8	35.7	786
Rural	15.8	14.3	17.4	5,428
Region				
Northern	14.3	10.8	18.7	626
Central	18.0	15.4	20.9	2,954
Southern	17.6	15.5	19.8	2,634
Wealth Quintile				
Lowest	12.6	10.4	15.3	1,397
Second	12.9	10.9	15.3	1,357
Middle	16.9	14.3	19.9	1,469
Fourth	17.7	14.3	21.7	1,127
Highest	32.9	28.3	37.9	865
Child's age (years)				
0	18.0	14.7	21.9	1,296
1	17.4	15.1	20.1	1,545
2	19.3	16.4	22.5	1,359
3	16.2	13.4	19.4	1,091
4	15.5	12.7	18.6	924
Current age of child				
0-23 months	15.4	12.0	19.5	801
24-59 months	17.8	16.1	19.5	5,414
Child's sex				
Male	17.9	16.0	20.1	3,161
Female	16.9	14.8	19.3	3,053
Mother's education				
None	14.3	11.5	17.6	952
Primary	15.6	14.0	17.4	4,429
Secondary +	30.8	26.3	35.7	833
Parity				
1	19.4	16.4	22.8	1,207

2	18.2	15.4	21.3	1,203
3+	16.6	14.8	18.6	3,804
Number of household members				
<4	18.5	14.8	22.9	823
4-5	17.5	15.5	19.6	2,411
6-7	16.0	13.8	18.4	1,853
8-9	17.4	14.1	21.2	801
10+	23.3	17.1	31.0	326
ITN used the previous night				
No	15.5	13.7	17.5	3,717
Yes	20.4	18.1	22.8	2,497
Cluster altitude				
<1000 m	16.9	15.0	18.9	3,139
1000+ m	18.1	15.5	21.0	2,967
missing	15.8	12.3	20.1	108
Total	17.4	15.9	19.1	6,214

* WN = Weighted number of cases (denominator)

Table A.3.1.12: 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, Malawi

	DHS 2004				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence								
Urban	4.9	2.4	9.8	231	6.8	4.2	10.9	636
Rural	11.3	9.7	13.2	1,942	9.0	7.8	10.4	3,879
Region								
Northern	7.0	4.2	11.4	309	8.4	6.2	11.4	512
Central	12.0	9.1	15.6	824	10.6	8.7	12.9	2,102
Southern	10.6	8.8	12.8	1,040	6.6	5.3	8.3	1,901
Wealth Quintile								
Lowest	13.4	10.2	17.5	414	11.4	8.9	14.5	819
Second	14.2	10.6	18.8	490	9.3	7.2	12.0	1,038
Middle	9.4	6.8	12.7	537	9.3	7.0	12.2	997
Fourth	10.0	7.1	13.8	454	7.9	5.8	10.6	833
Highest	3.8	2.0	7.1	280	5.3	3.6	7.8	828
Number of household members								
<4	14.9	11.0	19.9	304	11.2	7.8	15.8	385
4-5	8.7	6.8	10.9	844	9.2	7.5	11.2	1,702
6-7	11.4	8.8	14.5	602	7.1	5.6	9.1	1,437
8-9	9.1	6.0	13.5	281	9.7	7.2	13.0	677
10+	13.2	7.5	22.3	142	7.5	5.0	11.3	314
Cluster Altitude								
<1000m	11.1	9.3	13.2	1,237	8.5	7.2	9.9	2,213
1000m+	10.1	7.6	13.2	937	9.1	7.3	11.4	2,240
Child's sex								
Male	11.6	9.6	14.0	1,060	9.1	7.7	10.8	2,224
Female	9.7	7.8	12.0	1,113	8.2	6.7	10.0	2,291
Age (in months)								
6-11	24.9	19.2	31.6	242	15.0	11.4	19.4	503
12-23	18.5	15.1	22.5	552	12.2	10.0	14.8	1,082
24-35	7.2	4.7	11.0	446	10.4	7.9	13.5	970
36-47	3.4	2.2	5.2	471	5.6	4.0	7.8	1,010
48-59	4.5	2.8	7.2	463	2.9	1.9	4.4	950

Age (in months)								
6-23	20.4	17.3	24.0	794	13.1	11.0	15.4	1,584
24-59	5.0	3.8	6.5	1,380	6.3	5.1	7.8	2,930
Mother's Education								
No education	14.3	11.0	18.4	533	10.7	8.0	14.2	767
Primary	10.2	8.5	12.1	1,283	8.9	7.5	10.4	2,900
Secondary or Higher	10.6	6.6	16.6	200	6.4	4.2	9.7	619
Missing	2.1	0.8	5.0	158	5.8	3.2	10.0	229
Used ITN previous night								
No	11.1	9.4	13.0	1,805	9.7	8.2	11.4	2,589
Yes	8.5	5.8	12.3	368	7.3	6.0	8.9	1,925
Parity								
1	10.6	7.7	14.5	393	7.4	5.5	9.9	808
2	11.0	7.8	15.2	395	11.1	8.2	14.9	836
3+	11.8	9.7	14.2	1,168	8.5	7.1	10.1	2,560
Missing	3.8	1.8	7.7	217	7.0	4.2	11.2	311
Total	10.6	9.1	12.4	2,173	8.7	7.6	10.0	4,515

* WN = Weighted number of cases (denominator)

Table A.3.1.13: Relative reduction in severe anemia, 2004–2010 by age group (months)

Age	2004	2010	Relative change 2004–20010
6–11 mos.	24.9	15.0	-39.8%
12–23 mos.*	18.5	12.2	-34.1%
24–35 mos.	7.2	10.4	44.4%
36–47 mos.	3.4	5.6	64.7%
48–59 mos.	4.5	2.9	-35.6%
Total	10.6	8.7	-17.9%

*Only difference which is significant at $\alpha<0.05$

Table A.3.1.14: Trends in anemia prevalence in children by malaria risk area

Percentage of children under 5 with hemoglobin lower than 8.0 g/dL, by age, malaria risk area and survey year, Malawi

	DHS 2004				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*
High**								
6-59 months	13.5	10.7	16.8	754	8.4	6.6	10.6	1457
6-23 months	24.1	18.5	30.8	288	12.8	9.2	15.4	515
24-59 months	6.9	4.8	9.7	466	5.9	4.3	8.2	942
Medium								
6-59 months	12.7	10.1	16	841	10.3	8.3	12.6	1666
6-23 months	25.5	19.9	32	309	14.3	11.2	18.1	604
24-59 months	5.3	3.4	8.2	532	8.2	5.9	11.2	1172
Low								
6-59 months	7.4	5.3	10.3	579	6.9	5.3	8.9	1282
6-23 months	13.4	8.8	19.9	197	11.8	8.5	16.1	465
24-59 months	4.3	2.5	7.2	382	4.1	2.9	5.9	817

* WN = Weighted number of cases (denominator)

**High, medium, low correspond to upper, middle and lower malaria risk terciles, respectively

Table A.3.1.15: Prevalence of malaria in children

Percentage of children age 6–59 months with malaria infection, by background characteristics, Malawi, 2010[1]

	Microscopy				RDT			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence								
Urban	14.7	10.5	20.3	232	17.3	11.4	25.4	245
Rural	46.9	41.7	52.1	1,840	51.4	46.4	56.4	1,920
Region								
Northern	22.8	12.3	38.2	218	19.7	8.6	39.0	227
Central	49.7	43.5	56.0	856	55.7	49.2	62.0	922
Southern	42.3	34.7	50.2	998	46.4	39.1	53.8	1,015
Wealth Quintile								
Lowest	51.4	44.7	58.0	613	59.5	53.1	65.6	660
Second	52.4	45.0	59.6	308	59.0	52.5	65.2	337
Middle	46.8	39.1	54.8	491	49.5	41.9	57.2	494
Fourth	34.5	27.0	42.9	353	36.3	29.7	43.3	359
Highest	22.5	17.2	28.9	306	20.0	14.7	26.6	315
Age (in months)								
<12	35.6	28.3	43.7	301	30.2	23.3	38.2	309
12-23	41.0	34.7	47.7	450	44.4	38.3	50.8	475
24-35	43.3	36.6	50.2	487	50.2	43.8	56.6	510
36-47	46.2	39.6	52.9	426	53.9	47.8	59.8	448
48-59	48.5	41.4	55.6	408	53.8	46.4	60.9	422
Age (in months)								
<24	45.8	40.8	50.9	1,321	52.5	47.7	57.3	1,380
24-59	38.9	32.9	45.1	752	38.8	33.3	44.6	785
Child's sex								
Male	45.1	39.8	50.5	1,026	47.7	42.6	52.9	1,085
Female	41.5	36.4	46.9	1,046	47.4	42.2	52.6	1,080
Used ITN previous night								
No	45.2	39.4	51.0	898	53.4	47.6	59.1	943
Yes	41.9	36.7	47.3	1,174	43.0	37.9	48.2	1,222
At least one ITN in household								
No	46.1	40.5	51.8	622	52.7	47.1	58.2	657
Yes	42.1	36.9	47.5	1,451	45.3	40.1	50.6	1,508
At least two ITNs in household								
No	44.2	39.4	49.1	1,417	49.9	45.1	54.7	1,487
Yes	41.3	34.8	48.1	655	42.3	35.7	49.1	678
Total	43.3	38.7	48.1	2,072	47.5	42.9	52.2	2,164

[1] Source of data is the 2010 MIS

* WN = Weighted number of cases (denominator)

Table A.3.1.16: Age-specific childhood mortality

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

	1996-2000			2000-2004			2006-2010		
	q	LCI	UCI	q	LCI	UCI	q	LCI	UCI
Neonatal mortality	42	37	47	27	23	31	31	28	35
Post-neonatal mortality	62	56	68	49	44	54	35	31	38
Infant mortality	104	96	111	76	70	82	66	61	71
Child mortality	94	87	101	62	56	68	50	46	54
Under-five mortality	189	179	197	133	125	141	112	106	118
1-59	153	144	161	109	102	116	84	78	89
6-59	125	117	133	87	80	93	69	64	74
6-23	75	68	81	51	46	56	40	36	44
24-59	55	49	60	37	32	42	30	27	33

Table A.3.1.17: 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, Malawi

	1996–2000			2000–2004			2006–2010		
	5q0	LCI	UCI	5q0	LCI	UCI	5q0	LCI	UCI
Residence									
Urban	129.7	98.0	160.3	102.5	80.3	124.1	117.3	97.2	136.9
Rural	196.5	187.0	205.9	137.9	129.2	146.6	111.2	105.1	117.2
Region									
Northern	156.0	123.0	187.7	105.9	86.3	125.1	99.1	82.0	115.9
Central	188.2	172.9	203.2	139.4	124.7	153.9	113.5	103.8	123.0
Southern	196.3	184.8	207.6	135.1	124.5	145.6	113.9	105.5	122.3
Wealth Quintile									
Lowest	211.3	190.7	231.3	149.5	128.2	170.2	109.7	97.4	121.8
Second	183.0	164.8	200.9	154.7	136.4	172.6	121.2	107.8	134.5
Middle	192.9	172.8	212.5	145.3	128.2	162.1	115.0	102.9	127.0
Fourth	197.2	177.1	216.9	116.1	99.9	132.0	116.6	102.8	130.1
Highest	150.9	130.1	171.2	89.8	72.0	107.3	95.3	78.6	111.8
Missing	233.4	0.0	0.0						
Number of household members									
<4	380.4	353.1	406.6	265.7	237.5	292.8	242.5	218.5	265.7
4-5	180.4	165.6	194.9	131.8	118.9	144.5	108.2	98.3	118.0
6-7	131.2	116.2	146.0	95.0	81.0	108.8	82.6	73.4	91.8
8-9	104.9	85.9	123.5	94.2	71.3	116.5	89.5	73.9	104.7
10+	159.0	126.5	190.4	75.3	45.0	104.6	73.2	52.1	93.8
Child's sex									
Male	193.8	181.3	206.1	145.2	133.6	156.7	125.3	116.0	134.5
Female	182.8	170.3	195.2	121.1	110.0	132.0	98.9	91.6	106.3
Mother's Education									
None	182.8	167.6	197.7	153.4	137.2	169.3	112.1	98.8	125.2
Primary	198.1	186.3	209.8	132.5	122.3	142.5	116.4	108.8	123.8
Secondary+	111.9	76.0	146.3	73.9	52.5	94.7	88.8	72.3	105.1
Parity									
1	227.1	209.2	244.5	146.8	129.9	163.3	116.8	103.6	129.8
2	201.3	182.0	220.3	134.6	117.4	151.4	99.7	87.1	112.2
3+	168.6	156.2	180.8	126.8	116.2	137.2	114.7	106.9	122.5
ITNs per household									

0				142.2	132.1	152.3	116.6	105.8	127.2
1				130.2	111.3	148.6	123.2	111.9	134.4
2				97.0	73.8	119.5	98.9	87.4	110.2
3+				87.7	59.6	114.9	91.2	73.7	108.5
Total	188.3	179.2	197.3	133.1	125.1	141.2	112.1	106.1	118.0

Table A.3.1.18: Prevalence of severe anemia and parasitemia in children

Percentage of children age 6–59 months with hemoglobin lower than 8.0 g/dL and malaria infection[1], by background characteristics and survey year, Malawi, 2010[2]

	MIS 2010			
	%	LCI	UCI	WN*
Residence				
Urban	1.5	0.7	3.3	225
Rural	10.5	8.3	13.2	1,780
Region				
Northern	1.0	0.3	3.1	200
Central	10.9	8.2	14.4	853
Southern	9.9	6.8	14.2	951
Wealth Quintile				
Lowest	13.2	9.6	17.8	602
Second	12.8	8.6	18.6	301
Middle	9.5	6.5	13.8	471
Fourth	6.0	3.5	9.8	339
Highest	2.4	1.1	5.1	293
Age (in months)				
<12	14.7	8.9	23.3	282
12-23	13.3	9.6	18.1	438
24-35	10.1	7.3	14.0	475
36-47	6.9	4.4	10.8	419
48-59	3.3	1.8	5.9	391
Age (in months)				
<24	13.9	9.8	19.3	721
24-59	7.0	5.4	9.1	1,284
Child's sex				
Male	10.3	7.4	14.0	1,003
Female	8.7	6.7	11.2	1,002
Slept under ITN				
No	12.4	9.7	15.7	864
Yes	7.2	5.2	10.0	1,141
At least one ITN in household				
No	11.8	8.6	16.0	602
Yes	8.5	6.1	11.7	1,404
At least two ITNs in household				
No	10.7	8.5	13.5	1,373
Yes	6.7	4.1	10.9	633
Total	9.5	7.5	11.9	2,005

[1] By microscopy

[2] Source of data is the 2010 MIS

* WN = Weighted number of cases (denominator)

Table A.3.1.19: 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, Malawi

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
Residence																
Urban	31.9	28.4	35.7	1,358	29.9	25.6	34.6	1,341	29.5	26.6	32.6	3,366	30.7	27.5	34.1	2,559
Rural	43.0	41.6	44.5	9,201	38.3	36.7	39.9	8,436	35.6	34.7	36.6	19,628	35.1	33.7	36.5	15,454
Region																
Northern	33.8	29.6	38.2	1,166	28.4	24.4	32.7	1,239	28.9	27.1	30.8	2,315	29.4	25.6	33.5	2,130
Central	43.6	41.4	45.9	4,594	39.9	37.4	42.4	4,071	36.7	35.2	38.2	10,569	38.1	36.0	40.3	7,749
Southern	41.6	39.9	43.4	4,799	37.1	35.0	39.2	4,468	34.1	32.7	35.5	10,111	32.4	30.7	34.1	8,134
Wealth Quintile																
Lowest	44.6	41.9	47.4	2,311	40.0	37.3	42.8	1,889	37.1	35.2	39.1	5,112	35.6	33.3	38.0	3,927
Second	41.2	38.4	44.1	2,144	41.2	38.6	43.8	2,170	36.0	33.9	38.1	4,686	34.8	32.6	37.1	3,896
Middle	39.8	37.2	42.5	1,965	37.6	35.0	40.3	2,206	36.6	34.4	39.0	4,736	37.4	35.1	39.8	3,924
Fourth	44.5	41.9	47.2	2,120	35.3	32.5	38.2	1,916	36.1	34.0	38.2	4,243	34.1	31.8	36.5	3,300
Highest	37.1	34.1	40.2	2,007	29.7	26.4	33.1	1,597	27.1	24.9	29.3	4,217	29.2	26.8	31.6	2,966
Number of household members																
<4	47.2	44.3	50.2	1,762	40.3	37.1	43.6	1,516	33.3	30.6	36.1	1,838	36.6	33.8	39.5	2,248
4-5	40.1	38.3	42.0	3,895	37.2	35.0	39.4	3,931	33.9	32.0	36.0	4,305	35.0	33.2	36.8	6,895
6-7	40.3	37.8	42.9	2,800	36.4	34.1	38.8	2,697	34.0	31.8	36.2	2,889	34.0	32.2	35.9	5,446
8-9	40.4	37.3	43.6	1,345	33.3	29.7	37.2	1,124	31.1	27.7	34.8	1,205	33.1	30.4	35.9	2,423
10+	43.1	38.7	47.7	758	39.5	33.7	45.6	509	37.6	31.9	43.7	535	32.6	28.3	37.2	1,001
Cluster altitude																
<1000m					36.1	34.1	38.1	4,823					34.3	32.7	36.0	9,146
1000+ m					38.2	35.9	40.5	4,954					34.5	32.4	36.7	8,601
missing					37.1	35.6	38.7	9,777					40.7	28.3	54.4	266
Age (in months)																
<12	46.6	44.0	49.2	2,517	42.4	39.8	45.0	2,297	33.8	32.0	35.6	5,026	34.9	32.8	37.0	3,717
12-23	53.7	51.1	56.3	2,238	49.5	47.0	52.0	2,194	40.3	38.6	42.1	5,080	40.9	38.6	43.3	3,774

24-35	44.0	41.3	46.8	2,107	39.5	36.6	42.5	1,743	36.9	34.8	39.0	5,027	37.0	34.8	39.2	3,675
36-47	32.6	30.2	35.0	2,047	28.8	26.0	31.7	1,741	32.9	30.5	35.3	4,540	31.4	29.3	33.7	3,471
48-59	25.8	23.5	28.3	1,650	21.1	18.8	23.7	1,802	27.1	25.3	28.9	3,322	27.4	25.3	29.5	3,376
Child's sex																
Male	41.7	39.9	43.6	5,225	37.1	35.2	39.0	4,839	34.2	32.9	35.5	11,368	35.7	34.1	37.3	8,864
Female	41.5	39.8	43.3	5,334	37.2	35.3	39.2	4,938	35.3	34.0	36.6	11,626	33.4	31.7	35.1	9,149
Mother's Education																
None	41.4	39.4	43.5	3,388	36.7	34.2	39.2	2,485	35.4	33.5	37.3	5,614	30.3	28.1	32.6	3,144
Primary	42.9	41.2	44.6	6,453	38.2	36.4	40.0	6,230	35.0	33.8	36.2	14,875	36.4	35.0	37.8	12,168
Secondary+	31.0	26.8	35.6	718	32.1	28.2	36.2	1,062	31.9	29.2	34.8	2,452	30.8	28.1	33.7	2,701
Non-standard curriculum									30.0	19.5	43.2	53				
Parity																
1	39.6	37.2	42.2	2,366	34.4	31.7	37.2	2,259					33.0	31.0	35.1	3,653
2	39.5	37.1	42.1	2,058	37.6	34.7	40.6	2,036					34.0	31.7	36.3	3,542
3+	43.1	41.4	44.8	6,135	38.1	36.4	39.8	5,482					35.2	33.6	36.7	10,818
Slept under ITN																
No	41.7	40.3	43.1	10,268	37.3	35.7	38.9	8,339	33.3	31.9	34.8	9,334	34.3	32.8	35.9	10,832
Yes	37.7	32.1	43.6	292	36.3	33.2	39.5	1,438	36.3	33.2	39.5	1,438	34.8	33.1	36.5	7,181
Total	41.6	40.2	43.0	10,559	37.1	35.6	38.7	9,777	33.7	32.3	35.1	10,771	34.5	33.2	35.8	18,013

* WN = Weighted number of cases (denominator)

Table A.3.1.20: Prevalence of fever and parasitemia in children

Percentage of children aged 6–59 months with fever in the two weeks preceding the survey and malaria infection[1] by background characteristics and survey year, Malawi, 2010[2]

	MIS 2010			
	%	LCI	UCI	WN*
Residence				
Urban	5.1	3	8.6	212
Rural	21.6	17.5	26.4	1,742
Region				
North	9	2.5	27.4	211
Central	21.6	17.7	26.1	799
South	20.7	14.4	28.8	944
Wealth Quintiles				
Lowest	25.1	18.6	33	589
Second	20.9	15.6	27.4	298
Middle	22.4	16.5	29.7	452
Fourth	16.2	12	21.6	329
Highest	7.7	4.4	13.1	286
Age (in months)				
<12	12.9	6.7	23.3	308
12-23	23	17.1	30.1	450
24-35	24	19.1	29.8	470
36-47	16.9	12.3	22.7	373
48-59	19.3	14.3	25.5	352
Age (in months)				
<24	18.9	13.2	26.3	758
24-59	20.4	16.9	24.5	1,196
Sex				
Male	20.5	16	25.8	987
Female	19.1	15.4	23.4	967
Slept under ITN				
No	22.4	18.2	27.2	819
Yes	18	13.9	22.8	1,133
Missing	0			2
At least one ITN in household				
No	22	17.8	27	558
Yes	18.9	14.6	24.2	1,394
Missing	0			2
At least two ITNs in household				
No	21.1	17.6	25.1	1,337
Yes	17.1	11.5	24.6	615
Missing	0			2
Total	19.8	16.1	24.2	1,954

[1] By microscopy

[2] Source of data is the 2010 MIS

* WN = Weighted number of cases (denominator)

Table A.3.1.21: Trends in mortality by malaria risk area

Age-specific mortality (deaths per 1000 births) stratified into terciles by parasitemia prevalence, Malawi

	DHS 2000			DHS 2004			DHS 2010		
	%	LCI	UCI	%	LCI	UCI	%	LCI	UCI
High**									
1-59 months	154	139	168	113	100	126	89	81	98
6-59 months	129	114	143	89	79	99	78	70	86
6-23 months	76	64	89	57	49	65	45	38	51
24-59 months	57	48	65	34	27	41	35	29	41
Neonatal (NN)	44	38	52	26	21	33	26	21	31
Postneonatal (PNN)	60	53	72	53	45	64	32	27	37
Infant (1q0)	104	93	115	79	68	91	58	51	64
Child (4q1)***	97	84	110	62	53	71	59	51	66
Under-five (5q0)	191	176	206	136	123	150	113	103	122
Medium									
1-59 months	166	152	179	116	103	128	84	75	92
6-59 months	138	125	150	92	80	103	70	62	77
6-23 months	82	72	92	52	43	60	39	33	44
24-59 months	61	51	70	43	34	51	33	27	38
Neonatal (NN)	43	35	52	29	23	37	31	26	37
Postneonatal (PNN)	65	59	76	54	47	63	30	25	35
Infant (1q0)	108	96	119	83	72	93	61	54	69
Child (4q1)***	105	94	116	64	54	74	54	47	61
Under-five (5q0)	201	187	216	142	128	155	112	103	122
Low									
1-59 months	133	116	150	95	81	110	76	66	87
6-59 months	102	89	115	77	63	90	57	48	66
6-23 months	61	51	71	44	34	54	37	29	45
24-59 months	44	34	53	34	24	44	21	16	26
Neonatal (NN)	37	29	47	26	20	34	38	31	46
Postneonatal (PNN)	60	48	76	38	31	48	43	34	52
Infant (1q0)	97	81	113	64	53	74	81	70	92
Child (4q1)***	75	64	87	58	46	71	33	27	39
Under-five (5q0)	165	146	183	118	103	134	111	99	123

* WN = Weighted number of cases (denominator)

**High, medium, low correspond to upper, middle and lower terciles, respectively

***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.3.1.22: Contextual Factors

	DHS 2000				DHS 2004				MICS 2006				DHS 2010			
	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*	%	LCI	UCI	WN*
HOUSEHOLD ENVIRONMENT																
Access to improved sources of water	65.2	62.1	68.2	14,213	63.5	60.5	66.3	13,664	75.1	73.3	76.8	30,553	79.7	77.7	81.5	24,825
Drinking water <15 min	33.4	31.2	35.7	14,213	41.9	39.7	44.1	13,664	31.4	29.8	33.0	30,553	34.7	32.9	36.6	24,825
Household water piped into dwelling/yard/plot	7.1	5.7	9.0	14,213	6.2	4.6	8.4	13,664	5.0	4.2	5.9	30,553	6.6	5.6	7.9	24,825
Household flush toilet/VIP latrine	3.6	2.5	5.2	14,213	4.5	3.1	6.5	13,664	2.2	1.6	3.0	30,553	5.1	4.4	5.9	24,825
Household roof not grass thatch or mud	-	-	-	-	-	-	-	-	25.8	24.5	27.3	30,553	35.0	32.9	37.0	24,825
Household floor material not earth, sand or dung	18.8	16.5	21.4	14,213	20.7	17.9	23.8	13,664	18.6	17.3	19.9	30,553	23.3	21.3	25.3	24,825
Household has electricity	4.8	3.6	6.4	14,213	6.9	5.3	8.9	13,664	5.1	4.4	5.9	30,553	8.7	7.6	9.9	24,825
Household has telephone (landline or mobile)	-	-	-	-	5.1	3.8	6.9	13,664	7.3	6.6	8.1	30,553	39.3	37.6	41.1	24,825
HYGIENE																
Proportion of mothers whose youngest child under five's stools are contained	75.6	74.0	77.2	8,057	-	-	-	-	82.5	81.2	83.7	15,141	-	-	-	-
% washing hands with soap after toilet or after cleaning child after toilet	86.3	85.2	87.3	8,057	-	-	-	-	2.4			8,697	-	-	-	-
SOCIODEMOGRAPHIC FACTORS																
Proportion of women 15-49 with at least a primary school education	19.1	17.1	21.2	13,220	25.5	23.2	28.0	11,698	79.1	78.1	80.1	26,259	29.3	27.8	30.8	23,020
Proportion of women 15-49 literate	56.5	54.5	58.4	13,220	62.4	60.3	64.4	11,698	55.8	54.4	57.3	26,259	67.6	66.3	68.9	23,020

Proportion of women 15-49 married	71.5	70.2	72.8	13,220	71.1	69.6	72.5	11,698	72.4	71.3	73.4	26,259	67.5	66.4	68.5	23,020
FERTILITY-RELATED RISKS																
High risk birth*	57.3	56.2	58.5	12,201	54.3	52.8	55.7	10,771	-	-	-	-	56.6	55.4	57.7	19,697
Avoidable risk birth	56.0	54.8	57.2	12,201	53.3	51.8	54.7	10,771	47.3	45.9	48.6	10,552	55.5	54.3	56.6	19,697
Unavoidable risk birth**	16.5	15.7	17.3	12,201	16.8	15.9	17.8	10,771	16.6	15.7	17.5	10,552	14.4	13.7	15.1	19,697
Birth intervals <24 months	17.1	16.1	18.1	9,370	15.0	14.0	16.0	8,241	-	-	-	-	14.9	14.1	15.8	15,658
Fourth or greater birth	41.7	40.4	42.9	12,201	39.9	38.4	41.4	10,771	40.8	39.6	42.0	10,552	43.0	41.8	44.2	19,697
Mother age <18 yrs or >34 years	22.7	21.6	23.8	12,201	21.3	20.2	22.5	10,771	19.9	18.8	21.2	10,552	21.4	20.6	22.3	19,697

* Births to women <18 and >34 and births <2 years apart
** First order births to women between the ages of 18 and 34

EPI COVERAGE*																
BCG	92.4	90.7	93.8	2,238	91.4	89.4	93.1	2,194	95.7			5,080	97.2	96.4	97.8	3,774
DPT3	84.2	81.8	86.4	2,238	81.6	78.9	84.0	2,194	96.4			5,080	93.0	91.7	94.2	3,774
polio3	79.8	77.2	82.2	2,238	77.7	75.2	80.1	2,194	81.3			5,080	85.6	83.9	87.2	3,774
measles	83.2	80.9	85.3	2,238	78.7	76.4	80.8	2,194	84.4			5,080	93.0	91.8	94.0	3,774
Fully vaccinated	70.1	67.2	72.8	2,238	64.4	61.5	67.2	2,194	70.4			5,080	80.9	78.9	82.8	3,774

* Proportion of children 12-23 months with the recommended immunizations

OTHER CHILDHOOD ILLNESS																
Suspected ARI (cough with rapid breathing) in past 2 weeks	26.7	25.3	28.1	10,559	18.8	17.5	20.2	9,777	26.3	25.3	27.2	22,994	15.4	14.5	16.3	18,013
Diarrhea in past 2 weeks	17.6	16.7	18.6	10,559	22.3	21.0	23.6	9,777	24.1	23.3	24.9	22,994	17.5	16.8	18.3	18,013
IMCI COVERAGE																
Care seeking for suspected ARI	26.7	24.4	29.1	2,816	36.5	33.5	39.6	1,840	20.9	18.8	23.2	6,040	65.4	62.9	67.9	2,774
Care seeking for diarrhea	28.3	25.7	31.2	1,859	31.9	29.2	34.6	2,177					62.4	60.0	46.7	3,158
ORS for diarrhea	47.9	45.0	50.7	1,859	61.1	58.6	63.6	2,177	51.4	48.9	53.8	5,532	69.0	66.7	71.2	3,158
NUTRITIONAL STATUS																

Small or very small at birth (mother's report)	16.6	15.7	17.6	12,201	15.6	14.6	16.6	10,771	14.2	13.2	15.3	10,552	15.5	14.8	16.3	19,697
Low birth weight (<2500 g)	4.9	4.4	5.5	12,201	5.3	4.7	5.8	10,771	5.1	4.5	5.7	10,552	12.3	11.5	13.1	13,107
Stunting	54.3	52.6	55.9	9343	52.5	51.0	54.0	8,568	46.0	44.9	47.0	20,404	47.1	45.2	49.0	4,849
Underweight	20.5	19.2	21.7	9,343	17.3	16.3	18.5	8,568	20.5	19.3	21.7	20,404	12.8	11.6	14.2	4,849
Wasting	6.3	5.7	7.0	9,975	6.0	5.3	6.7	8,568	3.5	2.9	4.2	20,404	4.0	3.3	4.8	4,849
MICRONUTRIENTS																
Vitamin A supplementation	70.6	69.0	72.1	9,285	65.4	63.7	67.1	8,668	68.5	67.3	69.6	20,641	85.5	84.6	86.4	16,315
ANC COVERAGE																
Antenatal Care (>4 visits)	56.0	54.0	57.8	8,057	57.1	55.4	58.7	7,271	51.0	49.6	52.5	10,214	45.5	44.2	46.7	13,664
At least 1 dose of tetanus toxoid during pregnancy	81.5	80.3	82.7	8,057	84.6	83.4	85.8	7,271	85.5	84.4	86.6	10,214	87.3	86.5	88.1	13,664
At least 2 doses of tetanus toxoid during pregnancy	61.0	59.6	62.5	8,057	66.2	64.7	67.7	7,271	71.2	69.8	72.5	10,214	68.9	67.8	70.0	13,664
Postnatal vitamin A supplementation	41.7	39.8	43.6	8,057	41.0	39.4	42.6	7,271	45.7	44.0	47.3	10,214	56.5	55.3	57.7	13,664
Delivery in a health facility	55.3	52.7	57.9	12,201	57.2	54.8	59.6	10,771	53.8	51.8	55.8	10,552	73.2	71.3	74.9	19,697
Skilled attendant at birth	55.6	53.0	58.1	12,201	57.1	54.6	59.4	10,771	53.6	51.5	55.6	10,552	73.0	71.2	74.7	19,697
Postnatal checkup <2days after delivery in those w non-facility birth	43.8	37.2	50.7	231	50.9	43.9	58.0	250	48.2	42.5	54.0	522	43.2	38.8	47.8	1,154
BREASTFEEDING																
<1 month																
Exclusive	85.9	76.0	92.1	108	83.0	73.6	89.5	112	86.1	78.1	91.6	326	95.6	89.9	98.1	160
Predominant	8.4	4.4	15.6	108	8.4	4.5	15.2	112	9.6	5.2	16.9	326	2.4	0.8	6.7	160
Partial	5.7	1.9	15.6	108	6.8	2.7	16.1	112	1.3	0.4	4.7	326	2.1	0.5	7.7	160
Not	0.0			108	1.8	0.3	12.0	112	3.0	1.3	6.6	326	0.0			
1-5 months																
Exclusive	40.4	36.8	44.1	1154	49.5	45.9	53.0	983	52.0	49.0	55.0	2027	6.9	6.5	7.2	1496
Predominant	13.0	11.0	15.2	1154	23.6	20.7	26.9	983	17.6	15.6	19.9	2027	6.6	5.1	8.4	1496

Partial	46.6	43.0	50.2	1154	26.4	23.3	29.8	983	29.0	25.9	32.2	2027	24.0	21.1	27.2	1496
Not	0.0	0.0	0.2	1154	0.5	0.2	1.2	983	1.4	0.9	2.3	2027	0.7	0.3	1.4	1496
6-11 months																
Exclusive	2.0	1.4	3.0	1230	2.1	1.4	3.2	1181	3.0	1.9	4.5	2673	4.0	3.0	5.2	1992
Predominant	3.3	2.3	4.7	1230	12.9	10.7	15.4	1181	5.5	4.4	7.0	2673	4.5	3.5	5.7	1992
Partial	94.2	92.5	95.4	1230	83.8	81.3	86.1	1181	90.0	88.2	91.5	2673	89.8	87.9	91.4	1992
Not	0.6	0.3	1.3	1230	1.2	0.5	2.9	1181	1.5	1.0	2.4	2673	1.8	1.2	2.7	1992
12-23 months																
Exclusive	0.5	0.3	0.9	2165	0.4	0.2	0.9	2115	0.5	0.2	1.1	5080	17.5	16.4	18.7	3636
Predominant	1.0	0.6	1.6	2165	1.6	1.1	2.5	2115	3.3	2.6	4.1	5080	3.2	2.7	3.7	3636
Partial	87.9	86.2	89.4	2165	88.3	86.7	89.8	2115	83.7	82.1	85.2	5080	72.2	70.9	73.5	3636
Not	10.6	9.2	12.2	2165	9.6	8.3	11.1	2115	12.5	11.2	14.0	5080	7.1	6.3	7.9	3636
Early initiation of breastfeeding (within 1 hr of birth)	72.1	70.7	73.5	11991	69.8	68.3	71.3	10593	58.3	56.7	59.9	10,552	67.0	66.3	67.7	19,271
Exclusive breastfeeding <6 months	44.2	40.7	47.7	1,260	52.9	49.6	56.2	1,095	56.7	53.5	59.9	2353	71.4	68.0	74.6	1,656
% of 6-9 mo breastfeeding and consuming complementary foods	93.4	91.3	95.0	799	79.6	76.1	82.7	816	88.8	86.5	90.7	1755	87.4	84.9	89.5	1,352

* WN = Weighted number of cases (denominator)

A.3.2 Micronutrient Survey Data Tables

Table 3.2.1: Malaria parasitemia* in children 6–35 months, Malawi, 2001, 2009

Background characteristics	Percentage of children with malaria parasitemia 2001	95% CI	Weighted sample size	Percentage of children with malaria parasitemia 2009	95% CI	Weighted sample size
Region						
Northern	55.2	44.7-65.7	154	14.7	6.6-22.8	177
Central	57.0	44.2-69.7	186	29.2	20.7-37.7	178
Southern	65.0	54.5-75.4	157	13.6	7.6-19.7	176
Age(in months)						
6-11	54.1	43.5-64.7	108	14.7	8.2-21.2	116
12-23	57.8	46.3-69.3	207	20.5	12.8-28.2	215
24-35	68.1	57.1-79.0	182	23.7	17.2-30.2	200
Total	**60.5**	**53.0-68.0**	**497**	**20.4**	**15.7-25.1**	**531**

* By microscopy

Table 3.2.2: Severe anemia in children 6–35 months (hemoglobin <8g/dL), Malawi, 2001, 2009

Background characteristics	Percentage of children with anemia 2001	95% CI	Weighted Sample Size	Percentage of children with anemia 2009	95% CI	Weighted Sample Size
Region						
Northern	9.8	4.6-15.0	153	5.2	0.8-9.6	173
Central	12.4	7.1-17.8	185	7.7	4.3-11.1	181
Southern	24.4	17.0-31.7	156	7.4	3.1-11,8	175
Age(in months)						
6–11	27.0	18.1-35.9	108	6.6	1.6-11.6	129
12–23	20.5	13.9-27.1	205	10.2	5.9-14.7	227
24–35	8.0	3.7-12.3	181	4.8	1.9-7.7	233
Total	17.7	13.5-21.8	494	7.3	4.8-9.8	529

A.3.3 MAC Anemia and Parasitemia Surveys Data Tables

Table 3.3.1. Prevalence of parasitemia and severe anemia in Northern Region, 2005–2009.

District	Parasitemia			Severe Anemia (Hb < 8 g/dL)		
Karonga	%	95% CI	N	%	95%CI	N
2005	-			-		
2006	-			-		
2007	13.3	8.7-19.8	647	12.2	8.8-16.7	680
2008	-			9.3	7.1-12.2	1,008
2009	3.8*	2.0-7.3	235	11.9	7.5-18.5	285
Rumphi	%	95% CI	N	%	95%CI	N
2005	8.6	5.0-14.4	268	11.3	7.7-16.1	293
2006	-			9.4	6.8-13.0	466
2007	13.3	9.0-19.2	661	8.3	6.0-11.4	709
2008	3.4*	2.2-5.2	935	8.9	6.9-11.5	964
2009	3.3*	2.0-5.3	484	1.6**	0.8-3.4	501

-=no survey conducted/no data

*p<.05 **p<.001

reference category is earliest year

Table 3.3.2. Prevalence of parasitemia and severe anemia in Central Region, 2005–2009.

District	Parasitemia			Severe Anemia (Hb < 8 g/dL)		
Lilongwe	%	95% CI	N	%	95%CI	N
2005	37.0	25.9-49.8	81	23.2	14.6-34.7	95
2006	-			16.7	12.5-21.9	749
2007	20.9*	14.2-29.7	502	7.8*	4.9-12.2	514
2008	21.9*	16.4-28.5	755	16.8	13.0-21.3	758
2009	31.4	24.6-39.2	347	15.3	10.7-21.5	353
Nkhotakota	%	95% CI	N	%	95%CI	N
2005	-			-		
2006	-			-		
2007	76.5	70.7-81.4	442	23.9	18.5-30.2	465
2008	-			16.9*	13.8-20.6	1,081
2009	32.3**	26.1-39.2	353	12.2*	8.3-17.4	354

-=no data

*p<.05 **p<.001

reference category is earliest year

Table 3.3.3. Prevalence of parasitemia and severe anemia in Southern Region, 2005–2009.

District	Parasitemia			Severe Anemia (Hb < 8 g/dL)		
Blantyre	%	95% CI	N	%	95%CI	N
2005	21.9	13.5-33.4	77	14.3	7.5-25.7	98
2006	-			12.4	9.2-16.6	434
2007	5.7*	3.0-10.4	265	16.9	10.9-25.2	278
2008	6.6*	3.7-11.6	544	11.3	7.3-17.2	573
2009	10.9	6.4-17.8	294	7.3	3.6-14.2	301
Chiradzulu	%	95% CI	N	%	95%CI	N
2005	20.8	11.5-34.7	72	22.0	12.8-34.9	82
2006	-			28.2	21.4-36.2	429
2007	11.3	7.9-15.9	353	18.5	14.0-24.1	383
2008	12.9	10.2-16.2	588	18.9	14.6-24.0	593
2009	18.8	14.6-23.9	362	8.6*	5.2-13.7	374
Mwanza	%	95% CI	N	%	95%CI	N
2005	50.4	39.9-60.9	121	27.5	19.1-37.9	131
2006	-			24.0	18.9-30.0	571
2007	3.4**	1.6-7.1	388	14.4*	10.7-19.1	487
2008	18.2**	14.5-22.7	576	13.8*	9.6-19.4	582
2009	26.4**	21.8-31.7	386	13.2*	9.0-19.0	431
Phalombe	%	95% CI	N	%	95%CI	N
2005	28.4	22.4-35.3	183	20.6	15.2-27.3	209
2006	-			28.3	23.1-34.1	520
2007	15.5*	11.8-20.1	556	12.4*	9.0-16.8	614
2008	19.5*	16.4-23.0	991	18.1	14.8-21.8	991
2009	48.1**	41.4-54.9	393	5.3**	3.6-7.8	432

-=no data

*p<.05 **p<.001

reference category is earliest year

Annex 4: Additional Results from Multivariable Models

A.4.1 Integrated Disease Surveillance and Response (IDSR) Analysis

Data sources

- Integrated Disease Surveillance and Response (IDSR) health facility-based morbidity data, 2005–2010
- District-level ITN distribution data from Population Services International (PSI)
- Mid-year district-level population data from census estimates from 1998 and 2008[11]
- NASA Land Processes Distributed Active Archive Center Data Pool from the USGS/Earth Resources Observation and Science Center, MODIS satellite (temperature data)[12]
- USGS FEWS NET data portal (rainfall data)[13]

Methodology

Detailed information on the IDSR can be found in the routinely-collected facility-based data section and in Annex 1.11. In order to estimate the effect of uptake of malaria control interventions on malaria case rates in children under five, a multivariable random-effects Poisson model was created. The dependent variable in this model was number of severe inpatient suspected malaria cases[14] in children under five years of age in facilities reporting to the IDSR. The explanatory variable of interest was ITNs distributed per 1000 population per year as a measure of ITN program intensity. Rates per population are based upon census estimates from 1998 and 2008. Annual rates of change per district were computed to estimate population sizes for interim years. The proportion of children under five years in the population was assumed to be 17.7%, based upon 2010 MIS results. Models were adjusted for previous months' cases and for the number of facilities reporting in order to reduce serial correlation and confounding. Models were also adjusted for other variables including MEI (*El Niño* index), region, rainfall anomaly, maximum and minimum monthly temperature and calendar year. The MEI is an indicator of sea surface temperature anomalies in the southern Pacific, where positive values indicate warmer than average temperatures (*El Niño*) and negative values indicate cooler than average temperatures (*La Niña*)[15]. More information on MEI and other climate variables can be found in Annex 1.16. Rainfall anomaly, maximum and minimum monthly temperatures were lagged by two months. The lag is necessary as climate variables affect malaria cases indirectly; rainfall and temperature influence mosquito growth and reproduction, as well as parasite development in the mosquito vector, a process which requires several months. Interactions between MEI and region were also included.

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[11] NSO Republic of Malawi 2008 Population Census Report. National Statistics Office (NSO).
[12] USGS EROS Center (2012) MODIS Reprojection Tool on the Web (MRTWeb). Sioux Falls, South Dakota.
[13] USGS and USAID (2012) Famine Early Warning Systems Network (FEWS).
[14] Inpatient cases were used instead of outpatient cases due to the lack of widespread parisitological confirmation of malaria in outpatients during the evaluation period. Inpatient suspected malaria cases are patients admitted with a clinical or laboratory diagnosis of malaria. Inpatient malaria cases are more likely to be confirmed and thus this outcome should be more specific to malaria than would the use of outpatient cases.
[15] http://www.esrl.noaa.gov/psd/enso/mei/

Results

Results show that the number of ITNs distributed per 1000 population was not significantly associated with district-level severe suspected malaria cases in children under five years of age, controlling for the other variables in the model. A significant interaction between the MEI (*El Niño* index) and region (Table 28) was apparent; the *El Niño* index, lagged at one month, was inversely associated with severe case totals in children under five years of age in the Southern region (IRR=0.82, 95% CI=0.70–0.97). The MEI effect was not apparent in other regions. After controlling for seasonality, monthly rainfall anomalies and minimum temperature lagged at two months did not have a significant effect on malaria incidence, and maximum temperature lagged at two months was only marginally significant (p=0.059). Annual incidence of inpatient malaria cases in IDSR facilities was significantly higher in 2006 compared to 2005 (IRR=1.31, 95% CI = 1.02–1.68), and marginally higher for 2009, in adjusted models.

Table 4.1.1: Multivariable Poisson model predicting inpatient severe suspected malaria cases in children under five†

Predictor	Incidence Rate Ratio	95% Confidence Interval**	P-value
ITNs distributed per 1000 population	1.000	0.997-1.003	0.881
Region			
Northern Region (ref)	1		
Central Region	1.29	0.91-1.82	0.159
Southern Region	0.87	0.61-1.24	0.436
MEI (*El Niño* index)			
El Niño index (-1 month)	1.03	0.89-1.19	0.681
El Niño x Central interaction (-1 month)	0.94	0.81-1.10	0.446
El Niño x Southern interaction (-1 month)	0.82*	0.70-0.97	0.023
Monthly rainfall anomaly (-2 months)	1.000	0.999-1.000	0.174
Mean monthly max temp. (-2 months)	1.014	1.000-1.030	0.059
Mean monthly min temp (-2 months)	0.996	0.980-1.010	0.597
Year			
2005 (ref)	1		
2006	1.31*	1.02-1.68	0.032
2007	1.30	0.92-1.83	0.136
2008	1.25	0.89-1.76	0.190
2009	1.45	0.97-2.18	0.073
2010	1.31	0.87-1.95	0.192

*Significant at p<0.05

** Bootstrapping was used to produce empirically-estimated standard errors; in this case bootstrapping adjusts for inflated p-values due to our use of population totals as the exposure.

†Model also controls for previous month's cases and the number of facilities reporting

Conclusion

The number of ITNs distributed per 1000 population was not significantly associated with incidence of severe inpatient malaria cases in IDSR facilities in adjusted models. Controlling for ITN distribution, climate factors, and completeness of facility reporting, severe malaria incidence appears to be higher in 2006 compared to a baseline of 2005. Climatic trends over this period should not be ignored; in addition to seasonal trends, the period was characterized by large fluctuations in global climate drivers including the *El Niño* Southern Oscillation. The apparent increases may be due to the use of 2005, an abnormally dry year, as a baseline (see Figure 54 in report). The observed increases in parasite prevalence and health facility cases in the last few years of the evaluation period may in part be due to weather factors, as is also likely to have been the case in neighboring Zambia[16]. Similarly, a recent study in Queen Elizabeth Central Hospital in Blantyre, Malawi found no evidence of decreasing cerebral malaria between 2001 and 2010[17], although slide positivity rates in outpatients were significantly lower in 2005–2010 as compared to 2001. As this is a population-based model presented here, the results do not imply that ITNs are not effective at prevention of malaria on an individual level; it is possible that district-level ITN coverage is not sufficiently high to significantly impact malaria case loads.

Additional information for IDSR analysis

Crude outpatient cases

Total outpatient malaria case rates and <5 outpatient malaria cases were markedly seasonal over the period of highest reporting (2006–2010). In the Northern region, cases peaked in Jan-Mar of 2006, 2007, and 2009, associated with rainfall in the preceding two months (Figure 4.1.1). In the Central region, cases peaked substantially in Jan-Mar of 2009 and 2010 (Figure 4.1.2). Although January rains were lower than in the preceding three years, November rains in 2008 and 2009 were high, and February rains in 2009 and 2010 were the highest of the period. In the Southern region, cases peaked in 2008 and 2009, with the highest December rains occurring at the beginning of the 2008 transmission season (Figure 4.1.3).

[16] Zambian Ministry of Health National Malaria Control Centre (2010) Zambia Malaria Inidicator Survey (MIS).
[17] Roca-Feltrer A, Kwizombe C, Sanjoaquin M, Sesay S, Faragher B, et al. (2012) Lack of Decline in Childhood Malaria, Malawi, 2001-2010. Emerging Infectious Diseases 18.

Figure 4.1.1: a) Under 5 Malaria OPD and Mean Monthly Rainfall, and b) Under 5 Malaria OPD per 10,000 Under 5 and Number of Facilities Reporting, Northern Region, 2005–2010

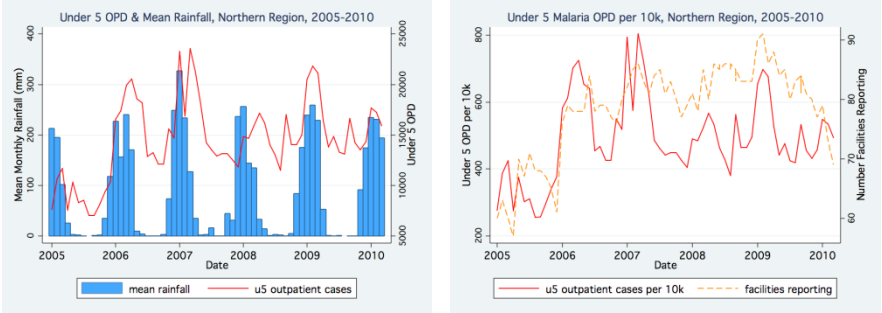


Figure 4.1.2: a) Under 5 Malaria OPD and Mean Monthly Rainfall, and b) Under 5 Malaria OPD per 10,000 Under 5 and Number of Facilities Reporting, Central Region, 2005–2010

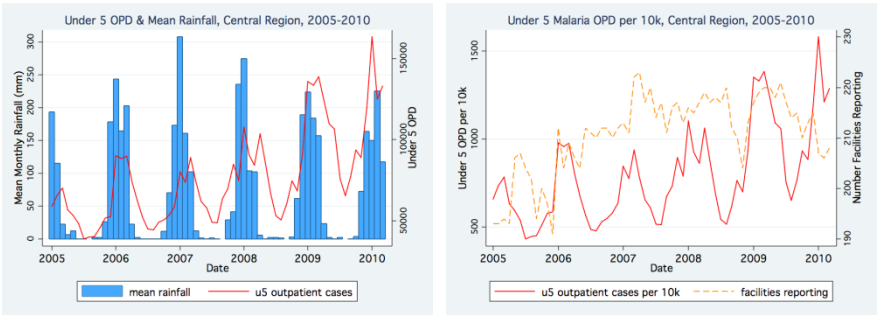
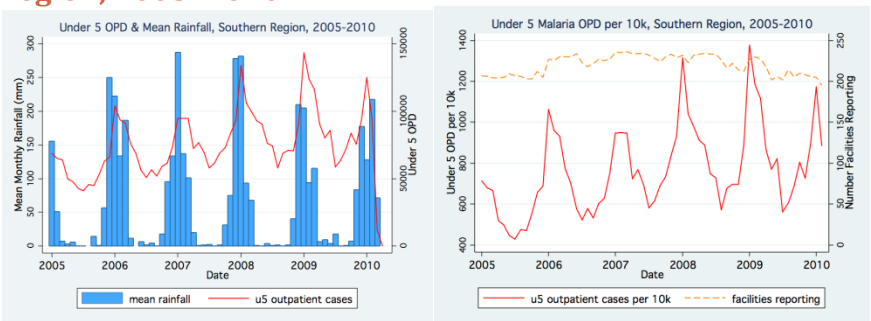


Figure 4.1.3: a) Under 5 Malaria OPD and Mean Monthly Rainfall, and b) Under 5 Malaria OPD per 10,000 Under 5 and Number of Facilities Reporting, Southern Region, 2005–2010



Crude inpatient cases and deaths

Inpatient <5 severe malaria cases and deaths peaked dramatically in 2006 in the Northern region, with smaller peaks occurring in 2009 and 2010 (Figure 4.1.4; Figure 4.1.5a). Severe pneumonia deaths peaked in 2007 in Northern region, but have dropped since, with the exception of a slight peak in 2009 (Figure 4.1.5a). Similarly, deaths due to diarrhea with severe dehydration appear to have declined since 2007, when abnormally high May temperatures may have led to a spike (Figure 4.1.5b). In the Central region,

<5 severe malaria cases peaked substantially in 2009 and 2010, and deaths were high these years as well, but less dramatically so compared to the preceding several years (Figure 4.1.6). Under 5 severe pneumonia and diarrhea deaths were seasonal, but appear not to have changed substantially over this period, with the exception of a spike in severe diarrhea deaths in 2009 (Figure 4.1.7a,b). In the Southern region, <5 severe malaria cases and deaths both peaked in 2008 (Figure 4.1.8), while severe pneumonia deaths have declined steadily since 2006 (Figure 4.1.9a). Severe diarrhea deaths peaked in 2005 and 2009, but otherwise appear to have remained similar across the time period (Figure 4.1.9b). The ratio of severe malaria deaths to severe malaria inpatient cases has declined steadily in the Southern Region, which may reflect improved clinical management, diagnostics, or therapeutics. Nationally, the proportion of deaths reported due to malaria, out of the total deaths reported due to pneumonia, diarrhea, and malaria – three of the largest causes of death of children under 5 in Malawi – appears to have increased slightly over the scale-up period (Figure 4.1.10).

Figure 4.1.4: a) Under 5 Severe Malaria Inpatient Cases, b) Under 5 Malaria Deaths, and c) Ratio of Deaths to Severe Inpatient Cases, Northern Region, Malawi, 2005–2010

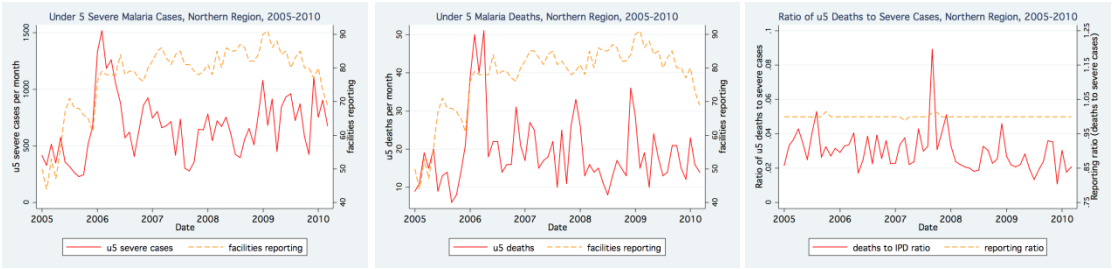


Figure 4.1.5: a) Under 5 Severe Pneumonia Deaths, and b) Under 5 Severe Diarrhea Deaths, Northern Region, Malawi, 2005–2010

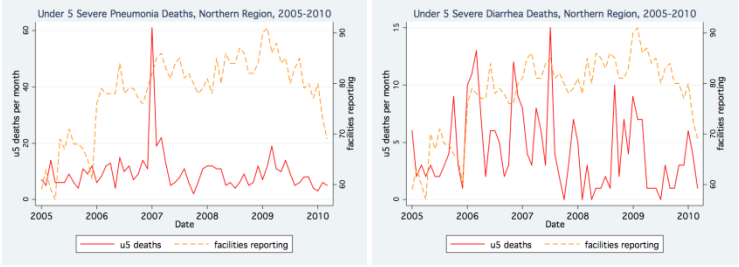


Figure 4.1.6: a) Under 5 Severe Malaria Inpatient Cases, b) Under 5 Malaria Deaths, and c) Ratio of Deaths to Severe Inpatient Cases, Central Region, Malawi, 2005–2010

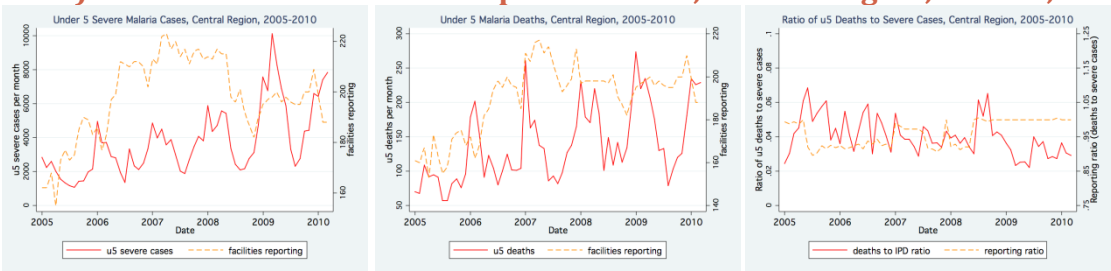


Figure 4.1.7: a) Under 5 Severe Pneumonia Deaths, and b) Under 5 Severe Diarrhea Deaths, Central Region, Malawi, 2005–2010

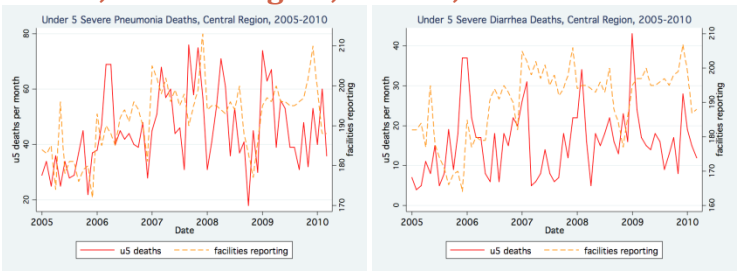


Figure 4.1.8: a) Under 5 Severe Malaria Inpatient Cases, b) Under 5 Malaria Deaths, and c) Ratio of Deaths to Severe Inpatient Cases, Southern Region, Malawi, 2005–2010

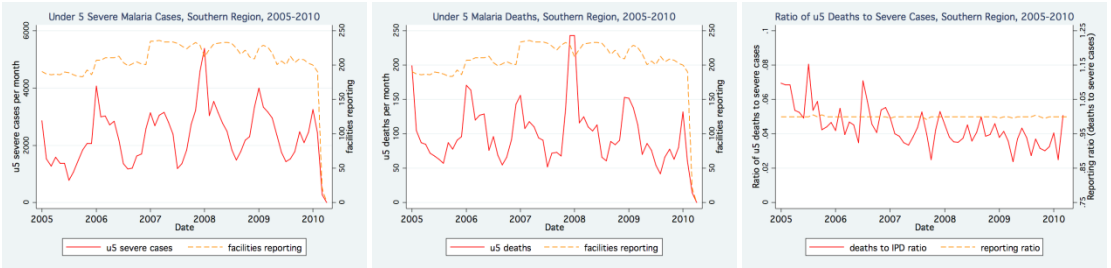


Figure 4.1.9: a) Under 5 Severe Pneumonia Deaths, and b) Under 5 Severe Diarrhea Deaths, Southern Region, Malawi, 2005–2010

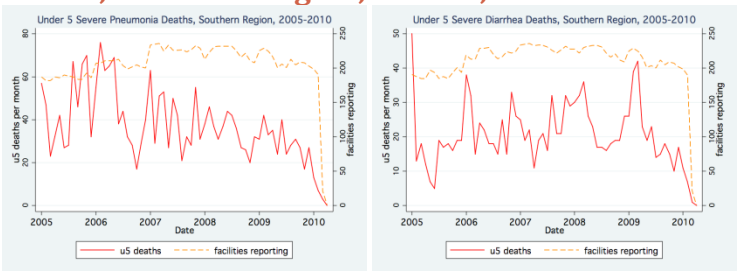
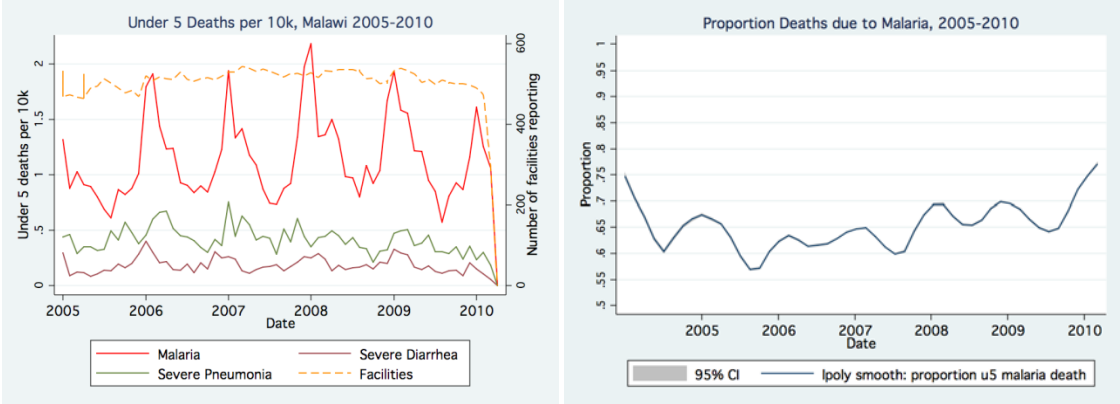


Figure 4.1.10: a) Under 5 Severe Malaria, Severe Pneumonia, and Severe Diarrhea Deaths, and b) Proportion of Under 5 Severe Malaria, Severe Pneumonia, and Severe Diarrhea Deaths due to Severe Malaria, Malawi, 2005–2010



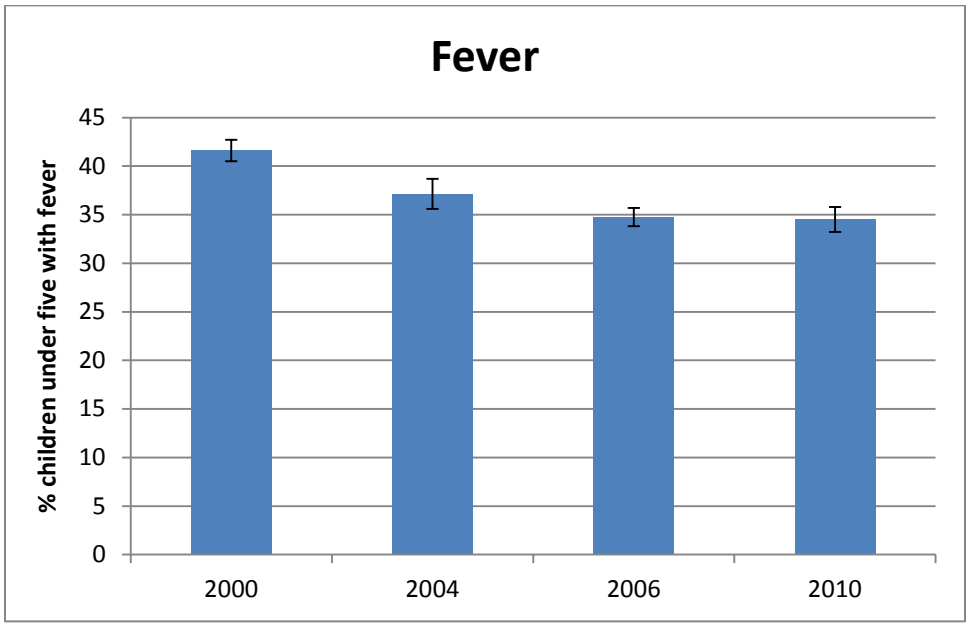
Annex 5: Additional Topics

A.5.1 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[18] 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 5.1.1: Fever during the two weeks prior to survey, children under-five years of age, 2000–2010



[18] D'Acremont, V., Lengeler, Christian, & Genton, B. (2010). Reduction in the proportion of fevers associated with Plasmodium falciparum parasitaemia in Africa: a systematic review. *Malaria journal*, *9*, 240. doi: 10.1186/1475-2875-9-240

Although prevalence of recent fever in children under five has decreased over the study period, the only significant decrease occurred between 2000 and 2004 (Figure 5.1.1). The trend has leveled out and remains virtually the same from 2006 to 2010. 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. Spatial patterns of fever prevalence are depicted in Figure 5.1.2.

Figure 5.1.2: Fever prevalence in Malawi by region, 2000–2010

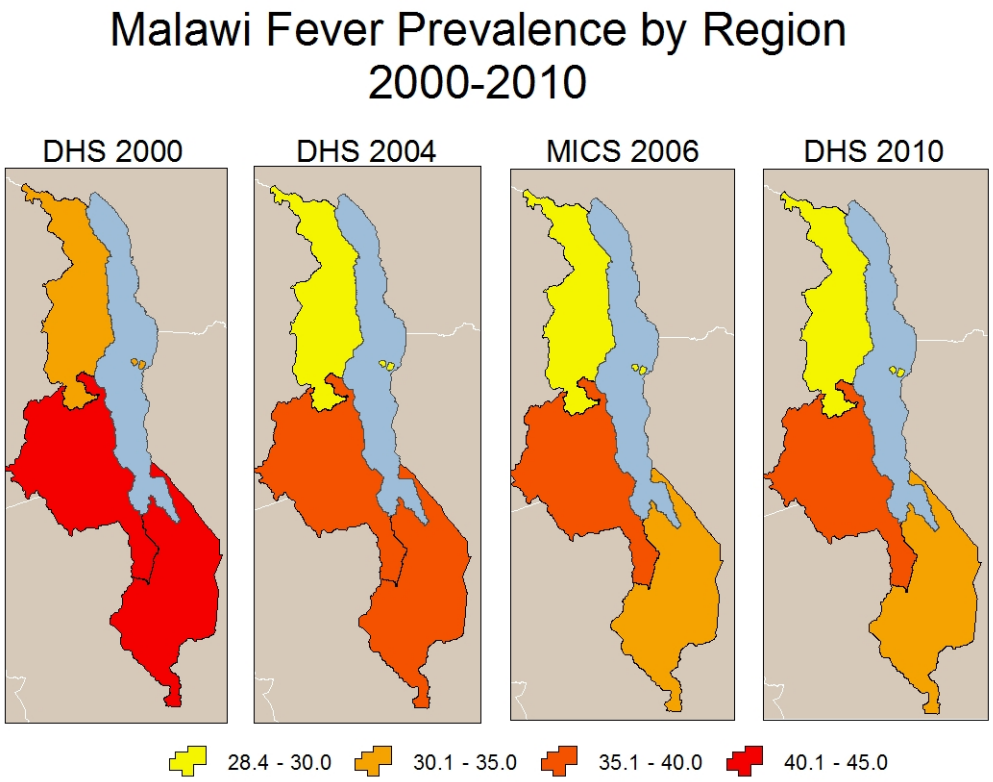
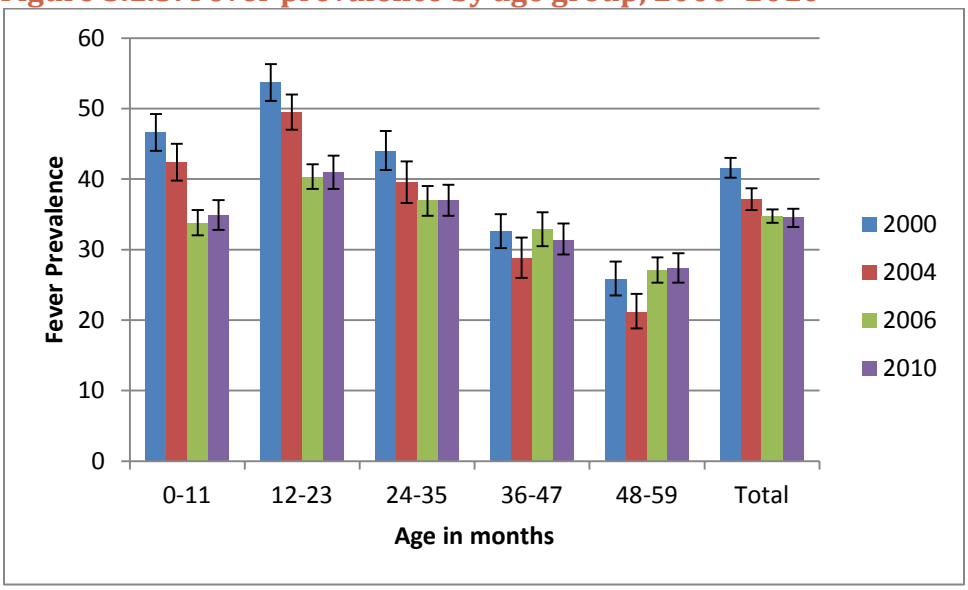


Figure 5.1.3: Fever prevalence by age group, 2000–2010



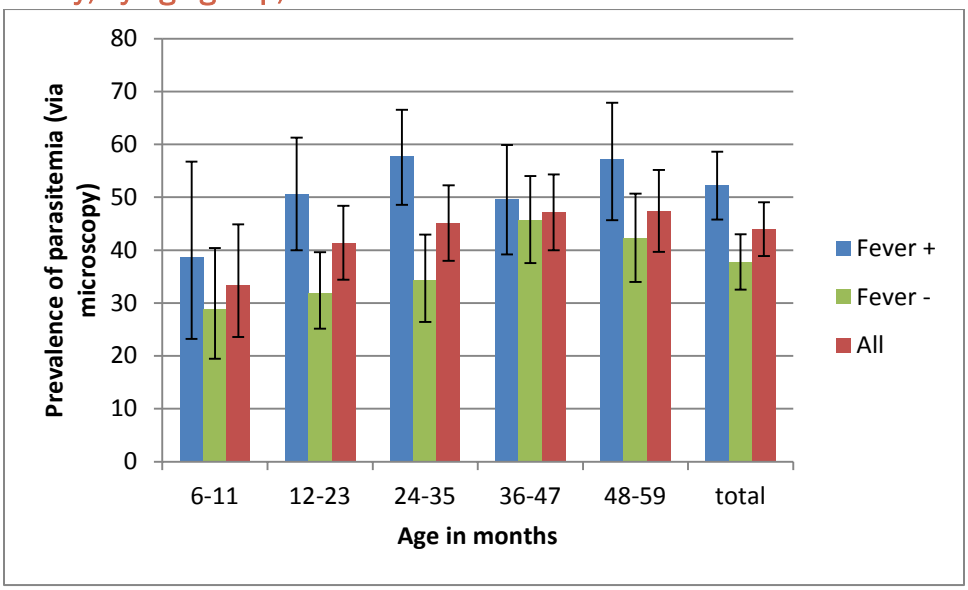
Breaking down the trends in fever by age group reveals important declines in fever prevalence over the study period in children 0–23 months, but not in older children (Figure 5.1.3). This is consistent with the observed trend in anemia and with expected results of intense malaria control interventions in highly endemic regions[19,20].

In the 2010 MIS, 52% of children (6–59 months) who had experienced fever in the two weeks prior to survey also tested positive for malaria on the day of survey (Figure 5.1.4). Children with fever were more likely to test positive for malaria than were children without recent fever. Older children with fever were more likely to test positive for malaria as compared to younger children; however, the small sample sizes lead to large standard errors around these stratified estimates.

[19] Roca-Feltrer A, Carneiro I, Smith L, Schellenberg J, Greenwood B, et al. (2010) The age patterns of severe malaria syndromes in sub-Saharan Africa across a range of transmission intensities and seasonality settings. Malaria Journal 9: 282.

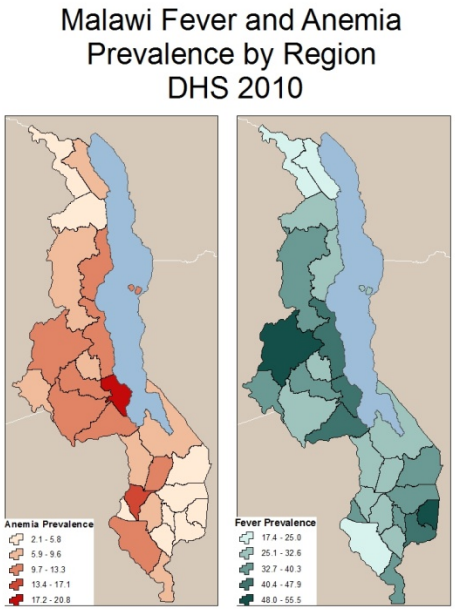
[20] Carneiro I, Roca-Feltrer A, Griffin JT, Smith L, Tanner M, et al. (2010) Age-Patterns of Malaria Vary with Severity, Transmission Intensity and Seasonality in Sub-Saharan Africa: A Systematic Review and Pooled Analysis. PLoS ONE 5: e8988.

Figure 5.1.4: Proportion of all children 6–59 months of age, and those with and without fever in the two weeks prior to the survey who tested positive via microscopy on the day of survey, by age group, 2010 MIS



The prevalence of fever in children under five years of age declined over the study period. Between 2000 and 2010, the proportion of children with fever in the two weeks before survey fell from 42% to 35%, a relative decline of 17%. The most severe decline occurred between 2000 and 2004 after which fever prevalence did not change significantly. A more detailed examination of fever trends by age group reveal a sharp decline in fever prevalence between 2004 and 2006 in children under 2 years of age with no clear trends in older children.

Figure 5.1.5: Anemia (hemoglobin <8g/dL) and fever prevalence by district, Malawi, 2010



A.5.2 Karonga Health and Demographic Surveillance System (HDSS) Mortality

HDSS data provide a unique opportunity to assess population-based trends in cause-specific mortality using longitudinal data over long periods of time. Unlike HMIS data which includes only those individuals who access health facilities, HDSS provides vital registration and migration data on the entire population and is thus potentially more accurate, although limited to a sub-national scale. The Karonga HDSS collects data on vital events, migration, and cause-specific mortality obtained using verbal autopsy (VA) methods in Karonga District, northern Malawi. Verbal autopsy classification of cause specific mortality, particularly malaria, can be prone to bias[21]. Data collection began with a baseline census from 2002–2004. Currently, more than 35,000 individuals are under continuous

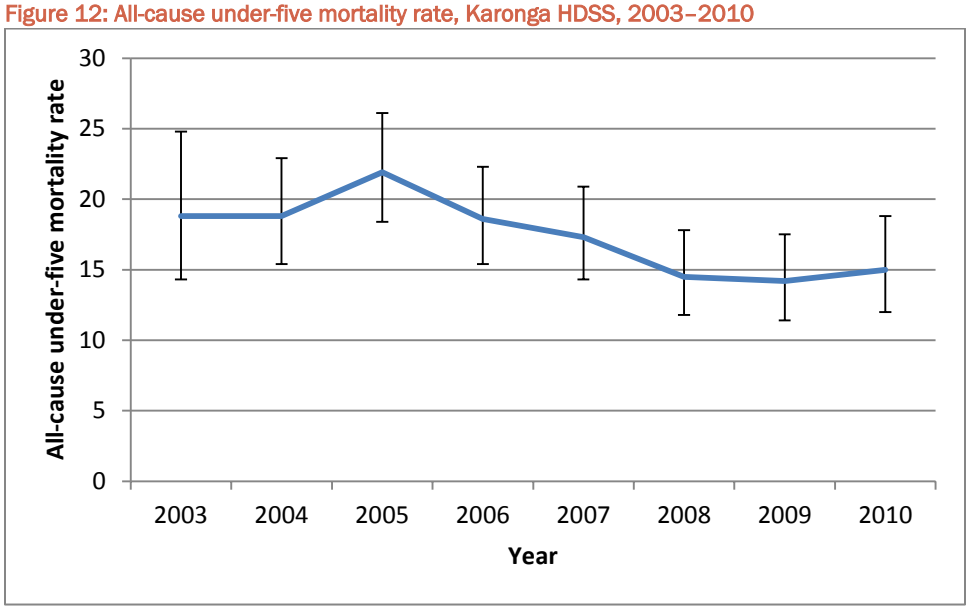
[21] Snow RW, Armstrong JR, Forster D, Winstanley MT, Marsh VM, et al. (1992) Childhood deaths in Africa: uses and limitations of verbal autopsies. Lancet 340: 351-355.

demographic surveillance at this site[22]. More details are included in Annex 1.13.

Analysis of the Karonga HDSS data from 2003 to 2010 included examination of temporal trends in age-specific and cause-specific mortality rates. Although all-age, all-cause mortality has significantly decreased over this time period, all-cause mortality in children 6–23 months of age and the all-cause mortality rate in children under five years of age have decreased, but not significantly (Figures 5.2.1 and 5.2.2). Too few malaria-specific deaths occurred per year for reliable malaria-specific mortality rates to be calculated. From 2003 to 2010 only 95 deaths due to malaria were identified by the VA method. It should be noted that data from 2003 and 2004 should be interpreted with caution. The lower mortality rates in these years could be a result of low coverage in capturing the death event as the system was just starting.

An examination of the distribution of overall deaths by ICD 10-defined causes in Karonga suggests that malaria is responsible for 4.4% of all of the coded deaths (Table 5.2.1). The majority of deaths were in patients with HIV (23.3%). Additional data tables can be found below.

Figure 12: All-cause under-five mortality rate, Karonga HDSS, 2003–2010



[22] Crampin A, Dube A, Mboma S, Price A, Chihana M, et al. (2012) Profile: the Karonga Health and Demographic Surveillance System. Int J Epidemiol 41: 676-685.

Figure 13: All-cause mortality rate in children 6–23 months, Karonga HDSS, 2003–2010

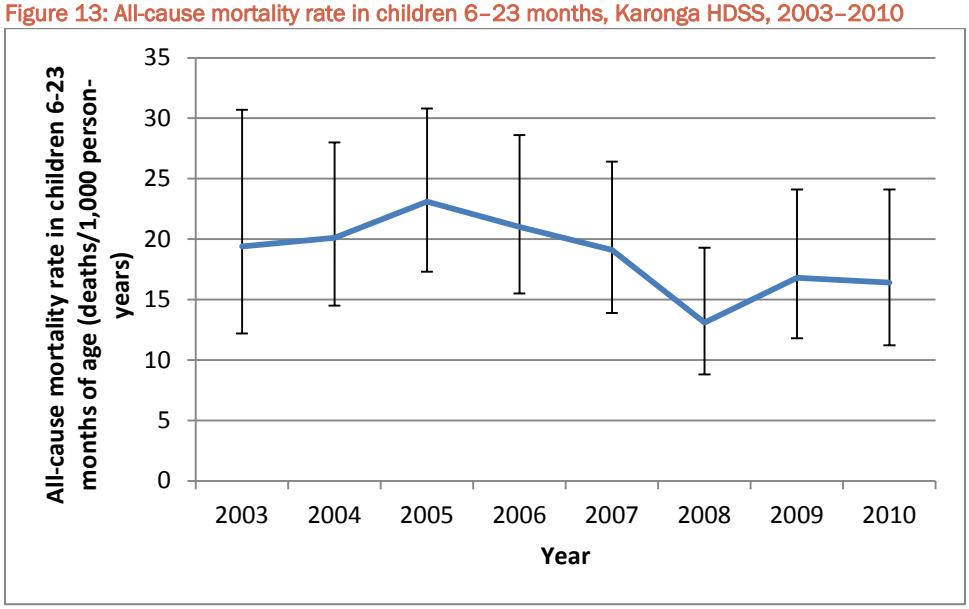


Table 5.2.1: Distribution of deaths in all age groups by ICD-10-defined causes, Karonga HDSS, 2003–2010

	Cause	Number	%
1	HIV/AIDS	507	23.3
2	Neonatal causes*	218	10.0
3	Cardiovascular	194	8.9
4	Other/unspecified	146	6.7
5	Acute febrile illness, other/unspecified	145	6.7
6	Pneumonia	129	5.9
7	External cause	104	4.8
8	Gastrointestinal	95	4.4
9	Malaria	95	4.4
10	Diarrhoeal	92	4.2
	Other causes (including 15 causes)	454	20.8
	Total coded	2179	100
	Uncoded	26	
	Total of deaths	2205	

*Deaths in children less than 28 days not attributed to another cause

Karonga HDSS Data Tables

Table 5.2.2: Description of study population 2003–2010

	Year	2003	2004	2005	2006	2007	2008	2009	2010
Overall	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	Individuals	25086	33430	35425	36637	37464	37790	37926	36963
<1 Year	Person Time	421.76	706.32	793.63	750.48	760.96	716.71	699.70	655.82
	Individuals	1122	1540	1646	1594	1608	1528	1540	1437
6 - 23 Months	Person Time	929.59	1738.66	1992.14	1948.31	1935.41	1913.64	1781.40	1581.77
	Individuals	1604	2175	2368	2346	2296	2283	2171	2108
<5 Years	Person Time	2710.76	5165.70	5748.35	6084.23	6192.29	6138.86	5935.16	5004.73
	Individuals	4750	6509	6908	7262	7348	7229	7107	6755
5 - 15 Years	Person Time	4358.47	8380.85	9486.00	9893.44	10263.04	10562.14	10577.26	9038.75
	Individuals	6906	9375	10160	10513	10929	11201	11297	11068
>15 Years	Person Time	8494.74	15580.25	17203.86	17792.40	18149.29	18366.13	18368.48	15627.23
	Individuals	13448	17610	18458	18965	19291	19486	19629	19222

Table 5.2.3: All-cause mortality rate by age groups and year, 2003–2010, rates per 1000 person years

		2003	2004	2005	2006	2007	2008	2009	2010
Overall	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	186	318	341	324	290	272	240	209
	Rate (95% CI)	12 (10.4-13.8)	10.9 (9.8-12.2)	10.5 (9.5-11.7)	9.6 (8.6-10.7)	8.4 (7.5-9.4)	7.8 (6.9-8.7)	6.9 (6.1-7.8)	7.0 (6.2-8.1)
<1 Year	Person Time	421.76	706.32	793.63	750.48	760.96	716.71	699.70	655.82
	# deaths	34	58	81	68	60	56	57	44
	Rate (95% CI)	80.6 (57.6-112.8)	82.1 (63.5-106.2)	102.1 (82.1-126.9)	90.6 (71.4-114.9)	78.8 (61.2-101.5)	78.1 (60.1-101.5)	81.5 (62.8-105.6)	67.1 (49.9-90.2)
6 - 23 Months	Person Time	929.59	1738.66	1992.14	1948.31	1935.41	1913.64	1781.40	1581.77
	# deaths	18	35	46	41	37	25	30	26
	Rate (95% CI)	19.4 (12.2-30.7)	20.1 (14.5-28)	23.1 (17.3-30.8)	21.0 (15.5-28.6)	19.1 (13.9-26.4)	13.1 (8.8-19.3)	16.8 (11.8-24.1)	16.4 (11.2-24.1)
<5	Person Time	2710.76	5165.70	5748.35	6084.23	6192.29	6138.86	5935.16	5004.73
	# deaths	51	97	126	113	107	89	84	75

	Rate (95% CI)	18.8 (14.3-24.8)	18.8 (15.4-22.9)	21.9 (18.4-26.1)	18.6 (15.4-22.3)	17.3 (14.3-20.9)	14.5 (11.8-17.8)	14.2 (11.4-17.5)	15.0 (12.0-18.8)
5 - 15 Years	Person Time	4358.47	8380.85	9486.00	9893.44	10263.04	10562.14	10577.26	9038.75
	# deaths	11	13	11	16	10	12	11	12
	Rate (95% CI)	2.5 (1.4-4.6)	1.6 (0.9-2.7)	1.2 (0.6-2.1)	1.6 (1-2.6)	1.0 (0.5-1.8)	1.1 (0.6-2)	1.0 (0.6-1.9)	1.3 (0.8-2.3)
>15 Years	Person Time	8494.74	15580.25	17203.86	17792.40	18149.29	18366.13	18368.49	15627.23
	# deaths	124	208	204	195	173	171	145	122
	Rate (95% CI)	14.6 (12.2-17.4)	13.4 (11.7-15.3)	11.9 (10.3-13.6)	11.0 (9.5-12.6)	9.5 (8.2-11.1)	9.3 (8-10.8)	7.9 (6.7-9.3)	7.8 (6.5-9.3)

Note that these are actual annual rates not directly comparable with DHS rates

Table 5.2.4: Distribution of deaths by cause--ICD 10

Cause	Number	%	cum %
142. cd-AIDS	507	23.27	23.27
5. infancy	218	10.00	33.27
31. ncd-Cardiovascular	194	8.90	42.18
0. other/unspec	146	6.70	48.88
110 cd-acute febrile illness, other/unspecified	145	6.65	55.53
114. cd-pneumonia	129	5.92	61.45
4. external	104	4.77	66.22
33. ncd-Gastrointestinal	95	4.36	70.58
111. cd-malaria	95	4.36	74.94
150. cd-diarrhoeal	92	4.22	79.16
36. ncd-neoplasm	75	3.44	82.61
112. cd-meningitis	46	2.11	84.72
39. ncd-nutritional	38	1.74	86.46
140. cd-TB or AIDS	35	1.61	88.07
2. maternal	34	1.56	89.63
35. ncd-endocrine	33	1.51	91.14
34. ncd-CNS	32	1.47	92.61
141. cd-TB	32	1.47	94.08
30. ncd-other/unspecified	31	1.42	95.50
38. ncd-anaemia	30	1.38	96.88
32. ncd-respiratory	20	0.92	97.80
37. ncd-Genitalurinary	18	0.83	98.62
100. cd-other/unspecified	16	0.73	99.36

130. cd-hepatitis	11	0.50	99.86
170. cd-rabies	3	0.14	100.00
Total coded	2179		
Uncoded	26		
Total of deaths	2205		

Note: cd: Communicable disease, ncd: non-communicable disease

Table 5.2.5: Malaria mortality by age groups and year, 2003–2010, rates per 1000 person years

		2003	2004	2005	2006	2007	2008	2009	2010
Overall	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	7	7	12	12	13	15	16	12
	Rate (95% CI)	-	-	0.4 (0.2-0.7)	0.4 (0.2-0.6)	0.4 (0.2-0.6)	0.4 (0.3-0.7)	0.5 (0.3-0.7)	0.4 (0.2-0.7)
<1year	Person Time	421.76	706.32	793.63	750.48	760.96	716.71	699.70	655.82
	# deaths	4	0	6	0	2	5	2	3
6 - 23 Months	Person Time	929.59	1738.66	1992.14	1948.31	1935.41	1913.64	1781.40	1581.77
	# deaths	3	4	7	2	5	5	5	4
<5 Years	Person Time	2710.76	5165.70	5748.35	6084.23	6192.29	6138.86	5935.16	5004.73
	# deaths	-	-	11	11	11	13	12	11
	Rate (95% CI)	2.2 (1-4.9)	1.4 (0.6-2.8)	1.9 (1.1-3.5)	1.8 (1-3.3)	1.8 (1-3.2)	2.1 (1.2-3.6)	2 (1.1-3.6)	2.2 (1.2-4)
5-15 Years	Person Time	4358.47	8380.85	9486.00	9893.44	10263.04	10562.14	10577.26	9038.75
	# deaths	1	0	0	0	0	1	3	0
<15 Years	Person Time	8494.74	15580.25	17203.86	17792.40	18149.29	18366.13	18368.49	15627.23
	# deaths	0	0	1	1	2	1	1	1

Note: Rate was not computed when the number of deaths is below 10.

Table 5.2.6: Cause specific mortality for selected causes by age groups and year, rate per 1000 person years

		2003	2004	2005	2006	2007	2008	2009	2010
AIDS	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	78	104	103	87	59	50	35	24
	Rate (95% CI)	5.0 (4.0-6.3)	3.6 (2.9-4.3)	3.2 (2.6-3.9)	2.6 (2.1-3.2)	1.7 (1.3-2.2)	1.4 (1.1-1.9)	1 (0.7-1.4)	0.8 (0.5-1.2)
Infancy	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	11	24	33	30	35	30	35	20
	Rate (95% CI)	0.7 (0.4-1.3)	0.8 (0.6-1.2)	1.0 (0.7-1.4)	0.9 (0.6-1.3)	1.0 (0.7-1.4)	0.9 (0.6-1.2)	1.0 (0.7-1.4)	0.7 (0.4-1.0)

Acute Febrile illness /other unspecified	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	11	26	16	19	22	13	10	21
	Rate (95% CI)	0.7 (0.4-1.3)	0.9 (0.6-1.3)	0.5 (0.3-0.8)	0.6 (0.4-0.9)	0.6 (0.4-1.0)	0.4 (0.2-0.6)	0.3 (0.2-0.5)	0.7 (0.5-1.1)
Pneumonia	Person Time	15563.97	29126.81	32438.21	33770.07	34604.62	35067.13	34880.91	29670.71
	# deaths	11	16	32	22	12	11	17	6
	Rate (95% CI)	0.7 (0.4-1.3)	0.5 (0.3-0.9)	1.0 (0.7-1.4)	0.7 (0.4-1)	0.3 (0.2-0.6)	0.3 (0.2-0.6)	0.5 (0.3-0.8)	-

Note: Rate was not computed when the number of deaths is below 10.

A.5.3 What is the importance of seasonality in malaria parasitemia trends?

Data sources

- Chikwawa District Rolling MIS[23]
- Meteorological Department, NSO (Nchalo station, Chikwawa District), monthly rainfall data

Methods

Since May 2010, a rolling (monthly) MIS (rMIS) has been conducted in Chikwawa District, in Southern Malawi, to monitor the burden of malaria in an area of 50 villages within 400 square km (population ~30,000)[24]. Although this time period falls at the end of the evaluation period, the insights gained about seasonal patterns of parasitemia are informative. Chikwawa is located in Malawi's southern Rift Valley, 500 meters above sea level, and has perennial malaria transmission with seasonal peaks. In Chikwawa (and in Malawi in general), a unimodal rainfall season usually occurs between November and April with limited rainfall recorded in the remaining months and therefore the malaria season is usually considered to peak during those months each year. Malaria control interventions have rapidly been scaled-up in this area including the distribution of LLINs and the introduction of annual district-wide indoor residual spraying (IRS) in February 2011.

All 50 villages (approximating census enumeration areas) were sampled once every six months (eight or nine villages per month, once during the rainy season-November to April- and once during the dry season). Within each village, households were randomly selected with a probability proportional to village population size, from a sampling frame based on an enumeration conducted in 2008. An adapted version of the standard national MIS evaluation package was applied to collect malaria disease burden and coverage indicators. Monthly rainfall data was also collected from the Meteorological Department, NSO (Nchalo station, Chikwawa District). To evaluate the relationship between malaria indicators and

[23] Roca-Feltrer A, Lalloo DG, Phiri K, Terlouw DJ (2012) Short Report: Rolling Malaria Indicator Surveys (rMIS): A Potential District-Level Malaria Monitoring and Evaluation (M&E) Tool for Program Managers. Am J Trop Med Hyg 86: 96-98.
[24] Ibid

seasonality, a logistic regression model was used. Adjusting for potential confounders (e.g. travel distance to closest health facility, distance to river, age, sex, wealth index, and season), estimates were 'clustered' by village to adjust the standard errors to account for potential correlation between surveys from the same village.

Results

Two survey teams, each consisting of a nurse and a field worker sampled an average of 100 (range: 60–124) households and 60 children under five years each month during both the rainy and dry months (May 2010 to April 2011). Overall, a total of 1,229 households were interviewed, with 753 children under five years. Blood samples were successfully collected from 740 of these children.

Estimates of key malaria impact and coverage indicators obtained from pooling the 12 months of rMIS data were similar to those obtained by the 2010 MIS and the 2010 DHS (see Table 5.3.1).

Table 5.3.1: Malaria intervention coverage indicators and disease burden indicators for the Chikwawa District from the DHS 2010 and rolling MIS 2010

Indicator (%)	DHS (June-Nov 2010)	rMIS (May 2010 to Apr 2011)
Reported Fever U5s	18.8	27.6
RDT+ (6–59 months)	-	37.4
Hb<8.0g/dL (6–59 months)	11.6	7.2
HH with any nets	70.8	62.4
HH with at least one ITN	61.9	55.5
U5s slept under an ITN the night before	46.0	46.9
Care seeking indicators		
U5s took any antimalarials	36.1	43.9
U5 took first-line antimalarials	33.3	36.7

HH=households; U5s=children under five years of age

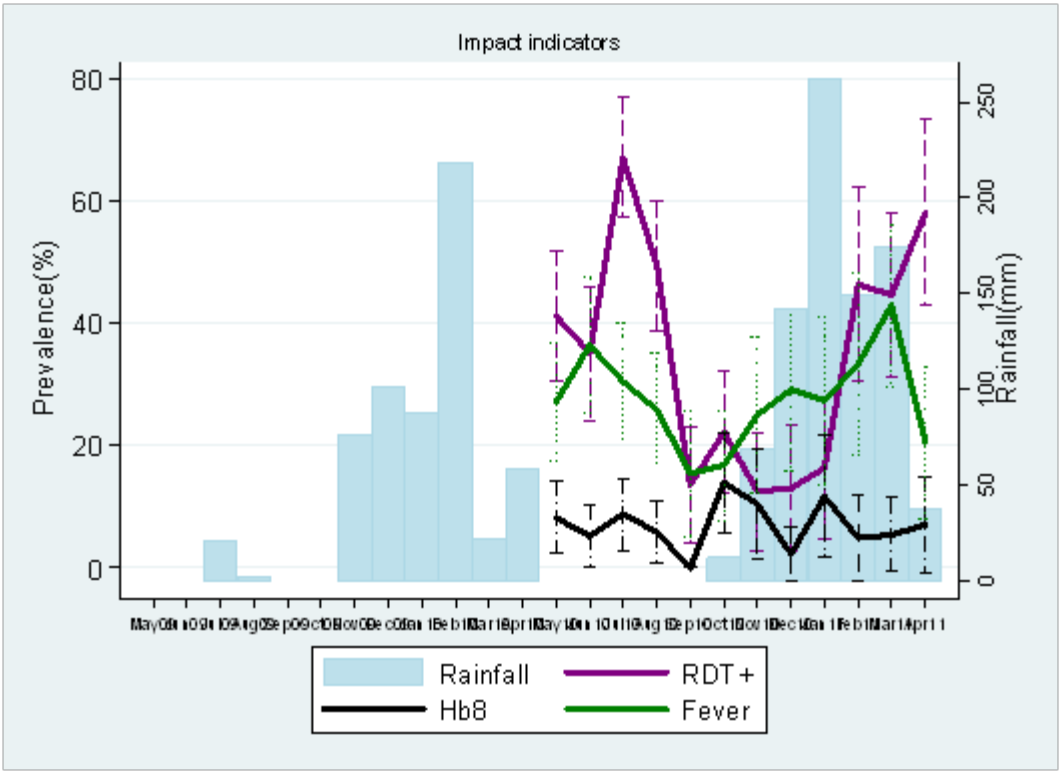
Twelve-month pooled village-specific parasitemia (RDT+) estimates ranged from a low of 0 to a high of 95%, with only villages within 2km from the Shire River found to exceed 50% prevalence. Moreover, the majority of the villages with >75% parasite prevalence were found within 2km from the Shire River during both the dry and wet season. This potential risk factor (≤2km vs >2km distance to river) was

therefore included in the logistic regression analysis when assessing the potential seasonal variations of key malaria disease burden indicators such as RDT positivity, severe anemia and reported fevers.

Disease burden indicators. Monthly parasite prevalence was found to be relatively high (>30%) throughout most of the 12-month period (May to August 2010 and February to April 2011), with a marked peak in the months of June and July and a drop at the end of the dry season and beginning of the rainy season (with less than 20% prevalence from September 2010 to January 2011) following an apparent 3-month lag with the rainy season (see Figure 59). Due to this 3-month lag from the start of the rains, children under five years were found to be less parasitemic in the rainy season compared to the dry season even after adjusting for all significant risk factors (including distance to river) OR=0.67 (95% CI=0.44-1.01); p-value=0.058 though this finding was borderline statistically significant (Table 5.3).

Overall, the prevalence of severe anemia (hemoglobin <8g/dL) was not found to significantly vary by rainy season (p-value=0.840) even after adjusting for significant covariates (e.g. age and wealth index). Similarly, no significant differences in reported fevers in the previous two weeks were found by season (p-value=0.420). No covariates were found to be significantly associated with reported fevers. These findings suggest that September, October, and November were the months of lowest malaria morbidity in the study area (Figure 5.3.1).

Figure 5.3.1: Monthly rainfall and crude prevalence of impact indicators



Coverage indicators. A significantly higher LLIN coverage was found in the rainy season as compared to the dry season for each indicator explored (Figure 5.3.2): the OR for households with at least one LLIN was 1.87 (p =0.002), the OR for children under five years sleeping under a LLIN the previous night was 2.78 (p <0.001), and the OR for children under five years sleeping under a LLIN the night before among households that owned at least one LLIN was 3.69 (p <0.001). No other covariates were found to be associated with the coverage of any LLIN indicator.

Figure 5.3.2: Monthly rainfall and ownership/use of LLINs

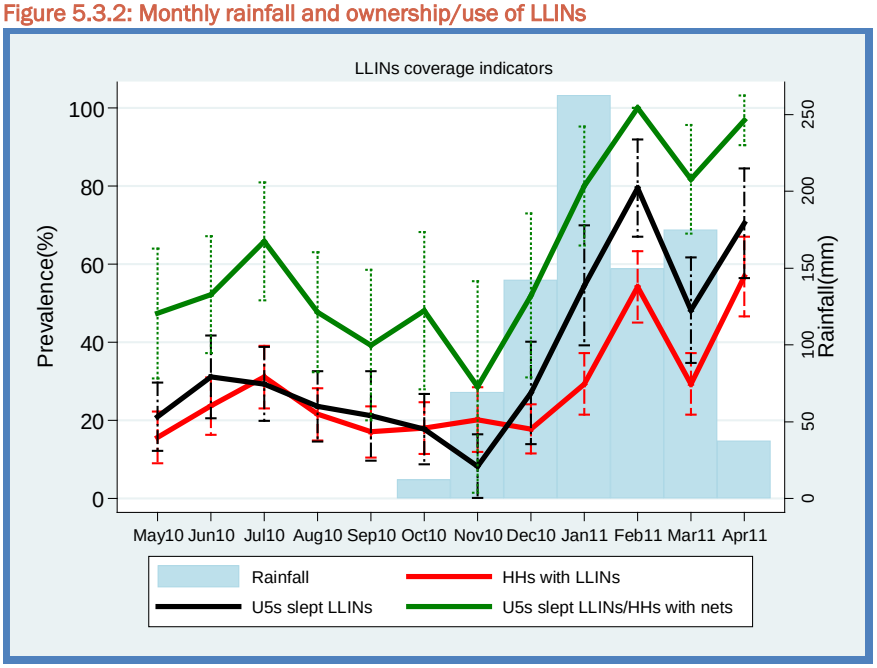


Table 5.3.2: Covariates from logistic regression of RDT positivity by seasonality and by background characteristics

Background characteristic	Unadjusted Odds Ratio (95% CI)	p-value	Adjusted Odds Ratio (95% CI)†	p-value
Season				
Dry	1.0	-	1.0	-
Wet	0.68 (0.46-1.00)	0.048	0.67 (0.44-1.01)	0.058
Distance to river				
>2km	1.0		1.0	
≤2km	3.47 (1.97-6.11)	<0.001	3.55 (1.94-6.47)	<0.001
Gender				
Male	1.0	-	-	-
Female	0.87 (0.67-1.13)	0.300	-	-
Travel distance to hospital				
<15 min	1.0	-	-	-
>15 min	1.02 (0.46-2.25)	0.969	-	-
Age				
Each year after <11 months old	1.23 (1.11-1.37)	<0.001	1.27 (1.13-1.42)	<0.001
Wealth index				
Each quintile increase after poorest	0.70 (0.61-0.81)	<0.001	0.67 (0.58-0.79)	<0.001

† Adjusted Odds Ratio column only shows data for covariates included in the final model

Discussion

Overall, results from the pooled 12-months of data obtained from the monthly rolling Malaria Indicator Surveys (rMIS) were comparable with the Chikwawa-specific estimates reported by the national DHS conducted in Malawi during the same year (2010) (Table 5.3.1). In addition, the rMIS showed marked seasonal variations in the prevalence of parasitemia with prevalence estimates ranging from 12.5% to 67% within one year. Seasonal variations were also observed in the coverage of LLINs after adjusting for

potential risk factors such as proximity to permanent water bodies. Estimates of LLIN use by children under five years of age ranged from approximately 10% to approximately 80% within the year of data collection. Strong local heterogeneity was also observed in the study area where factors such as proximity to permanent breeding sites were found to be significantly associated with key impact and malaria coverage indicators.

Some malaria indicators are likely to be more sensitive to seasonal changes than others and these changes might be more marked at different times of the year. For example, parasitemia indicators tend to follow a time lag of 7–9 weeks from the start of the rains to enable mosquitoes to breed and initiate malaria transmission each season. In addition, a minimum of 80mm of rainfall per month and temperatures between 22–32°C are usually required to enable malaria transmission[25]. Results from the rMIS showed that despite suitable rainfall conditions beginning in November, parasitemia did not increase significantly until February leading to a 3-month lag between the start of the rains and the observed peak in malaria prevalence[26]. A contributing factor may have been that average daily temperatures in the district tend to exceed 35°C during the October and November months which might have partly inhibited malaria transmission. Seasonal differences in the coverage of LLINs were also observed, with higher LLIN coverage beginning soon after the start of the rains, probably reflecting behavioral changes for optimising protection against mosquitoes. Lastly, some indicators did not seem to vary by season, as they are *a-priori* not influenced by rainfall (such as the proportion of febrile under-fives whose mothers sought any form of care).

Conclusion

Marked seasonality was observed in use of ITNs and in parasitemia prevalence in children under five over the course of one year in Chikwawa District. The variability in these indicators based on season highlights the challenge inherent in interpreting trends in malaria interventions and outcomes from data obtained from cross-sectional surveys: surveys are often fielded during different months from one survey to the next; climate patterns may change from one year to the next; relevant climate data are rarely collected as part of these surveys. The results of this study suggest the importance of measuring and controlling for seasonal variation in analyses. In addition, measures of malaria control impact other than parasitemia prevalence may be preferable.

[25] Roca-Feltrer A, Lalloo DG, Phiri K, Terlouw DJ (2012) Short Report: Rolling Malaria Indicator Surveys (rMIS): A Potential District-Level Malaria Monitoring and Evaluation (M&E) Tool for Program Managers. Am J Trop Med Hyg 86: 96-98.
[26] Ibid