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

Mozambique Malaria Impact Evaluation Group

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Executive Summary

BACKGROUND AND OBJECTIVE

Malaria is a significant public health problem in Mozambique. It is a major cause of mortality, illness, and absence from school and work. The entire population of Mozambique is at risk for malaria. In 2012, it was estimated that there were 7 million cases of malaria and approximately 18,000 deaths due to malaria in Mozambique [1]. Confirmed malaria accounts for 29% of all deaths and approximately 42% of all deaths among children under five years of age. Between 2003 and 2011, the government of Mozambique and several international development partners invested extensively in malaria control activities such as insecticide-treated nets (ITNs), indoor residual spraying (IRS) in selected areas, intermittent preventive treatment in pregnancy (IPTp), and prompt and effective malaria case management. This report was co-commissioned by the US President's Malaria Initiative (PMI) and Mozambique's Ministry of Health (MISAU) to report on the impact of these investments on morbidity and mortality among children under five years of age during the period 2003-2011.

DESIGN

The evaluation was based on a before-and-after assessment, which used a plausibility evaluation design that measured changes in malaria intervention coverage, malaria-related morbidity, and all-cause mortality in children under five years of age (ACCM), while accounting for other contextual determinants of child survival during the evaluation period. ACCM was used as the primary measure of impact. Further analyses, including a multiple logistic regression model investigating the relationship between household ITN ownership and malaria parasitemia, and case studies from Sofala and Zambézia Provinces were included to provide further evidence to support the plausibility design.

DATA SOURCES

Data used in the report mainly come from the following five large population-based household surveys: the 2003 Demographic Health Survey (DHS), 2007 Malaria Indicator Survey (MIS), 2008 Multiple Indicator Cluster Survey (MICS), 2009 AIDS Indicator Survey (AIS) and the 2011 DHS. These national survey data are supplemented, where relevant, by programmatic data from the National Malaria Control Program and the Mozambique routine Health Management Information System (HMIS) and from United Nations Children's Fund (UNICEF), World Bank and Joint United Nations Programme on HIV/AIDS (UNAIDS) databanks. Data sources are clearly cited throughout the report.

IMPLEMENTATION OF MALARIA CONTROL INTERVENTIONS

Household ITN ownership increased from 16% in 2007 to 54% in 2011 nationwide, and was significantly greater in households with children under five years of age by 2011 (59% compared to 43% in households with no children under five years of age). ITNs were used

the night before the survey by 36% of children under five years of age, 34% of pregnant women, and 30% of the entire surveyed population in 2011. Similar to the national trends, both ITN ownership and use increased in low, medium and high malaria risk zones in Mozambique; the high risk zones reported the highest ownership and use in 2011.

The proportion of households with at least one ITN and/or IRS in the last 12 months also increased significantly, from 35% in 2007 to 60% in 2011; however, most of this was attributed to increased household ITN ownership. IRS coverage increased over the evaluation period up through 2011 and then declined in 2012. National household survey data, only available during the latter part of the evaluation period, showed IRS coverage remained stable, ranging from 19-25%.

Implementation of IPTp began in Mozambique in 2006. Coverage of IPTp (2 doses of SP) increased significantly in the first few years of implementation, from 16% in 2007 to 43% in 2008. However, due to stock-outs of SP in the country, IPTp coverage declined to 19% in 2011.

Care-seeking for fever from formal health providers in children under five years of age remained stable during the evaluation period, from 60% in 2003 to 56% in 2011. Among children under five years of age with fever, treatment with any antimalarial significantly improved from 15% in 2003 to 30% in 2011. Treatment with a first-line antimalarial fluctuated over the evaluation period, increasing from 15% in 2003 to 34% in 2008, and then declining to 18% in 2011. This fluctuation was likely due to the changes in the first-line treatment policy in 2004 (to AS+SP) and 2009 (to AL).

IMPACT

Morbidity

Malaria parasitemia prevalence declined in children aged 6-59 months from 52% in 2007 to 36% in 2011, and was lower among children aged 6-23 months (the age group most likely to be affected by severe malaria) in 2007 and 2011 (44% and 31% respectively) compared to children aged 24-59 months (56% and 39% respectively). Data from the HMIS showed that the number of reported malaria cases for all age groups, including children under five years of age, increased from 2000 to 2005, and then showed a steady decline in cases from 2005 to 2012.

Severe anemia among children aged 6-59 months nationwide declined from 12% in 2007 to 9% in 2011. Overall, trends in malaria parasitemia, severe anemia and reported malaria cases demonstrate an overall decline during the latter part of the evaluation period when malaria control interventions were scaling up in the country.

Mortality

In general, mortality in children under five years of age declined by 36% between the period from 1999 to 2003 and from 2007 to 2011, from 152 to 97 deaths per 1000 live births. However, the greatest decline (from 126 deaths to 97 deaths per 1000 live births) occurred during the latter part of the evaluation period from 2004-2008 to 2007-2011,

when coverage of most of the malaria control interventions was increasing. Mortality declines during this time period were overall greater in regions with medium- or higher-malaria risk than those with lower malaria risk[1]. The relative decline in mortality in children 6–23 months (39%), who are at higher risk of severe malaria and malaria mortality, was slightly lower than the decline observed in children 24–59 months (42%) during the evaluation period. However, when assessing the trend in the higher malaria risk zone, children 6-23 months old experienced a higher relative decline in mortality (44%) compared to children 24-59 months old (39%). Data from the HMIS showed that the number of reported malaria deaths for all age groups generally increased from 2000 to 2006, then dropped between 2006 and 2010, before slightly rising again in 2011-2012.

Contextual factors

This report includes a comprehensive review of contextual determinants of child survival, which could also have contributed to the observed changes in mortality during the evaluation period. Several non-malaria related child health interventions could have contributed to reductions in ACCM, including improvements in early initiation and exclusive breastfeeding, vitamin A supplementation (postnatal and child supplementation), reductions in suspected acute respiratory infection (ARI) among children under five years of age, and the overall reduction in HIV prevalence that has been accompanied by improved coverage of prevention of mother-to-child transmission (PMTCT) and antiretroviral therapy (ART). Additionally, improvements in various socio-economic determinants of child survival could have contributed to the observed declines in ACCM, including Gross Domestic Product (GDP), women's education, housing conditions and mass media exposure.

Multiple logistic regression analysis

Multiple logistic regression analysis assessing the associations between ITN ownership by age of net and IRS with parasitemia prevalence among children 6-59 months were inconclusive. Both models demonstrated other variables, including place of residence, mother's education, wealth index and age of child to be more strongly related to parasitemia than ITN ownership or household IRS.

Case studies from Sofala and Zambézia Provinces

Using data from the HMIS, a case study from Sofala Province demonstrated that improvements in malaria control interventions (ITNs, IRS, case management and IPTp) between 2007 and 2012 were accompanied by a significant decline in malaria cases and deaths during the same time period. Similarly in Zambézia Province, improvements in malaria control activities between 2007 and 2012 were accompanied by a parallel decline in the number and incidence of reported malaria cases during the same period.

[1] High, medium and low-risk malaria zones are defined as 30%-60%, 10 to less than 30% and 1% to less than 10% parasite prevalence, respectively. More information on how these risk zones were defined and developed is provided in the Introduction section and Table 4.

CONCLUSION

In summary, the results show that Mozambique made progress in expanding coverage of many malaria control interventions during the evaluation period. Household ITN ownership increased more than three-fold, from 16% in 2007 to 54% by 2011. Similarly, improvements were found in ITN use among children under five years of age, pregnant women and the population as a whole (36%, 34% and 30%, respectively by 2011). Additionally, IRS coverage steadily increased over the evaluation period and overall treatment coverage of children under five years of age with antimalarials also showed improvements from 2003 to 2011. The results observed demonstrate that that the majority of improvements in coverage of malaria control interventions occurred during the latter part of the evaluation period, which is consistent with the declines observed in malaria morbidity and mortality in the country. Severe anemia and malaria parasitemia both declined between 2007 and 2011, and similarly, the greatest decline in ACCM occurred during the second part of the evaluation period. Part of the declines observed in ACCM could be due to a number of socio-economic factors and coverage of other non-malaria control interventions that showed improvements over the evaluation period, such as improvements in GDP, women's education, housing conditions, and child nutrition (breastfeeding and vitamin A supplementation). Furthermore, the proportion of children with ARI declined, as well as HIV prevalence. Considered all together, the evidence suggests that malaria control interventions in Mozambique were likely to have contributed to reductions in ACCM, particularly to the reductions observed during the second half of the evaluation period. Calculations using the LiST (Lives Saved Tool) model estimate that the expanded coverage of malaria control interventions during the latter part of the evaluation period (2007 to 2011) could have prevented at least 13,861 deaths among children under five years of age in Mozambique.

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Acronyms

$_1q_0$	Infant mortality rate (first year), per 1,000 live births
$_4q_1$	Child mortality rate between exact age 1 and exact age 5, per 1,000 children surviving to 12 months of age
$_5q_0$	Mortality rate of children under five years of age, per 1,000 live births
ACCM	All-cause mortality in children under five years of age
ACT	Artemisinin combination therapy
AIS	AIDS Indicator Survey
AL	Artemether-lumefantrine
ANC	Antenatal care
ARV	Anti-retroviral therapy
BCG	Bacille Calmette–Guérin (vaccine)
CDC	(United States) Centers for Disease Control and Prevention
CI	Confidence Interval
DDT	Dichlorodiphenyltrichloroethane
DHS	Demographic and Health Survey
dL	Deciliter
DPT	Diphtheria, pertussis, tetanus (vaccine)
EPI	Expanded Programme on Immunization
GDP	Gross domestic product
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
Hb	Hemoglobin
HBV	Hepatitis type B vaccine
Hib	*Haemophilus influenzae* type B vaccine
HMIS	Health Management Information System
IGME	Inter-agency Group for Mortality Estimation
INE	National Statistics Institute
IPTp	Intermittent preventive treatment in pregnancy
IRS	Indoor residual spraying
ITN	Insecticide-treated net
LiST	Lives Saved Tool
LLIN	Long-lasting insecticide-treated net
LSDI	Lubombo Spatial Development Initiative
MERG	Monitoring and Evaluation Reference Group
MICS	Multiple Indicator Cluster Survey
MIS	Malaria Indicator Survey
MISAU	Ministry of Health (Ministerio da Saúde)
NMCP	National Malaria Control Program
NN	Neonatal mortality (first month), per 1,000 live births
PMI	President's Malaria Initiative
PMTCT	Prevention of mother-to-child (HIV) transmission
PNN	Post-neonatal mortality (age 1-11 months), per 1,000 live births
RBM	Roll Back Malaria Partnership
RDT	Rapid diagnostic test

SP	Sulfadoxine-pyrimethamine
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization
WN	Weighted number

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INTRODUCTION AND BACKGROUND

Introduction

Purpose and Scope

Malaria is a significant public health problem in Mozambique. It is a major cause of mortality, illness, and absence from school and work. The entire population of Mozambique is at risk for malaria. In 2012, it was estimated that there were 7 million cases of malaria and approximately 18,000 deaths due to malaria in Mozambique [1]. Confirmed malaria accounts for 29% of all deaths and approximately 42% of all deaths among children under five years of age in Mozambique [2]. Due to the serious burden caused by malaria, and the extensive funding, both internal and external that has been devoted to malaria control, there is a growing demand from policy-makers, program managers, donors and researchers to measure the extent to which malaria control interventions have made an impact on malaria. The objective of this report is thus to assess progress in Mozambique's malaria control efforts between 2003 and 2011, in particular the country's progress towards achieving national and international goals and targets, including those set forth in the 2008 Global Malaria Action Plan and updated in 2011 [3,4].

The report is co-commissioned by the US President's Malaria Initiative (PMI) and Mozambique's Ministry of Health (MISAU) in support of the monitoring and evaluation activities conducted by the Roll Back Malaria Partnership (RBM) and Mozambique's MISAU. The main objective of the evaluation is to assess the impact of malaria control interventions, such as insecticide-treated bednets (ITNs), indoor residual spraying of insecticide (IRS), intermittent preventive treatment in pregnant women (IPTp) and malaria case management, on malaria morbidity and all-cause mortality in children under five years of age, between 2003 and 2011 in Mozambique. The report does not aim to present a review of program implementation or effectiveness. However, it does include a detailed description of intervention implementation and sub-national variations in intervention coverage, as available. The evaluation also considers other factors that might have contributed to the mortality decline over the period.

The evaluation focuses on the period 2003-2011 because this is the period over which most changes have taken place in malaria control interventions. In 2004, Mozambique adopted the artemisinin combination therapy (ACT) artesunate-sulfadoxine-pyrimethamine as the first-line drug. Additionally, since 2006, the National Malaria Control Program (NMCP) along with partners intensified efforts for distribution of long-lasting insecticide-treated nets (LLINs) in the country. Intermittent preventive treatment of malaria during pregnancy (IPTp) was adopted in Mozambique in 2006. Lastly, indoor residual spraying (IRS) steadily increased in the country, starting in 2001 through 2010.

Evaluation Design

The evaluation is based on a before-and-after assessment, which uses a plausibility evaluation design that measures changes in malaria intervention coverage, malaria-related morbidity, and all-cause mortality in children under five years of age (ACCM) while

considering other contextual determinants of child survival during the evaluation period [5,6].

This report, therefore describes in detail the improvements in malaria control interventions, as well as changes in malaria morbidity and mortality. The plausibility of a cause and effect relationship is further bolstered if:

- the magnitude of impact is consistent with intervention efficacy;
- the age-pattern of change is consistent with malaria-mediated morbidity and mortality; and
- the timing of intervention expansion matches trend change in impact, and if there is an ecological association between malaria risk and the observed impact.

At the national level, the report examines changes in other factors that have the potential to influence changes in malaria-related morbidity and/or ACCM. These contextual factors include weather, socio-economic factors such as gross domestic product (GDP), education, access to improved water and sanitation, and proximate determinants including access to health services, and other predictors of maternal and child health such as nutrition, immunization and comorbidities.

The plausibility of causal association was further examined through a multiple regression model examining the relationship both between household ITN ownership and indoor residual spraying on malaria parasitemia prevalence in children 6-59 months and sub-national case studies from Sofala and Zambézia Provinces.

The Lives Saved Tool (LiST) model, created by the Child Health Epidemiology Reference Group, was used to estimate the potential contribution of various health interventions (including, but not limited to malaria control interventions) to the number of children under five years of age lives saved between 2003 and 2011. The LiST tool has been used by the malaria community to estimate the number of deaths prevented due to the expanded coverage of ITNs and IPTp in multiple countries in sub-Saharan Africa [7,8].

Evaluation Indicators

The selection and definition of indicators used in this evaluation for national-level analysis was guided by the recommendations of RBM's Monitoring & Evaluation Reference Group (MERG) shown in Table 1.

Table 1: Roll Back Malaria Core Population-Based Indicators Used in this Report

Intervention	Indicator Description
Prevention	
Insecticide-treated nets (ITNs) and indoor residual spraying (IRS)	Proportion of households with at least one ITN
	Proportion of households with at least one ITN for every two people
	Proportion of population with access to an ITN within their household
	Proportion of population who slept under an ITN the previous night
	Proportion of children under 5 years old who slept under an ITN the previous night
	Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months
Prevention and control of malaria in pregnant women	Proportion of pregnant women who slept under an ITN the previous night
	Proportion of women who received intermittent preventive treatment (IPTp) with at least two doses of SP for malaria during antenatal care (ANC) visits during their last pregnancy
Case Management	
Diagnosis	Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick
Treatment	Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought
	Proportion receiving first line treatment, among children under five years old with fever in the last two weeks who received any antimalarial drugs
	Proportion of children under five years old with fever in last two weeks who received any antimalarial treatment*
	Proportion of children under five years old with fever in last two weeks who received first-line treatment according to national policy within 24 hours from onset of fever*
Impact Measure	**Indicator Description**
Mortality Indicator	All-cause mortality in children under five years of age (ACCM)
Morbidity Indicators	Malaria Parasitemia Prevalence: proportion of children aged 6-59 months with malaria infection
	Severe Anemia Prevalence: proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL

Source: Household Survey Indicators for Malaria Control [8].
*These indicators are no longer recommended by the RBM MERG but are included here as they are still used to track NMCP targets and/or MDG.

ITNs

ITNs are one of the principal tools in the arsenal of malaria control. The RBM ITN indicators report on both ownership and use of ITNs. ITN ownership is a household-level indicator, whereas use is measured for the individual. Use at the population level is measured, as is use by the target populations historically at greatest risk of malaria morbidity and mortality: children under five years of age and pregnant women.

IRS

Indoor residual spraying (IRS) is another effective tool for vector control. In sub-Saharan Africa IRS is most commonly targeted in specific areas and not used at a national scale. IRS coverage is measured together with household ownership of ITNs to provide a measure of household coverage of at least one of the vector control strategies.

IPTp

Intermittent preventive treatment for malaria in pregnancy (IPTp) is another key tool of malaria control programs which is measured by RBM indicators. The World Health Organization (WHO) recommends IPTp in highly endemic countries. IPTp was defined as at least two doses of SP after quickening and at least one month apart; however these recommendations have since been updated [9]. As of 2012, the WHO recommends that pregnant women living in areas of moderate to high malaria transmission receive SP at each scheduled antenatal care (ANC) visit, with at least one month between each dose, beginning as early as possible in the second trimester [9].

Malaria Case Management

Proper diagnosis and treatment of malaria cases is also essential to malaria control. RBM population-based indicators measure some elements of diagnosis and treatment of malaria; however, facility-based data are often better suited to monitoring trends in malaria case management and are included in this report where relevant. Population-based surveys do not typically contain data on outcomes from visits to health facilities; thus, the proportion of children with fever receiving diagnostic tests for malaria is measured via a proxy indicator in which receipt of a finger or heel stick is considered an indicator for having had a diagnostic test. Questions on care-seeking behavior for fever in children under five years of age, and of the type and timing of treatment with antimalarial drugs are also included.

Malaria Morbidity

The prevalence of severe anemia and malaria parasitemia in children 6-59 months of age are two outcomes examined in this evaluation that lie on the causal pathway between malaria control and child mortality. Severe anemia, defined as blood hemoglobin levels less than 8 grams per deciliter (dL), is a potential impact measure for total malaria-related disease burden as it is associated with malaria-related mortality and it is measurable at the population level; it is also affected less by seasonality than malaria parasitemia [10,11,12].

Malaria parasitemia prevalence is perhaps the most direct measure of malaria burden but there are challenges to using national estimates to measure success of programs given the focal nature of malaria transmission. For this reason, morbidity analyses in this report are supplemented by longitudinal facility-based data on malaria cases where possible.

Mortality

In line with RBM-MERG guidance, the principal measure of impact used in this evaluation is ACCM, because malaria-specific mortality cannot be reliably measured in most parts of sub-Saharan Africa with the current sources of data. This measure is preferable to malaria-attributable mortality for a number of reasons, including: the non-availability of national-level, malaria-specific mortality data; concerns about the sensitivity and specificity of the verbal autopsy method for detecting malaria deaths [13] and the fact that malaria is thought to make an "indirect" contribution to the mortality of children under five years of age that is equivalent to 50%-100% of the mortality that can be directly attributed to malaria [14].

After a thorough analysis of the data options available to examine ACCM in Mozambique, the impact evaluation team chose to use the direct mortality estimates from the three DHS's (1997, 2003, and 2011), the 2008 MICS indirect mortality estimates and the corresponding ACCM estimates from the UN Inter-agency Group for Child Mortality Estimation (IGME).

Data Sources

No new primary data were collected for this evaluation. The data sources for malaria control intervention coverage indicators and some of the contextual factors are the following five national surveys: 2003 DHS, 2007 MIS, 2008 MICS, 2009 AIDS Indicator Survey (AIS) and 2011 DHS surveys. The evaluation covers the period from 2003 to 2011, with a particular focus on the later years after coverage of malaria control intervention expansion began. The 2003 DHS provides a baseline for coverage of IRS and case management coverage, as well as for ACCM in Mozambique. The 2007 MIS provides baseline estimates of other malaria control interventions, including ITNs and IPTp, and for morbidity measures, including parasitemia and severe anemia prevalence. The 2008 MICS and 2009 AIS, where applicable, provide estimates for select malaria control interventions and for various contextual factors. The 2011 DHS provides an endline measure of malaria control interventions, morbidity and ACCM. Supplementary data sources include: Mozambique Health Management Information System (HMIS) data, UNICEF, World Bank and UNAIDS data. Finally, the study makes reference to numerous published studies on the relationship between malaria control interventions and their impact. Throughout the report, the source of data is clearly cited and caveats on data quality, comparability and assumptions are indicated. A more detailed description of the data sets, survey methods, sample sizes and other statistical parameters can be found in the annexes.

Report Structure

The main body of this report is divided into six sections. The first provides a brief description of the country context and malaria situation, including the evolution of the malaria strategy and funding. The second section describes in detail the implementation of malaria control interventions: ITNs, IRS, IPTp, and case management. The third section examines changes in morbidity; specifically malaria parasite prevalence, number of reported malaria cases and severe anemia. Section four describes changes in mortality in children under five years of age. Section five presents further analyses, which includes a multiple logistic regression model and sub-national case studies from Sofala and Zambézia Provinces. Section six, presents the plausibility analysis and conclusion, which includes an assessment of the changes found in terms of the malaria interventions, morbidity, mortality and contextual factors during the evaluation time period. The report concludes with a discussion on the evidence and the LiST model to demonstrate the potential contribution to lives saved, as well as implications for the future.

Country Context

Background

Mozambique is a country located in the Eastern Coast of Africa. At 309,475 sq. mi (801,537) km^2 it is the 16th largest country in Africa. It is bordered by six countries; Swaziland to the south, South Africa to the southwest, Zimbabwe to the west, Zambia and Malawi to the northwest and Tanzania to the north. The Indian Ocean borders the east of the country, with a coastline that stretches for more than 2500 km. Mozambique is divided into 11 provinces that are clustered into three regions: North, Central and South. The provinces are subdivided into 128 districts and the districts are further divided into 405 administrative posts.

Figure 1: Map of Mozambique

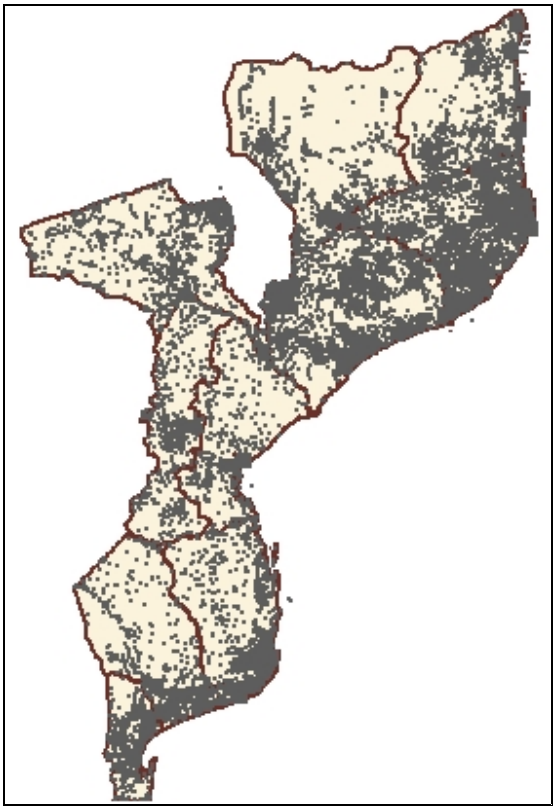
Mozambique has a tropical climate with two seasons, a wet season from October to March and a dry season from April to September. Climatic conditions, however, vary depending on altitude. There are three main geographic divisions:

1. The coastal belt which covers approximately 44% of the country, comprising most areas south of the Save River and the lower Zambezi area;
2. The middle plateau, ranging from 200-1,000m in elevation and covering about 29% of the country; and
3. The plateau and highland region with average elevations of around 1,000m to the north of the Zambezi River covering the remaining 27% of the country [15].

Rainfall is heavy along the central coast region and decreases in the north and south. Annual precipitation varies from 500 to 900 mm depending on the region, with an average of 590 mm (23.2 in). Average temperature ranges in Maputo are from 13°C to 24°C in July to 22°C to 31°C in February. The country is prone to natural disasters such as drought, cyclones, and floods particularly in low-lying coastal areas and along major rivers.

The estimated population of Mozambique in 2012 was 23,700,715 (projected from the national census of 2007 assuming an annual population growth rate of 2.4% per year, National Statistics Institute (INE)). The census found that 52% of the population was female, 18% were below age five, 46% were below age 15, 51% were aged 15-59 years and 3% were above 60 years. The provinces of Zambézia and Nampula are the most populous, with about 40% of the entire population of Mozambique. About 70% of the population resides in rural areas and the population density across the country is variable with the majority of the population residing along the coastline as shown in Figure 2.

Figure 2: Mozambique population density map



Source: NMCP records

On basic development indicators, results from the DHS 2011 show that 51% of the population has access to an improved water source (i.e., protected, borehole, piped) with a large disparity between the rural and urban populations of 84% and 37%, respectively. Illiteracy levels are at 60% in women and 30% in men. The fertility rate is 5.9. Approximately 43% of children under five years of age are stunted, while 15% are underweight. The majority of infants (97%) are breastfed and the median breastfeeding duration is 20 months. About 77% of infants are breastfed within the first hour of birth and 92% within the first day of birth, while approximately 41% are exclusively breastfed for the first six months. Infant and ACCM mortality rates declined sharply between 2003 and 2011 from 101 to 64 per 1,000 live births and 153 to 97 per 1,000 live births, respectively, while the maternal mortality rate remained the same at 408 per 100,000 live births during this time period. In 2011, HIV prevalence among the adult population aged 15-49 years was 11.5%, with a higher prevalence among females (13.1%) compared to males (9.2%).

Table 2: Mozambique Basic Social and Health Indicators

Social Indicators	
Population aged 0-14 years, 2007*	45.5%
Life Expectancy at Birth, 2011**	50
Adult (15-49) literacy rate, 2011**** Male Female	69.9% 40.2%
Improved water source (% of population with access), 2011****	51%
Child Health Indicators	
Children under five years of age who are stunted 2011****	43%
Children who completed all vaccinations in 12 months, 2011****	52%
Maternal Health Indicators	
Total Fertility Rate (number of births per woman), 2011****	5.9
Antenatal care from a skilled provider, 2011****	91%
Hospital Deliveries, 2011****	55%

Data Source:
*2007 Population Census
** UNICEF Country Statistics, http://www.unicef.org/infobycountry/mozambique_statistics.html
*** United Nations Educational Social and Cultural Organization, http://stats.uis.unesco.org
****2011 DHS

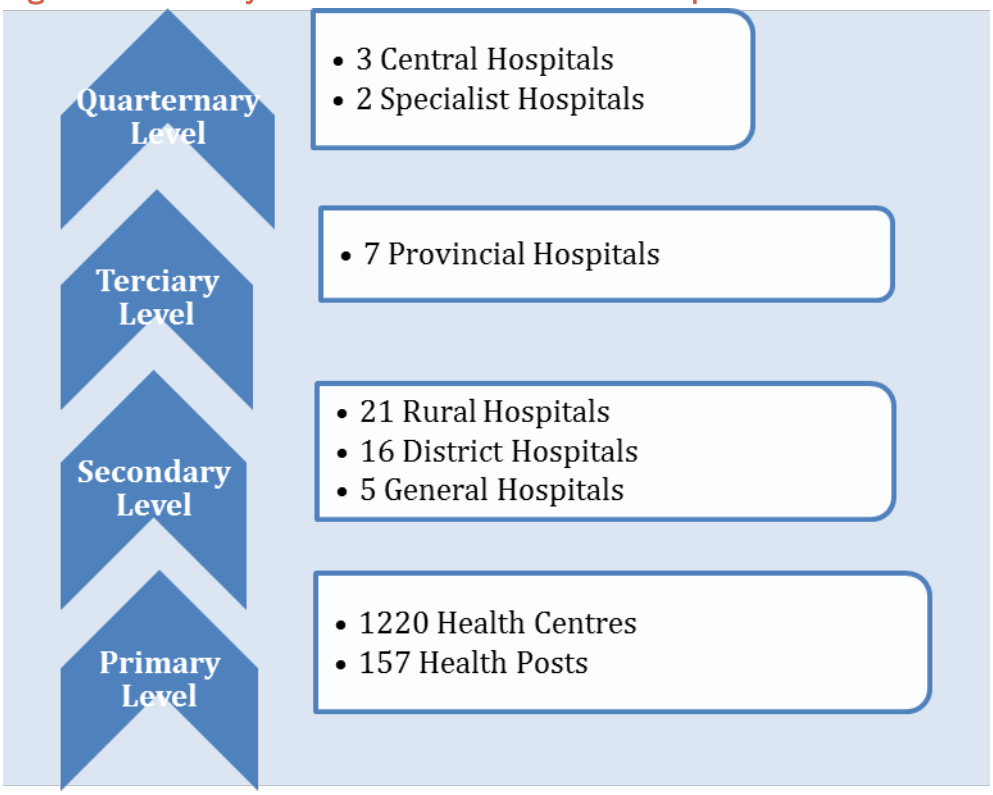
The main economic activity in Mozambique is agriculture with 70% of the population living in rural areas and practicing agriculture. Over the last few years, mineral deposits of coal, gas and petroleum have been discovered and the average annual economic growth of Mozambique has remained above 7% with the poverty index declining from 69.4% in 1996 to 54.7% in 2009 [16]. In 2011, the GDP of Mozambique was $12,762,040,280, GDP growth was 7.3% and the inflation was 6.4% [16]. The country's GDP per capita was just above $1000 in 2012 [16]. The Gini index, a measure of the degree of inequality in the distribution of family income in a county (where a 0 represents perfect equality and an index of 100 implies perfect inequality), was 45.6 in 2008 for Mozambique [17].

Health Services

The public health sector is by far the largest provider of health services in Mozambique. The National Health System health facilities are classified into 4 levels: primary, secondary, tertiary and quaternary levels (Figure 3). The primary health facilities consist of health centres and health posts that offer primary care including outpatient and maternal and child health services. The secondary level is the first referral level and consists of rural,

general and district hospitals. There are 42 health facilities of this type across all 128 districts; consequently there are districts that do not have a secondary level health facility and have to rely on a health facility in another district. Maputo province does not have a provincial hospital, but one is currently under construction. There are three central hospitals, one for each region, Maputo Central Hospital for the South, Beira Central Hospital for the central and Nampula Central Hospital for the North. There are two additional specialist hospitals in Maputo and Nampula that are psychiatric hospitals.

Figure 3: Hierarchy of Health Facilities in Mozambique



Access to health services is limited to an estimated 60% of the population as of 2010, and varies per province. Table 3 below shows the population for each primary level facility.

Table 3: Population per primary health facility

Province	Primary Level Health Facility	Pop/Primary Level Health Facility
Niassa	148	9,966
Cabo Delgado	110	16,488
Nampula	201	22,994
Zambézia	217	21,636
Tete	103	22,038
Manica	97	18,578
Sofala	147	12,637
Inhambane	120	13,229
Gaza	122	11,195
Maputo	82	18,521
Maputo City	30	36,816
Total	**1,377**	**17,542**

The total number of health workers in the country is estimated to be around 34,500, of whom only 3.2% are doctors.

Malaria in Mozambique

Malaria is endemic throughout Mozambique. Transmission is perennial, with seasonal peaks during and after the rainy season, which is between October and March. The peak malaria-transmission season extends from December into April. The seasonal intensity of transmission may vary depending on the amount of rain and air temperature. While, there is no widely used stratification or risk map for malaria in the country, the data from the 2007 MIS has been used by the NMCP to map out parasitemia prevalence across the country. For this evaluation, three malaria transmission risk zones will be used based on the 2007 MIS, which are outlined in Table 4[2].

Table 4: Malaria risk zones in Mozambique

ZONE	CHARACTERISTICS	PARASITE PREVALENCE	PROVINCE
Zone 1	Low transmission	1% to <10%	Maputo City, Maputo Province
Zone 2	Moderate transmission	10% to <30%	Gaza, Manica
Zone 3	High transmission	30%-60%	Inhambane, Sofala, Tete, Zambézia, Nampula, Niassa, Cabo Delgado

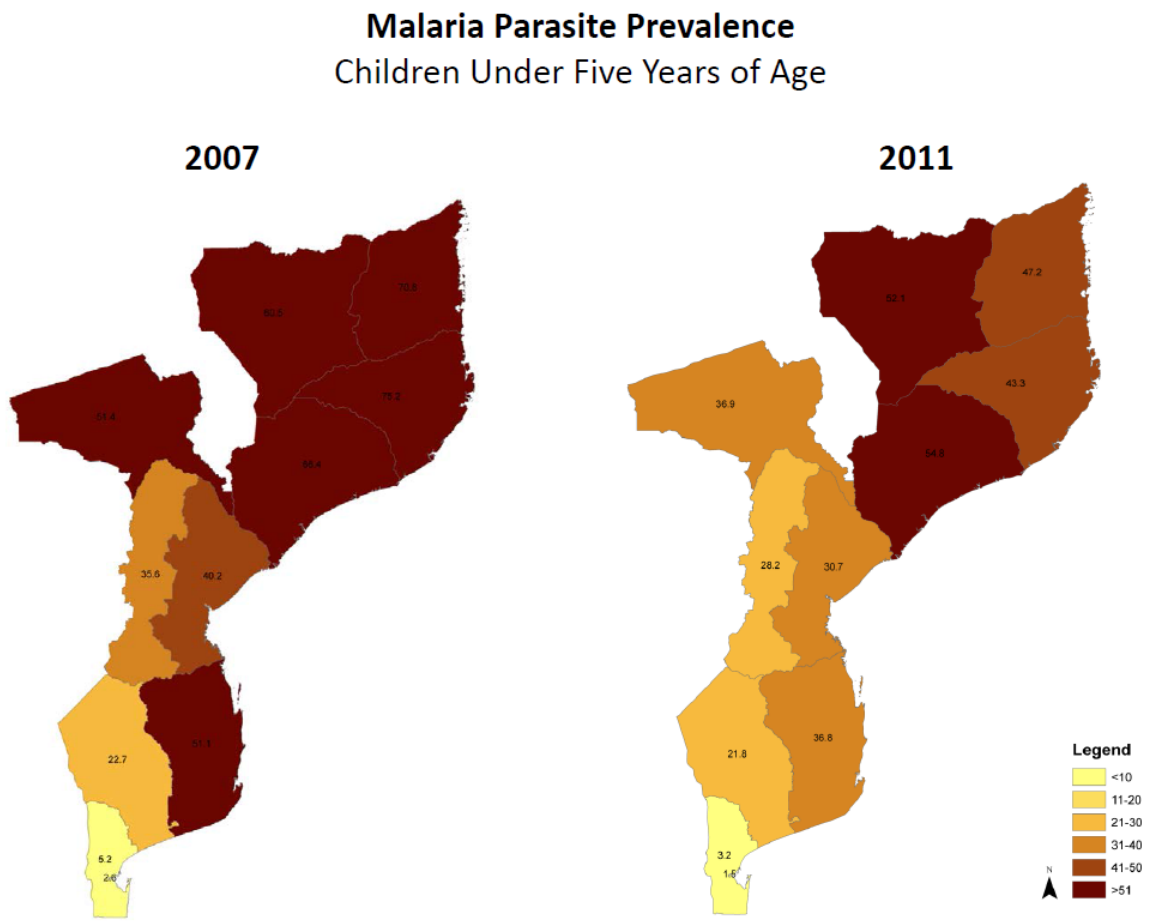
[2] The malaria risk stratification used in the report was discussed and agreed upon by the Technical Working Group of the NMCP in September, 2013.

Plasmodium (P.) falciparum infections account for 90% of all malaria infections, with *P. malariae* and *P. ovale* responsible for about 9% and 1%, respectively. To date, no study has documented existence of *P. vivax* transmission.

The main vectors in Mozambique belong to the *Anopheles (An.) funestus* group and *An. gambiae* complex and the subspecies are *An. gambiae s.s., An. arabiensis,* and *An. funestus s.s.* Among the major subspecies of the *An. gambiae* complex, *An. arabiensis* is more prevalent in the south and *An. Gambiaes* in the north.

The 2007 MIS and 2011 DHS both included an assessment of parasitemia among children and pregnant women. For both years, parasitemia prevalence in children 6-59 months was lowest in Maputo City and Maputo Province, and highest in Niassa, Cabo Delgado, Nampula and Zambézia Provinces (Figure 4).

Figure 4: Malaria Parasite Prevalence (RDT), 2007 and 2011

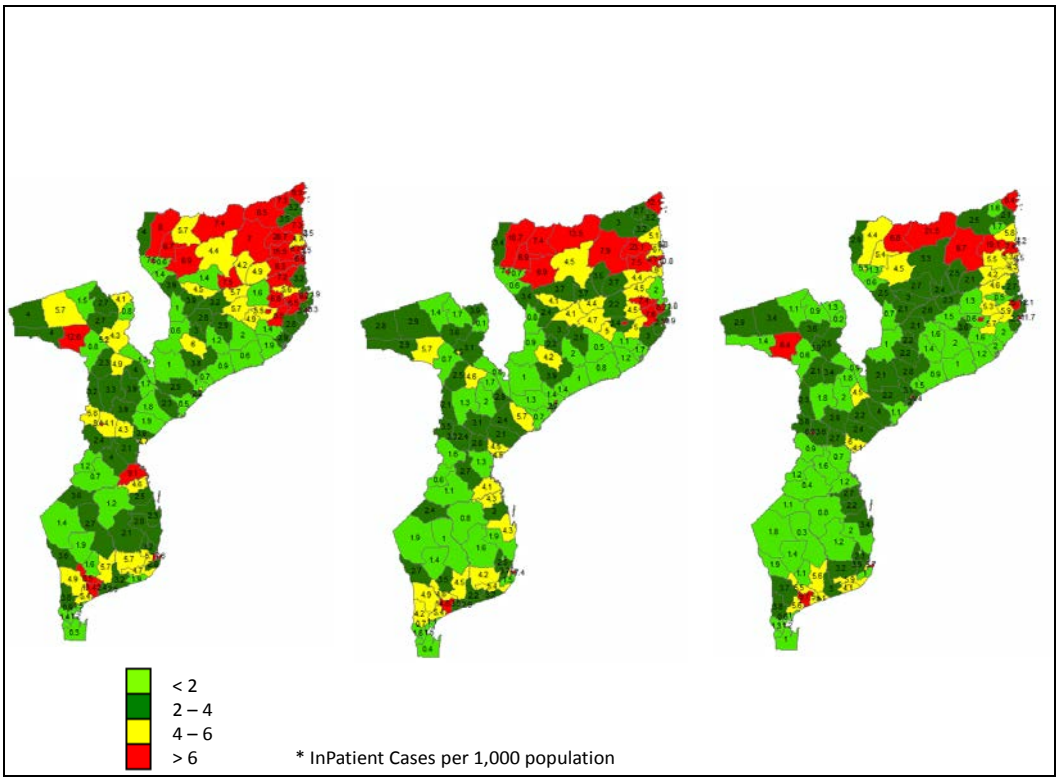


Source: NMCP records

The malaria burden in the country is large, accounting for nearly 45% of all cases observed in outpatient consultations, approximately 56% of pediatric inpatient admissions, and

nearly 26% of hospital deaths in 2010. Using inpatient malaria case data from the HMIS, the NMCP developed the incidence maps below which show higher incidences in the northern region of the country.

Figure 5: Inpatient Malaria Incidence Rates 2010–2012



Source: NMCP records

Malaria Control Strategy

Malaria control in Mozambique dates back to the 1950s at the beginning of the Global Malaria Eradication Program. The current NMCP was established in 1982, mainly focusing on vector-control activities. In 1991, the NMCP formally adopted three main strategies for malaria control, namely: early diagnosis and treatment, vector control, and health education.

A joint Roll Back Malaria (RBM) review mission in 1999 concluded that these strategies had been ineffective in controlling malaria in Mozambique mainly due to:

- Limited access among the rural population to the formal health facilities run by the National Health Service;
- Insufficient health infrastructure following 16 years of destruction during the civil war that took place from 1977 to 1992;
- Weak linkages between the community and health services;

- Emergence of chloroquine drug resistance coupled with limited availability of drugs at community level;
- Indoor residual spraying (IRS) campaigns were concentrated in urban areas only;
- Health education, information, and communication often did not reach the target population;
- Limited capacity of the population to recognize symptoms and signs of malaria; and
- Cultural practices that negatively influence treatment-seeking behavior [18].

The brief evaluation of the malaria situation in 1999 by a joint international consultancy mission was followed by a situational analysis led by the Ministry of Health in 2000. The analysis covered the districts of Moatize, Massinga, Quelimane, Angoche, Mocuba, and Manhiça. The results helped inform the development of the first Malaria Strategic Plan for Mozambique for the period, 2001-2005. Following a review of this plan, a new plan to cover the period 2006–2009 was developed. After the plan's expiration in 2009, a Malaria Program Review was conducted in 2010 and a new Strategic Plan developed for 2012 - 2016.

Key malaria control interventions are governed by government legislative instruments as shown in Table 5. The different laws provide for registration and regulation of medicines and chemicals; tax exemption of medicines and chemicals but not spray pumps; regulation of private-sector involvement in malaria control and the national health policy.

Table 5: Useful legislation supporting malaria control

LEGISLATION	SUBJECT
Article 1 of Law No. 26/91 of 31 December	Licensing and registration of private health facilities.
Ministerial Order No. 4072003 of 2 April	Regulating the mechanisms of partnership between the National Health Service and the nonprofit-oriented private sector.
Decree No. 31/89 of 10 October; published in BR 40, Supplement 2	Regulating the norms for establishment and functioning of health posts and clinics at the workplace.
Resolution No. 4/95 of 11 July; published in BR 27 Supplement	Approval of the national health policy.
Law No. 4/98	Law on drugs and establishing the Council of Drugs.
Decree No. 22/99 of May 4	Regulating the Drug Registration System.
Law No. 6/2009 of March 10	Imported antimalarial drugs, rapid diagnostic tests, insecticide-treated nets, and insecticides for indoor residual spraying are exempt from customs duties and taxes, but not spray pumps. Resulting in reduced cost of malaria control commodities.

The different milestones in malaria control policies and implementation from 1999 to 2011 are summarized in Table 6. Details of the implementation of specific malaria control interventions are presented in subsequent sections of this report.

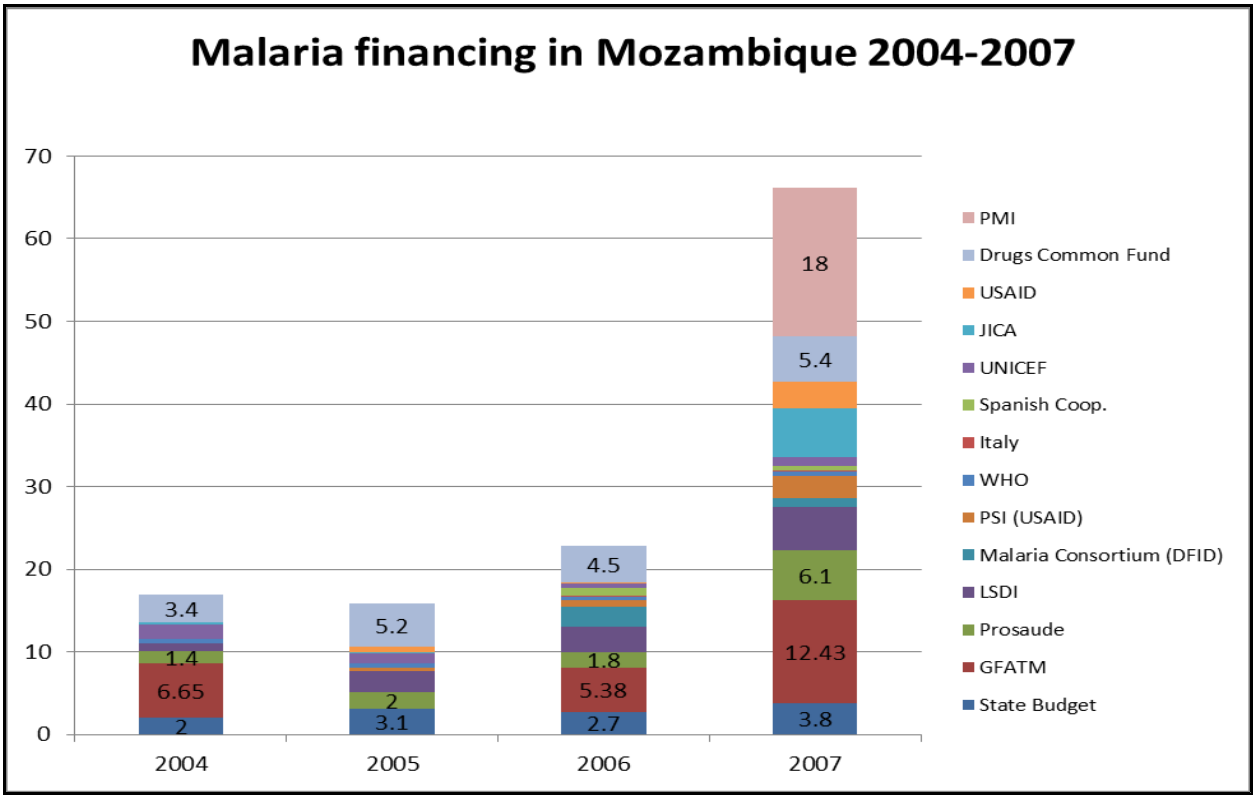
Table 6: Milestones in Malaria Control Strategy: Timeline with roll-out of policies and interventions

Survey		Milestones in Malaria Policy and Implementation
	1999	• Review of malaria situation by a joint international consultancy mission. • **IRS**: Mozambique signs on to the Lubombo Spatial Development Initiative (LSDI) malaria control programme with Eastern Swaziland and North-eastern South Africa. • Mozambique endorsed the Global Initiative to Roll Back Malaria.
	2000	• **ITN**: Distribution of ITNs to children under 5 and pregnant women during the flooding emergency in Gaza province. • **IRS**: LSDI IRS program begins in Maputo province. • First National Malaria Control Strategic plan (2001-2005) is developed.
	2001	• Implementation of the First National Malaria Control Strategy begins.
	2002	• **ITN, IRS and IPTp**: First Malaria Global Fund Grant proposal supporting ITN distribution, IRS, and prompt and effective treatment is submitted and approved. • **Case Management**: First meeting to develop malaria treatment guidelines is held and artesunate-amodiaquine is adapted as first-line regimen.
2003 DHS		
	2004	• **Case Management**: First-line treatment guidelines are changed from amodiaquine – sulfadoxine-pyrimethamine (AQ+SP) to artesunate-sulfadoxine-pyrimethamine (AS+SP), with implementation beginning in 2005. • **IPTp**: Two doses of sulfadoxine-pyrimethamine (SP) are approved as a national policy.
	2005	• **ITN, IRS and IPTp**: First Malaria Global Fund grant begins implementation. • **ITN**: Routine distribution of ITNs in ANCs begins. • **Case Management**: Introduction of Rapid Diagnostic testing. • Second National Malaria Strategic Plan (2006-2009) is developed.
	2006	• **ITN, IRS, IPTp and Case Management**: Second Global Fund grant proposal is submitted and approved. • **IPTp**: IPTp implementation begins in May. • **IRS:** LSDI IRS project expands to Gaza province.
2007 MIS	2007	• **ITN, IRS, IPTp and Case Management**: Second Global Fund grant begins implementation. • First MIS conducted. • PMI begins implementing malaria control activities in Mozambique.
2008 MICS	2009	• **ITN, IRS and Case Management**: Law exempting antimalarial drugs, rapid diagnostic tests, insecticide-treated nets, and insecticides for indoor residual spraying from customs duties and taxes is passed. • **ITN, IRS, IPTp and Case Management**: Third Malaria Global Fund grant proposal is resubmitted and approved. • **Case Management**: Malaria treatment guidelines are reviewed and AL is adapted as first-line treatment. • **Case Management**: A ministerial decree declares malaria diagnosis and treatment free of charge in public health facilities. • **ITN**: ITN strategy for universal coverage is adapted and included in Global Fund proposal (1 LLIN per two people).
	2010	• The first Malaria Program Review is conducted. • **ITN**: Pilot for ITN universal coverage mass campaign is implemented.
2011 DHS	2011	• **ITN**: Roll out of ITN universal coverage mass campaigns. • **ITN, IRS, IPTp and Case Management**: Third Global Fund grant begins implementation.
	2012	• The National Malaria Policy is finalized. • The 2012-2016 National Malaria Prevention and Control Strategic Plan is finalized [19].

Resources and Inputs

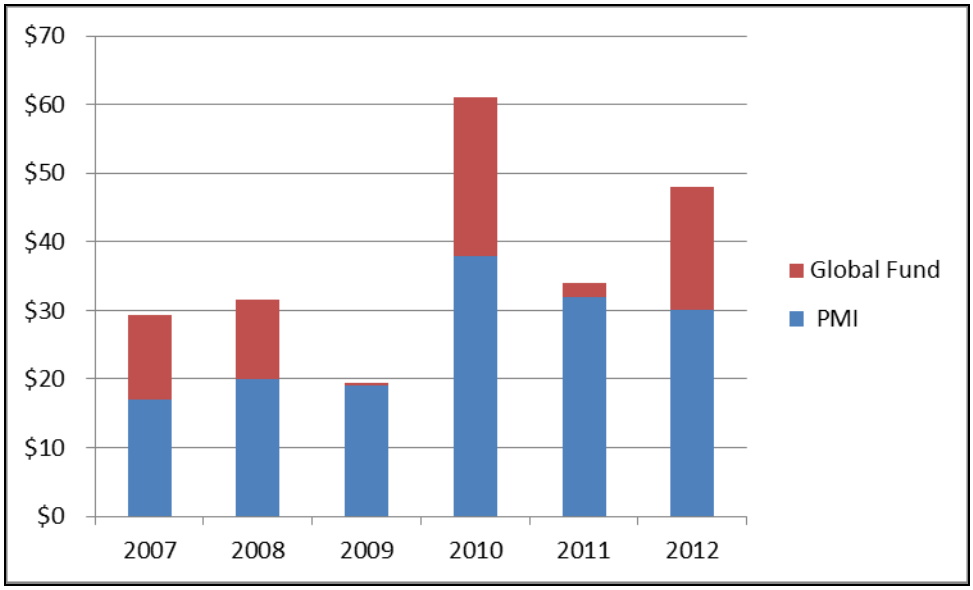
The main sources of funding for the Mozambique NMCP include the state budget, Sector-Wide Approach common fund partners and other donors such as the Global Fund, PMI, World Bank, UNICEF, the United Kingdom Department for International Development and the WHO. A funding mapping exercise conducted in 2008 demonstrated a sharp rise of funding for the NCMP in 2007 with the entrance of PMI in the country (Figure 6).

Figure 6: Malaria financing (US$ Millions) in Mozambique between 2004 and 2007,



In the recent past, the main sources of funding for NMCP activities have been the Global Fund and PMI (Figure 7). The first malaria Global Fund grant was the round 2 grant of $26.5 million whose implementation began in 2004. The second grant was the round 6 grant of $30.6 million whose implementation began in 2007 while the third grant was the round 9 grant of $53.4 million whose implementation began in 2011. All the Global Fund grants have been five year grants. There was a sharp increase of resources in 2007 mainly attributable to PMI's entrance into the country with a grant amounting to $18 million in the first year that steadily increased annually over a period of 4 years reaching $32.2 million in 2011.

Figure 7: Global Fund and PMI Malaria financing in Mozambique between 2007 and 2012



The country was the recipient of a $21 million Global Fund grant for the three-country Lubombo Spatial Development Initiative (LSDI), a cross-border project involving South Africa and Swaziland. The LSDI involved implementation of malaria control activities in the Maputo and Gaza Provinces from 2000 to 2010. The World Bank has also injected $17 million through the Health Sector Development Project and a further $2.7 million through its Health Sector Commodities Project. These two 5 year grants were approved in 2008 and implementation commenced in 2011. The MISAU's contribution through the state budget and common fund used to be about $10 million annually until 2010 when it began to reduce steadily, such that by 2012 it was only $3.9 million.

EXPANDED COVERAGE OF MALARIA CONTROL INTERVENTIONS

Insecticide-Treated Nets (ITNs)

This section describes ITN distribution in Mozambique beginning in 2000, assesses trends in ITN ownership and use, and describes equity of ITN use.

Background

ITNs are a highly effective tool for prevention of malaria both through direct insecticidal effects, and reducing contact between vector and humans, therefore lowering parasite loads at the community level [20,21,22]. Use of ITNs has been found to reduce child mortality [23], lower the risk of clinical malaria illness, reduce parasite prevalence and reduce the risk of high-density malaria parasitemia [24]. ITN use also reduces the risk of severe anemia and splenomegaly and may improve anthropometric outcomes in children [25]. ITN use by pregnant women has been shown to reduce placental malaria parasitemia, improve birth weight and reduce fetal loss and stillbirth [26,27]. The protective effects of ITNs are most pronounced in high transmission settings in children under two years of age and in pregnant women, both of whom have limited immunity to malaria [28,29].

ITN Implementation

Net distribution began in Mozambique during the floods that devastated large areas of the country (mainly Gaza, Sofala, Zambézia, Maputo Provinces) in 2000. The strategy then was to target children under five years of age and pregnant women with insecticide-treated nets (ITN) through mass campaign distributions. The initial distribution in the year 2000 was done in Gaza, the province worst affected by the floods. Between 2000 and 2005, ITN distribution was implemented during child vaccinations campaigns that took place in various provinces at a small scale, however the areas where this was done is not well documented other than in Manica and Sofala Provinces.

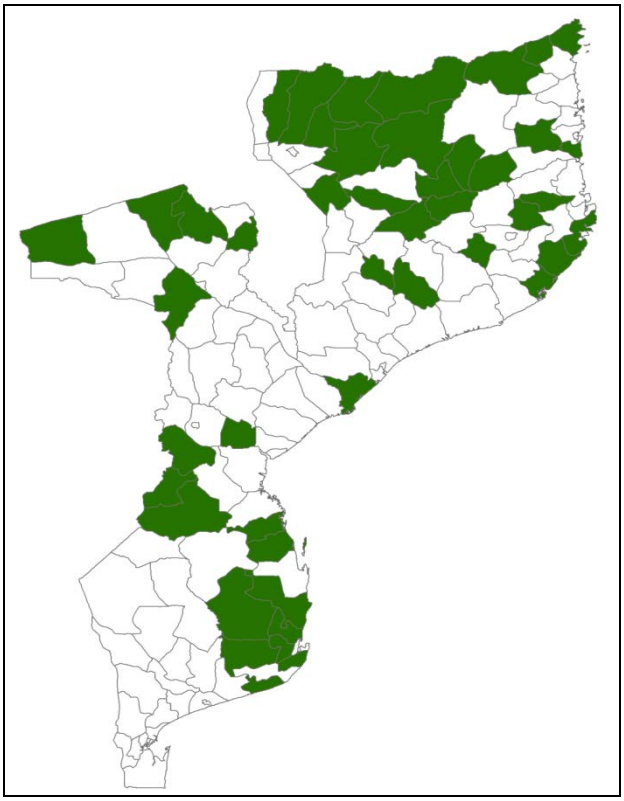
Since 2006, the NMCP with the support of partners, procures and distributes LLINs only. Between 2005 and 2006, the provinces of Gaza, Inhambane, Tete, Cabo Delgado and Niassa began distributing LLINs in antenatal care (ANC) clinics. By 2007, this expanded to the whole country.

Between 2006 and 2009, nets were distributed routinely through ANC and some small scale mass campaigns continued to be implemented ad hoc in certain areas for specific target populations. For example, 367,000 LLINs were distributed to persons living with HIV/AIDS, orphans, and vulnerable children from 2006 to 2008 and a further 183,778 in 2009 (not documented in which provinces). A province-wide distribution of 800,000 LLINs was done in Nampula Province in 2008 during the national measles–Vitamin A–deworming campaign. In 2009, provincial health directorates conducted district-level campaigns targeted at children under five years of age in Zambézia, Niassa, Cabo Delgado, and Inhambane Provinces.

In 2009, the country adapted the strategy for mass campaigns in order to achieve universal coverage and incorporated a plan and request for funding in the Round 9 Global Fund proposal. The country came up with a systematic mass campaign distribution method with

the aim of achieving universal coverage in targeted areas. An initial LLIN universal coverage pilot campaign using this method was implemented in four districts in Sofala Province in late 2009 and early 2010 with a total of 140,000 LLINs being distributed to approximately 60,000 households. The implementation of mass campaigns at a larger scale for universal coverage of the whole population began in 2011 with 2.3 million LLINs being distributed in 45 districts and 1.6 million LLINs in 15 districts in 2012. The map below shows the 60 districts that benefitted from these mass campaigns (Figure 8).

Figure 8: Districts that benefited from LLIN mass campaigns for universal coverage between 2011 and 2012



Source: NMCP records

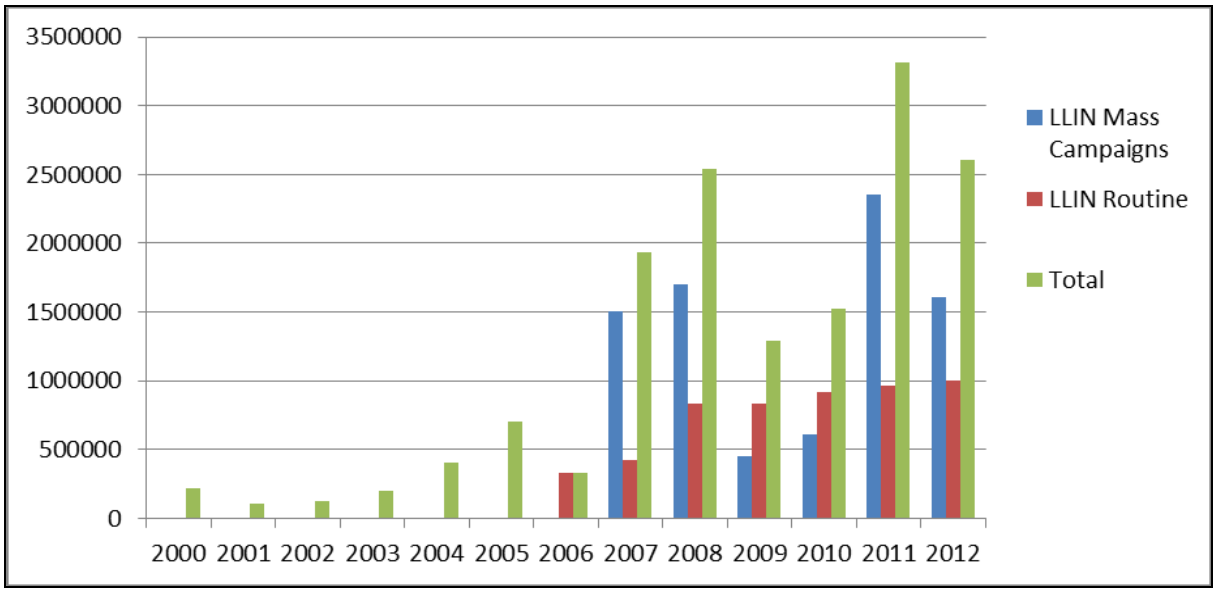
In addition to these documented nets, some organizations have distributed mosquito nets on a small scale in different provinces, but data on them is not kept by the NMCP. Table 7 and Figure 9 show the total number of LLINs that have been distributed from 2000 to 2012 in the country according to NMCP data.

Table 7: Number of ITNs distributed in Mozambique between 2000 and 2012

Year	# of Nets Distributed
2000	219,344
2001	104,277
2002	130,326
2003	201,492
2004	401,802
2005	706,364
2006	332,767
2007	1,931,601
2008	2,540,228
2009	1,292,159
2010	1,525,979
2011	3,311,246
2012	2,601,953

Source: NMCP records

Figure 9: ITNs distributed in Mozambique between 2000 and 2012



Source: NMCP records

ITN Coverage Trends

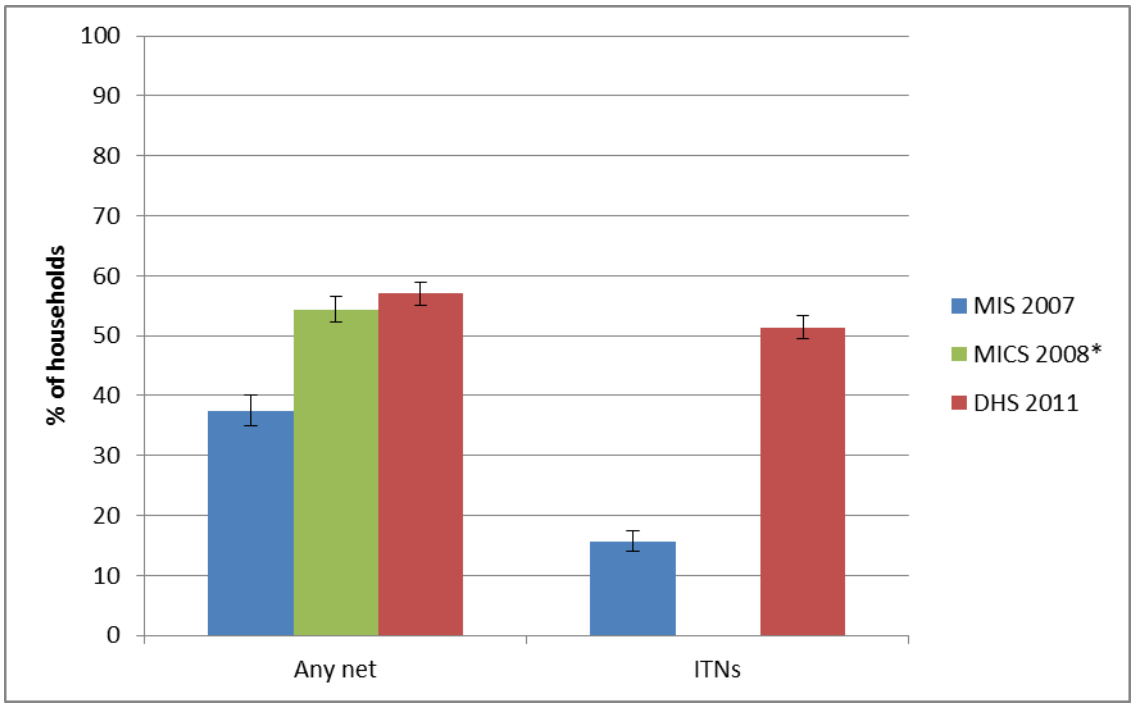
ITN coverage trends are described below using two main indicators: household ownership and use by target groups. The combined ITN and/or IRS coverage indicator is also presented under the ITN ownership section. Unless otherwise stated, all data cited come from the 2007 MIS, 2008 MICS and 2011 DHS surveys. Data from the 2003 DHS is not

included, since the report did not measure household ITN ownership or ITN use amongst any of the target groups.

ITN Ownership

Figure 10 shows the percentage of households that owned at least one net (treated or untreated) and ITN in 2007, 2008 and 2011. The percentage of households that owned at least one net increased significantly from 38% (95% CI: 35–40%) in 2007 to 54% (95% CI: 52–57%) in 2008. There was a slight increase from 2008 to 2011, to 57% (95% CI: 55-59%). Ownership of ITNs rose significantly[3] from 16% (95% CI: 14–18%) in 2007 to 51% (95% CI: 50–53%) in 2011.

Figure 10: Household ownership of any nets and ITNs, 2007-2011

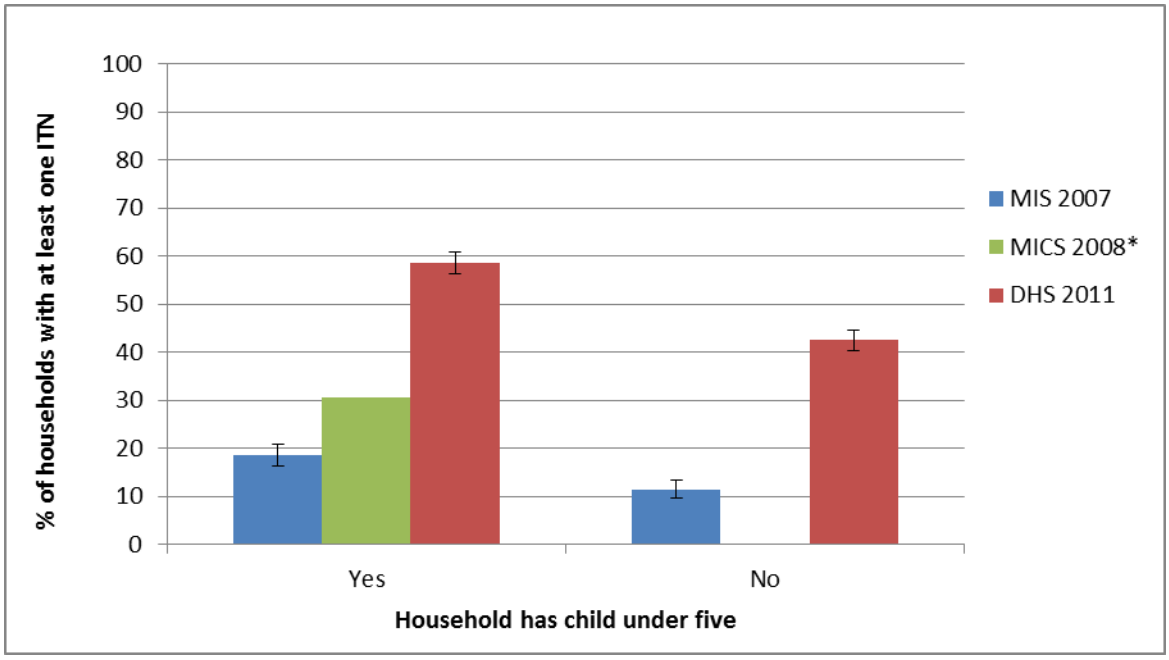


*For the 2008 MICS survey, household ITN ownership is only available for households with children under five years of age. Therefore the results are not included.

Figure 11 shows ITN ownership in households with and without children under five years of age in 2007 and 2011. In households with children under five years of age, ITN ownership increased significantly from 19% (95% CI: 16-21%) in 2007 to 59% (95% CI: 56-61%) in 2011. Similarly, in households with no children under five years of age, ITN ownership increased significantly from 11% (95% CI: 10-13%) in 2007 to 43% (95% CI: 40-45%) in 2011.

[3] In this report, results are referred to as "significant", "statistically significant" or that "increased significantly" if the 95% confidence intervals of the particular estimates for each survey year do not overlap.

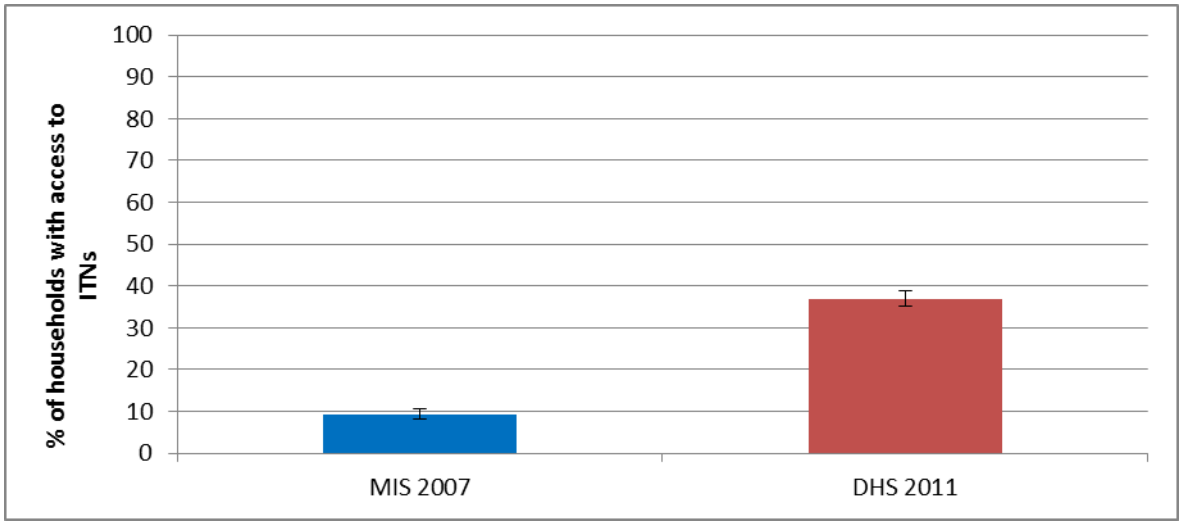
Figure 11: ITN ownership in households with/without children under five years of age, 2007-2011



*Note: For the 2008 MICS, data on household ownership of ITNs is not available for households that do not have children under five years of age. Furthermore, the results reported in the 2008 MICS Report for ITN use among children under five of age were unable to be replicated.

Figure 12 shows the percentage of the de facto population (persons who spent the night before the interview in the household) with "access" to an ITN in 2007 and 2011. Access to an ITN, defined as the proportion of the de facto population who could sleep under an ITN, assuming each ITN in the household is used by two people, increased significantly from 9% (95% CI: 8–11%) in 2007 to 37% (95% CI: 35–39%) in 2011.

Figure 12: Percentage of de facto population with "access" to an ITN*, 2007-2011

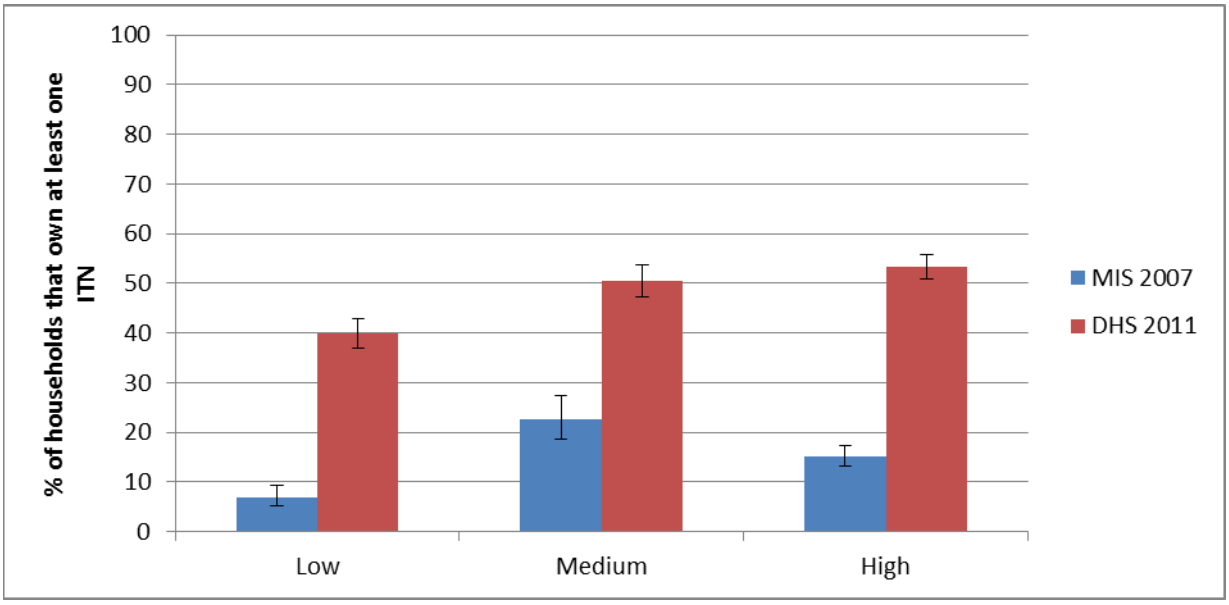


*Access is defined as the proportion of the de facto household population who could sleep under an ITN if each ITN in the household is used by two people.

ITN Ownership by Malaria Risk Zones in Mozambique

Household ownership of ITNs by malaria risk zones are shown in Figure 13. ITN ownership significantly increased across all three risk zones from 2007 to 2011. The largest increases were observed in the low and high risk zones, where ownership increased from 7% (95% CI: 5–9%) to 40% (95% CI: 37–43%) in the low risk zones and from 15% (95% CI: 13–17%) to 53% (95% CI: 51–56%) in the high risk zones. By 2011, ITN ownership was highest in the high malaria risk zone.

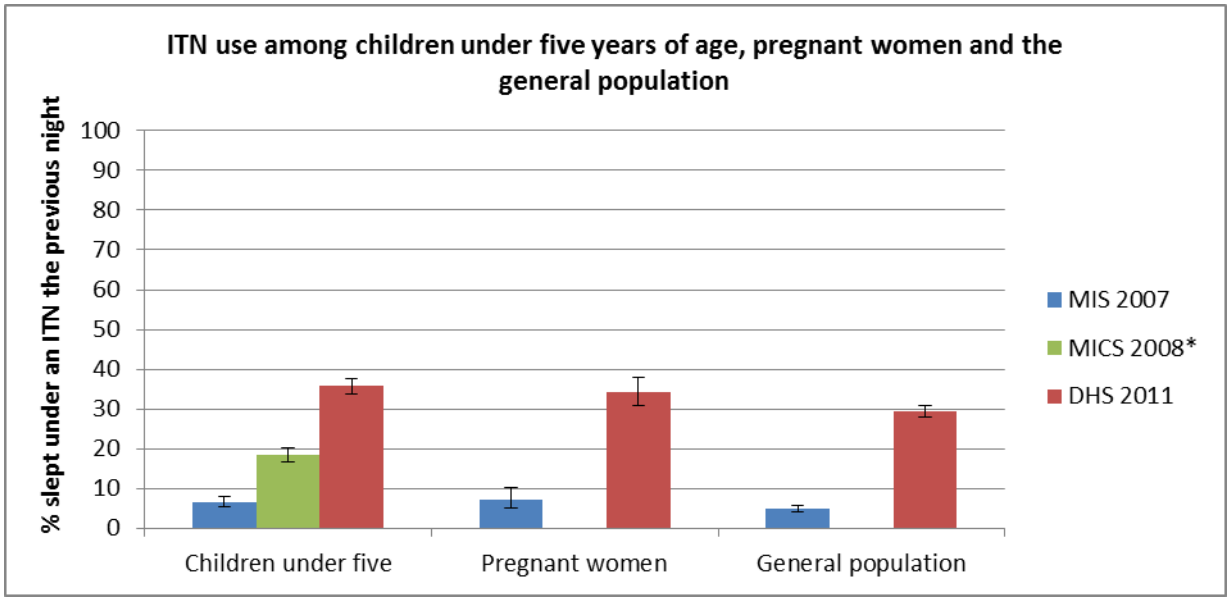
Figure 13: Household ownership of ITNs, by malaria risk zones, 2007-2011



ITN Use

Figure 14 shows ITN use among children under five years of age, pregnant women and the general population during the time period 2007 to 2011. ITN use was measured among all the households surveyed (not only households with an ITN) and among those who slept in the household the night before the interview. Among children under five years of age, use of ITNs the night before the survey rose significantly from 7% (95% CI: 6–8%) in 2007 to 19% (95% CI: 17-20%) in 2008, and then to 36% (95% CI: 34–38%) by 2011. Similarly, for pregnant women, ITN use increased significantly from 7% (95% CI: 5–10%) to 34% (95% CI: 31–38%) from 2007 to 2011. For the population as a whole, ITN use also had a significant increase from 5% (95% CI: 4–6%) to 30% (95% CI: 28–31%) over the same period.

Figure 14: ITN use among children under five years of age, pregnant women and the general population, 2007-2011



*The MICS 2008 survey does not provide estimates of ITN use for pregnant women or for the general population. Furthermore, the results reported in the 2008 MICS Report for ITN use among children under five of age were unable to be replicated.

Equity in ITN Use

Table 8 presents data on equity of ITN use for children under five years of age stratified by sex, place of residence, wealth, and mother's education for 2007, 2008 and 2011. There were no differences observed in ITN use among children by sex. Across the three survey years, the percentage of children who slept under an ITN the previous night was higher in urban areas than in rural areas. The difference in ITN use by place of residence was only found to vary significantly in 2011, where 42% of children slept under an ITN in urban areas compared to only 33% in rural areas the previous night. For wealth, the percentage of children that used an ITN the previous night from the poorest households did not vary significantly from those from the least poor households in 2007 or 2011, but did vary significantly by wealth in the 2008 survey (15% ITN use among the poorest compared to 23% among the least poor). In 2007 and 2011, there was a significant difference in ITN use among children whose mother had no education compared to the children whose mother had a secondary or higher level of education. For example, in 2011, ITN use among children whose mother had a secondary level of education or higher was 50% compared to 30% of children whose mother had no education.

Table 8: ITN use by children under five years of age by socio-demographic factors, 2007-2011

Background Characteristics	2007 MIS				2008 MICS*				2011 DHS				Relative Change (%)
	%	95% CI		WN	%	95% CI		WN	%	95% CI		WN	
Sex													
Male	6.1	4.9	7.6	2,547	18.5	16.5	20.7	5658	35.9	33.6	38.2	5,448	488.5
Female	7.3	5.7	9.1	2,520	18.6	16.7	83.3	5759	35.4	33.4	37.6	5,437	384.9
Residence													
Urban	8.1	6.7	9.8	2421	21.9	19.3	24.8	3243	42.2	39.4	45.1	3,043	421.0
Rural	6.3	4.9	8.1	2646	17.2	15.1	19.5	8176	33.1	30.8	35.6	7,842	425.4
Wealth													
Quintile 1 (Poorest)	6.7	4.7	9.5	1,090	15.3	12.8	18.3	2574	32.4	28.6	36.5	2,505	383.6
Quintile 2	7.8	5.2	11.5	1,037	16.8	14	20.1	2523	35.7	32.1	39.4	2,326	357.7
Quintile 3	6.3	4.5	8.7	1,103	20.8	17.4	24.6	2555	35.9	32.7	39.2	2,192	469.8
Quintile 4	6.2	4.1	9.2	945	18.2	15.5	21.3	2267	36.1	32.8	39.6	2,199	482.3
Quintile 5 (Least Poor)	5.8	4	8.3	892	23.1	19.5	27	1799	39.6	36.1	43.2	1,663	582.8
Mother's Education													
None	6.2	4.9	7.8	2,589	17.6	15.1	20.4	3730	29.5	26.8	32.4	3834	375.8
Primary	8	5.8	11	1,550	17.4	15.5	19.4	6861	39.1	36.8	41.5	5210	388.8
Secondary and higher	7.9	5.5	11.2	512	32.4	27.8	37.4	825	49.5	45.3	53.7	1045	526.6
Missing	4.7	2.4	9	416	*	*	*	3	24.6	20.7	28.9	796	423.4
Total	6.7	5.5	8.1	5,067	18.5	16.8	20.3	11,419	35.7	33.8	37.6	10885	432.8

Notes: * The results reported in the 2008 MICS Report for ITN use among children under five years of age were unable to be replicated; WN= weighted number of cases

Table 9 presents data on equity of ITN use for pregnant women stratified by place of residence, wealth, and mother's education. In 2007, there was no difference in ITN use among pregnant women by place of residence. In contrast, in 2011, a significantly higher percentage of pregnant women (47%) from urban areas used an ITN the previous night compared to those from rural areas (30%). In both 2007 and 2011, there were more pregnant women from the least poor households using ITNs the previous night than among those from the poorest households. However, the difference in ITN use by wealth was not found to be significant in either survey year. In 2007, there was no difference in ITN use among pregnant women by their level of education. However in 2011, the percentage of pregnant women that used an ITN the previous night who had a secondary level of education or higher (41%) was significantly higher than those who had no education (26%).

Table 9: ITN use by pregnant women by socio-demographic factors, 2007-2011

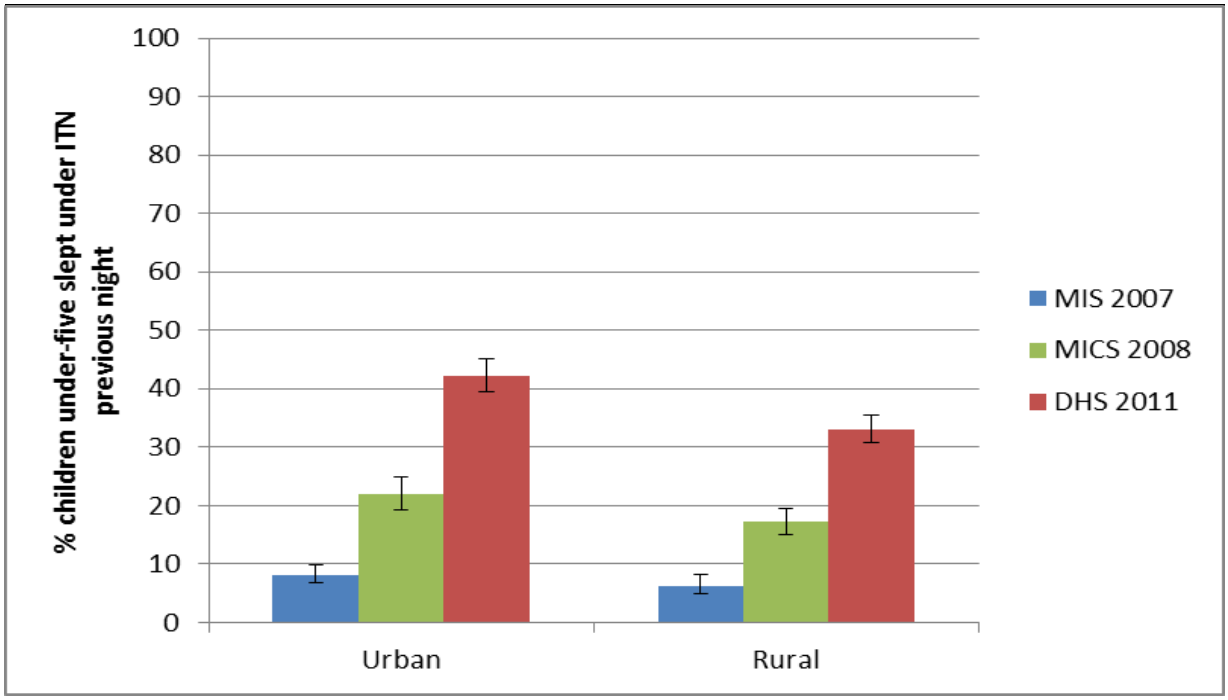
Background Characteristics	2007 MIS				2011 DHS				Relative Change (%)
	%	95% CI		WN	%	95% CI		WN	
Residence									
Urban	7.9	5.1	11.9	301	46.5	40.8	52.3	375	488.6
Rural	7.2	4.6	10.9	288	30.1	25.9	34.6	1,075	318.1
Wealth									
Quintile 1 (Poorest)	4.1	1.9	8.7	129	30.7	23.8	38.5	371	648.8
Quintile 2	7.7	3.7	15.2	130	30.8	24.1	38.5	343	300.0
Quintile 3	10.6	5.8	18.7	145	35.0	28.9	41.7	264	230.2
Quintile 4	6.9	2.9	15.5	92	38.2	31.6	45.2	277	453.6
Quintile 5 (Least Poor)	6.4	2.7	14.4	93	41.1	33.8	48.8	195	542.2
Mother's Education									
None	8.5	5.4	13.0	330	26.0	n/a	n/a	517	205.9
Primary	4.5	1.9	10.3	175	37.4	n/a	n/a	764	731.1
Secondary and higher	8.3	3.3	19.3	67	41	n/a	n/a	170	394.0
Missing	*	*	*	17	*	*	*	0	n/a
Total	7.3	5.2	10.3	589	34.3	30.8	38.0	1,450	369.9

Notes; * Indicates fewer than 25 unweighted cases and therefore has been suppressed; WN = weighted number of cases.

Figure 15 shows ITN use among children under five years of age by area of residence for 2007, 2008 and 2011. In both urban and rural households, ITN use among children under five years of age increased over the survey years. From 2007 to 2011, ITN use in urban households rose significantly from 8% (95% CI: 7–10%) in 2007, to 22% (95% CI: 19-25%) in 2008 to 42% (95% CI: 39–45%) in 2011. In rural households, ITN use in children under five years of age rose from 6% (95% CI: 5–8%) in 2007, to 17% (95% CI: 15-20%) in 2008, to 33% (95% CI: 31-36%) in 2011. Overall, the change was greater in urban areas

and was consistently higher in urban areas compared to rural areas across all three surveys.

Figure 15: ITN use among children under five years of age, by area of residence, 2007-2011

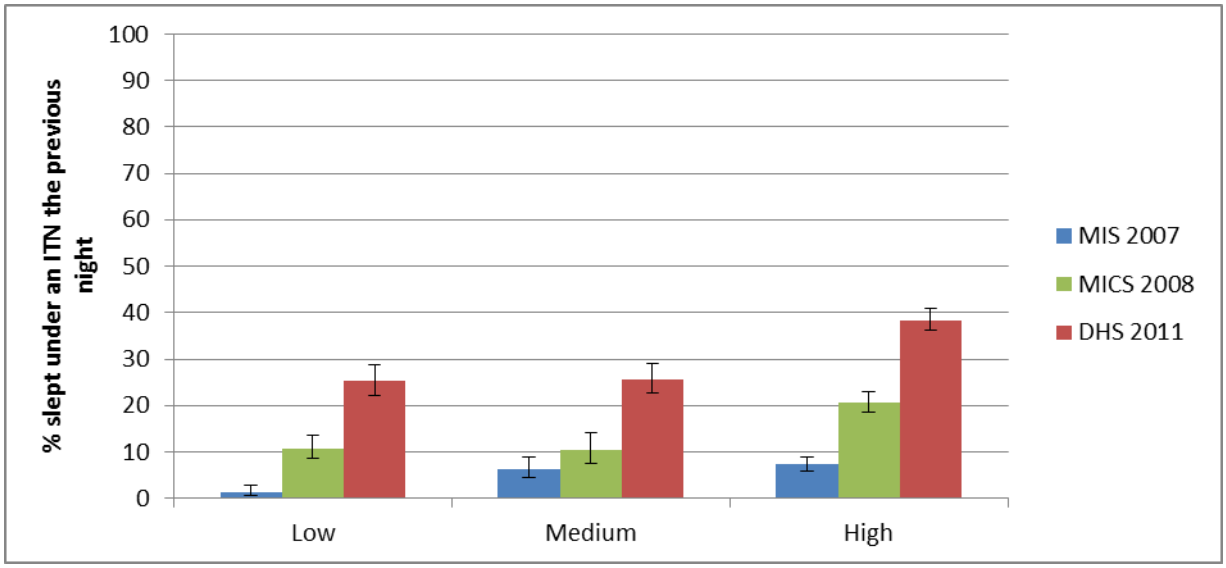


*The results reported in the 2008 MICS Report for ITN use among children under five years of age were unable to be replicated.

ITN Use by Malaria Risk Zones in Mozambique

Similar to household ITN ownership, ITN use in children under five years of age increased significantly across all malaria risk zones during the period from 2007 to 2011 (Figure 16). The largest increases were observed in the low and high risk zones. In the low risk zone, ITN use rose significantly from 1% (95% CI: 0.7–3%) in 2007 to 25% (95% CI: 22–29%) in 2011, and similarly in the high risk zone, it rose from 7% (95% CI: 6–9%) to 38% (95% CI: 36–41%) during the same time period. Across all survey years, ITN use was highest in the high risk zones, with an over 13% gap by 2011 between the high and low risk zones.

Figure 16: ITN use among children under five years of age, by malaria risk zones, 2007-2011



Summary of ITNs

Between 2007 and 2011, Mozambique experienced a significant increase in household ITN ownership, from 16% in 2007 to 51% in 2011. This increase was greater in households with children under five years of age, where ITN ownership rose significantly from 19% in 2007 to just under 60% in 2011. Across all malaria risk zones, household ITN ownership rose significantly, however by 2011, ownership was greater in medium and higher risk zones (50% and 53%, respectively), compared to the low risk zones (40%). Overall access to ITNs within the household (defined at 1 ITN per every two people) also rose during this same period, from about 9% to 37%, but was well below the percent of households that owned at least one ITN.

The rise in household ITN ownership from 2007 to 2011, was accompanied by an increase in ITN use among children under five years of age (7% to 36%), pregnant women (7% to 34%) and the general population (5% to 30%). Overall greater inequities were observed in ITN use among children under five years of age in 2011, compared to 2007. For example, there was a greater gap observed in ITN use among children under five years of age in 2011 by wealth quintile, place of residence and mother's education in 2011 compared to 2007. Overall, ITN use among children under five years of age rose the greatest in the higher malaria risk zones (38% in 2011), compared to the low and medium risk zones (25% and 26%, respectively in 2011). While ITN use overall did rise significantly from 2007 to 2011, nationally, use remained below the target and reflects the overall population access to ITNs.

Indoor Residual Spraying (IRS)

This section describes the history of and recent IRS implementation in Mozambique and assesses trends in IRS coverage from 2003 to 2011.

Background

In 2006, WHO reaffirmed their recommendation for indoor residual spraying with insecticides for malaria control in sub-Saharan Africa. A total of four insecticide classes are currently available for IRS [30]. A recent meta-analysis of thirteen IRS studies in sub-Saharan Africa suggests that use of IRS effectively reduces the prevalence of malaria parasitemia in a community by 62% [31]. Despite its apparent effectiveness, few if any countries in sub-Saharan Africa use IRS at a national scale, as costs are often an impediment [32]; nonetheless, in 2009, IRS conferred vector control protection to 10% of the population of Africa [33].

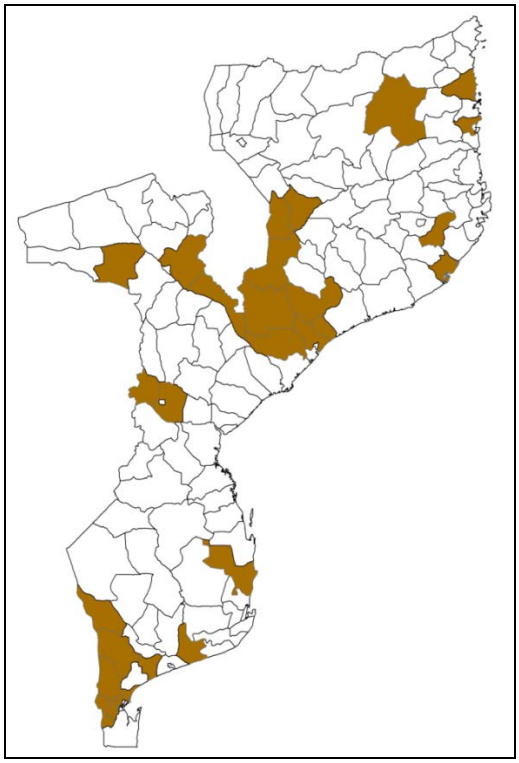
Mozambique is bordered by South Africa and Swaziland which implement large-scale IRS programs using dichlorodiphenyltrichloroethane (DDT) in areas bordering Mozambique with the aim of eliminating malaria. For these reasons IRS remains an important vector control intervention in Mozambique.

IRS Implementation

The Mozambique government began the implementation of IRS in 1946, initially covering only peri-urban areas in provincial capital cities until it was stopped in 1970. IRS resumed in 1994, targeting suburbs again in peri-urban areas of provincial capital cities and also areas where there were private sector companies such as the sugar factories in Mafambisse and Marromeu in Sofala Province and Chinavane in Maputo Province. However, it was not until 2000 when the multi-country cross border LSDI project began that IRS was implemented at a larger scale, including in rural areas. The LSDI project was initially implemented in Maputo province only and then expanded to include Gaza province from 2006. In 2005, the NMCP began to implement IRS in a similar way to the LSDI project in the districts of Quelimane, Nicoadala and Namacurra in Zambézia Province and later expanded to the districts of Mocuba and Morrumbala in the same province, using lambdacyhalothrin and DDT. Population coverage of IRS in these districts reached 88% in Quelimane, 100% in Nicoadala, 75% in Namacurra, 92% in Mocuba and 96% in Morrumbala.

IRS implementation steadily increased between 2001 and 2010. The highest IRS coverage in terms of districts reached was achieved in 2010 when 57 of 128 districts benefited from IRS. In 2011, the number of districts that benefitted from IRS dropped slightly to 55. The government began to face challenges in mobilizing funds for IRS in 2011 however, resulting in a sharp drop in the number of districts performing IRS in 2012 (only 6 districts in Zambézia province implemented IRS). The map in Figure 17 shows the districts that were reached with IRS in 2010 and 2011.

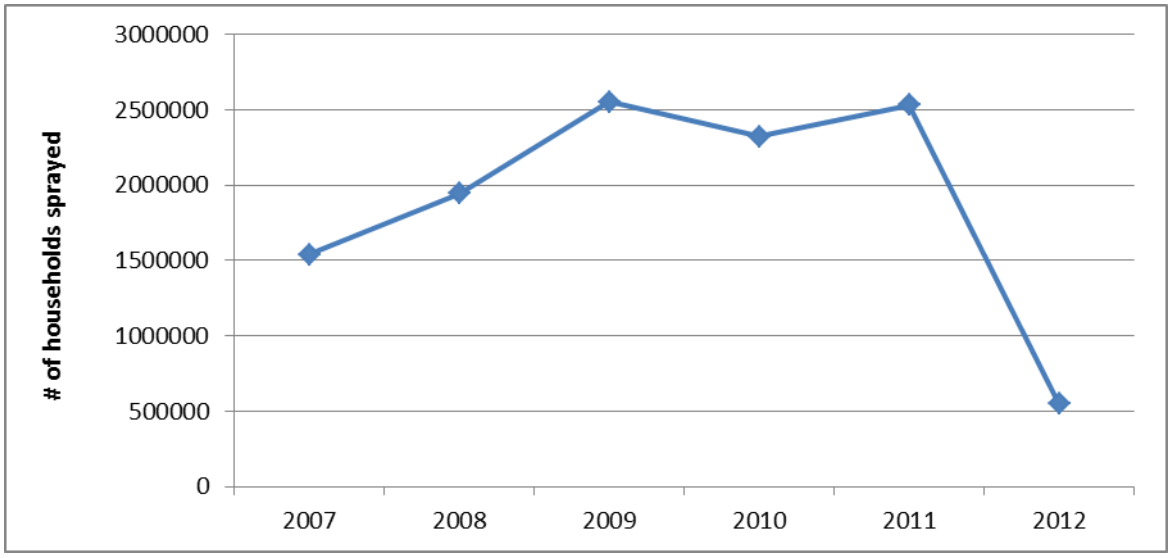
Figure 17: Map of districts reached by IRS in 2010 and 2011



Source: NMCP records

From the NMCP data, the annual number of households sprayed also showed a sharp decline in 2012 (Figure 18).

Figure 18: Number of households sprayed annually between 2007 and 2012



Source: NMCP Records

IRS Coverage

National IRS coverage, defined as the percentage of households that were sprayed with insecticides in the 12 months before the survey was measured in the 2007 MIS, 2009 AIS and 2011 DHS surveys. Figure 19 shows that IRS coverage overall remained stable from 2007 to 2009, from 23% (95% CI: 20-26%) to 25% (95% CI: 21-30%), then slightly declined to 19% (95% CI: 16-21%) in 2011.

Figure 19: Percentage of households with indoor residual spraying (IRS) in the last 12 months, 2007-2011

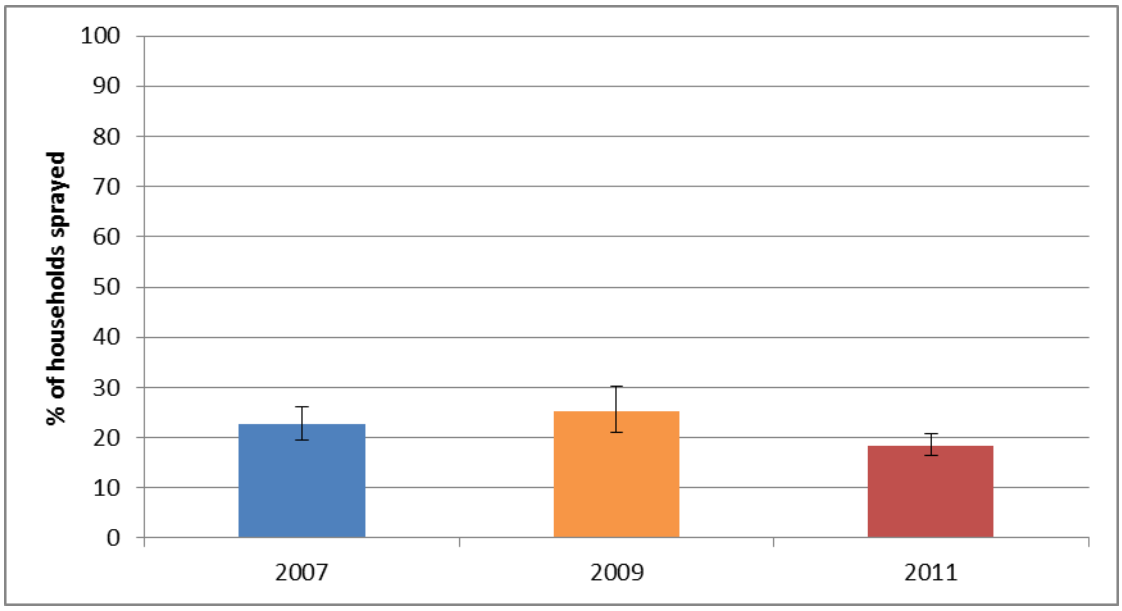
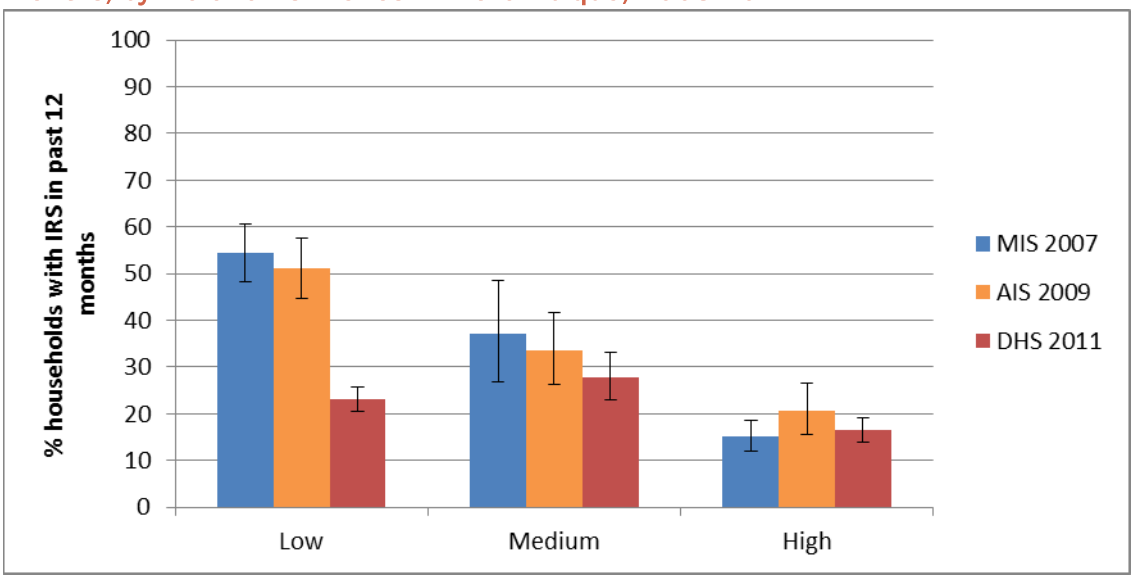


Figure 20 shows IRS coverage by the three malaria risk zones. IRS coverage declined significantly in the low risk zones, from 55% (95% CI: 48-61%) in 2007 to 23% (95% CI: 21–26%) in 2011. In the medium risk zones, IRS coverage declined from 37% (95% CI: 27-49%) in 2007 to 28% (95% CI: 23-33%). In the high risk zones, IRS coverage slightly increased from 2007 to 2009 (15% vs. 21%), and then slightly declined again in 2011 to 16% (95% CI: 14-19%).

Figure 20: Percentage of households with indoor residual spraying (IRS) in the last 12 months, by malaria risk zones in Mozambique, 2003-2011



ITN Ownership and IRS

Figure 21 shows the percentage of households with at least one ITN and/or IRS in the last 12 months in 2007 and 2011. Coverage of households with at least one ITN and/or IRS in the last months experienced a significant increase from 35% (95% CI: 31-38%) in 2007 to 60% (95% CI: 58-62%) in 2011. Figure 22 demonstrates that the main reason for this significant increase in coverage is due to ITN ownership increasing significantly from 2007 to 2011.

Figure 21: Percentage of households with at least one ITN and/or IRS in the last 12 months, 2007-2011

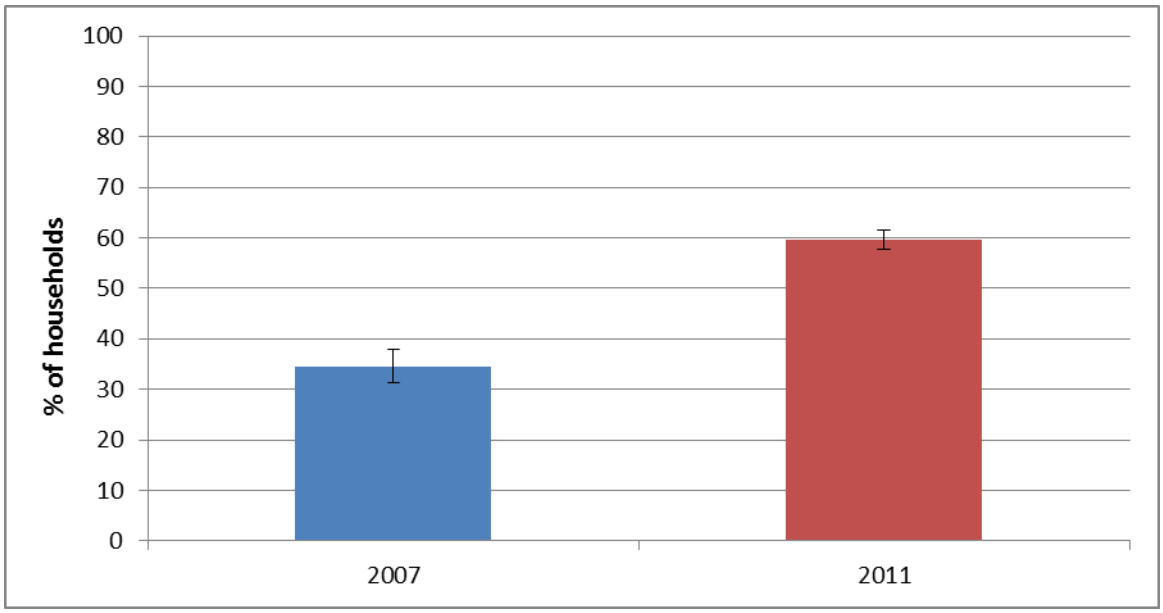
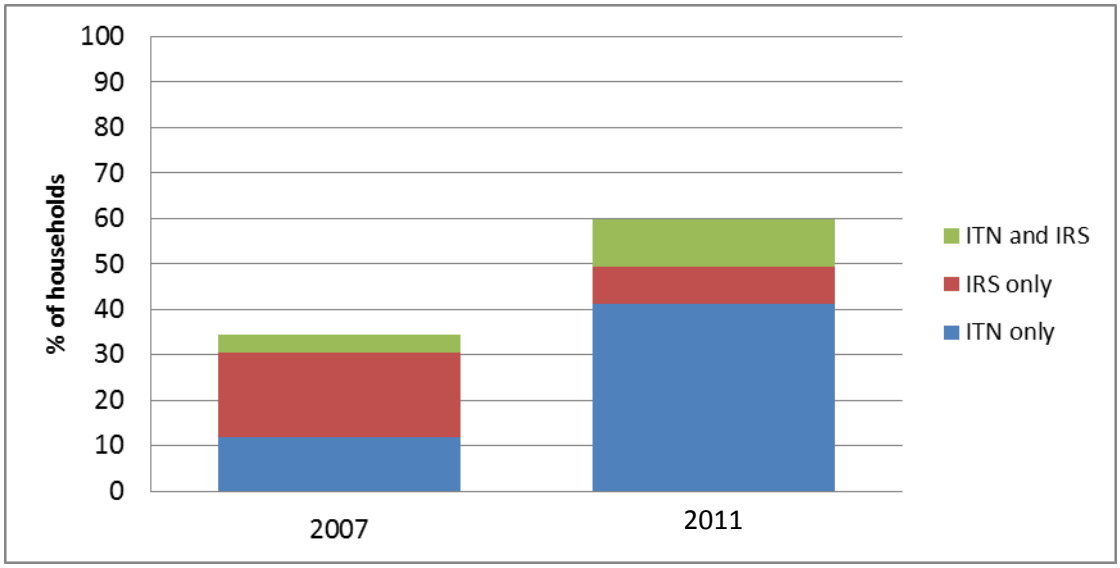


Figure 22: Percentage of households with at least one ITN (only), with IRS only, and those with at least one ITN and IRS the last 12 months, 2007-2011



Summary of IRS

Nationally, IRS coverage remained stable between 2007 and 2009 (23% and 25%, respectively), before slightly declining to 19% in 2011 (though not statistically significant). The trend in IRS coverage differed across the three malaria risk zones. In the low the risk zones, a significant decline was observed between 2007 and 2011, from 55% to 23%. In the medium risk zones, the coverage declined over the same time period, from 37% to 28%, however the decline was not statistically significant. In the high risk zones, coverage overall remained stable, slightly increasing between 2007 and 2009, and then slightly declining in 2011. Interestingly, overall IRS coverage was higher in the low and medium risk zones across all years, compared to the high risk zones. Coverage of households with at least one ITN and/or IRS in the last 12 months experienced a significant increase from 35% in 2007 to 60% in 2011, which was mainly due to significant increases in household ITN ownership.

Intermittent Preventive Treatment in Pregnancy

Background

Malaria prevention and control during pregnancy has a three-pronged approach, including IPTp, ITN use and diagnosis and treatment of clinical illness. ITN use by pregnant women was previously discussed (ITN section, page 38). Data on case management of clinical illness in pregnant women are not collected in national household-based surveys and therefore are not included in this evaluation.

Malaria in pregnancy significantly raises the risk of severe illness in the pregnant woman and baby, including severe anemia, miscarriage, intra-uterine growth retardation, pre-term birth and low birth weight [34,35]. In high transmission settings, malaria is expected to be a significant indirect contributor to maternal death [36]. Malaria in pregnancy is thought to affect neonatal mortality risk via low birth weight and anemia in the newborn [37]. Use of ITNs and IPTp during pregnancy has been found to be associated with an 18% decreased risk of neonatal mortality and a 21% protective efficacy against low birth weight [38].

IPTp Implementation

IPTp has been implemented in Mozambique since 2006, as part of routine antenatal care (ANC) within the package of services recommended for pregnant women. The IPTp policy document was developed in 2004 as part of the antenatal care (ANC) basic package of services. The policy was approved in January 2005 and officially launched in May 2006. The IPTp strategy is based on administration of SP in therapeutic doses after 20 weeks of pregnancy. Due to the high prevalence of HIV in Mozambique, the recommendation was to have three doses during pregnancy, given four weeks apart during ANC visits. Each dose should be administered using directly observed treatment. In June 2006, the program rolled out training to clinicians and nurses in all provinces and districts.

Since then, IPTp has been administered to pregnant women in ANC as part of a package of services. Table 10 below shows the number of IPTp treatments that have been administered since 2008 through 2012. The table indicates a decline in coverage between 2009 and 2011. However, this decline needs to be interpreted with caution, as during the period there was a change in the definition and calculation of the indicator. The denominator used to calculate the indicator changed from the number of women expected at ANC in 2008, to the number of first ANC visits in 2011. Furthermore, the data used to calculate the coverage in 2008 were unreliable, as the official HMIS registers were only introduced in 2011. The observed decline can also be attributed to a complete stock-out of SP in the country for six months between 2010 and 2012. Although IPTp uptake through ANC has increased since 2008, it is still far below the recommended WHO target of 80%.

Table 10: IPTp Implementation in Mozambique: Number of Pregnant Women Attending ANC and that Received 1, 2 or 3 doses of SP, 2008-2012

Year	Number of pregnant women that attended at least one ANC consultation*	Number of pregnant woman that received at least one dose of SP	Number of pregnant women that received at least two doses of SP (IPTp)	Number of pregnant women that received three doses of SP (IPTp
2008	259,313	187,113	127,406	99,881
2009	975,028	646,449	497,868	329,504
2010	1,344,545	433,909	322,224	192,515
2011	1,287,927	455,216	253,942	129,131
2012	1,324,604	768,243	473,912	244,361

*Note: For 2008 to 2010 data, this number reflects the number of women expected at ANC, while the data from 2011 to 2012 reflects the number of pregnant women that attended at least one ANC consultation.
Source: NMCP records

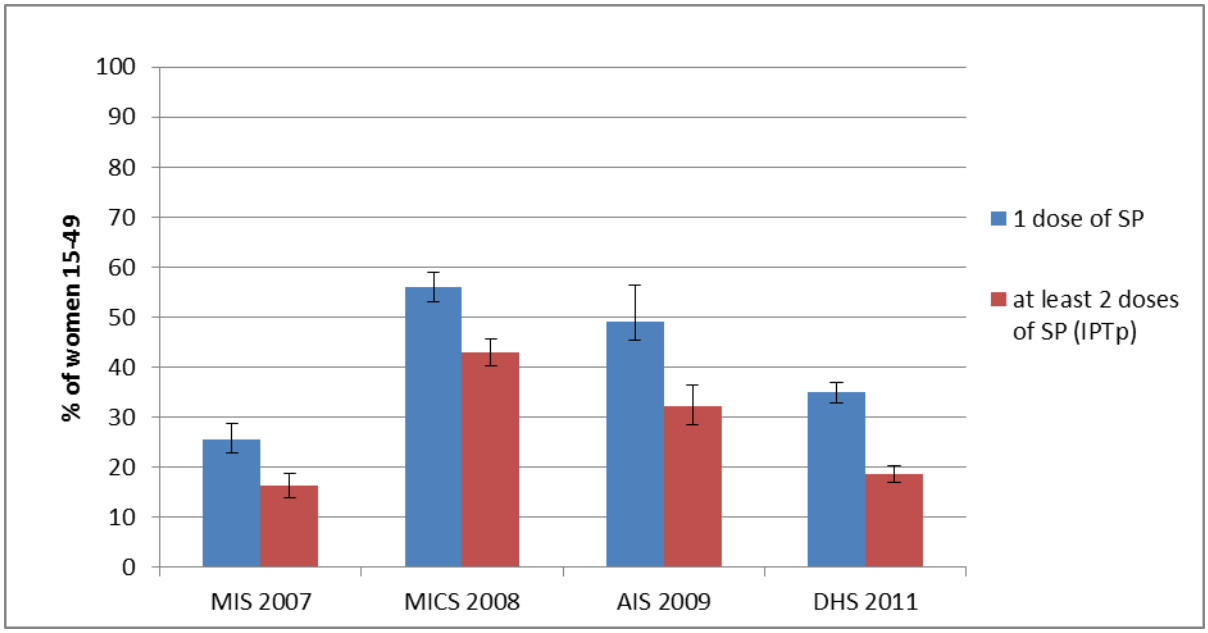
Trends in IPTp coverage

The IPTp coverage indicator refers to women who received at least two doses of SP for malaria prevention, of which, at least one dose was received at an antenatal clinic[4]. The indicator is restricted to the most recent pregnancy that resulted in a live birth, 0-2 years prior to the survey.

Figure 23 shows the proportion of women (15-49 years) with a live birth 0-2 years prior to the survey who received at least one dose of SP and at least two doses of SP (IPTp) in 2007, 2008, 2009 and 2011. IPTp coverage increased significantly from 16% (95% CI: 14-19%) in 2007 to 43% (95% CI: 40-46%) in 2008, and then declined in 2009 to 32% (95% CI: 28-36%) and again in 2011 to 19% (95% CI: 17-20%). A similar trend was observed for women who received one dose of SP, with a significant increase observed from 26% (95% CI: 23-29%) in 2007 to 56% (95% CI: 53-59%) in 2008 and then a significant decline to 35% (95% CI: 33-37%) in 2011. For one dose of SP however, coverage remained about the same from 2008 to 2009 (56% in 2008 and 58% in 2009).

[4] IPTp coverage in the four surveys (2007 MIS, 2008 MICS, 2009 AIS and 2011 DHS) was measured as receipt of at least two doses of SP for malaria prevention as defined by the WHO-recommended policy at the time. The current national policy however for IPTp however, is that women receive three doses of SP during pregnancy.

Figure 23: Proportion of women (15-49 years) with a live birth 0-2 years prior to survey who received at least one dose of SP and IPTp, 2007-2011



Equity in IPTp

Disparities in IPTp coverage by residence, wealth, and mother's education are presented in Table 11 for the 2007 MIS, 2008 MICS, 2009 AIS and the 2011 DHS. Across all surveys, IPTp coverage was significantly higher in urban areas compared to rural areas. For example in 2011, IPTp coverage was 26% in urban areas and only 16% in rural areas. Disparities in IPTp coverage by wealth index and women's education level are also apparent in all four survey years. IPTp coverage in the poorest households was 10% and 17% in 2007 and 2011, respectively, while it reached 28% and 25% in the same years respectively, for the least poor households. A similar trend was observed in IPTp coverage for women's level of education across the four surveys. Women with a secondary level of education or higher had significantly higher coverage rates for IPTp than women with no education in all survey years.

Table 11: Proportion of women (15-49 years) with live birth 0-2 years prior to survey who received IPTp by socio-demographic factors, 2007-2011

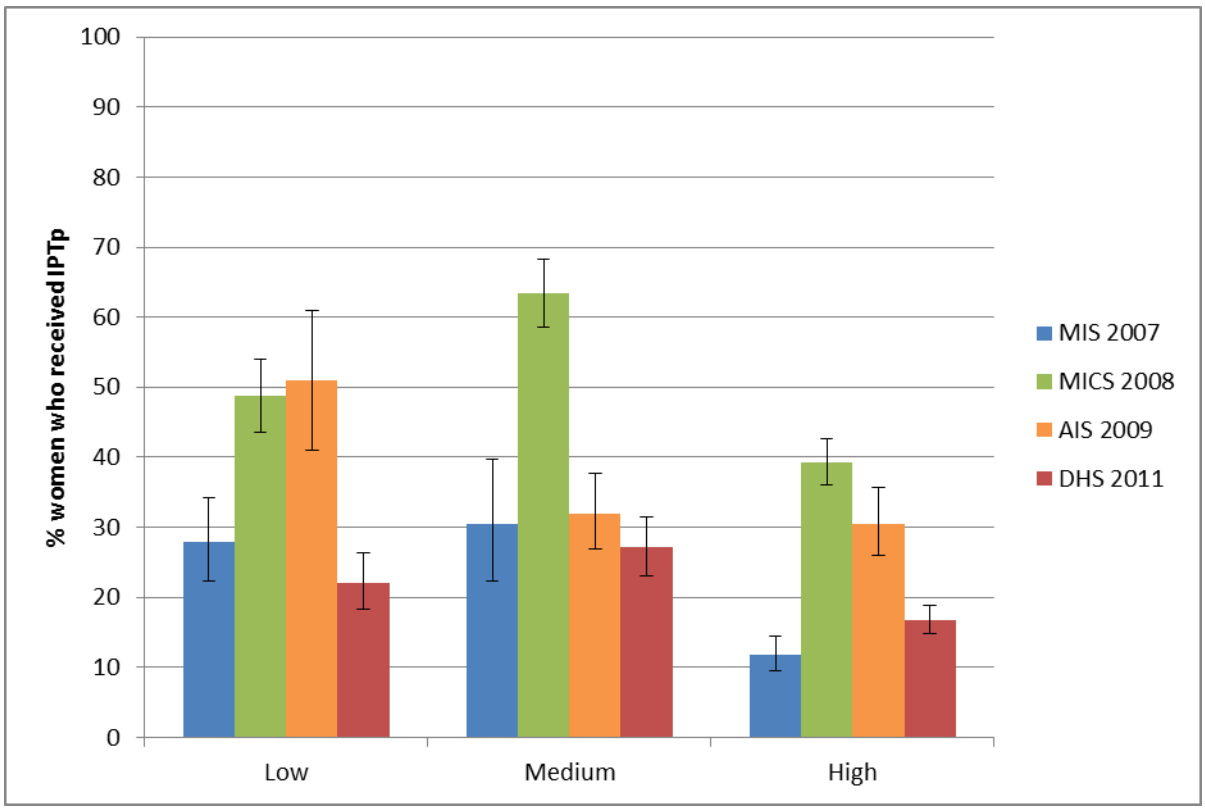
Background Characteristics	2007 MIS				2008 MICS				2009 AIS				2011 DHS				Relative Change (%)
	%	95% CI		WN	%	95% CI		WN	%	95% CI		WN	%	95% CI		WN	
Residence																	
Urban	24.7	21.5	28.2	956	54.2	50	58.4	1493	46.3	40.8	51.9	730	26	22.6	29.7	1356	5.3
Rural	13.8	11.1	17	1016	38.3	35	41.7	3698	27.6	23	32.8	1097	15.7	13.8	17.9	3557	13.8
Wealth																	
Quintile 1 (Poorest)	9.8	6.1	15.5	416	33.4	29.1	38	1209	19.2	12.7	28.1	287	16.6	13.4	20.4	1145	69.4
Quintile 2	12.7	9.3	17.2	407	37.9	33.2	42.8	1144	30.3	23.9	37.5	332	14.4	11.5	17.9	1067	13.4
Quintile 3	17.4	12.9	23.1	426	42	37.5	46.7	1041	31.2	24.9	38.2	344	17.5	14.6	20.8	1025	0.6
Quintile 4	21.2	16.9	26.4	369	49.9	45.6	54.2	1018	39.5	32.9	46.4	443	21.7	18.3	25.5	941	2.4
Quintile 5 (Least Poor)	28	21.7	35.2	354	57	52.5	61.4	778	46.7	40.6	52.8	421	25.1	21.6	29	736	-10.4
Mother's Education																	
None	11.6	9.1	14.6	1061	40.2	35.6	44.9	1624	25.9	19.5	33.4	493	14.6	12.5	17	1747	25.9
Primary	21.9	18	26.4	677	42	39.3	44.8	3086	33.4	29.6	37.5	1091	19.5	17.3	21.9	2588	-11.0
Secondary and higher	29.4	21.6	38.6	224	58.7	52.3	64.8	439	46	38.2	54.1	243	26.6	23	30.5	578	-9.5
Missing	*	*	*	10	46.5	28.1	65.9	42	0	*	*	*	0	*	*	*	n/a
Total	16.2	13.9	18.7	1972	42.9	40.2	45.6	5191	32.3	28.4	36.4	1827	18.6	17	20.3	4913	14.8

Notes: WN = weighted number of cases; * Indicates fewer than 25 unweighted cases and has been suppressed.

IPTp by Malaria Risk Zones in Mozambique

Figure 24 shows the proportion of women (15-49 years) with a live birth 0-2 years prior to the survey who received IPTp by the three malaria risk zones from 2007 to 2011. Across all malaria risk zones, there was a general increase in IPTp coverage from 2007 to 2008, and then an overall decline in coverage by 2011. In the low risk zones, coverage increased significantly from 28% in 2007 to 51% in 2009, then declined significantly to 22% in 2011. In the medium risk zones, a large increase in IPTp coverage was observed from 30% in 2007 to 64% in 2008, then declined significantly to 27% in 2011. In the high risk zones, overall coverage of IPTp was lower than in the low and medium risk zones across all survey years; however coverage followed a similar trend, increasing from 12% in 2007 to almost 40% by 2008, then declining to 17% by 2011.

Figure 24: Proportion of women (15-49 years) with a live birth 0-2 years prior to survey who received IPTp by malaria risk zones, 2007-2011



Summary of IPTp

Coverage of IPTp overall increased from 2007 (16%) to 2009 (32%), but then declined in 2011 (19%) to about the same level of coverage observed nationally in 2007. The large decline between 2008-2009 and 2011, may have been due to a severe stock-out of SP during 2010 to 2012. The same trend was observed across the three malaria risk zones, with large increases observed between 2007 and 2008/2009 and then large declines by 2011. Overall, the lowest coverage in IPTp however was observed in the high malaria risk zones, and the highest coverage in the low malaria risk zones. Across all survey years,

inequities in IPTp coverage were observed by place of residence, wealth quintile and mothers education level – favoring women in urban areas, those from the wealthier quintiles and with higher levels of education.

Malaria Case Management

In this section, a brief background is provided on the evolution and implementation of treatment policies in Mozambique. Trends in prompt and effective treatment of malaria in children under five years of age are presented, as well as equity in receipt of treatment.

Background

Malaria case management, including the identification, diagnosis, and rapid treatment of all malaria cases with appropriate and effective antimalarial drugs, is one of the key strategic areas for malaria control recommended by the World Health Organization [39]. Most malarial fevers occur at home, and prompt and effective treatment is critical to prevent severe morbidity and mortality related to malaria.

Case Management Policy

Development of the treatment policy in Mozambique has been guided by the results of therapeutic efficacy testing since 2000.

In 2002, a consensus to change the first-line treatment for malaria was reached due to low efficacy study results of chloroquine and SP. An AQ+SP combination was adopted as an interim first-line antimalarial. The AQ+SP combination was implemented for only two years, before the first line regimen was altered by the NMCP in 2004 to AS+SP as the first line. The implementation of this new policy of AS+SP was launched in 2004, guidelines were developed in 2005 and official implementation began in May 2006.

In 2009, the NMCP initiated yet another revision of the antimalarial drug policy due to information on the increasing contraindications to use of SP in a setting of large-scale use of cotrimoxazole for prophylaxis in HIV-infected individuals and increased levels of SP resistance. Thus in 2009, AL was selected as the first-line malaria treatment and AS+AQ as an alternative treatment. These guidelines also introduced for the very first time the concept of pre-referral treatment of cases of severe malaria. The updated antimalarial guidelines got ministerial approval in November 2010 and were printed in 2011. Table 12 summarizes the different malaria treatment policy guidelines in Mozambique, from 2002-2009.

Table 12: Malaria treatment policy guidelines in Mozambique

Year	Regimen
2002	The first consensus meeting was held and defined the following as Malaria treatment regimens: 1st Line: Amodiaquine (AQ) + sulfadoxine-pyrimethamine (SP) 2nd Line: Lumefantrine +Artemether (AL) 3rd Line: Quinine
2004	The first line antimalarial treatment was altered by the NMCP. 1st Line: Artesunate (AS)+ sulfadoxine-pyrimethamine (SP) 2nd Line: Lumefantrine + Artemether (AL) 3rd Line: Quinine
2009	2nd Malaria treatment guideline review meeting was held and the following treatment regimens were decided on: 1st Line: Lumefantrine + Artemether (AL) Alternative 1st Line : Artesunate (AS) + Amodiaquine (AQ) 2nd Line: Parenteral Artesunate and Parenteral Quinine as alternatives Pre referral Treatment: Rectal Artesunate (AS), and parenteral AS and quinine can be used as alternatives.

In 2009, in recognition of the malaria burden, a ministerial decree was issued that all malaria treatment is free of charge in public health facilities. In addition, in recognition of the low access to health care by most of the population, the policy recommended the use of AL and rapid diagnostic tests (RDTs) at community level as part of the community malaria management program.

Diagnostics

Treatment based on clinical diagnosis is the norm (as of 2011) in Mozambique and as such, continued even after the introduction of the policy of parasitological diagnosis (microscopy initially; RDTs since 2005) for all suspected malaria cases. Clinical diagnosis is still widely practiced as testing in the country is still below 90%. Currently (2011), coverage of microscopy continues to be limited to a small number of health facilities, only 24% (314 out of 1,274 health facilities) have a laboratory. Insufficient number of laboratory technicians and assistants, and challenges in obtaining laboratory consumables (e.g., Giemsa reagent, methanol and oil immersion) also factor into the limited coverage and reliability of microscopy.

The introduction of RDTs in Mozambique placed an additional challenge for the diagnosis of malaria as guidelines are unclear concerning criteria for their use, along with low-quality training and lack of quality control systems in distribution and storage. Even with these efforts of improving diagnosis of malaria, the continued treatment of fever as malaria can be attributed to inadequate guidance on what to do with a negative result. A system for quality assurance of microscopy testing is implemented by the national reference laboratory. The National Malaria Reference Laboratory was recently rehabilitated and

launched in 2012. A manual for laboratory supervision was developed and approved in 2010.

Malaria Case Management in Children

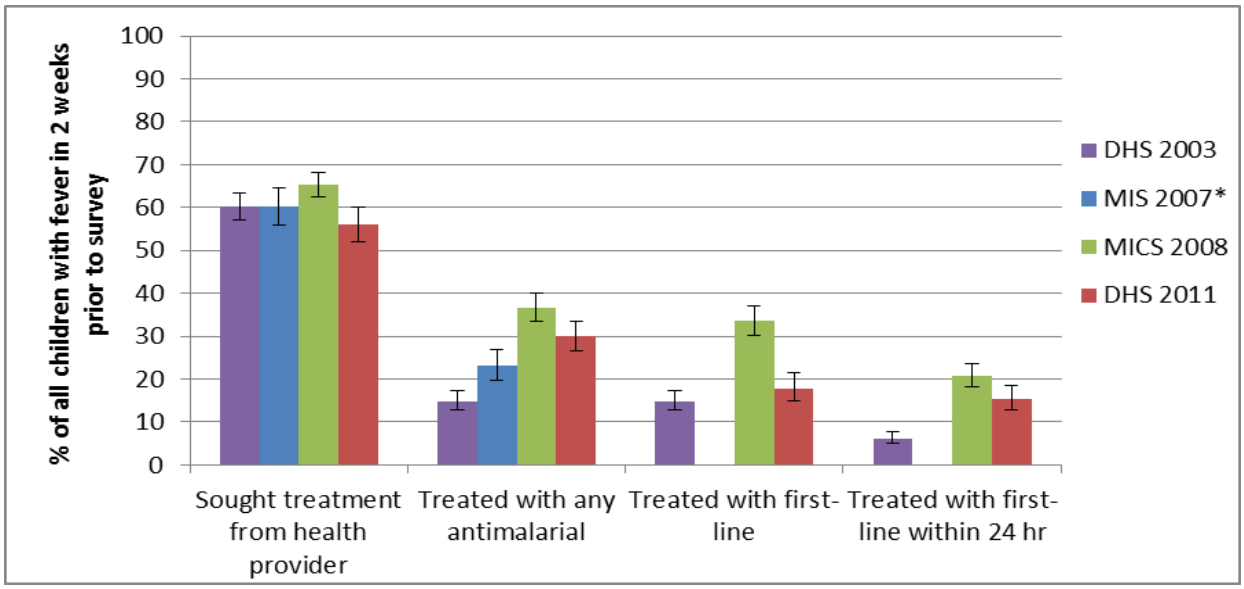
Monitoring malaria case management in Mozambique is challenging. Correct and timely care of children with malaria depends on many factors including care-seeking behavior, access to health facilities, facility reporting of visits and diagnoses, diagnostic capacity, and availability of appropriate medicines. Measuring trends in malaria case management is further complicated by the policy changes that have occurred in the past decade, affecting both first-line medications and diagnostic procedures. As a result, the original RBM indicator measuring the proportion of children with recent fever who receive antimalarial treatment has been supplemented in this report with two new RBM indicators: an estimate of the proportion of children with fever for whom treatment was sought from a healthcare provider and an estimate of the proportion of treated children receiving recommended, first-line treatments.

The 2003 DHS, 2007 MIS, 2008 MICS and the 2011 DHS surveys asked mothers to report history of fever in children under five years of age during the two weeks prior to the survey. Of children who experienced fever, a series of further questions are asked about care seeking – including the source of advice and/or treatment, the timing of care seeking, treatment received, and type of antimalarial used, if any.

Figure 25 shows the percentage of children under five years of age with fever in the two weeks preceding the interview for whom treatment was sought from a healthcare provider, who were treated with any antimalarial, with first-line antimalarials, and with first-line antimalarials within 24 hours of fever onset for the four national surveys: 2003 DHS, 2007 MIS, 2008 MICS and 2011 DHS[5]. The percentage of children under five years of age with fever in the past two weeks for whom treatment was sought from a health provider, was similar across all survey years. The percentage of children under five years of age with fever in the past two weeks that received any antimalarial increased from 15% (95% CI: 13-15%) in 2003 to 37% (95% CI: 33-40%) in 2008. A similar trend was observed for the percentage of children under five years of age with fever in the past two weeks that were treated with first-line antimalarials and for those treated with first-line antimalarials within 24 hours; with an increase observed between 2003 and 2008, and then a slight decline in 2011.

[5] The 2007 MIS did not provide information on treatment with the first-line antimalarial (AS+SP) or treatment with the first-line antimalarial within 24 hours.

Figure 25: Percentage of children under five years of age with fever in the two weeks preceding the survey for whom treatment was sought, who were treated with any antimalarial, with first-line antimalarials, and with first-line antimalarials within 24 hours of first-line antimalarials, and with first-line antimalarials within 24 hours of fever onset, 2007-2011



*For the 2007 MIS, treatment with the first-line antimalarial and treatment with the first-line antimalarial within 24 hours is not available. The first-line treatment varied by survey, with chloroquine being the first-line treatment during the DHS 2003 survey, AS+SP as the first-line drug for the 2008 MICS, and AL ((Coartem®) used as the first-line drug for the 2011 DHS.

Table 15 provides a breakdown of the specific antimalarials taken by children under five years of age with fever from 2003 to 2011. In 2003, the most frequently used antimalarials were chloroquine (15%), followed by SP and quinine (both at 11%). In 2007, the most frequently used antimalarial was quinine (16%) followed by chloroquine (6%). No data from the 2007 MIS is available on use of the first-line treatment of AS+SP. However, in the 2008 MICS, AS+SP use was measured and a huge shift was observed in the most frequently used antimalarials, with 34% using the ACT therapy AS+SP. By 2011, the most frequently used antimalarials were ACTs (AL) at 18%, followed by SP at 7%.

Table 13: Percentage of children under five years of age with fever in the two weeks preceding the survey by type of antimalarial used for treatment, 2003-2011

Antimalarial	2003 DHS				2007 MIS*				2008 MICS**				2011 DHS			
	%	95% CI		WN	%	95% CI		WN	%	95% CI		WN	%	95% CI		WN
ACT	n/a	n/a	n/a	n/a	0.2	0.004	1.2	1268	33.5	30.1	37.1	2686	17.9	14.9	21.4	1457
Amodiaquine	n/a	n/a	n/a	n/a	0.4	0.1	1.4	1268	n/a	n/a	n/a	n/a	0.6	0.2	1.4	1457
Chloroquine	14.9	12.7	17.3	2322	5.5	4	7.5	1268	n/a	n/a	n/a	n/a	0.8	0.3	2.2	1457
SP	10.7	8.6	13.2	2322	15.6	12.9	18.8	1268	n/a	n/a	n/a	n/a	7.1	5.4	9.3	1457
Quinine	10.7	8.6	13.2	2322	0.7	0.3	1.5	1268	2.4	1.7	3.3	2686	2.5	1.7	3.7	1457
Other antimalarial	n/a	n/a	n/a	2322	6.4	4.5	8.9	1268	3.5	2.7	4.5	2686	1.4	0.7	2.6	1457
Total "any anti-malarial"***	14.9	12.8	17.3	2322	23	19.6	26.9	1268	36.7	33.4	40.2	2686	29.9	26.5	33.6	1457

Notes: *For the 2007 MIS, the ACT used is Coartem. The report inaccurately reports both Coartem and AS+SP, thus the results do not match the report. AS+SP was not a response option in the questionnaire and was incorrectly combined. **For the 2008 MICS, the ACT used is AS+SP. The report did not include Coartem as a response option. ***For the total "any antimalarial", it is important to note that children could have been reported to have tkken more than one antimalarial for treatment of the fever, the total "any antimalarial" does not necessarily reflect the sum of each of the antimalarial treatments (e.g. the sum of ACT, amodiaquine, chloroquine, SP, quinine and other antimalarial).

Equity in Treatment

Table 16 presents data on equity of treatment with first-line antimalarials of children under five years of age with fever in the two weeks before the survey by sex, place of residence, wealth and mother's education level from the 2003 DHS, 2007 MIS, 2008 MICS and the 2011 DHS. There were no statistically significant differences observed by sex in the percentage of children who received first-line treatment, however, the percentage of males that received treatment was slightly higher in the 2003, 2007 and 2008 surveys. For place of residence in 2003 and 2011, the percentage of children that received first-line treatment from rural areas was slightly higher at 16% and 20%, respectively, compared to only 13% of children from urban areas for both survey years. In contrast, in both 2007 and 2008, the percentage of children from urban areas who received treatment was slightly higher than those from rural areas. There were no clear trends observed in the percentage of children receiving treatment by wealth index across the four survey years. In both 2003 and 2008, the percentage of children who received first-line treatment was the same among children from the poorest households and those from the least poor. In 2007, a slightly higher percentage of children from the least poor households received treatment (26%) compared to those from the poorest households (15%), however this difference was not significantly different. In contrast, in 2011, a significantly higher percentage of children from the poorest households received treatment (22%) compared to those from the least poor households (8%). Similarly, there were no clear trends observed in the percentage of children that received first-line treatment by their mother's education level. In 2003 and 2011, a slightly higher percentage of children whose mother had no education received treatment (13% and 18%, respectively), compared to children who mother had a

secondary or higher level of education (11% and 14%, respectively). In contrast, only 12% of children whose mother had no education received treatment in 2007, compared to 25% of children whose mother had a secondary level of education or higher.

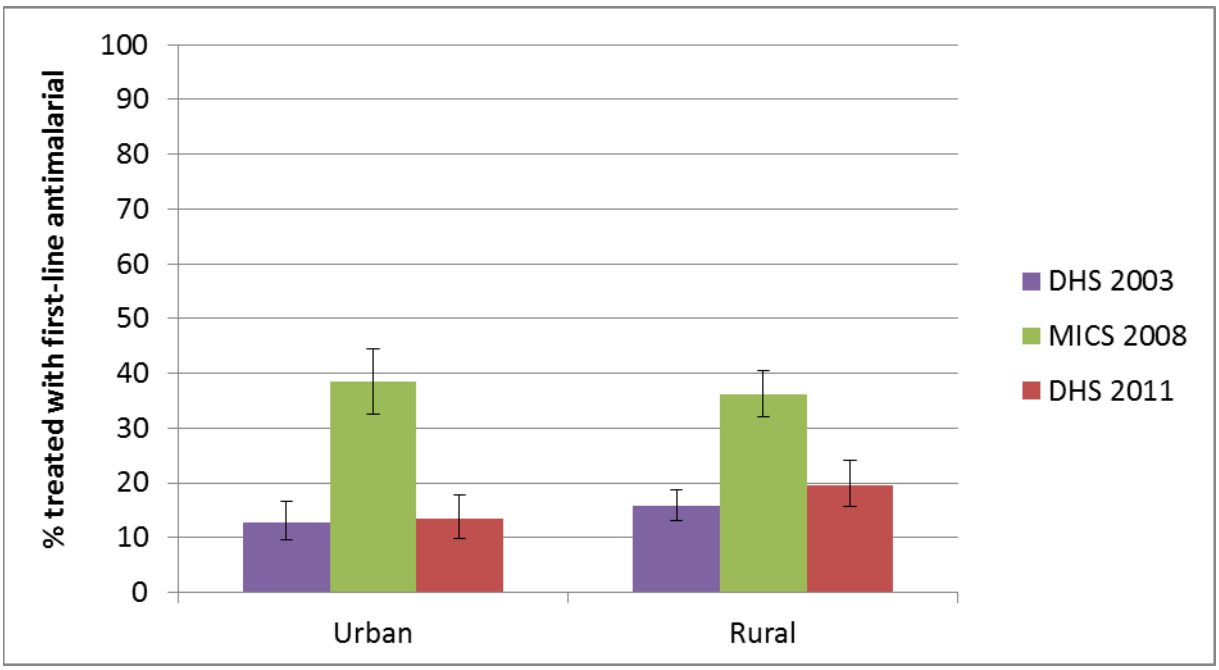
Table 14: Percentage of children under five years of age with fever in the two weeks preceding the survey who were treated with first-line antimalarials, by socio-demographic factors, 2003-2011

Background Characteristics	2003 DHS %	2003 DHS 95% CI		2003 DHS WN	2008 MICS %	2008 MICS 95% CI		2008 MICS WN	2011 DHS %	2011 DHS 95% CI		2011 DHS WN	% Relative Change 2003 to 2011
Sex													
Male	17	14.1	20.3	1,163	37.6	33.7	41.7	1,384	17.7	13.9	22.2	747	4.1
Female	12.8	10.3	15.8	1,159	35.8	31.7	40.1	1,301	18.1	14.5	22.4	709	41.4
Residence													
Urban	12.7	9.6	16.6	779	38.4	32.6	44.5	760	13.4	9.9	17.8	388	5.5
Rural	15.7	13.1	18.8	1,543	36.1	32	40.4	1,926	19.6	15.7	24.1	1,069	24.8
Wealth													
Quintile 1 (Poorest)	13.6	10.3	17.6	521	32	26.2	38.4	607	22	15.1	31	361	61.8
Quintile 2	15.1	10.6	21.1	401	41.2	35	47.8	580	15.5	10.9	21.7	339	2.6
Quintile 3	17.6	13.3	22.9	483	37.4	30.8	44.6	547	25.1	19	32.4	285	42.6
Quintile 4	14.7	10.9	19.6	492	39.8	34.1	45.7	572	14.9	10.6	20.5	274	1.4
Quintile 5 (Least poor)	12.8	8.9	18	425	31.8	25.6	38.8	380	8.2	4.9	13.5	198	-35.9
Mother's Education													
None	13.4	10.4	17	908	35.5	30.2	41.1	816	18.3	13	25.1	507	36.6
Primary	16.3	13.8	19.2	1308	32.3	28.3	36.6	1713	18.4	15.1	22.1	813	12.9
Secondary or higher	11.1	4.1	27	106	36.6	28.1	46.1	158	13.7	8.4	21.5	137	23.4
Missing	*	*	*	0	*	*	*	0	*	*	*	0	n/a
Total	14.9	12.7	17.3	2322	33.5	30.1	37.1	2686	17.9	14.9	21.4	1457	20.1

* Indicates fewer than 25 unweighted cases and has been suppressed.

Figure 26 presents the coverage of treatment with first-line antimalarials among children under five years of age by place of residence. There was no consistent trend observed across the three survey years. In 2003, the percentage of children treated with first-line antimalarials was slightly higher in rural areas at 16% (95% CI: 13-19%) compared to urban areas at 13% (95% CI: 10-17%). In 2008, the percentage of children treated was slightly higher in urban areas (38%, 95% CI: 33-45%) than in rural areas (36%, 95% CI: 32-40%). Similar to 2003, a higher percentage of rural children (20%, 95% CI: 16-24%) were treated with first-line antimalarials in 2011 than urban children (13%, 95% CI: 10-18%).

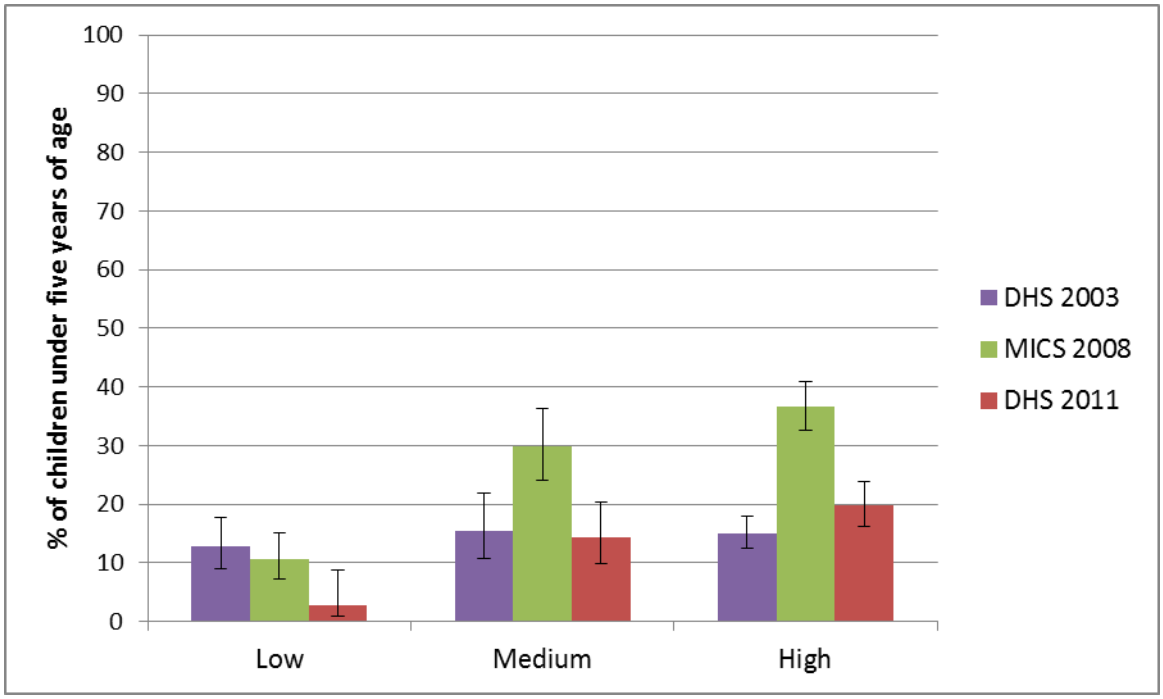
Figure 26: Percentage of children under five years of age with fever in the two weeks preceding the interview who were treated with first-line antimalarials, by area of residence, 2003-2011



Treatment by Malaria Risk Zones in Mozambique

Figure 27 shows the percentage of children under five years of age with fever in the two weeks preceding the survey who were treated with first-line antimalarials by the three malaria risk zones. In the low risk zones, the percentage of children treated with first-line antimalarials declined significantly from 13% (95% CI: 9-18%) in 2003 to 3% (95% CI: 1-9%) in 2011. In the medium risk zones, the percentage that were treated increased from 16% (95% CI: 11-22%) in 2003 to 30% (95% CI: 24-36%) in 2008, and then declined significantly to only 14% (95% CI: 10-20%) in 2011. A similar trend was observed in the high risk zones, with a significant increase in the percentage of children treated with first-line antimalarials between 2003 and 2008 (15%, 95% CI: 13-18% vs. 37%, 95% CI: 33-41%), and then a significant decline to 20% (95% CI: 16-24%) in 2011. By 2011, treatment with ACTs was highest in the high malaria risk zones.

Figure 27: Percentage of children under five years of age with fever in the two weeks preceding the survey who were treated with first-line antimalarials (ACT), by malaria risk zones, 2003-2011



Summary of Malaria Case Management

Treatment of children under five years of age with any antimalarial did increase significantly from 15% in 2003 to about 30% in 2011, while treatment with the first-line antimalarial increased significantly from 2003 (15%) to 2008 (34%), but then declined significantly in 2011 (18%). Interestingly, no notable inequities were found in treatment coverage with first-line antimalarials among children under five years of age by sex, wealth quintile or level of education of the mother; however, in both the 2003 and 2011 surveys, treatment coverage was slightly higher in rural areas compared to urban areas. Treatment coverage with the first-line antimalarials was overall higher in the medium and high risk zones, compared to the low risk zones across all survey years (2003, 2008 and 2011), with similar trends showing increases in treatment coverage from 2003 to 2008, then declines by 2011.

MALARIA MORBIDITY

Malaria Parasitemia

Background

Reductions in malaria parasitemia prevalence should have the desired effect of reducing malaria-attributable morbidity and mortality at the population level. MIS and DHS surveys are the main data collection tools that have been used to collect malaria parasitemia data. In Mozambique, both the 2007 MIS and 2011 DHS surveys collected malaria parasitemia data.

Interpreting changes in trends in national malaria parasitemia prevalence is a challenging task; as malaria transmission dynamics are quite sensitive to climatic variability [40] and are heterogeneous over small areas [40,41]. Therefore, national prevalence data can often be a crude method for monitoring progress in malaria control. In addition to seasonal trends, fluctuations in weather patterns over several years may contribute to similar fluctuations in malaria parasitemia levels (within and between years) which could mask successes or lapses in malaria control efforts [42,43,44]. Thus, malaria parasitemia is a challenging impact measure to interpret in many settings, although it is arguably the most direct measure of success in malaria control efforts.

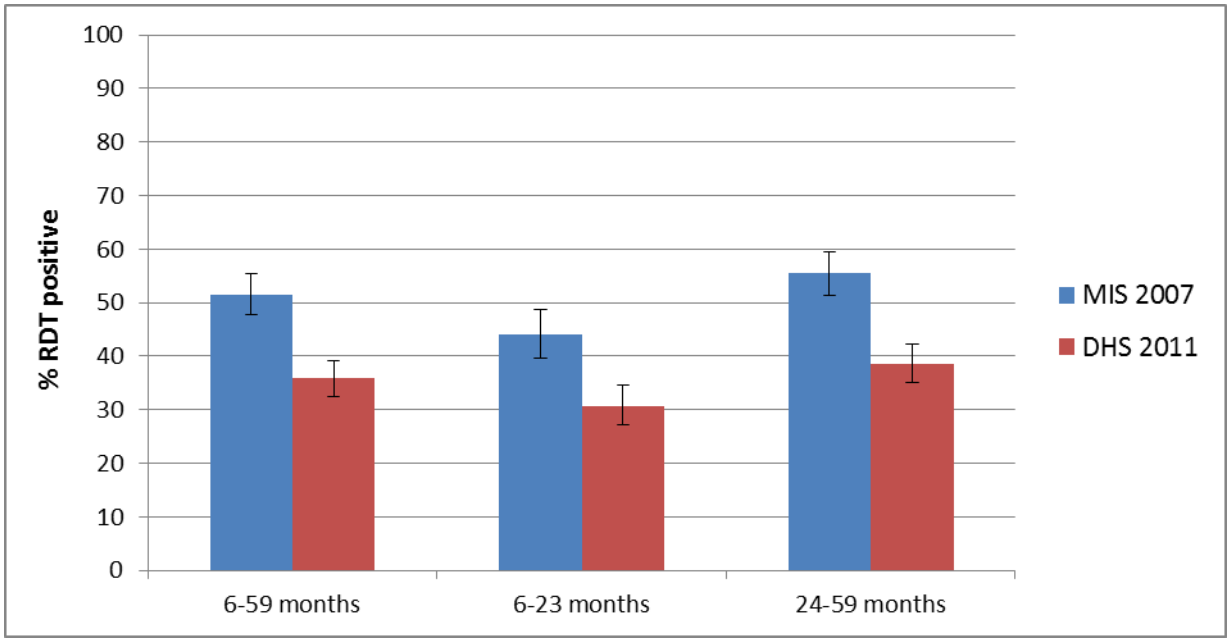
Trends in Malaria Parasitemia

The 2007 MIS tested children aged 6-59 months for the presence of *P. falciparum* parasites using RDTs (ICT Malaria Pf, ICT Diagnostics) and thick and thin blood smears for microscopic analysis. Similarly, the 2011 DHS tested children aged 6-59 months for the presence of *P. falciparum* parasites using RDTs (SD Bioline Malaria Ag P.f/P.v®) and the presence of any *Plasmodium* parasites using thick smears under light microscopy. Both surveys took place predominantly in the dry season. The 2007 survey was conducted between June 2007 and August 2007, while the 2011 survey was conducted between June 2011 and November 2011, only overlapping the rainy season two months and missing the peak malaria-transmission season from December into April.

Figure 28 shows the trends in malaria parasitemia prevalence in children aged 6-59 months, 6-23 months and 24-59 months, for both 2007 and 2011 using RDT[6]. Malaria parasitemia prevalence declined significantly in all age groups between 2007 and 2011. For children aged 6-59 months, malaria parasitemia decreased from 52% (95% CI: 48-55%) in 2007 to 36% (95% CI: 33-39%) in 2011. Malaria parasitemia prevalence was lower in children 6-23 months across both survey years compared to children aged 24-59 months. For example in 2011, malaria parasitemia was 31% (95% CI: 27-35%) among children 6-23 months and was 39% (95% CI: 35-42%) among children 24-59 months.

[6] RDT parasitemia prevalence data was used due to reported unreliability of the microscopy data collected in the 2007 MIS and 2011 DHS.

Figure 28: Trends in malaria parasitemia prevalence (RDT) in children 6-59 months, by age, 2007-2011



Similarly, as shown in Table 17, malaria parasitemia prevalence (via RDT) overall was higher in the older age group in both 2007 and 2011. For example, malaria infection was 41% (95% CI: 35-48%) among 6-11 month olds in 2007, and 57% (95% CI: 52-48%) among 48-59 month olds. A similar trend was observed in 2011. The higher prevalence of malaria parasitemia by age is consistent with findings in other high-burden countries, since older children (24-59 months) living in malaria endemic areas build immunity over time and are more likely to have an asymptomatic infection.

Table 15: Malaria parasitemia (RDT) in children 6-59 months, by age, 2007-2011

Age in months	2007 MIS				2011 DHS				Relative Change (%)
	Percentage of children with malaria parasitemia	95% CI		WN	Percentage of children with malaria parasitemia	95% CI		WN	
6-11	41.1	35	47.6	385	25.4	20.9	30.4	574	-38.2
12-23	45.7	40.6	50.8	739	39.9	35.6	44.3	1,145	-12.7
24-35	52.3	47.3	57.2	777	37	32.8	41.3	1,035	-29.3
36-47	57.7	51.8	63.5	687	41.6	36.9	46.4	1,106	-27.9
48-59	57.2	51.8	62.6	578	41.5	36.9	46.2	1,024	-27.4
Total	51.5	47.7	55.3	3166	38.3	35.1	41.5	4885	-25.6

Equity in Malaria Parasitemia

Disparities in malaria parasitemia (via RDT) in children aged 6-59 months, by socio-demographic characteristics, are shown in Table 18. Malaria parasitemia did not vary significantly by sex in either 2007 or 2011. For children living in rural areas, malaria parasitemia was significantly higher at 58% in 2007 and 46% in 2011, compared to urban areas, at 26% and 17% for the two respective survey years. There was a clear trend in malaria parasitemia by wealth index in both 2007 and 2011, where children from the poorest households had a significantly higher malaria prevalence compared to children from the least poor households. For example in 2011, 55% of children from the poorest households tested positive for malaria, compared to only 6% of those from the least poor households. Similarly, there was a clear trend in malaria parasitemia prevalence by the mother's education level. Among children whose mother had no education, malaria parasitemia prevalence was 60% in 2007 and 55% in 2011, compared to only 21% and 10% in the respective survey years for children whose mothers had a secondary level of education or higher. Interestingly, the largest declines in malaria parasitemia from 2007 to 2011 were amongst those that were from urban areas (relative change of 36%), from the least poor households (relative change of 63%), and amongst children whose mothers had the highest level of education (relative change of 52%), while there were relatively small changes in malaria parasitemia among children from the rural areas, the poorest households and amongst those whose mother's had no education.

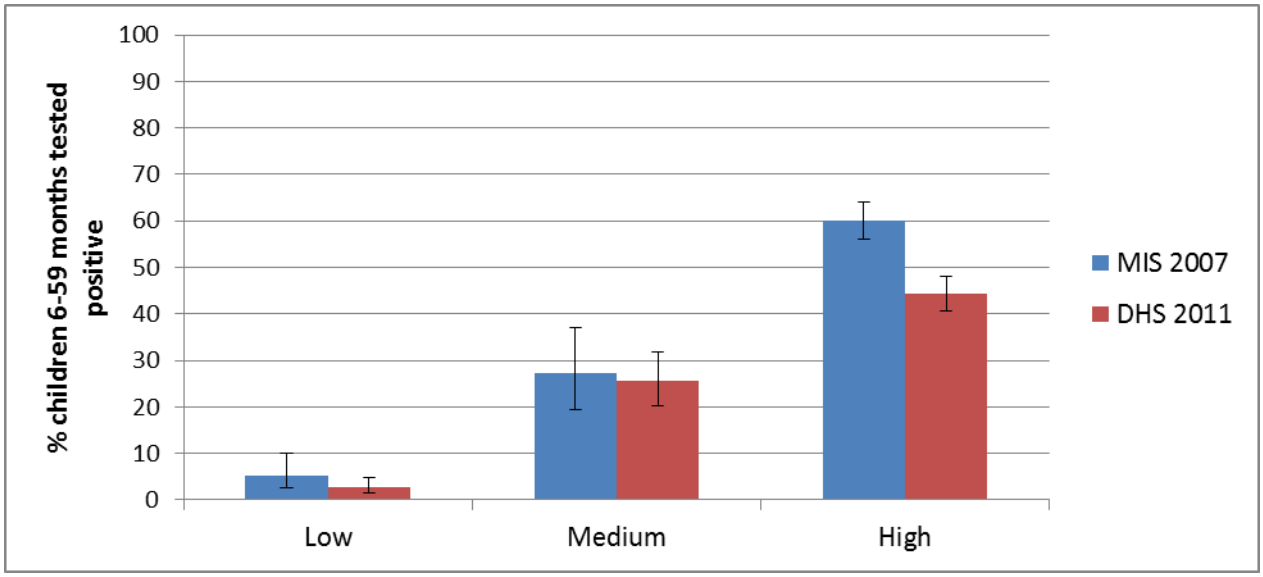
Table 16: Malaria parasitemia (RDT) in children 6-59 months, by background characteristics, Mozambique 2007-2011

Background Characteristics	2007 MIS				2011 DHS				Relative Change (%)
	Percentage of children with malaria parasitemia	95% CI		WN	Percentage of children with malaria parasitemia	95% CI		WN	
Sex									
Male	51.9	47.4	56.4	1624	39.6	36	43.2	2,409	-23.7
Female	51.1	46.8	55.4	1542	37	33.6	40.6	2,476	-27.6
Residence									
Urban	26.4	22	31.4	1429	16.8	13.2	21.2	1331	-36.4
Rural	57.5	52.9	62	1737	46.3	42.5	50.2	3552	-19.5
Wealth									
Quintile 1 (Poorest)	68.1	63	72.9	725	54.9	49.4	60.3	1,124	-19.4
Quintile 2	60.3	54.4	65.9	682	51.5	46.3	56.6	1,083	-14.6
Quintile 3	54.1	47.3	60.8	700	41.3	36.3	46.5	952	-23.7
Quintile 4	30.5	24.8	36.9	595	25.9	21.6	30.8	1,006	-15.1
Quintile 5 (Least Poor)	15.3	9.8	23.1	464	5.6	3.8	8.2	720	-63.4
Mother's Education									
None	59.8	55.7	63.8	1816	46.6	42.4	51	1,639	-22.1
Primary	39.9	34.6	45.4	1010	38.5	34.6	42.6	2,306	-3.5
Secondary and higher	20.8	13.7	30.2	298	10	6.7	14.6	506	-51.9
Total	51.5	47.7	55.3	3166	38.3	35.1	41.5	4885	-25.6

Parasitemia by Malaria Risk Zones in Mozambique

Figure 29 shows malaria parasitemia prevalence (RDT) in children 6-59 months of age across the three malaria risk zones. In the low risk zones, parasitemia prevalence remained stable from 2007 to 2011, at 5% (95% CI: 3-10%) and 3% (95% CI: 1-5%), respectively. A similar trend was found in the medium risk zones, with prevalence at 27% (95% CI: 19-37%) and 26% (95% CI: 20-32%) 2007 and 2011, respectively. In the high risk zones, a significant decline was observed across the same time period, from 60% (95% CI: 56-64%) to 44% (41-48%).

Figure 29: Trends in malaria parasitemia prevalence (RDT) in children 6-59 months of age, by malaria risk zones in Mozambique, 2007-2011



Parasitemia and ITN Ownership and Use

Figure 30 shows trends in malaria parasitemia prevalence via RDT among children aged 6-59 months, by the number of household ITNs owned. For the 2007 survey, parasitemia prevalence was the same in households with either no ITN and those with one ITN (52% and 53%, respectively), and lower in households that had two or more ITNs (36%, 95% CI: 26-47%), however this difference was not found to be significantly different. In 2011, there was no significant difference observed in parasitemia prevalence among children 6-59 months by the number of ITNs a household owned.

Figure 30: Trends in malaria parasitemia prevalence (RDT) in children 6-59 months of age, by the number of ITNs in household, 2007-2011

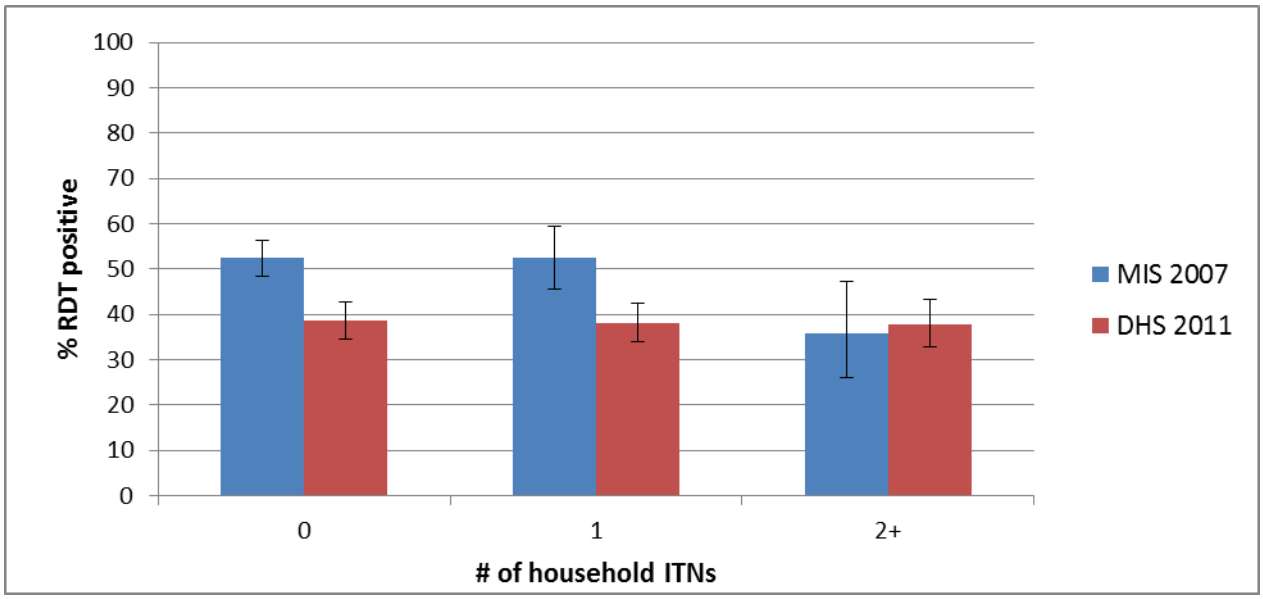
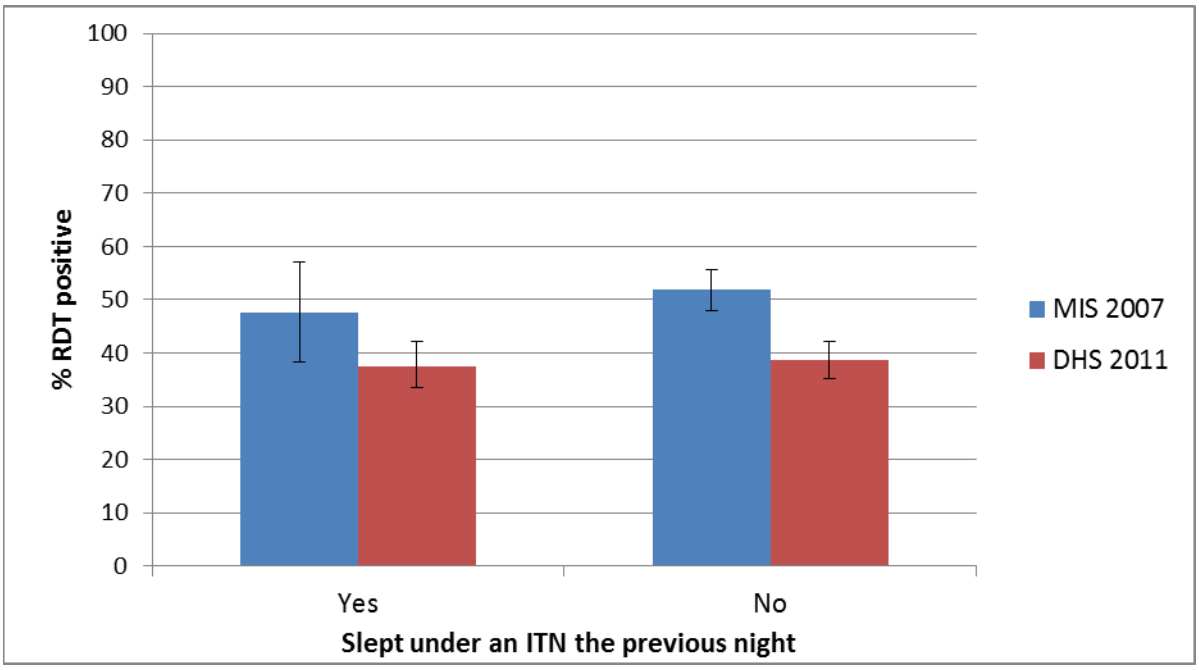


Figure 31 shows trends in malaria parasitemia prevalence using RDT among children aged 6-59 months, by whether they slept under an ITN the previous night or not. Malaria parasitemia prevalence was slightly lower among children who slept under an ITN the night before the survey than among children who did not in 2007, but was about the same in 2011. In 2007, malaria parasitemia prevalence was 48% (95% CI: 38-57%) among children who had slept under an ITN compared to 52% (95% CI: 48-56%), among those who had not slept under an ITN. In 2011, malaria parasitemia prevalence was 38% among both groups of children, those who had slept under an ITN and those who had not the previous night.

Figure 31: Trends in malaria parasitemia prevalence (RDT) in children 6-59 months of age, by ITN use the previous night, 2007-2011

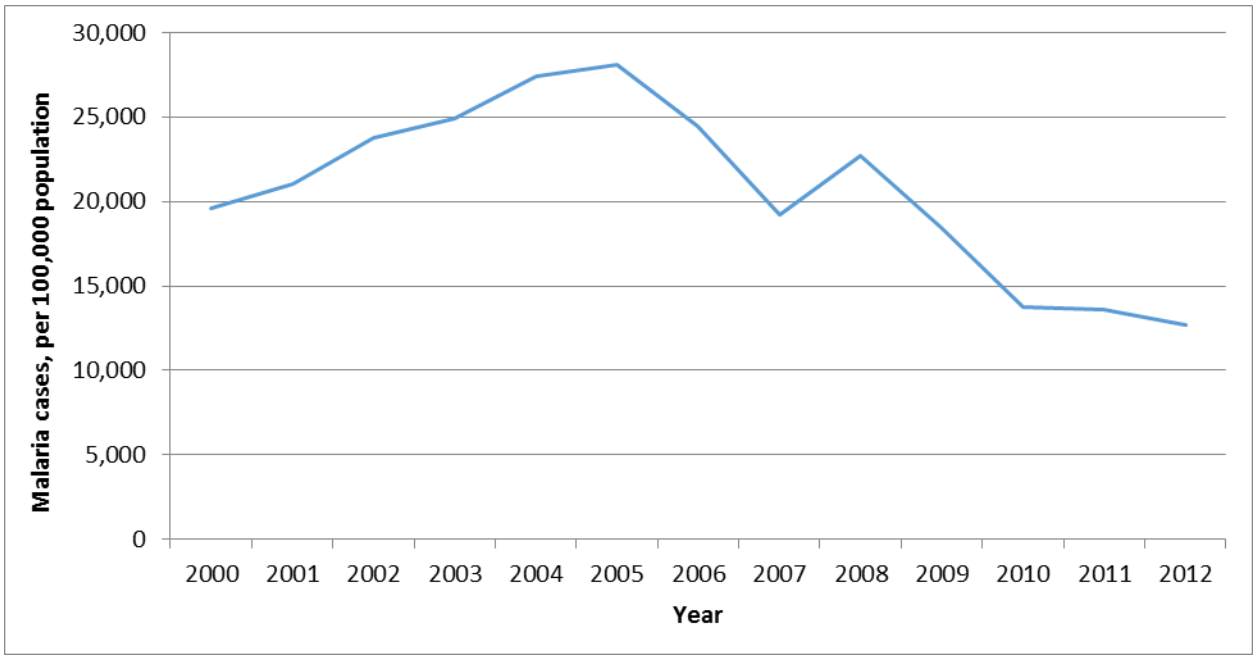


Facility-based Malaria Cases Data

Data from the HMIS were used to investigate trends in malaria cases between 2000 and 2012. Although the Mozambique HMIS has not been formally evaluated for accuracy, it represents one of the only sources of national-level data on clinical malaria over time. However, when examining HMIS data it is important to be aware of several challenges that may affect the quality of the data. These challenges include inaccurate and incomplete reporting, changes in the number of facilities reporting data, changes to indicators and case definitions (particularly as a result of increasing use of diagnostic testing).

According to the HMIS, the number of reported malaria cases (all ages) in Mozambique increased from 19.6 thousand cases per 100,000 population in 2000, to 28.1 thousand cases in 2005, when the number of cases peaked (Figure 32). Overall since 2005, reported malaria cases declined (with a slight increase in 2008). In 2012, about 12.7 thousand cases per 100,000 population were reported; the lowest number since 2000. The declining trend since 2005 may in part be attributed to the introduction of RDTs in 2005 (which led to the change in the definition of a malaria case from clinical to confirmed; which was instituted in Mozambique in 2009), as well as to the expansion of malaria prevention methods. Unfortunately, HMIS data regarding malaria cases among children under five years of age specifically is not available.

Figure 32: Malaria Cases* per 100,000 population in Mozambique, All Ages, 2000-2012

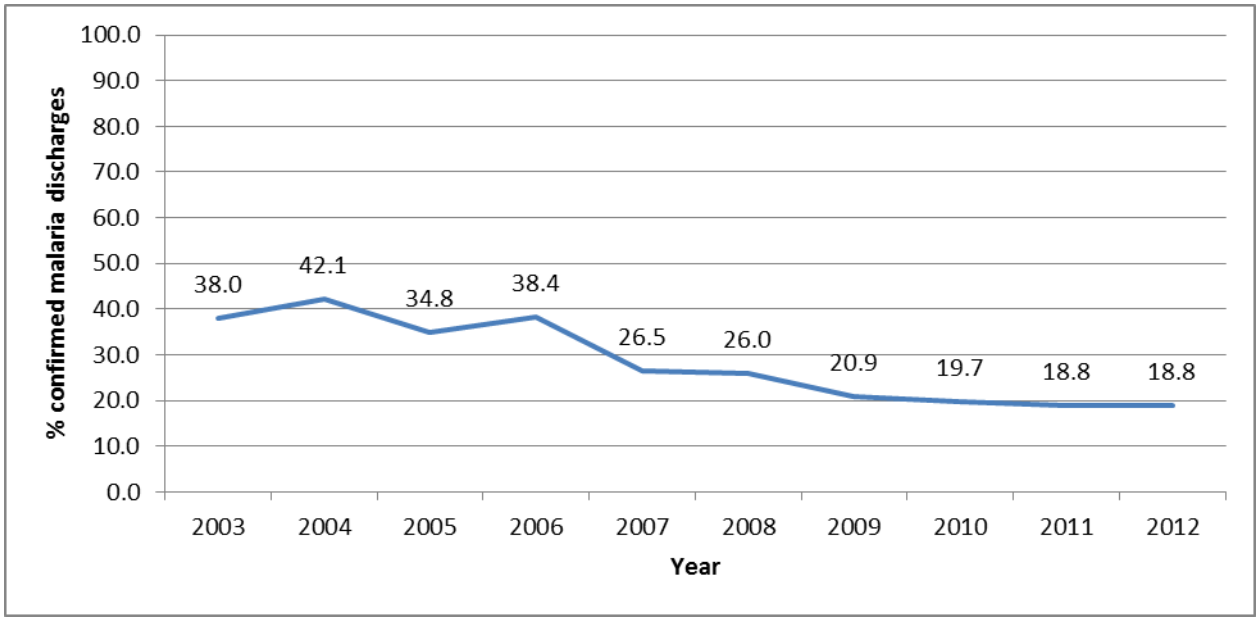


Source: Reported malaria cases from the National Malaria Control Program's Routine Data "Pais Annual"; Mozambique Population data from the World Bank data (http://data.worldbank.org/indicator/SP.POP.TOTL)
*Confirmed and non-confirmed clinical cases.

Figure 33 shows that between 2003 and 2006, the proportion of patients with confirmed malaria that were discharged from hospitals out of all hospital discharges fluctuated

around 38%. Between 2006 and 2012, the proportion of confirmed malaria discharges declined from 38% to 19%.

Figure 33: Proportion of Confirmed Malaria Discharges (All Ages) out of all Hospital Discharges, Mozambique, 2003-2012



Severe Anemia

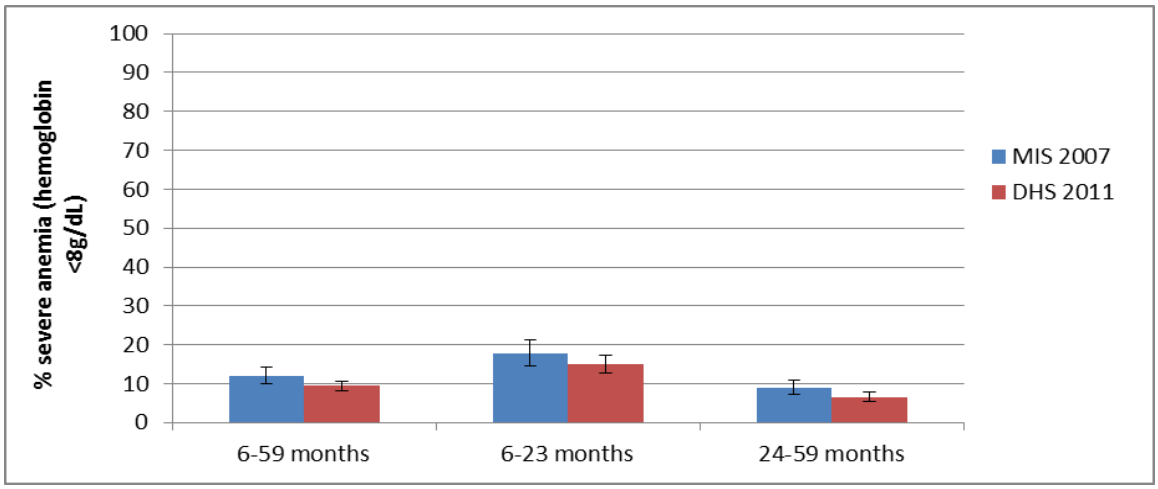
Background

Severe anemia, defined as blood hemoglobin (Hb) levels less than 8 grams per deciliter (g/dL), is an impact measure for total malaria-related disease burden as it is associated with malaria-related mortality and it is measurable at the population level with less seasonality than malaria parasitemia [8,10,11,12,39]. Infection with malaria parasites leads to anemia through the sequestration and lysis of red blood cells, as well as to suppressed production of new cells in the bone marrow (dyserythropoiesis) [45]. In addition to malaria parasites, iron deficiency, deficiencies in other nutrients and diseases such as soil-transmitted helminthes are all causes of anemia [45]. Declines in severe anemia have been found to be associated with malaria control interventions [46]. Severe anemia prevalence has also been collected in many more population-level surveys than parasitemia, and therefore, trends are more easily established using retrospective survey data. In sub-Saharan Africa, between 17% and 54% of malaria-attributable deaths are estimated to be due to severe anemia [46,47,48,49].

Trends in Severe Anemia

National estimates of the prevalence of severe anemia in children aged 6-59 months are available from the 2007 MIS and 2011 DHS surveys. Figure 34 shows the trends in severe anemia prevalence in children aged 6-59 months, 6-23 months and 24-59 months. The prevalence of severe anemia declined in all age groups between 2007 and 2011, however the decline observed was not significantly different. Among children aged 6-59 months, the prevalence of severe anemia showed a slight decrease from 12% (95% CI: 10–14%) to 9% (95% CI: 8–11%), although the decline was not significant. A similar trend was observed in children 6-23 months and children 24-59 months. , with children 6-23 months showing a small decline from 18% (95% CI: 15–21%) in 2007 to 15% (95% CI: 13–17%) in 2011, and children 24-59 months showing a slight decline from 9% (95% CI: 7–11%) to 7% (95% CI: 5–8%).

Figure 34: Trends in severe anemia (Hemoglobin < 8g/dL) prevalence in children 6-59 months, by age group, 2007-2011



The relative reduction in severe anemia by age groups in presented in Table 19. The largest declines in severe anemia by age group were found in children 48-59 months (relative change of 59%), followed by children 35-47 months (relative change if 26%). Children between 24-35 months experienced the smallest decline in severe anemia prevalence between 2007 and 2011. None of the declines observed were statistically significant.

Table 17: Relative reduction in severe anemia (hemoglobin < 8g/dL) by age groups (months), 2007-2011

Age in months	2007 MIS %	95% CI		WN	2011 DHS %	95% CI		WN	Relative change (%)
6-11	18.5	13.7	24.5	386	14.6	11.2	18.7	576	-21.1
12-23	17.2	13.7	21.3	739	15	12.2	18.3	1,146	-12.8
24-35	10.7	8	14.3	771	10.1	7.8	12.9	1,035	-5.6
36-47	9.4	6.7	13	681	7	5	9.7	1,106	-25.5
48-59	5.9	3.8	9	576	2.4	1.5	3.8	1,024	-59.3
Total	12	10.1	14.1	3153	9.4	8.3	10.7	4,888	-21.7

Equity in Severe Anemia

Disparities in the prevalence of severe anemia in children aged 6-59 months, by socio-economic characteristics are shown in Table 20. Overall there were no significant differences in severe anemia by sex in both survey years. However, severe anemia was significantly higher in rural areas compared to urban areas in both 2007 and 2011. For example, in 2007 the prevalence of severe anemia was 13% (95% CI: 11-16%) in rural areas compared to 8% (95% CI: 6-10%) in urban areas. Overall, severe anemia prevalence was higher among children from poorer households. For children 6-59 months from the poorest households, severe anemia was significantly higher at 17% (95% CI: 14–22%) in 2007 and 15% (95% CI: 13–18%) in 2011, compared to those from the least poor households, which was 5% (95% CI: 3–9%) in 2007 and 3% (95% CI: 2–5%) in 2011. Similarly, for children 6-59 months with mothers who had either no education or only a primary level education, severe anemia prevalence was significantly higher than those with mothers who had a higher education level in both survey years. For example, among children whose mothers had no education, severe anemia prevalence was 13% (95% CI: 13–16%) in 2007 and 11% (95% CI: 9–13%) in 2011, compared to only 6% (95% CI: 4–11%) in 2007 and 5% (95% CI: 3–7%) in 2011 for children whose mother had at least a secondary level of education.

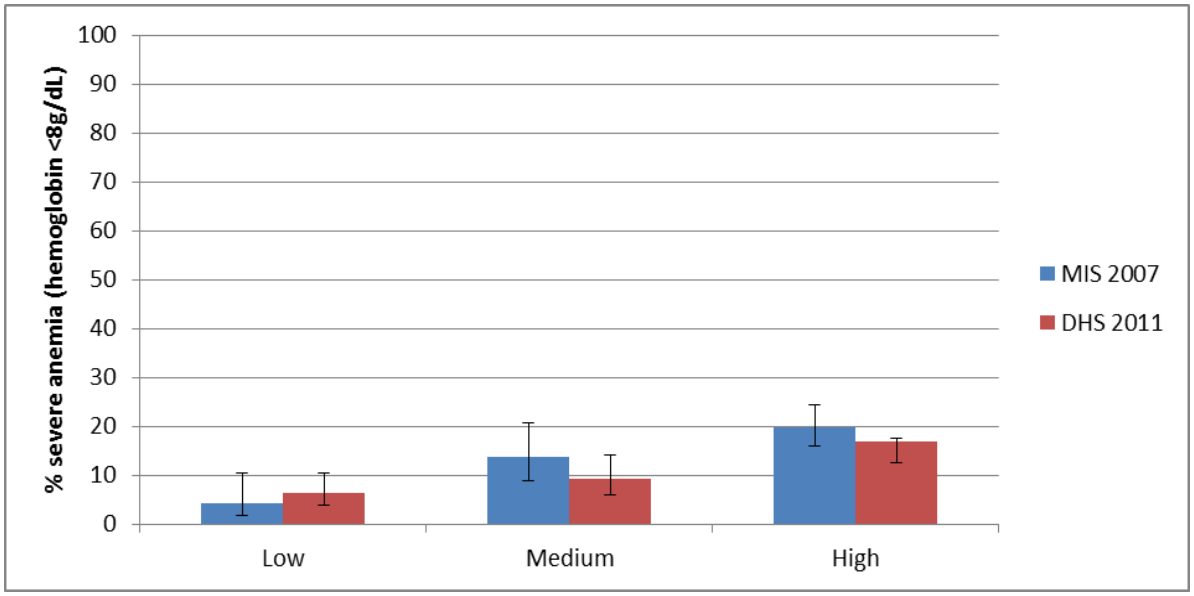
Table 18: Severe Anemia (Hb<8g/dL) prevalence in children 6-59 months of age, by background characteristics in Mozambique, 2007-2011

Background Characteristics	2007 MIS				2011 DHS				Relative Change (%)
	Percentage of children with severe anemia	95% CI		WN	Percentage of children with severe anemia	95% CI		WN	
Sex									
Male	12.8	10.4	15.7	1617	9.7	8.2	11.5	2,409	-24.2
Female	11	9.2	13.2	1536	9.2	7.7	10.8	2,479	-16.4
Residence									
Urban	7.9	6.3	9.9	1448	6	4.7	7.7	1,334	-24.1
Rural	13	10.7	15.6	1705	10.7	9.2	12.4	3,555	-17.7
Wealth									
Quintile 1 (Poorest)	17.2	13.5	21.5	712	15.2	12.5	18.3	1,127	-11.6
Quintile 2	12	8.9	16.1	656	12.5	10.2	15.3	1,083	4.2
Quintile 3	12.3	8.4	17.6	698	8.3	6.4	10.7	952	-32.5
Quintile 4	7.6	5.3	10.8	609	5.2	3.9	6.9	1,006	-31.6
Quintile 5 (Least Poor)	5.2	3	8.8	478	3.2	2.2	4.5	720	-38.5
Mother's Education									
None	13.3	11.3	15.7	1783	10.6	8.7	12.8	1,642	-20.3
Primary	11	8.3	14.5	1025	10.2	8.6	12.1	2,307	-7.3
Secondary and higher	6.4	3.6	11	302	4.5	2.8	7.3	506	-29.7
Missing	3	0.6	14.4	44	6.7	4.3	10.3	434	123.3
Total	12	10.1	14.1	3153	9.4	8.3	10.7	4,888	-21.7

Anemia by Malaria Risk Zones in Mozambique

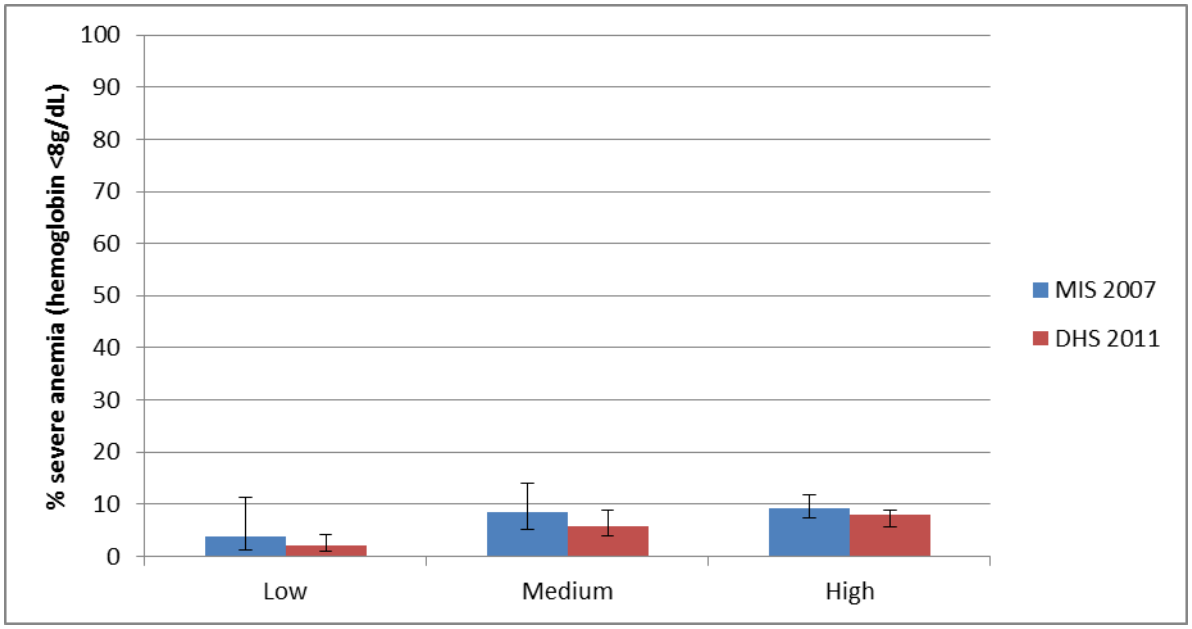
Figure 35 shows that the prevalence of severe anemia in children 6-23 months of age across the three malaria risk zones. In the low risk zones, the prevalence of severe anemia increased slightly from 4% (95% CI: 2-10%) in 2007 to 6% (95% CI: 4-10%) in 2011; while in the medium and high risk zones, the prevalence of severe anemia declined slightly from 2007 to 2011. However, none of the changes observed between 2007 and 2011 were statistically significant.

Figure 35: Trends in severe anemia (Hb <8g/dL) prevalence in children 6-23 months of age, by malaria risk zones, 2007-2011



The prevalence of severe anemia in children 24-59 months of age across the three malaria risk zones is shown in Figure 36. Across all risk zones, there was a slight decline in the prevalence of anemia from 2007 to 2011; however, none of these declines were statistically significant. As expected, severe anemia prevalence was the lowest in the low risk zones, and highest in the high risk zones. Overall, across all malaria risk zones, severe anemia prevalence was higher is children 6-23 months, compared to children 24-59 months of age.

Figure 36: Trends in severe anemia (Hb <8g/dL) prevalence in children 24-69 months of age, by malaria risk zones, 2007-2011



Summary of Malaria Morbidity

Malaria parasitemia prevalence (RDT) declined significantly across all age groups of children in Mozambique from 2007 to 2011, from 44% to 31% n children 6-23 months, and from 56% to 39% in children 24-59 months. There were striking inequities in malaria parasitemia found across place of residence, wealth quintile and mother's education level. Furthermore, the greatest declines observed in malaria parasitemia from 2007 to 2011 were amongst children from urban areas, the least poor households and among children whose mothers had the highest level of education. Malaria parasitemia showed a significant decline from 60% in 2007 to 44% in 2011 in the high malaria risk zones and no significant decline in the low and medium malaria risk zones. Unexpectedly, no clear trend was observed among malaria parasitemia and household ownership of ITNs in the 2007 and 2011 surveys. There was also no significant difference observed in either 2007 or 2011 in parasitemia prevalence among children that slept under an ITN and those that did not sleep under an ITN the previous night.

HMIS data on malaria cases from 2000 to 2012 show an overall declining trend starting in 2005 through 2012. Furthermore, the proportion of confirmed malaria discharges from hospitals, health centers and posts also demonstrated a decline from 2006 to 2012. Although there are no data specifically on malaria cases among children under five years of age, the decline does reflect the introduction of RDTs and the expansion of malaria prevention interventions.

In terms of severe anemia, a small decline was observed among children aged 6-59 months, 6-23 months and 24-59 months between 2007 and 2011. The greatest relative decline was observed in children 24-59 months, from 9% to 7% (percent relative change of 27%); however, overall none of the declines observed were statistically significant. The trend observed in severe anemia across the malaria risk zones was as expected, with the highest prevalence in the high risk zones and the lowest prevalence in the low risk zones. Across all three risk zones, a decline was observed in severe anemia prevalence from 2007 to 2011.

Similar to malaria parasitemia, there were notable inequities observed in severe anemia prevalence in children 6-59 months across place of residence, wealth quintile and mother's education level. Children from rural areas, the poorest households and those with mothers with no or only a primary level of education experienced much higher severe anemia prevalence in both 2007 and 2011.

MORTALITY

Mortality

Background

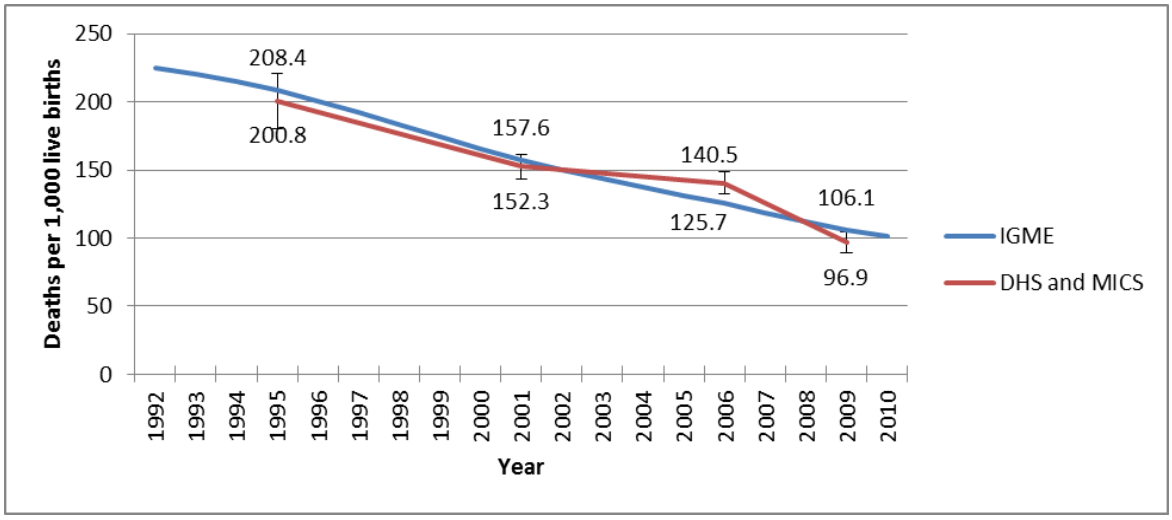
This section reviews recent trends in ACCM in Mozambique, with a view to assessing the magnitude, timing, and age-pattern of change between the 2003 and 2011 surveys. In addition, it includes an ecological analysis that examines changes in mortality with respect to malaria risk. Mortality estimates for 1993-1997, from the 1997 DHS, are included in some figures to put recent trends in a longer-term context. Similarly, mortality estimates from the 2008 MICS are also included when available. All mortality figures represent direct estimates, and unless otherwise stated, represent the period 0-4 years before each survey. ACCM trends from IGME are included in figures where relevant for comparative purposes.

Mortality estimates presented in this evaluation are derived from multiple Demographic and Health Survey (DHS) datasets and one Multiple Indicator Cluster Survey (MICS) rather than mortality estimates available from IGME. The level and detail of stratification needed to inform the plausibility design of this evaluation was not possible using IGME estimates. IGME and other mortality estimates are presented and discussed when applicable.

Trends in All-cause Mortality in Children Under Five Years of Age (ACCM)

Estimates of ACCM from the three DHSs (1997, 2003, and 2011) and the 2008 MICS are presented in Figure 37 along with the corresponding ACCM estimates from IGME. Significant reductions in ACCM are evident between all five-year periods. Overall, during the evaluation period, ACCM reduced significantly from 152 deaths (95% CI: 143-162) per 1,000 live births in the period from 1999 to 2003 to 97 deaths (95% CI: 90-104) in period from 2007 to 2011, representing a relative decline of 36%. The greatest decline (31%) occurred between 2004-2008 and 2007-2011.

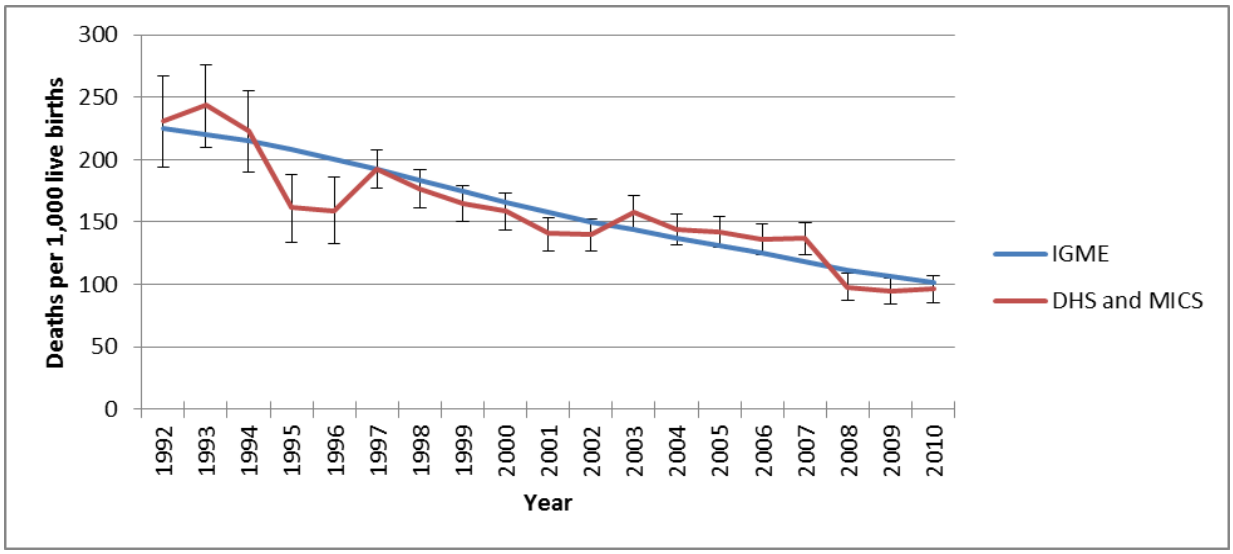
Figure 37: Trends in ACCM, Mozambique, five year estimates from DHS and MICS data, 1993–1997, 1999–2003, 2004-2008, 2007–2011*, and IGME estimates



*DHS (1997, 2003 and 2011) and MICS (2008) estimates are for the five years preceding the survey. Data points have been put at the mid-point of the five year range to accurately represent the timing of the estimate. The confidence intervals shown in the graph represent the upper and lower bound estimates for the DHS and MICS estimates.

Although DHS and MICS reports typically present five-year estimates of mortality it is possible to generate annual mortality estimates from the surveys. These estimates usually have greater levels of uncertainty due to smaller samples sizes, but allow examination of more fine-scale trends. Annual DHS and MICS estimates show a close correlation with the IGME estimates (with the exception of some of the annual estimates from the 1997 DHS, which has larger confidence intervals). As was seen in the five-year estimates, ACCM has been declining since 1993 (Figure 38), with an overall relative reduction of 58%.

Figure 38: Trends in annual ACCM (1993-2011), Mozambique, from DHS (1997, 2003, and 2011) and MICS (2008) data, and IGME estimates

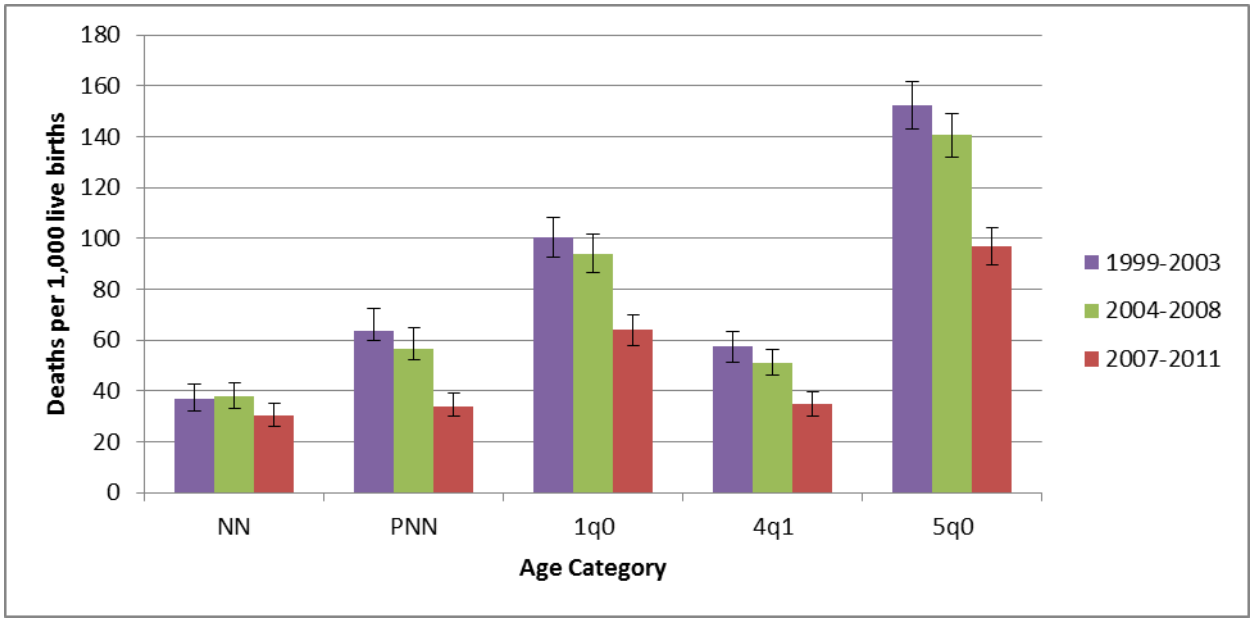


Notes: The confidence intervals shown in the graph represent the upper and lower bound estimates for the DHS and MICS estimates.

Trends in Age-specific Childhood Mortality

Trends in age-specific childhood mortality from the last two DHS surveys (2003 and 2011) and from the 2008 MICS are presented in Figure 39. Overall, childhood mortality decreased significantly for all age categories between the first and last survey years, with the exception of neonatal mortality which saw no significant decline. The declines were greatest for all age categories between the last two surveys (2004-2008 and 2007-2011) than between the first two surveys (1999-2003 and 2004-2008).

Figure 39: Trends in age-specific childhood mortality, Mozambique, five-year estimates from the 2003 DHS, 2008 MICS and 2011 DHS



NN = neonatal mortality (first month), per 1,000 live births; PNN = post-neonatal mortality (age 1-11 months), per 1,000 live births; ${}_1q_0$ = infant mortality (first year), per 1,000 live births; ${}_4q_1$ = child mortality between exact age 1 and exact age 5, per 1,000 children surviving to 12 months of age; ${}_5q_0$ = under-five mortality, per 1,000 live births.

The mortality estimates and relative change in these estimates by age categories are shown in Table 21. Four additional age categories are included: 6–23 months (where malaria-related mortality would be expected to be concentrated), 24–59 months, 1–59 months and 6–59 months (for comparison). For all age categories, the greatest decline occurred between the period of 2004-2008 and the period of 2007-2011. Overall, post-neonatal mortality declined the most (47%) between the first (1999-2003) and last (2007-2011) time periods and neonatal mortality the least (18%).

If a major proportion of ACCM was due to malaria, declines in malaria deaths over the period of expansion in malaria control interventions should be greatest in the children

most susceptible to severe malaria outcomes; that is, greater among 6-23 month old children compared to those aged 24-59 months. The overall decline of mortality among these age categories between 1999-2003 and 2007-2011 was similar, slightly less for children aged 6-23 months (39%) compared to those aged 24-59 months (42%).

Table 19: Age-specific mortality (deaths per 1000 live births) and relative change in age-specific mortality, Mozambique, 0–4 years prior to the survey by period of estimation

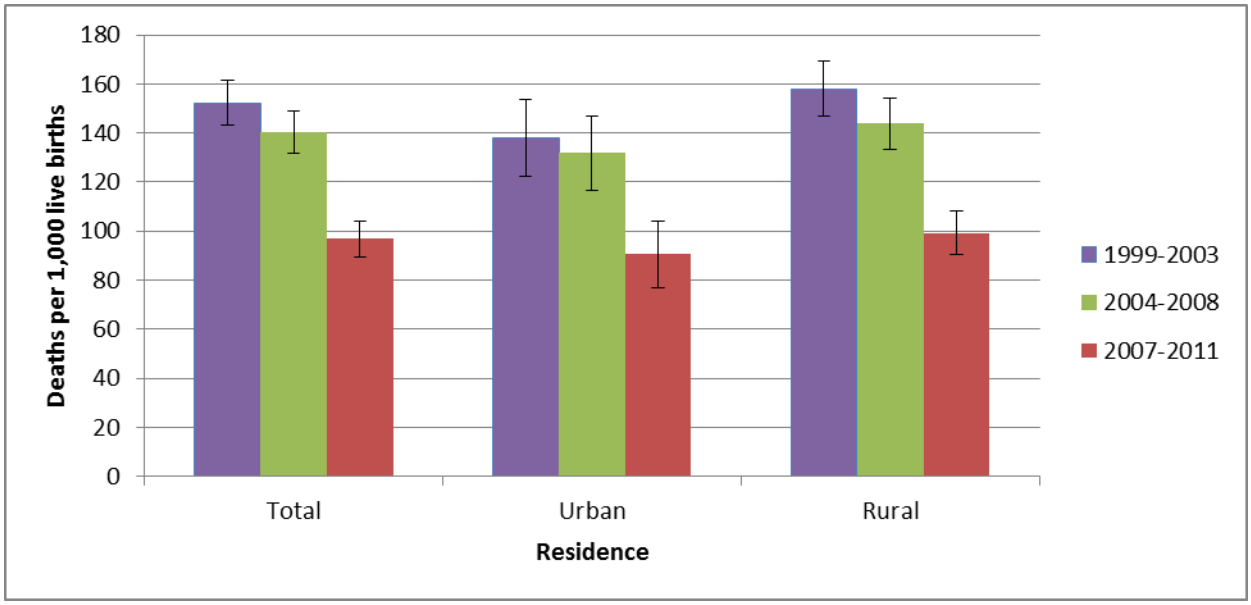
Age Category	Mortality (0–4 years prior to the survey)			Relative change	Relative change	Relative change
	A 2003 DHS	B 2008 MICS	C 2011 DHS	A–B	B–C	A–C
Neonatal (NN)	37.1	37.8	30.4	1.9%	-19.6%	-18.1%
Post-neonatal (PNN)	63.6	56.4	33.7	-11.3%	-40.2%	-47.0%
Infant ($_1q_0$)	100.6	94.1	64.1	-6.5%	-31.9%	-36.3%
Child ($_4q_1$) [a]	57.4	51.2	35.0	-10.8%	-31.6%	-39.0%
Under-five ($_5q_0$)	152.3	140.5	96.9	-7.7%	-31.0%	-36.4%
1–59 months [b]	119.7	106.8	68.5	-10.8%	-35.9%	-42.8%
6–59 months [c]	84.5	75.4	51.0	-10.8%	-32.4%	-39.6%
6–23 months [c]	50.8	46.7	31.2	-8.1%	-33.2%	-38.6%
24–59 months [d]	35.5	30.1	20.5	-15.2%	-31.9%	-42.3%

[a] Child mortality ($_4q_1$) is per 1,000 live-born children surviving to 12 months of age
[b] 1–59 month mortality and 1–5 month mortality is per 1,000 live-born children surviving to 1 month of age
[c] 6–59 month mortality and 6–23 month mortality is per 1,000 live-born children surviving to 6 months of age
[d] 24–59 month mortality is per 1,000 live-born children surviving to 24 months of age

ACCM by Residence

If a major part of the decline in ACCM was malaria-related, we would expect to see a greater decline in mortality from a higher baseline, among children living in rural areas compared to those living in urban areas [50,51]. Figure 40 shows mortality rates from 1999–2003, 2004–2008 and 2007–2011 stratified by urban and rural residence. ACCM in Mozambique declined significantly in both urban and rural areas between the last time period (2007–2011) and the first two (1999–2003 and 2004–2008), but not between the first two time periods. The overall decline was slightly greater in rural areas, from 158 deaths (95% CI: 147–169) per 1,000 live births in 1999–2003 to 99 deaths (95% CI: 90–108) in 2007–2011, representing a relative decline of 37%. In urban areas, the decline was from 138 deaths (95% CI: 122–154) per 1,000 live births in 1999–2003 to 91 deaths (95% CI: 77–104) in 2007–2011, representing a relative decline of 34%.

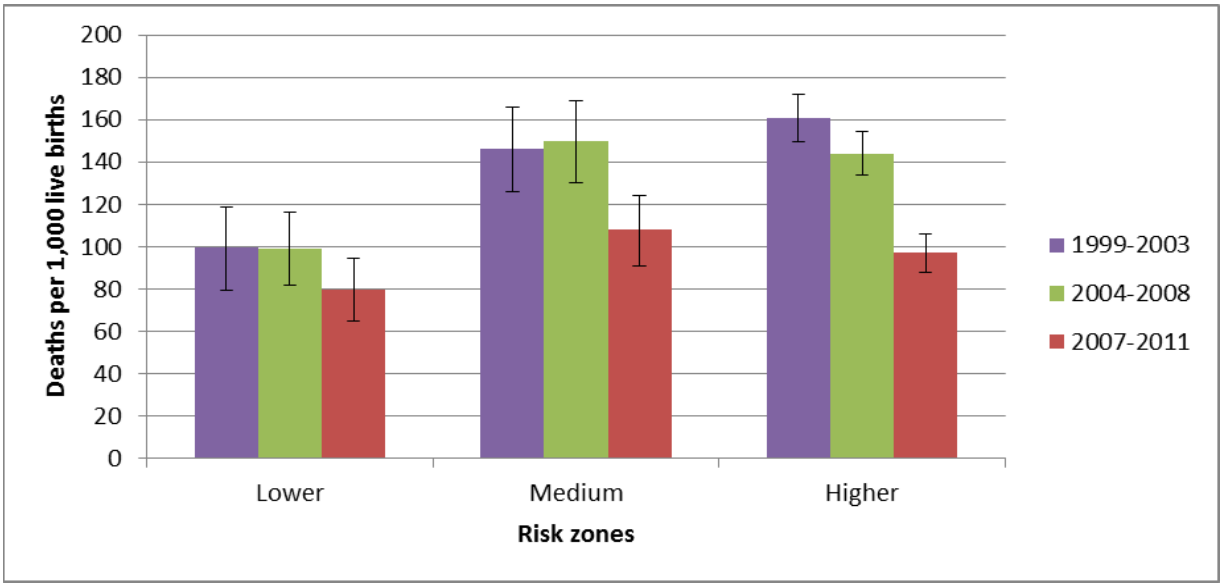
Figure 40: Trends in ACCM by residence, Mozambique, five-year estimates from the 2003 DHS, 2008 MICS and 2011 DHS



ACCM by Malaria Risk

If a major part of the decline in ACCM was malaria-related, all things being equal we would expect to see a greater decline in mortality, from a higher baseline, among children living in areas of greater malaria risk – as compared to areas of lower malaria risk [50,51]. To test this hypothesis, trends in childhood mortality rates stratified by malaria risk zones as defined previously were assessed (Table 4). For children under five years of age, the mortality rates from 1999–2003 were 161, 146, and 99 per 1,000 live births in the higher, medium and lower risk zones, respectively (Figure 41). By the 2007–2011 time period, the mortality rates had dropped to 97, 108, and 80 per 1,000 live births, respectively in the higher, medium and lower risk zones. The declines are statistically significant in the higher and medium risk zones but not in the lower zones.

Figure 41: Trends in ACCM in Lower, Medium and Higher Malaria Risk Zones, Mozambique, five-year estimates from the 2003 DHS, 2008 MICS and 2011 DHS



Trends in mortality in the three malaria risk zones were also stratified by two age groups: 6-23 months and 24-59 months. As shown in Figure 42, for the 6-23 months age group, mortality declined significantly and the most in the higher malaria risk zones (by 44% between the first and last time periods). For the 24-59 months age group (Figure 43), there was a significant, but smaller, decline in the higher risk zones (by 39% between the first and last time periods) and mortality declined the most in the lower risk zones (by 70% between the first and last time periods). Taken together, these results are consistent with the hypothesis that malaria control interventions have contributed to declines in ACCM.

Figure 42: Trends in 6-23 Months Mortality in Lower, Medium and Higher Malaria Risk Zones, Mozambique, five-year estimates from the 2003 DHS, 2008 MICS and 2011 DHS

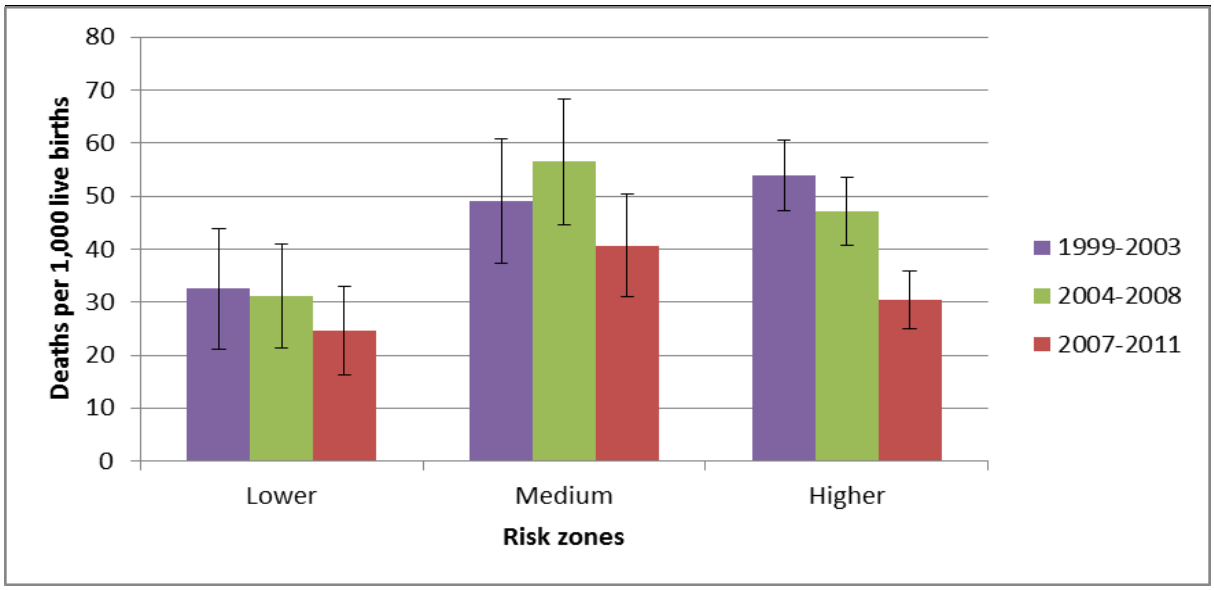
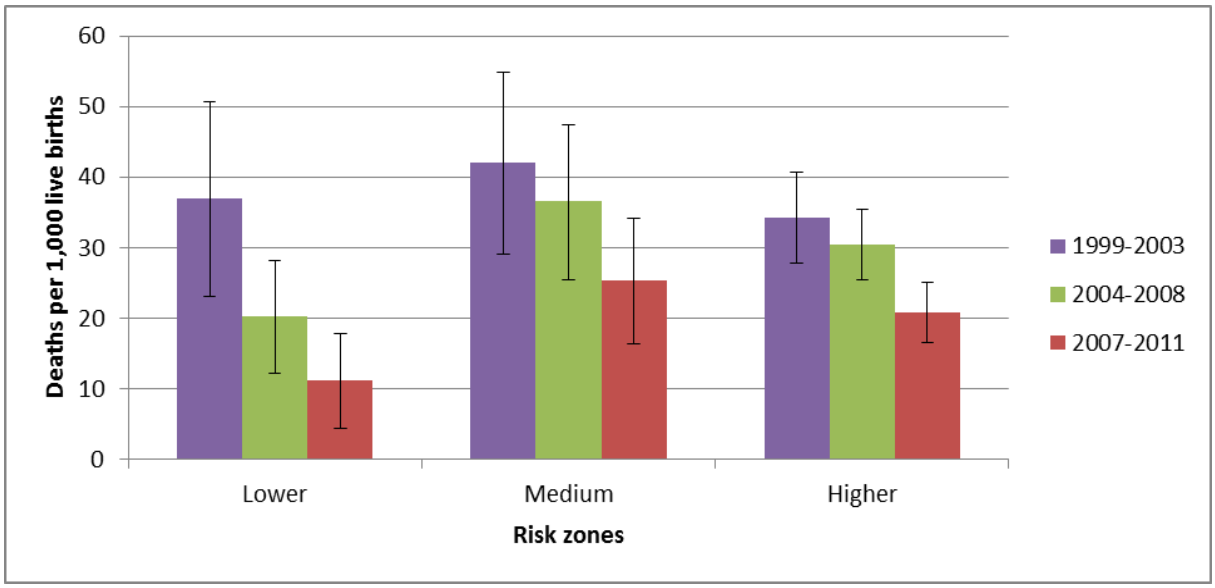


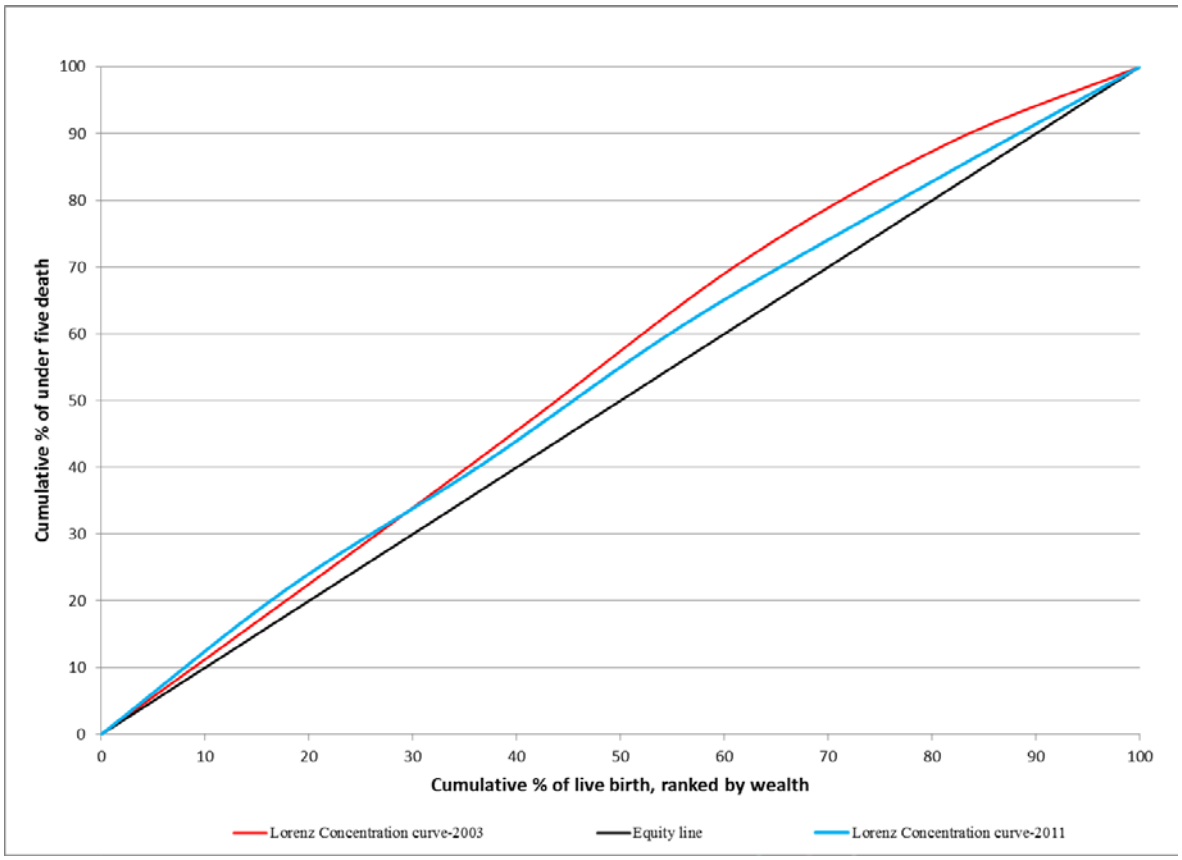
Figure 43: Trends in 24-59 Months Mortality in Lower, Medium and Higher Malaria Risk Zones, Mozambique, five-year estimates from the 2003 DHS, 2008 MICS and 2011 DHS



Equity in ACCM

It is conceivable that mortality changes described in this section could have occurred through disproportionately large gains in higher socio-economic groups. If this were the case, the differential in mortality by wealth quintile would have widened over time. Inequalities in mortality by wealth quintile are presented here using Lorenz Concentration Curves – where the straight line represents perfect equality (with a concentration index of zero), and "upward" departure from the diagonal indicates higher mortality in poorer population quintiles (with a negative sign on the concentration index). Figure 44 shows the results of this analysis for ACCM estimates during the time periods 1999–2003 and 2007–2011. The concentration index in 2007-2011 (-0.0641) was closer to "equality" than that from 1999-2003 (-0.0977), indicating that equity of child survival between households of different wealth quintiles improved between these two survey periods, although the results are not statistically significant.

Figure 44: Inequalities in ACCM 1998–2003 and 2007–2011, DHS



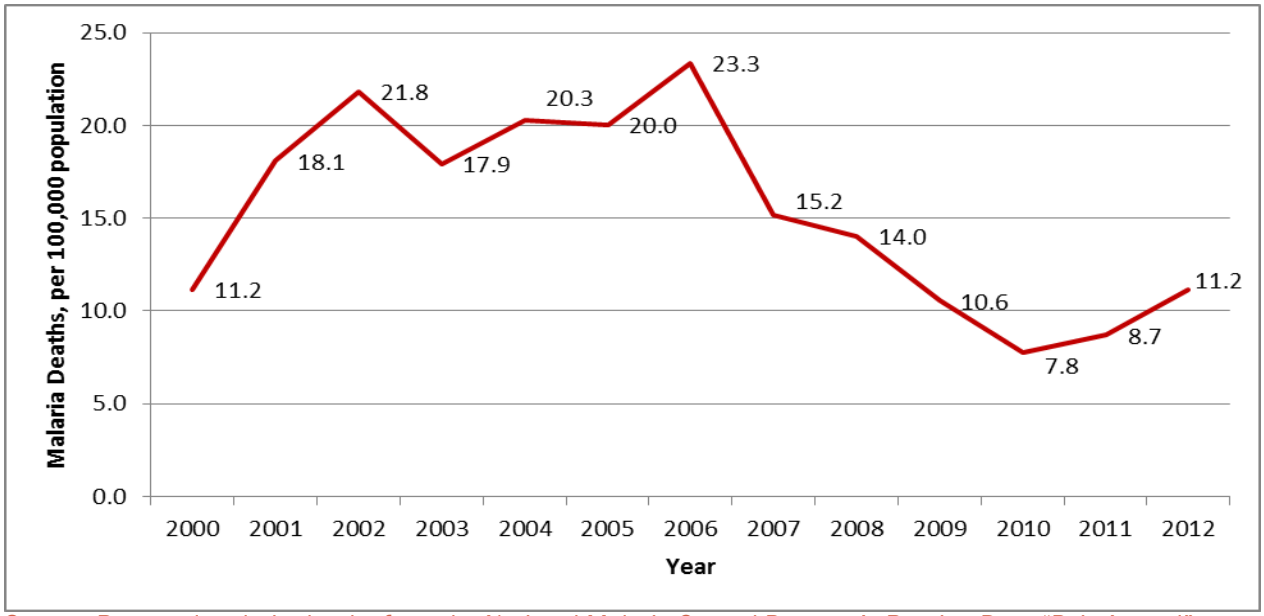
Concentration Index
1998-2003: -0.0977 (95% CI: -0.1765 – -0.0190)
2007-2011: -0.0641 (95% CI: -0.0860 – -0.0421)
*Concentration index values range between -1 to 1; a value of 0 suggests no difference among different socioeconomic groups.

Facility-based Malaria Mortality Data

As with the malaria cases examined earlier, HMIS data were used to investigate trends in malaria deaths in Mozambique between 2000 and 2012. Figure 45 shows that the number of reported malaria deaths (all ages), per 100,000 population, generally increased in the country between 2000 and 2006, when it peaked at 23.3 deaths. The increase in deaths is likely due to the increase in number of health facilities and the establishment of a death reporting system during that period. Between 2006 and 2010, malaria deaths dropped steadily, to the lowest level recorded in 2010 at 7.8 deaths per 100,000 population. The decline in deaths could be attributed to the increase in coverage of malaria control interventions. Similarly, the introduction of RDTs in 2005 could also have contributed to the decline, with more accurate diagnostics and classification of malaria deaths. In both 2011 and 2012, the number of reported malaria deaths increased again and reached 11.2

deaths per 100,000 population in 2012. This more recent increase in deaths could be due to the increase in the number of health facilities and the reduction of IRS implementation between 2011 and 2012. Unfortunately, data regarding the percent of health facilities reporting to the HMIS is not available for malaria deaths data. Similarly, data regarding malaria deaths among children under five years of age specifically at the national level is also not available. Thus in conclusion, due to the changes in reporting rates and limited information on health facilities reporting data on malaria deaths, and improved diagnostics through the introduction of RDTs, it is difficult to attribute the declines observed to the expansion of malaria control interventions.

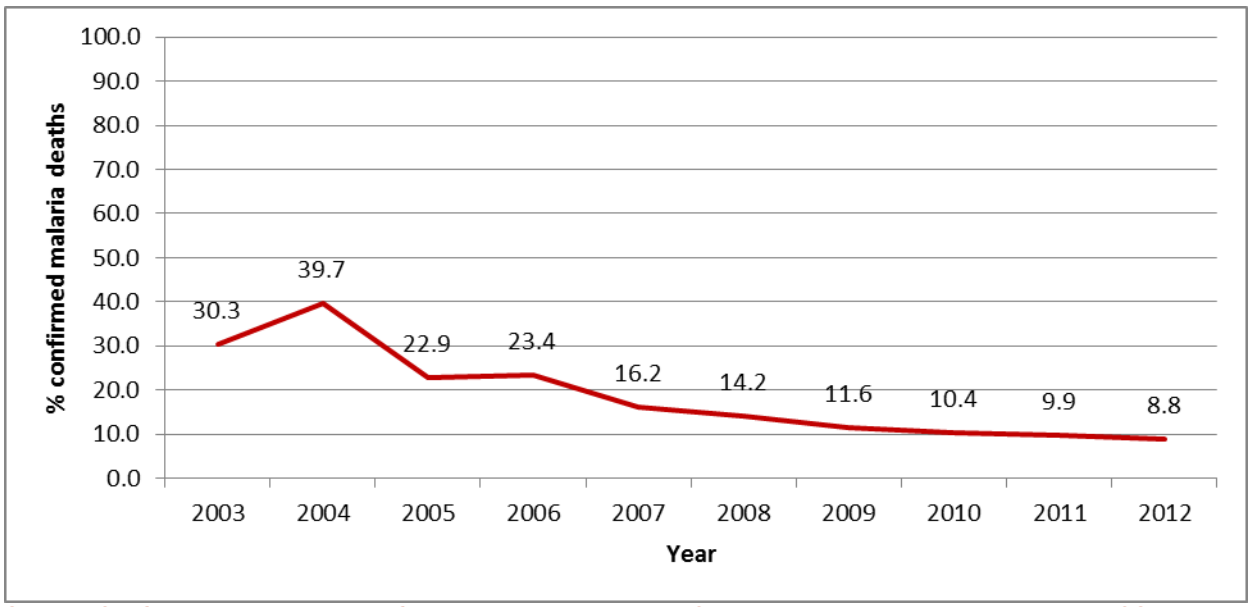
Figure 45: Reported Malaria Deaths in Mozambique per 100,000 Population, All Ages, 2000-2012



Source: Reported malaria deaths from the National Malaria Control Program's Routine Data "Pais Annual"; Mozambique Population data from the World Bank data (http://data.worldbank.org/indicator/SP.POP.TOTL)

Figure 46 shows that the proportion of confirmed malaria deaths (all ages) among all deaths occurring in hospitals, health centers and posts decreased between 2004 and 2012 in Mozambique. In 2004, 40% of all deaths were confirmed malaria, while by 2012 this had decreased to 9%.

Figure 46: Proportion of Confirmed Malaria Deaths (All Ages) out of All Hospital, Health Center and Health Post Deaths, Mozambique, 2003-2012



Source: Confirmed malaria deaths from the National Malaria Control Program's Routine Inpatient D03 (health centers and health posts) and D04 (hospitals) data.

Summary of All-cause Childhood Mortality

In summary, the data show that a significant decline in ACCM occurred in Mozambique between 1999-2003 and 2007-2011 (36%), with the greatest reduction occurring between 2004-2008 and 2007-2011 (30%), the period when malaria control interventions were expanded. This decline did not begin suddenly; data show a steady decline from 1993 through the end of the evaluation period in 2011 (over 50% reduction overall).

The mortality decline between 1999-2003 and 2007-2011 was greater among children living in rural areas (37%) compared to urban areas (34%). Stratification of child mortality by malaria risk showed the greatest reduction in ACCM in children living in higher and medium malaria risk zones. Mortality among the 6-23 months age group, those who are at greater risk of malaria mortality, declined the most in the higher malaria risk zones (44%), while for the 24-59 months age group, the largest decrease was in the lower risk zones (70%).

Many aspects of the mortality analysis presented in this section (timing, residence differentials, and relationship to malaria risk) are consistent with the results that would be expected if malaria were a major factor underlying the mortality change in Mozambique. It is also clear that other factors must have contributed to the observed decline in ACCM before the major investments in malaria control efforts began. These factors are discussed in the next section.

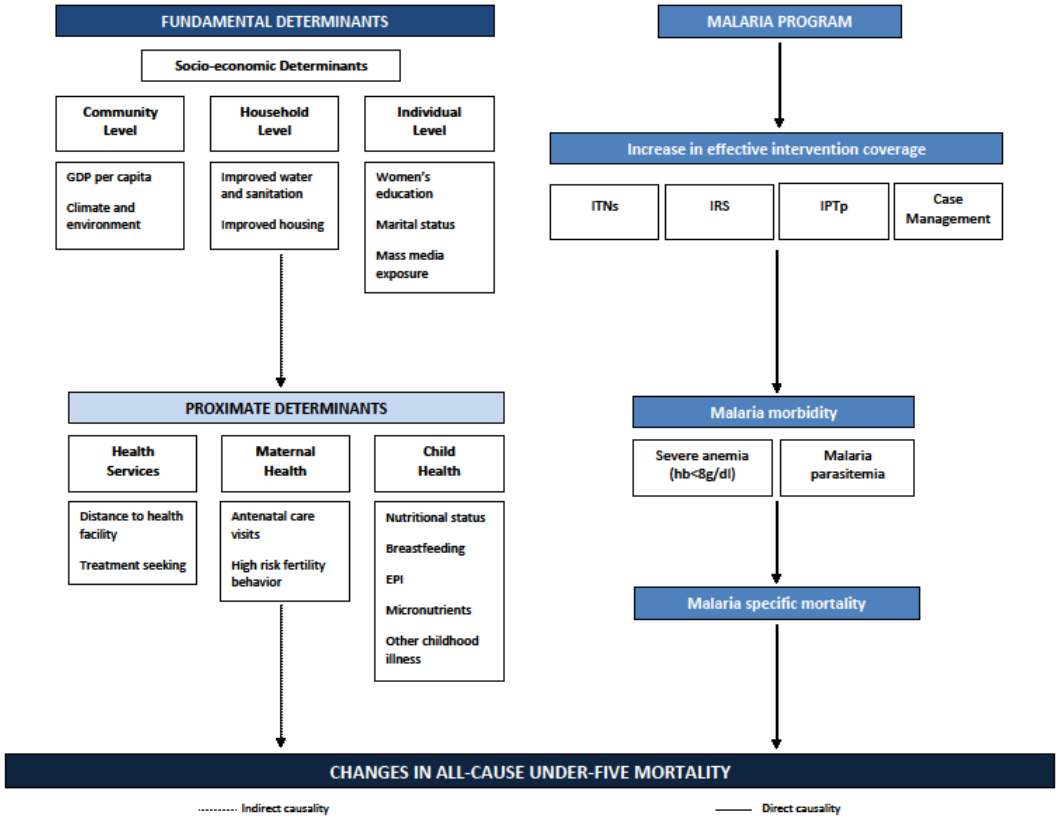
CONTEXTUAL FACTORS

Accounting for Contextual Factors

Appropriate consideration of contextual factors is essential to ensure the internal and external validity of evaluations of large-scale health programs [52], particularly for evaluations that are conducted when rapid changes are under way in many other aspects of health services [53].

Contextual factors associated with childhood mortality and illness, including malaria, can be broadly categorized into the fundamental and proximate determinants of disease [54,55,56,57,58,59,60,61]. Fundamental determinants are the social and economic conditions under which people live, while proximate determinants are biological risks. The conceptual framework [6,53,62,63] for the evaluation design in Mozambique, Figure 47, incorporates numerous contextual factors within various subcategories of the fundamental and proximate determinants of disease. In the following sections, relevant information and levels and trends on various contextual determinants – fundamental and proximate – of childhood mortality and illness are reviewed. Data on contextual factors were obtained from large population-based household surveys (including DHS, MIS, AIS, MICS), as well as other sources such as WHO, UNICEF, World Bank and UNAIDS.

Figure 47: Conceptual framework for the evaluation of the malaria control program, Mozambique, 2003-2011



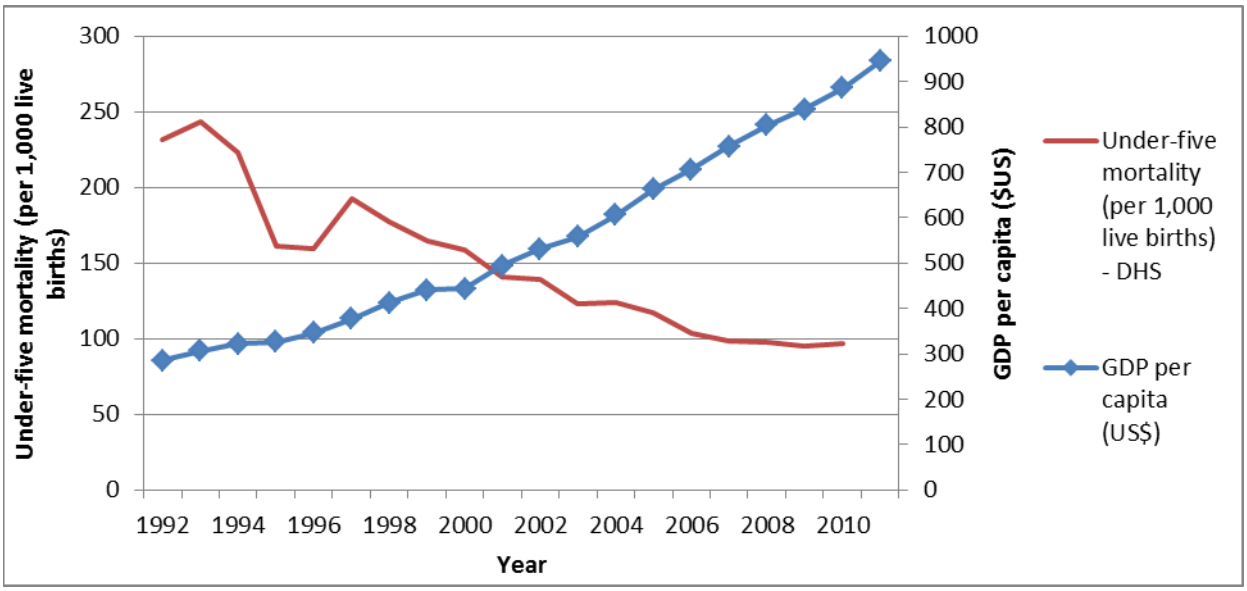
Fundamental Determinants

Socioeconomic Factors

A range of socioeconomic determinants at the community, household, and individual level are associated with child survival [57,64,65], as shown in the impact model in Figure 47. Economic poverty, either at the country or individual level, strongly correlates with poorer health outcomes [66]. Gross Domestic Product (GDP) per capita income, a measure of population wealth in a country, is considered to be a typical macroeconomic determinant of health [65]. The relationship between GDP per capita and ACCM indicates that a 1% annual increase in GDP per capita is associated with a 0.4-0.6% reduction in ACCM [67].

In Mozambique, the GDP per capita (current international $) has gradually risen from $606 in 2003 to $945 in 2011. Trends in GDP per capita and growth in Mozambique are shown in Figure 48, in addition to annual estimates of ACCM. Between 2003 and 2011, Mozambique experienced a steady GDP annual growth, ranging from 6% to as high as 8.8% [16].

Figure 48: Trends in GDP per capita and annual estimates of ACCM, Mozambique, 1992–2011



Household and microeconomic factors are important determinants of child health and malaria risk [64,68]. Socio-economic differentials at the household level are associated with access to malaria interventions [69,70,71], thereby increasing the vulnerability of the poorest to malaria [72]. Levels and trends in household attributes and other proxies of socio-economic status are summarized in Table 22.

Safe water and sanitary facilities contribute to improved child health and survival [69]. The proportion of households with an improved water source (i.e., protected, borehole, piped) did not change significantly between 2003 and 2011, while the proportion of households

with a water source within 15 minutes of the household increased slightly, from 36% to 41% over the same time period. Household access to improved toilet facilities however did improve significantly, from 9% in 2007 to 23% in 2011.

Housing construction, such as flooring and roofing material, has been used to assess household socioeconomic status, but house construction also can directly affect malaria risk [70,71]. From 2003 to 2011, households with an improved roof (i.e., not thatch, grass, or mud) remained about the same (34% in 2003 compared to 32% in 2011), while the proportion with modern floor materials (i.e., not earth, sand, or dung) did improve significantly, from 24% to 42%. No data are available on the proportion of houses that have sealed or screened eaves or ceiling boards – two important factors associated with malaria risk [73,74,75,76].

Overall household access to electricity and a telephone (landline or mobile) both improved significantly over the evaluation period, particularly telephone access which rose from 2% in 2003 to 34% in 2011.

Table 20: Household attributes and asset ownership, Mozambique, 2003–2011

Indicator	2003 DHS		2007 MIS		2008 MICS		2009 AIS		2011 DHS		% Relative Change 2003-2011	Sig.
	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN		
Improved water source*, (% households)	42.0 (38.4-45.7)	12315	73.1 (69.3-76.5)	5745	45.8 (42-49.6)	13955	43.7 (37.5-50.0)	6097	44.7 (41.7-47.7)	13919	6.4	NS
Time to water source <15 min, (% households)	35.7 (33.3-38.3)	12315	n/a	n/a	n/a	n/a	n/a	n/a	41.1 (38.7-43.5)	13919	15.1	S
Improved toilet facilities**, (% households)	n/a	n/a	9.3 (8.1-10.5)	5745	17.4 (15.3-19.6)	13955	22.5 (19.8-25.5)	6097	23.3 (21.6-25.2)	13919	150.5	S
Improved roof (not thatch/grass/mud), (% households)	n/a	n/a	33.7 (31-36.5)	5745	29.5 (26.6-32.6)	13955	29.9 (26.2-34.0)	6097	31.9 (29.8-34.2)	13919	-5.3	NS
Modern floor material (not earth/sand/dung), (% households)	24.3 (22.1-26.6)	12315	26.5 (24-29.1)	5745	22.5 (19.9-25.3)	13955	27.5 (23.8-31.4)	6097	42.4 (40.3-44.5)	13919	74.5	S
Electricity, (% households)	8.1 (6.8-9.5)	12302	19.7 (17.9-21.6)	5745	13.6 (11.5-15.9)	13955	15.1 (12.1-18.5)	6097	20.2 (18.1-22.5)	13919	149.4	S
Telephone (landline or mobile), (% households)	1.6 (1.2-2.2)	12315	20.9 (19.1-23.1)	5745	25.1 (22.6-27.8)	13955	25.9 (22.6-29.6)	6097	34.2 (31.9-36.5)	13919	2037.5	S

*Improved water source includes piped water into dwelling/yard/plot; public tap/standpipe, tube well or borehole, protected dug well, protected spring, or rainwater
**Improved toilet facilities includes flush to piped sewer system, septic tank, or pit latrine, Ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet. Information on sharing was not available.
WN = Weighted Sample Size; CI = Confidence Interval; Sig. = Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant; S denotes statistically significant.

Weather Variability

Malaria transmission in Mozambique, as in much of sub-Saharan Africa, is characterized by distinct seasonal trends, dependent on patterns of rainfall and temperature. In Mozambique, the rainy season typically begins in October and continues through March. April through September is typically drier and cooler. In Maputo, the temperature ranges from as low as 13°C to 24°C in July (during one of the coldest months) to 22°C to 31°C in February. Weather along the coastal regions, and in particular, the north-eastern coast, is overall more hot and humid, while the inland areas are overall cooler.

Mean minimum temperatures are particularly important for malaria transmission. Within the transmission season one of the primary limitations on transmission is low evening temperatures that slow parasite development within the vector. Higher minimum temperatures allow for greater degree-day time and more rapid parasite development within the vector. Maximum temperatures late in the dry season can in some areas reach levels where adult mosquito mortality occurs. In addition to annual seasonal fluctuations, inter-annual climatic drivers such as the El Niño Southern Oscillation can affect rainfall and temperature patterns in the region [77] within a given year, and longer-term patterns of climate change may influence rainfall and temperature patterns over many years or decades. It is important to consider and, where sufficient data exist, control for any inter-annual weather or longer term climate trends when evaluating trends in malaria morbidity and mortality. Rainfall is heavy along the central coast region and decreases in the north and south. Annual rainfall ranges from 500 to 900 mm depending on the region, with an average of 590 mm (23.2 in).

Mother's Education and Marital Status

At an individual level, maternal education is an important determinant of maternal and child health [65,78,79,80,81,82,83]. In Mozambique, maternal education did improve over the evaluation period. In 2003, 11% of women aged 15-49 had completed primary, as compared to 24% in 2011, a significant change. Women's literacy however, remained stable over the evaluation period (Table 23).

Survivorship and health outcomes of children under five years of age are better among married women [84,85,86]. In 2003, 70% of women were married or living with a partner, as compared to 68% in 2011, demonstrating no significant change over the evaluation period.

Table 21: Women's* education, and marital status in Mozambique, 2003-2011

Indicator	2003 DHS		2007 MIS		2008 MICS		2009 AIS		2011 DHS		% Relative Change 2003-2011	Sig.
	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN		
Mean years of education	2.5 (2.3-2.6)	12418	3.0 (2.9-3.2)	5629	n/a	n/a	3.5 (3.3-3.8)	11212	3.8 (3.6-4.0)	13745	52.0	S
Completed primary education (%)	10.7 (9.4-12.3)	12418	n/a	n/a	n/a	n/a	24.3 (21.3-27.5)	11212	24.3 (22.3-26.5)	13745	127.1	S
Literacy (%)	37.5 (35.1-40.0)	12418	41.2 (38.6-43.8)	6293	32.9 (30.8-35.1)	14120	n/a	n/a	40.2 (37.8-42.6)	13745	7.2	NS
Married (%)	70.4 (68.8-71.9)	12418	n/a	n/a	70.4 (68.8-71.9)	14188	69.8 (67.7-71.8)	11212	67.9 (66.6-69.1)	13745	-3.6	NS

* Women aged 15-49 years.
WN = Weighted Sample Size; CI = Confidence Interval; Sig. = Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant and S denotes statistically significant.

Mass Media Exposure

Exposure to mass media has been shown to have a positive influence over health knowledge, attitudes and behaviors [87,88,89,90]. This has been shown particularly among women; where women who are exposed to mass media are more informed about health services and have a greater uptake of health services [89]. This includes general exposure to mass media, for instance radio, television and newspapers, as well as exposure to specific media messages via similar communication channels.

Over the evaluation period, exposure to the different mass media forums – radio, television and newspapers – did change significantly among women and men (Table 24). The percentage of women and men that read a newspaper at least once a week increased slightly from 4% in 2003 to 9% in 2011 for women, and from 12% to 17% for men over the same time period. Similarly, the percentage of women and men that watched television at least once a week also increased significantly from 15% and 24%, respectively in 2003 to 23% and 32% in 2011. Interestingly, radio listenership declined among both women and men from 2003 to 2011; with men showing a significant decrease in radio listenership over the evaluation period, from 75% to 66%.

Table 22: Mass Media Exposure among Women and Men in Mozambique, 2003-2011

	2003 DHS		2011 DHS		Relative Change (%)	Sig.
	% (95% CI)	WN	% (95% CI)	WN		
Women						
Reads newspaper at least once a week (%)	3.9 (3.2-4.8)	12,418	8.7 (7.7-9.9)	13,745	123	S
Watches television at least once a week (%)	14.8 (12.8-16.9)	12,418	24.3 (22.3-26.5)	13,745	64.2	S
Listens to radio at least once a week (%)	46.4 (44.4-48.4)	12,418	42.5 (40.8-44.3)	13,745	-8.4	S
Men						
Reads newspaper at least once a week (%)	11.5 (9.3-14.1)	2,900	17 (14.4-20.0)	4,035	47.8	S
Watches television at least once a week (%)	22.5 (19.4-26.0)	2,900	32.3 (28.8-36.0)	4,035	43.6	S
Listens to radio at least once a week (%)	75 (72.2-77.7)	2,900	66.1 (63.5-68.5)	4,035	-11.9	S

Proximate Determinants

Maternal Health

Antenatal care visits are considered a key entry point for a continuum of care during and after pregnancy that offer timely opportunities for receiving health promotions, as well as preventive and therapeutic interventions aimed at improving maternal, fetal, and newborn survival and wellbeing [91]. Through antenatal visits, women benefit from various interventions, including counseling about healthy lifestyles, the provision of iron/folic acid supplements, and tetanus toxoid vaccinations to protect newborns against neonatal death in addition to malaria prevention interventions such as IPTp and distribution of ITNs. In Mozambique, the percentage of women who attended four or more antenatal care visits (ANC4+) as recommended by WHO did not change significantly over the evaluation period: from 53% in 2003 to 51% in 2011 (Table 25). This trend may be, at least in part, due to changes in recommendations regarding the number of suggested antenatal care visits which were implemented by WHO in 2002 [92].

Neonatal tetanus is often the result of infection from unhygienic cutting/cleaning of the umbilical cord at the time of delivery. To help prevent infection, tetanus vaccination is recommended for women who have never received the tetanus toxoid vaccine to receive vaccination during pregnancy. [93,94,95]. In Mozambique, the proportion of women whose most recent births (within the last two years) were protected against neonatal tetanus (two or more doses of tetanus toxoid vaccine) significantly increased from 57% in 2003 to 67% in 2008, and then declined to 56% in 2011.

Vitamin A is also administered to women who have given birth within 4-6 weeks after the birth, to ensure that vitamin A requirements are met postpartum and that the mother's milk contains sufficient vitamin A [96]. Furthermore, periodic vitamin A supplementation (e.g., every 6 months) in areas with pre-existing vitamin A deficiency has been shown to decrease under-five mortality by up to 23% [97,98]. In Mozambique, the percentage of women aged 15-49 with a live birth in the five years preceding the survey that received a high-dose vitamin A supplement within the first two months after birth increased significantly from 21% in 2003 to 68% in 2011.

Child birth at health facilities, usually by skilled attendants, can reduce the chances of maternal and newborn complications. In 2003, 48% of live births occurred in health facilities, compared with 55% in 2011. Similarly, births attended by a skilled birth attendant also only increased slightly, from 48% in 2003 to 54% in 2011. Births in women with high-risk fertility can increase the risk of early childhood mortality. From 2003 to 2011, births in any high-risk fertility category did not change significantly (61% in 2003 and 60% in 2011). Similarly, births in women with unavoidable fertility risk[7] remained the same around 13% over the decade.

[7] First order births to women between the ages of 18 and 34.

Table 23: Maternal health in Mozambique, 2003-2011

Indicator	2003 DHS		2007 MIS		2008 MICS		2011 DHS		% Relative Change 2003-2011	Sig.
	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN		
ANC visits 4+ (% women, most recent live birth 0-2 yrs.)	53.1 (50.7-55.5)	7179	54.9 (51.9-57.9)	1904	n/a	n/a	50.6 (48.7-52.6)	7874	-4.7	NS
Tetanus toxoid 2+ (% women, most recent live births, 0-2 yrs.)	57.1 (55.0-59.3)	7179	n/a	n/a	66.5 (64.3-68.7)	5191	55.8 (53.9-57.7)	7874	-2.3	NS
Postnatal vitamin A supplementation	20.8 (19.3-22.4)	7179	n/a	n/a	65.6 (63.0-68.1)	5191	67.6 (65.6-69.6)	7874	225	S
Delivery at a health facility (% women, live births, 0-4 yrs.)	47.6 (44.4-50.8)	10,620	n/a	n/a	58 (54.9-61.1)	5191	54.8 (51.8-57.8)	11,704	15.1	S
Skilled attendant at birth	47.7 (44.6-50.9)	10,620	58.4 (54.8-61.9)	3237	55.3 (51.9-58.5)	5191	54.3 (51.3-57.3)	11704	13.8	S
Births in any high-risk fertility category (%)**	60.9 (59.5-62.4)	10,620	n/a	n/a	n/a	n/a	59.9 (58.5-61.3)	11,704	-1.6	NS
Births with unavoidable fertility risk (%)*	12.9 (12.1-13.7)	10,620	n/a	n/a	n/a	n/a	13.3 (12.5-14.1)	11,704	3.1	NS

Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different change. NS denotes no statistically significant change and S denotes statistically significant change.

*First order births to women between the ages of 18 and 34.

**Births to women <18 and>34 and births <2 years apart.

Note: For postnatal vitamin A supplementation, the 2003 and 2011 DHS is calculated among women age 15-49 with a live birth in the past five years, while for the 2008 MICS, it is calculated among women with a live birth within the past two years.

Child Health

The WHO Expanded Program on Immunization (EPI) offers vaccinations against common childhood communicable diseases and is one of the most cost-effective child survival interventions [99,100]. Effective coverage of these vaccinations contributes substantially to reductions in ACCM. Mozambique's recommended EPI schedule for children includes immunizations to protect against tuberculosis (BCG), polio, diphtheria, pertussis, and tetanus (DPT), hepatitis B (HBV), *Haemophilus influenzae b* (Hib) and measles. The immunization schedule calls for BCG and the first dose of polio within 14 days after birth, DPT-HBV-Hib and polio at 6, 10 and 14 weeks after birth, and measles at or soon after 9 months of age [101]. The HBV and Hib antigens were added to the DPT vaccine in 2002. Recommendations call for complete immunizations before one year of age and specify that they should be recorded on an immunization card.

Coverage of each of these childhood vaccinations during 2003-2011, according to vaccination cards or mother's report during household surveys, is shown in Table 26. The proportion of children aged 12-23 months that received all of the vaccinations recommended in the EPI schedule did not change from 2003 to 2011 (63% in 2003 and 64% in 2011). Measles vaccination, in children aged 12-23 months, slightly increased from 77% in 2003 to 82% in 2011. BCG coverage in the same age group also slightly increased from 87% to 91% over the evaluation time period, coverage with three doses of DPT increased from 72% to 76% and coverage with three doses of polio from 70 to 73%; however none were significant increases.

Acute respiratory infections (ARI) and diarrheal diseases, caused by a variety of viral and bacterial pathogens, are among the leading causes of illness and death in children under five years of age, both globally and in Mozambique. Interventions to control these two diseases mainly include immunizations against specific pathogens, early diagnosis and treatment, community case management through community health workers, improvements in nutrition and feeding practices, and safer environments. Data on the prevalence and treatment seeking practices of these two conditions were collected during household surveys in Mozambique by asking mothers whether their children under five years of age had been ill with a cough accompanied by short, rapid breathing and whether they suffered from diarrhea in the two weeks preceding the survey. In the two weeks preceding the survey in 2003, 10% of children under five years of age were ill with symptoms of ARI (cough, and rapid breathing) as compared to only 2% in 2011, a significant decline. While prevalence of ARI declined, treatment seeking for children with symptoms of ARI did not change significantly over the same time period. The percentage of children under five years of age reported to have had diarrhea in the two weeks preceding the survey only slightly declined from 14% in 2003 to 11% in 2011. Treatment seeking for children with diarrhea remained stable over the evaluation period, with 49% of children with diarrhea taken to a health provider in 2003 compared to 56% in 2011. Similarly, the percentage of children under five years of age with diarrhea in the two weeks preceding the survey that used oral rehydration salts (ORS) only increased slightly from 49% in 2003 to 55% in 2011.

Table 24: Child health in Mozambique, 2003-2011

Indicator	2003 DHS		2008 MICS		2011 DHS		% Relative Change 2003-2011	Sig
	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN		
BCG	87.4 (84.8-89.7)	1933	87.3 (84.8-89.4)	2449	91.1 (89.2-92.7)	2325	4.2	NS
DPT3/Pentavalente 3	71.6 (68.0-74.9)	1933	73.2 (69.8-76.4)	2449	76.2 (73.2-78.9)	2325	6.4	NS
Polio3	69.6 (66.1-73.2)	1933	72.1 (68.8-75.1)	2449	73.2 (70.1-76.1)	2325	5.0	NS
Measles	76.7 (73.5-79.6)	1933	73.7 (70.8-76.5)	2449	81.5 (78.8-83.9)	2325	6.3	NS
All (BCG, measles, DPT3, polio3)	63.3 (59.7-66.9)	1933	60.3 (57.0-63.4)	2449	64.1 (60.7-67.3)	2325	1.1	NS
Vitamin A (6-59 months)	49.8 (47.5-52.2)	8318	71.5 (69.4-73.5)	10,202	72.8 (70.8-74.6)	9237	46.2	S
Children 0-4 years had ARI symptoms in previous 2 weeks*	9.8 (8.9-10.8)	9400	4.7 (4.1-5.4)	11,419	1.5 (1.3-1.9)	10,835	-85.0	S
Children 0-4 years with ARI sought treatment	55.4 (50.6-60.1)	919	65.6 (59.8-70.9)	538	50.2 (41.3-59.1)	166	-9.4	NS
Children 0-4 years with diarrhea in previous 2 weeks	14.1 (13.1-15.2)	9400	17.6 (16.6-18.6)	11,416	11.1 (10.3-12.1)	10,835	-21.3	S
Children 0-4 years with diarrhea sought treatment	48.9 (44.4-53.5)	1328	n/a	n/a	56.0 (51.5-60.4)	1205	14.5	NS
Children 0-4 years with diarrhea used ORS	48.5 (44.5-52.5)	1328	37.9 (35.0-41.1)	2008	55.0 (50.4-59.4)	1205	13.4	NS

Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different. NS denotes not statistically significant and S denotes statistically significant

*Definition of ARI is based on data available in the 2000 survey: child had illness with cough in past two weeks and he/she breathed faster than usual with short, fast breaths.

Breastfeeding Practices and Undernutrition in Children and Women

In addition to serving as a source of nutrition, breastfeeding during infancy provides protection against infectious diseases, including diarrhea and ARI, the leading causes of ACCM [60,102]. Early and exclusive breastfeeding is an important child survival intervention which reduces neonatal, infant, and child mortality [103]. Currently the WHO recommends early and exclusive breastfeeding for the first six months following birth [104]. In Mozambique, 30% of children less than six months of age were exclusively breastfed in 2003, as compared to 43% in 2011, a significant increase (Table 26). Similarly, the proportion of children born in the five years prior to interview who initiated breastfeeding early (within one hour of birth) also rose significantly, from 65% in 2003 to 76% in 2011.

Undernutrition due to chronic dietary deficiency of protein, energy, essential vitamins, and minerals (collectively referred to as micronutrients) is an important determinant of maternal and child health [105]. The continuum of maternal, fetal, and child undernutrition results in 3.5 million preventable child and maternal deaths globally, per year [106]. In children under five years of age, the standardized anthropometric measures of undernutrition [107] are a) low birth weight resulting due to intrauterine growth restriction ; b) underweight, a reflection of low weight-for-age; c) stunting, a chronic restriction of growth in height indicated by a low height-for-age; and d) wasting, an acute weight loss indicated by a low weight-for-height. Undernutrition prevalence in children under five years of age was measured in the 2003 DHS, 2008 MICS and 2011 DHS surveys (Table 27). In Mozambique, the proportion of babies born small or very small in size (by mother's report) decreased significantly over the study period, from 20% in 2003 to 13% in 2011. In addition to mother's report of her child's size at birth, DHS collects information on children's birthweight as recorded in health cards and by mother's recall. Children born with a low birthweight (<2500g) as measured by the health card or by mother's recall remained stable over the evaluation period, at 6% in 2003 and 7% in 2011. The percentage of children under five of age reported as under-weight declined significantly from 24% in 2003 to 15% in 2011. The percentage of children under five of age that are stunted remained the same over the evaluation period (41% in 2003 and 43% in 2011), while the percentage of children under five of age that are wasting increased slightly from 4% in 2003 to 6% in 2011.

Vitamin A deficiency has been implicated in increased morbidity and mortality from infectious diseases such as measles, diarrhea, and acute respiratory infections, and results in up to 600,000 deaths of children under five years of age annually world-wide [106]. Depletion of stored vitamin A occurs over a period of four to six months, when diet contains too little replacement. Periodic vitamin A supplementation (i.e., every six months) in areas with prevalent pre-existing vitamin A deficiency has been shown to replenish vitamin A stores needed for essential physiological functions and to decrease ACCM by up to 23% [97,98]. In Mozambique vitamin A supplementation has improved significantly over the evaluation period. In 2003, only 50% of children age 6–59 months received a vitamin A supplement in the six months prior to the survey as compared to 73% in 2011.

Table 25: Breastfeeding and undernutrition in children and women in Mozambique, 2003-2011

Indicator	2003 DHS		2008 MICS		2011 DHS		% Relative Change 2003-2011	Sig
	% (95% CI)	WN	% (95% CI)	WN	% (95% CI)	WN		
Early initiation of breastfeeding (%)	64.7 (n/a)	10,441	63.2 (60.5-65.8)	5,191	75.7 (n/a)	4,913	17	S
Exclusive breastfeeding in children <6 months of age (%)	30 (n/a)	1,065	36.8 (n/a)	1,217	42.8 (n/a)	1,156	42.7	S
% of children 6-9 months breastfeeding and consuming complementary foods	79.7 (n/a)	707	84.1 (80.6-87.2)	858	81 (n/a)	809	1.6	NS
Small/very small at birth (mother's estimate) %	19.7 (18.5-21.0)	10,441	13.2 (11.8-14.7)	5,191	13.1 (12.0-14.2)	11,704	-33.5	S
Low birth weight <2500 g (%)	6 (5.3-6.9)	10,620	7.6 (6.7-8.6)	5,191	7.2 (6.5-8.0)	11,704	20.0	NS
Under-fives stunted (%)*	41.0 (39.1-42.8)	8,697	43.6 (41.8-45.3)	10,676	42.6 (41.0-44.2)	10,313	3.9	NS
Under-fives underweight (%)*	23.7 (22.2-25.2)	8,697	18.2 (17.0-19.5)	10,872	15 (13.9-16.0)	10,313	-36.7	S
Under-fives wasted (%)*	4.0 (3.4-4.7)	8,697	4.2 (3.6-4.9)	10,642	5.9 (5.3-6.6)	10,313	47.5	S
Vitamin A supplementation within past 6 months (% children 6-59 months)	49.8 (47.5-52.2)	8,318	71.5 (69.4-73.5)	10,202	72.8 (70.8-74.6)	9,653	46.2	N

* Definitions and methods per WHO reference population.
Sig.= Statistical significance. Statistics with non-overlapping 95% confidence intervals are considered significantly different change. NS denotes no statistically significant change and S denotes statistically significant change.

HIV/AIDS among Children and Women

The advent of the HIV/AIDS epidemic in the 1980s, threatened child survival gains made globally since the 1960s [108]. Child survival stagnated and even reversed in many countries in sub-Saharan Africa [109] and HIV/AIDS was found to be an increasingly important cause of ACCM in Sub-Saharan Africa [110].

In Mozambique, the first cases of HIV infection were reported in 1986, with the epidemic rapidly spreading thereafter [111]. Data from 36 sentinel sites on pregnant women aged 15-49 attending ANC show that the epidemic reached its peak at about 16% in 2004, and has since been declining slowly overall, reaching about 13.7% in 2009 [112]. Data from the 2009 AIS population-based survey estimated overall adult HIV prevalence at 11.5%, slightly higher among women at 13.1%, which shows a similar trend to the sentinel surveillance data.

Both sentinel surveillance data and the AIS demonstrate large regional disparities in HIV prevalence across the country. Sentinel data show the highest prevalence in the Southern region, reaching up to 22% in 2009. Furthermore, the overall trend of the epidemic reaching its peak in 2004 and declining since has not been observed in the Southern region, rather it has only shown a steady increase from 2001 to 2009. The Central region shows slightly higher HIV prevalence than the overall country, at about 14.4% in 2009, while the Northern region, has a much lower overall prevalence at about 6.1% [113]. Based on the sentinel surveillance data, in both the Central and Northern regions, HIV prevalence has been on the decline since 2004. ACCM patterns do show some correlation with regional HIV prevalence patterns, with overall higher relative reductions in ACCM in areas with lower HIV prevalence, and lower relative reductions in ACCM in areas with the highest HIV prevalence. This suggests that HIV prevalence over the study period could have affected trends in ACCM.

Population-based estimates of HIV infection in children under five of age are not available; however, analyses based on national models of HIV and AIDS show that the HIV-attributable ACCM mortality per 1000 live births (corrected for other competing causes of mortality) was around 17% in 1999 as compared to 8% in 2009 [114,115]. Data from HMIS show the number of HIV infected pregnant women receiving antiretrovirals (ARVs) increasing over the latter part of the evaluation period. The first year for which these data are available is 2006 when coverage was very low. A rapid increase in HIV positive pregnant women receiving ARVs occurred, from just over 13,100 to just under 65,600 between 2006 and 2011. According to HMIS data, coverage of PMTCT during pregnancy and delivery (based on the estimated number of women in need of PMTCT) increased from about 14% in 2006, to about 66% in 2011 [2012 Global AIDS Response Progress Report]. Modelled data from HMIS in 2010 and 2011, show risk of transmission of HIV from mother-to-child to be just under 25% (measured by estimated the number of children who will be newly infected with HIV through MTCT out of the estimated number of HIV positive women who delivered in the previous year). This indicates, a large number of children being born with HIV. While coverage of PMTCT is still below desired levels, it has improved

dramatically from 2006 to 2011, suggesting it could also be contributing to the decline in ACCM over the evaluation period.

Summary of Contextual Factors

Mozambique has experienced some positive developments during the evaluation period, some of which would be expected to lead to improved child survival. A summary of these changes and the expected relationship with ACCM in Mozambique is presented in Table 26.

Table 26: Summary of changes in factors that could be associated with ACCM in Mozambique, 2003–2011

	Trends supporting lower mortality	Trends suggesting no change in mortality	Trends supporting higher mortality
Malaria control interventions	• Household ownership of ITNs • ITN use by children under five years of age • ITN use by pregnant women • IRS (in selected areas) • IPTp (during 2007-2009)	• Care seeking for fever • Proportion of children with fever who receive recommended treatment (of those receiving any treatment) • Use of ACTs (little evidence)	

Other contextual determinants	Fundamental determinants • GDP per capita growth • Maternal education • Some improvements in housing conditions (improved toilet facilities, modern floor material, electricity and access to telephone) • Mass media exposure (television and newspaper) Proximate determinants • Early initiation of breastfeeding • Exclusive breastfeeding • Vitamin A supplementation (postnatal and child supplementation) • ARI prevalence • Prevalence of underweight children under five years of age • PMTCT, ART • HIV prevalence (Northern and Central Regions)	Fundamental determinants • Specific housing characteristics (improved water source and time to water source and improved roof) • Women married • Mass media exposure (radio) Proximate determinants • Antenatal care attendances (4+) • Neonates protected from tetanus • All immunizations (BCG, DPT, Polio, measles and full coverage) • ARI care seeking • Diarrhea prevalence • Diarrhea care seeking and treatment (ORS) • Birth at health facility • Proportion of births that are high risk • Low birth weight • Stunting prevalence	Fundamental determinants • None Proximate determinants • HIV prevalence (Southern Region) • Prevalence of wasted children under five years of age

In addition to some of the improvements observed in the malaria control interventions, other favorable changes occurred in other contextual determinants during the evaluation period. GDP steadily increased, the proportion of women with at least a primary school education rose significantly, the percent of households with improved access to toilet facilities, modern floor material, and access to electricity and telephones increased, as well as mass media exposure through newspapers and television. The prevalence of ARI declined over the evaluation period, while the proportion of children that were exclusively breastfed and that initiated breastfeeding early (within the first hour) rose. Additionally, vitamin A supplementation for both children 6-59 months and women postpartum improved. Furthermore, HIV prevalence in two of the major regions of the country – Northern and Central – was on the decline since 2004, while coverage of PMTCT and ART increased dramatically over the evaluation period.

Very few contextual factors changed in a direction that would be expected to favor higher mortality, or congruously, favor slower declines in mortality among children under five

years of age. The prevalence of children under five years of age that were wasted slightly increased over the evaluation period. In the Southern Region of the country, HIV prevalence gradually increased over the evaluation period, up to 22% by 2009, though overall coverage of PMTCT and ART services increased. Many contextual factors remained stagnant over the evaluation period, including diarrhea prevalence, care seeking for fever, ARI and diarrhea, use of first-line antimalarials, immunization coverage, treatment for diarrhea (ORS) and stunting and low birth weight prevalence. Furthermore, antenatal care visits and tetanus vaccinations also did not improve substantially, nor the proportion of births at health facilities or proportion of high risk births.

FURTHER ANALYSES

Multiple Logistic Regression Analysis

Model-building Process

Using data from the 2011 Demographic and Health Survey (DHS) in Mozambique, we aimed to estimate the cross-sectional relationship between malaria parasitemia (*Plasmodium falciparum* defined as a positive rapid test result) in children under five years of age and owning an insecticide treated net (ITN) stratified by the age of the net, household indoor residual spraying (IRS), and other essential demographic factors in Mozambique. Demographic variables anticipated to associate with ITN use and IRS were selected based on prior published literature and availability within the DHS survey framework [116,117,118,119,120].

All analyses were conducted using Stata 13 (StataCorp LP, College Station, TX) and a significance level of 0.05. Generalized Linear Latent and Mixed Models (GLLAMM) using the binomial family and logit link were employed to account for the complex survey design as well as include household-level random effects and individual-level fixed effects [121].

First, we examined the unadjusted bivariate association between each predictor variable and malaria parasitemia. Second, we separately examined the associations for our two primary explanatory variables of interest (ITN ownership and IRS) adjusted for potential confounding variables of interest selected based on those variables hypothesized to both influence parasitemia and ITN ownership or IRS coverage. Confounding factors included: malaria endemicity zones, place of residence (urban/rural), mother's education in years, wealth quintiles, sex of child, number of household members, and age of child.

All factors assessed in unadjusted bivariate association were included as potential confounding variables in the adjusted models. We tested for interaction between age of net and malaria endemicity zones; malaria endemicity zones and place of residence; place of residence and wealth index; and age of child by age of net. The only interaction found to be significant was between place of residence (urban/rural) and wealth index.

Table 27: Bivariate (Unadjusted) Logistic Regression Models for ITN ownership and Household IRS, as well as Potential Confounding Factors

Characteristic	N	Parasitemia prevalence (%)	Unadjusted OR (95% CI)	P-value
Total	**3,484**	35.0		
ITN Net Ownership by Age of Net				
No ITN	1,740	36.6	1.00 (reference)	
ITN owned 0-1 months	210	39.1	1.41 (0.70, 2.8)	0.333
ITN owned 2-6 months	370	27.8	0.28 (0.15, 0.53)	<0.001
ITN owned 7-12 months	589	30.7	0.64 (0.38, 1.08)	0.096
ITN owned >12 months	575	37.4	0.83 (0.50, 1.37)	0.468
Had household IRS in last 12 months				
No	2,691	37.8	1.0 (reference)	
Yes	793	25.2	0.28 (0.18, 0.43)	<0.001
Malaria Endemicity Zones				
High parasite burden (>30%)	2,440	42.7	1.00 (reference)	
Medium parasite burden (20-30%)	550	29.1	0.25 (0.16, 0.38)	<0.001
Low parasite burden (<10%)	494	3.2	0.002 (0.0007, 0.006)	<0.001
Place of Residence				
Urban	1,128	14.8	1.00 (reference)	
Rural	2,356	44.6	25.8 (14.0, 47.6)	<0.001
Mother's Education in Years				
No Formal education	1,077	44.6	1.00 (reference)	
Primary education	1,618	35.9	0.48 (0.33, 0.69)	<0.001
Secondary or higher	463	8.0	0.01 (0.04, 0.02)	<0.001
Wealth quintile				
Quintile 3 (Middle)	687	43.7	1.00 (reference)	
Quintile 2	691	48.2	1.51 (0.92, 2.47)	0.010
Quintile 1 (Poorest)	661	54.2	2.31 (1.38, 3.87)	0.001
Quintile 4	731	25.6	0.21 (0.13, 0.35)	<0.001
Quintile 5 (Least Poor)	714	5.6	0.01 (0.004, 0.02)	<0.001
Sex of Child				
Female	1,774	34.3	1.00 (reference)	
Male	1,710	35.7	1.13 (0.85, 1.49)	0.403
Number of Household Members				
2-4	1,041	37.3	1.00 (reference)	
5-7	1,692	35.9	0.87 (0.59, 1.26)	0.459
>8	751	29.6	0.47 (0.29, 0.76)	0.002
Age of Child (in years)				
<1	504	28.0	1.00 (reference)	
1	821	33.7	1.81 (1.13, 2.91)	0.014
2	779	36.3	2.08 (1.31, 3.34)	0.002
3	771	37.7	2.55 (1.60, 4.06)	<0.001
4	609	37.1	2.15 (1.32, 3.51)	0.002

Table 28: Multiple Logistic Regression Model: The Effect of ITN Ownership and Household IRS on Malaria Parasitemia in Children Under-5, After Adjusting for Potential Confounders

Characteristic	N	Parasitemia prevalence (%)	Adjusted OR (95% CI)	P-value
Total	**3,484**	35.0		
ITN Net Ownership by Age of Net				
No ITN	1,740	36.6	1.00 (reference)	
ITN owned 0-1 months	210	39.1	1.20 (0.60, 2.40)	0.610
ITN owned 2-6 months	370	27.8	0.93 (0.52, 1.65)	0.791
ITN owned 7-12 months	589	30.7	0.80 (0.50, 1.27)	0.345
ITN owned >12 months	575	37.4	1.48 (0.93, 2.35)	0.096
Had household IRS in last 12 months				
No	2,691	37.8	1.0 (reference)	
Yes	793	25.2	0.76 (0.49, 1.19)	0.229
Malaria Endemicity Zones				
High parasite burden (>30%)	2,440	42.7	1.00 (reference)	
Medium parasite burden (20-30%)	550	29.1	0.49 (0.30, 0.78)	0.003
Low parasite burden (<10%)	494	3.2	0.06 (0.025,	<0.001
Mother's Education in Years				
No Formal education	1,077	44.6	1.00 (reference)	
Primary education	1,618	35.9	0.95 (0.67, 1.33)	0.748
Secondary or higher	463	8.0	0.20 (0.10, 0.41)	<0.001
Effect of Place of Residence for Middle Wealth*				
Urban	88	26.1	1.00 (reference)	
Rural	599	46.2	4.98 (1.66,	0.004
Effect of Wealth quintile for Rural Dwellers*				
Quintile 3 (Middle)	599	46.2	1.00 (reference)	
Quintile 2	633	47.6	1.11 (0.66, 1.86)	0.686
Quintile 1 (Poorest)	587	53.7	1.62 (0.96, 2.74)	0.074
Quintile 4	448	31.9	0.47 (0.27, 0.82)	0.008
Quintile 5 (Least Poor)	89	16.9	0.27 (0.08, 0.86)	0.026
Effect of Wealth quintile for Urban Dwellers*				
Quintile 3 (Middle)	88	26.1	1.00 (reference)	
Quintile 2	58	55.2	7.40 (1.50,	0.014
Quintile 1 (Poorest)	74	58.1	10.56 (2.23,	0.003
Quintile 4	283	15.6	0.51 (0.15, 1.58)	0.265
Quintile 5 (Least Poor)	625	4.0	0.14 (0.04, 0.51)	0.003
Sex of Child				
Female	1,774	34.3	1.00 (reference)	
Male	1,710	35.7	1.14 (0.86, 1.51)	0.360
Number of Household Members				
2-4	1,041	37.3	1.00 (reference)	
5-7	1,692	35.9	1.01 (0.69, 1.46)	0.978
>8	751	29.6	0.77 (0.47, 1.27)	0.310
Age of Child (in years)				
<1	504	28.0	1.00 (reference)	
1	821	33.7	1.92 (1.19, 3.10)	0.007
2	779	36.3	2.19 (1.36, 3.53)	0.001
3	771	37.7	2.71 (1.70, 4.32)	<0.001
4	609	37.1	2.16 (1.33, 3.52)	0.002

*The interaction term between wealth index and place of residence was significant (p=.006). The results presented here are when the interaction term is included in the model.

Results from the Logistic Regression Models

In bivariate association, owning an ITN that was between 2-6 months old was significantly protective (OR=0.28; 95% CI: 0.15–0.53) for *falciparum* parasitemia among children under five years of age compared to those owning no ITNs (Table 29). This association, however, was not significant after controlling for multiple potential confounders (Table 30). This may be due to limited statistical power related to the fact that malaria parasitemia is more significantly associated with factors such as wealth index and age of child compared to ownership of ITNs rather than indicating that ITNs are not effective in the Mozambican context. In addition, the point estimates still indicated a protective association of household ITN ownership for those who owned an ITN between 2-12 months. In summary, ITN ownership seems to be effective, especially when ITNs are relatively new, although one's wealth index or place of residence may have more bearing on their levels of parasitemia than their use of ITNs.

In bivariate association (Table 29), children under five years of age who lived in houses that had IRS were significantly protected against positive parasitemia compared to those whose houses were not sprayed (OR=0.28; 95% CI: 0.18–0.43). However, once important confounders were considered this association was found to be no longer statistically significant (Table 30). Similar to ITN ownership, it appears as though other variables such as wealth index and place of residence are more strongly related to parasitemia than IRS, therefore obscuring any association between IRS and parasitemia. However, even after controlling for many potential confounders, the point estimate still indicated a 26% reduction in the odds of parasitemia for those who had their household sprayed in the last 12 months, even though this association was not significant.

Other than our two main variables of interest (household ITN ownership and IRS), rural location, mothers education, wealth index, and age of child were significantly associated with parasitemia. Individuals in rural areas had 2.9 times the odds of parasitemia after adjusting for other potential confounders (Table 30). Children whose mother had a secondary education or higher had significantly lower odds of testing positive for parasitemia (OR = 0.18; 95% CI: 0.08 – 0.37). Increasing wealth was strongly associated with decreased odds of testing positive for parasitemia. Children over the age of one had significantly increased odds of testing positive for parasitemia.

The interaction between urban/rural location and wealth index was statistically significant, meaning that the effect of wealth index on parasitemia differs based on whether someone lives in an urban or a rural area (Table 30). The effect of wealth on parasitemia is more dramatic for urban dwellers than rural dwellers. Another way of saying this is that the effect of living in a rural area seems to be greater than one's wealth index. Even the least poor quintiles (Quintile 4 and 5) that live in rural areas have elevated odds of testing positive for parasitemia.

Summary of National-Level Logistic Regression Analyses using 2011 DHS Data

In bivariate association, household ownership of an ITN that was between 2-6 months old and household IRS were both shown to have a protective affect against parasitemia. However, after adjusting for other explanatory factors and confounding variables, ITN ownership and household IRS were no longer significant predictors of decreased odds of malaria parasitemia. This may be due to the fact that other variables such as wealth index, age of child or place of residence have more impact on parasitemia or it may be due to limited statistical power given the sample size. Rural location, mother's education, wealth index and age of child were all found to be significantly associated with parasitemia, after adjusting for potential confounders. Of note, the interaction between place of residence and wealth index was significant, indicating that the effect of one's socioeconomic status differs based on urban/rural location.

Case Study: Sofala Province

Background

The province of Sofala was chosen as a sub-provincial case study due to access to detailed program data at both the district and health facility levels. In addition, Sofala Province experiences endemic transmission of malaria and has heavy burdens of other infectious diseases such as HIV. The province of Sofala is situated in the Central Region of Mozambique, with a total population of approximately 1,654,000, divided between 13 districts. Nearly 62% of the population is concentrated along the major shipping and transport route of the "Beira Corridor," the national highway and railway that runs from the Beira City seaport to the border of Zimbabwe [122]. Beira City is the most populous city in Sofala Province, with an estimated population of 436,240 [123]. The remainder of the population is widely distributed in small villages and individual compounds in isolated rural areas.

Sofala suffers from chronically low literacy levels (33% for women), high fertility, and high infectious disease mortality similar to other very poor regions in Sub-Saharan Africa. Only 7% of households overall have access to piped water, and 6% have access to electricity. Public transport is poorly developed and private minibuses are expensive. About 67% of the population report access to radio and 10% to television programs. The greatest contributors to disability adjusted life years (DALYs) in Sofala include HIV/AIDS, malaria, diarrheal diseases, acute respiratory infections, tuberculosis (TB), and maternal and perinatal conditions. In particular, malaria accounts for an estimated 30% of deaths within hospital settings in Sofala Province. The public sector is the primary formal provider of health care, and there is limited availability of private health care. Overall, less than 0.5% of Sofala and 1.5% of Beira outpatient care is carried out at private health facilities (HIS-MISAU, 2008). The population to health facility ratio is 1/12,000 in Sofala, and human resource coverage is among the lowest in the world (2.4 doctors/100,000 people, and 21 nurses/100,000) [124].

Summary of Malaria Control Activities

Over the past ten years there has been broad expansion of activities targeted to decrease morbidity and mortality related to malaria in Sofala Province. There have been universal campaigns to distribute bed nets, along with targeted bed net distribution through antenatal care at health facilities. These bed net distribution efforts have focused on districts that are not covered by household indoor residual spraying.

Malaria case management was first defined within the national policy change of malaria treatment in 2002 as the prompt diagnosis and treatment of malaria cases with effective anti-malaria medications. The new guidelines at that time defined non-ACT 1st line, medications that were not widely accepted within the country and as a result were implemented in only a few districts in Maputo Province. Two years later in 2004, 1st line malaria treatment medications were changed to ACTs and expansion of case management

to other provinces, including Sofala, occurred. RDTs were introduced in the country in 2005 but it was not until 2006 that they became available in the provinces, including Sofala.

Figure 49: Map of Districts of Sofala Province, Mozambique

As can be seen in Table 31, IRS was implemented in Beira City and Dondo District as early as 1997, with a number of other districts implementing IRS later (Caia in 2005, Nhamatanda in 2008, Buzi in 2008, and Marromeu in 2010). IRS in Sofala Province is conducted once per year using lambdacyhalothrin, which is one of the pyrethroid insecticides. The spraying period usually lasts three months between September and November and is timed to happen just before the rainy season becomes intense in December.

As stated above, malaria case management with ACTs as first-line treatment for malaria has been implemented since 2004 in all districts of Sofala Province. Pilot mass distribution of ITNs began in Cheringoma, Gorongosa, Muanza and Nhamatanda Districts in 2009 and

was extended to Chemba, Chibabava, Maringue, and Nhamatanda Districts in 2011/2012. Intermittent preventive therapy (IPT) during pregnancy was rolled out in 2006 across all districts in Sofala Province.

Sofala Province has one quaternary hospital located in Beira City (Beira Central Hospital), 4 secondary rural hospitals, and 134 primary-level health facilities. The cities have a more dense population per square kilometer with the city of Beira having a very high ratio of 758.5.

Table 29: Summary of Malaria Control Interventions in Sofala Province, by District

District	IRS	ITN	Case Manage-ment	IPTp	Number of Health Facilities	Population Density (pp/km^2)
CIDADE DA BEIRA	Since 1997		Since 2004	Since 2006	11 Primary 1 Quaternary	758.5
BÚZI	Since 2008		Since 2004	Since 2006	15 Primary 1 Secondary	25.1
CAIA	Since 2005		Since 2004	Since 2006	16 Primary	39.7
CHEMBA		Universal LLIN distribution in 2011	Since 2004	Since 2006	6 Primary	19.3
CHERINGOMA		Pilot Universal LLIN distribution in 2009	Since 2004	Since 2006	7 Primary	6.9
CHIBABAVA		Universal LLIN distribution in 2011	Since 2004	Since 2006	11 Primary 1 Secondary	17.2
DONDO	Since 1997		Since 2004	Since 2006	12 Primary	63.9
GORONGOSA		Pilot Universal LLIN distribution in 2009	Since 2004	Since 2006	15 Primary	21.2
MACHANGA			Since 2004	Since 2006	6 Primary	10.7
MARÍNGUE		Universal LLIN distribution in 2011	Since 2004	Since 2006	6 Primary	12.7
MARROMEU	Since 2010		Since 2004	Since 2006	6 Primary 1 Secondary	26.1
MUANZA		Pilot Universal LLIN distribution in 2009	Since 2004	Since 2006	5 Primary	4.6
NHAMATANDA	Since 2008	Pilot Universal LLIN distribution	Since 2004	Since 2006	18 Primary	64.7

District	IRS	ITN	Case Manage-ment	IPTp	Number of Health Facilities	Population Density (pp/km^2)
		in 2009 Universal LLIN distribution in 2012			1 Secondary	

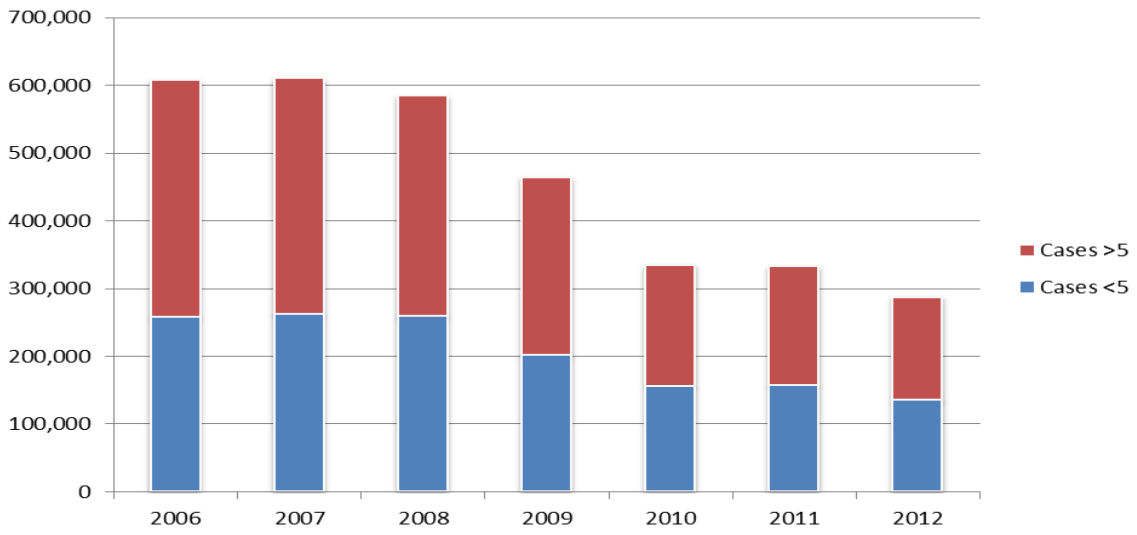
Analyses

Sub-national malaria indicators are reported in Mozambique through the routine health information system (HIS), which collects data through clinical encounters at all government health facilities in Mozambique. Monthly program data are aggregated at the health facility level, sent to the district level for aggregation across facilities, and aggregated across higher-level administrative levels to the national level, resulting in a continuous time-series of repeated monthly counts of multiple health indicators. Concerns about malaria data quality exist due to inconsistent use, difficulties with malaria diagnosis in the clinical encounter, and historically poor linkages between laboratory versus clinical diagnosis of malaria. Nevertheless, improvements are being made through routine data quality audits (DQAs) implemented through the Doris Duke African Health Initiative at health facilities in Sofala Province [125]. The DQAs started in 2009 and were conducted in 27 health facilities around Sofala Province (over 19% of all health facilities in the province). At these 27 facilities, overall data concordance across all four key indicators has increased from 54% in 2009 to 83% in 2012.

Malaria cases are reported though the weekly Mozambique disease notification system called the Boletim Epidemiological Semanal (BES). The system has been used to report malaria cases since 2000. Initially, data was reported as total cases of malaria until 2006 when data began to be disaggregated into < 5 and over >5. In 2008, the NMCP defined that a malaria case as one that has been confirmed using either RDT or microscopy. The BES was also revised and configured to report only confirmed malaria cases and the implementation of this new reporting system commenced in 2009. This system does not have a reporting category for clinical cases in instances where there is no availability of either RDT or microscopy, even though on-the-ground, the reality is that many clinicians continue to record malaria cases without RDT or microscopy to confirm the case. Regarding timely reporting of data, Sofala Province is known to be one of the best provinces in Mozambique, reporting over 98% of BES data on time from 2008-2013.

Hospitalizations for malaria, deaths due to malaria, women conducting 1st antenatal care visit, and women receiving 1st, 2nd, and 3rd dose of IPT are reported through the HMIS electronic database known as Modulo Basico (MB). These data are seen as a full sample of public health facilities in Sofala Province, although there are occasional facilities that miss reporting deadlines. Graphs of these selected indicators over time on a provincial-level or district-level where relevant are presented below.

Figure 50: Malaria cases stratified by under-5 and over-5, Sofala Province, 2006-2012



The absolute number of malaria reported cases in Sofala Province peaked in 2007, and then decreased steadily through 2012 by 53%. This decrease was higher for cases over age five (56.5% decrease) compared to cases under five (47.5% decrease) (Figure 50). This decrease in the absolute number of malaria cases has occurred during the same period that there has been a 17.2% increase in the absolute number of outpatient consults at health facilities from 2009 to 2012 (Figure 51).

Figure 51: Number of Outpatient Consults for Any Reason, All Ages, Sofala Province, 2004-2012

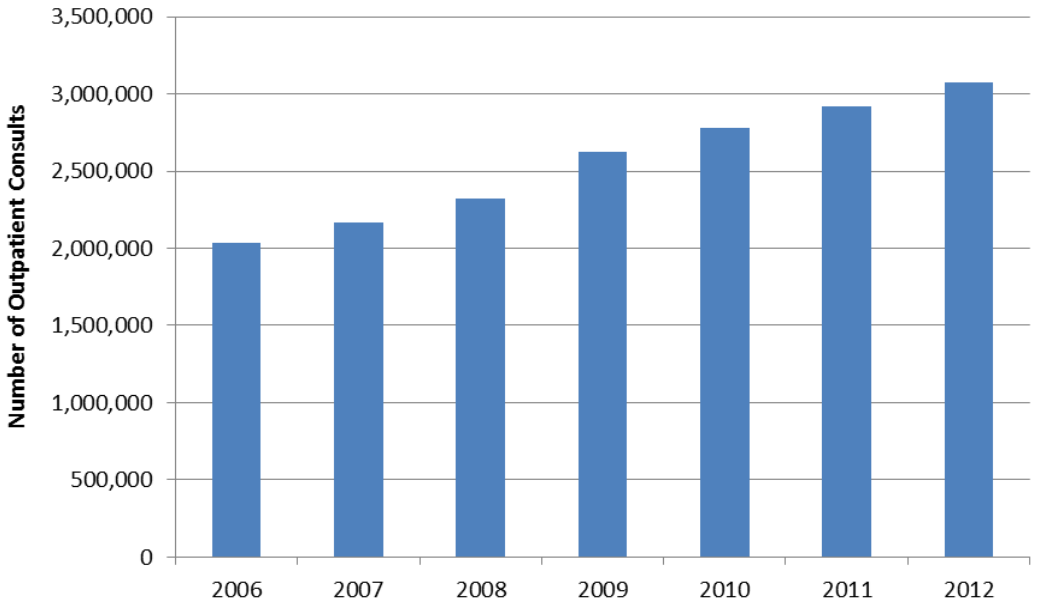
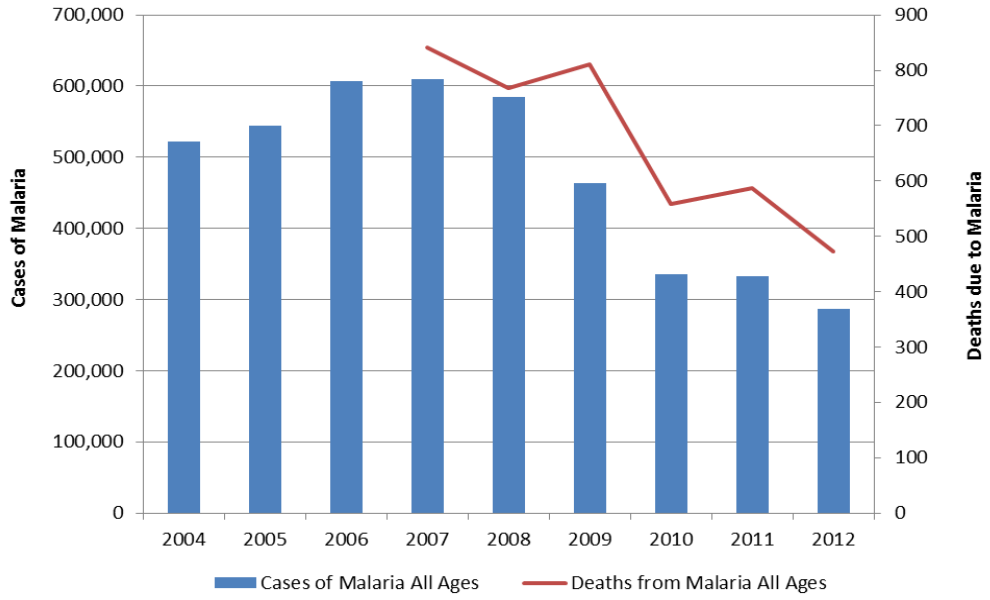
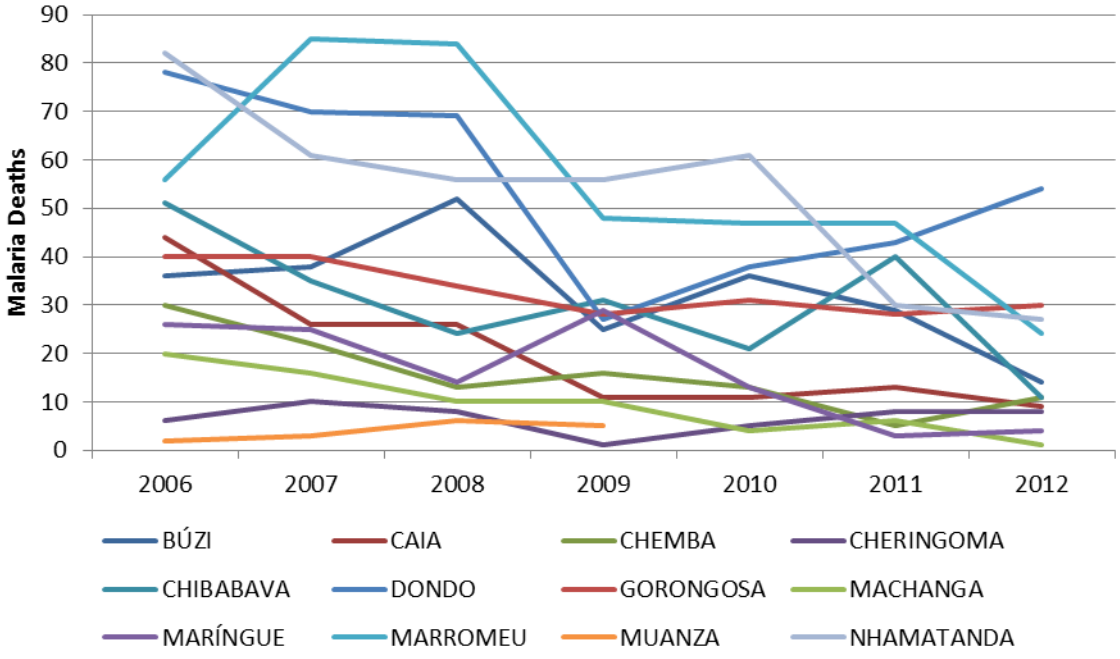


Figure 52: Malaria deaths and malaria cases, All Ages, Sofala Province, 2004-2012



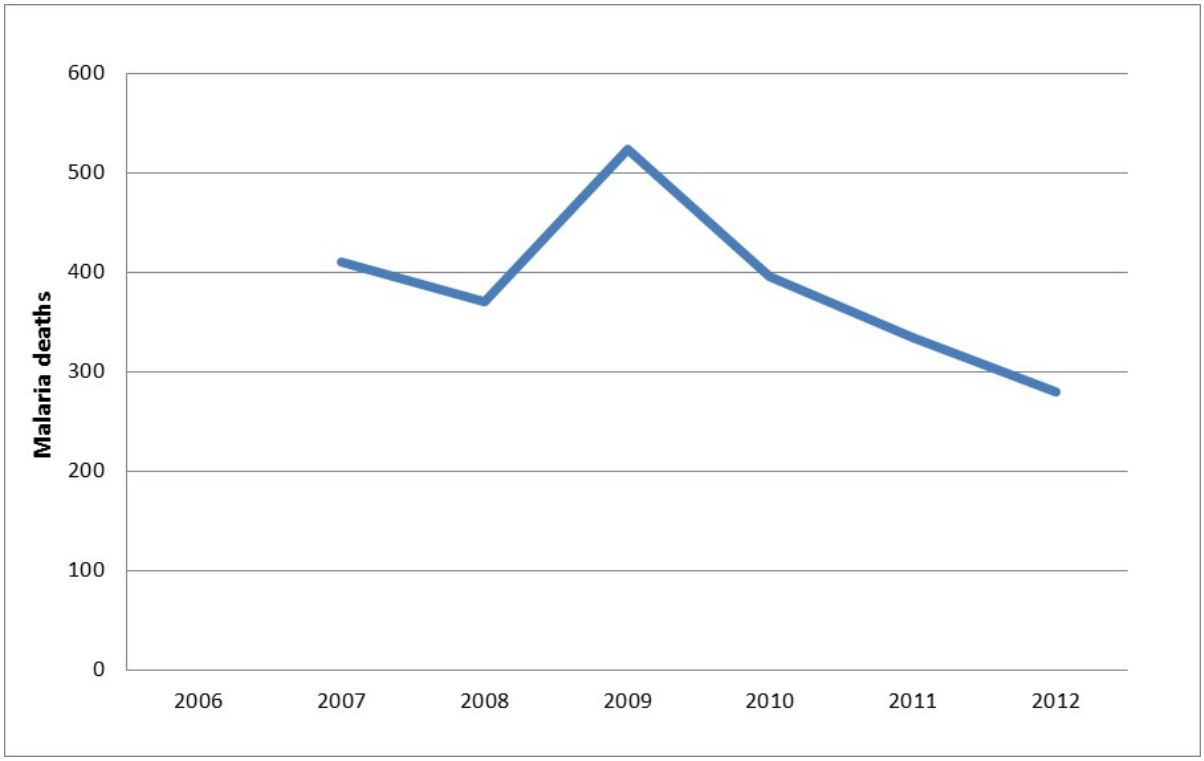
While reported malaria cases have decreased dramatically since the peak in 2007, deaths due to malaria across all ages, as reported from the NMCP, has also decreased (Figure 53). In 2007, there were 841 reported deaths due to malaria across Sofala Province; this has decreased by 44%, to 473 deaths reported in 2012.

Figure 53: Malaria deaths at the district level (excluding Beira City), All Ages, Sofala Province, 2006-2012



Disaggregating the malaria death data at the district level shows that most districts had steady decreases in the number of malaria deaths from 2006-2012 (Figure 53). Some larger districts such as Marromeu and Nhamatanda, had very large decreases over the time period. For example, Nhamatanda had between 60-80 malaria-related deaths each year in 2006-2007, which has since decreased to 27 deaths in 2012. By contrast, Dondo achieved its lowest number of malaria deaths in 2009 and has since seen over a doubling of malaria deaths from 2009-2012. This is concerning and warrants further investigation.

Figure 54: Malaria deaths in Beira City, All Ages, Sofala Province, 2007-2012



Beira City did not report any data on malaria deaths in 2006, thus our analyses begin with data from 2007. As Beira City is home to the quaternary-level Beira Central Hospital, the malaria deaths from this district include those serious cases referred from peripheral hospitals or clinics. While there was an increase in deaths from 2008 to 2009, it is unclear what might have caused such a large jump in deaths. Since 2009, the number of malaria deaths in Beira City has decreased 46%, from a peak of 523 deaths in 2009 to 280 deaths in 2012 (Figure 54).

Figure 55: Sub-provincial Malaria cases among children under five years of age, Districts of Sofala Province, 2006-2012

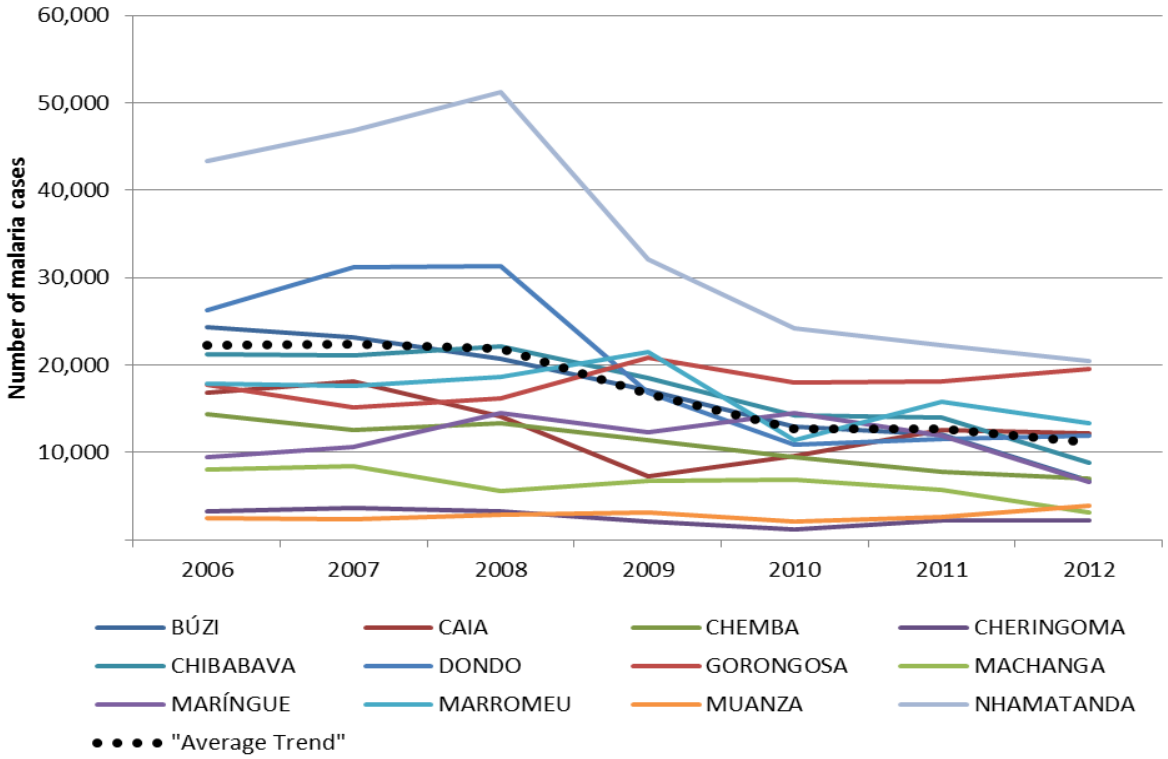
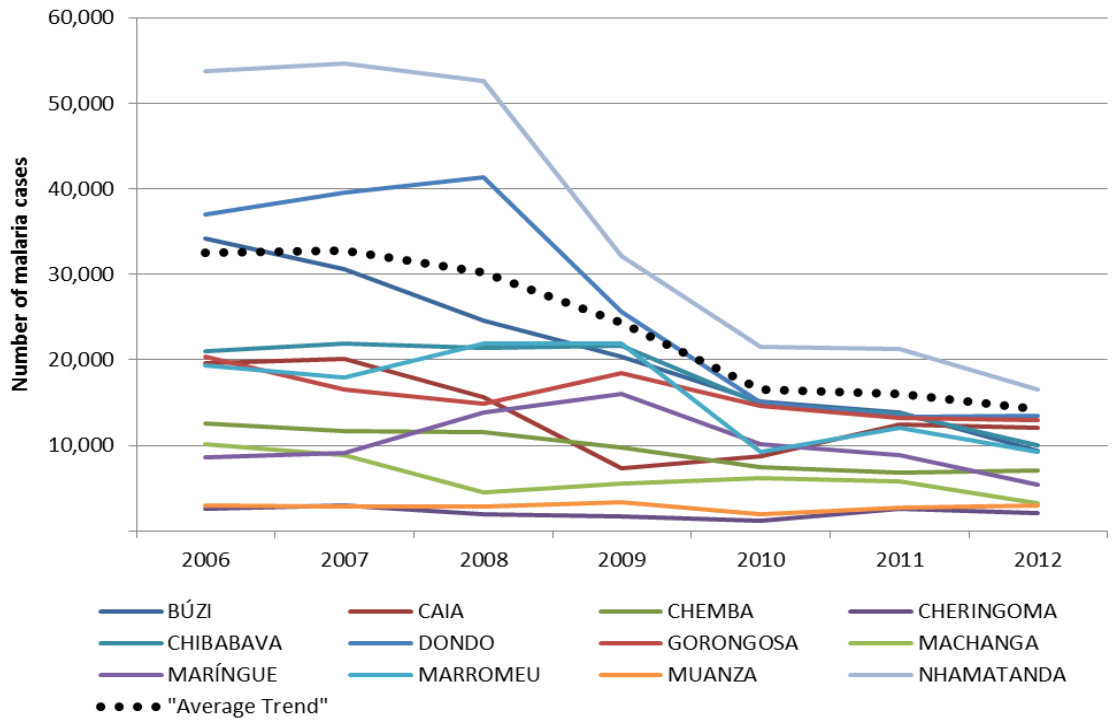
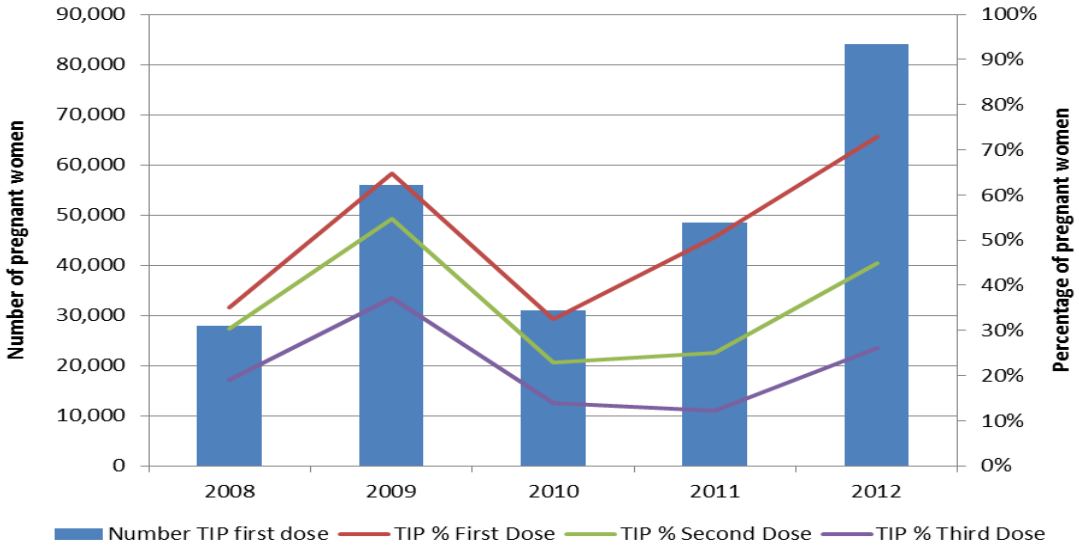


Figure 56: Sub-provincial Malaria cases among those over five years of age, Districts of Sofala Province, 2006-2012



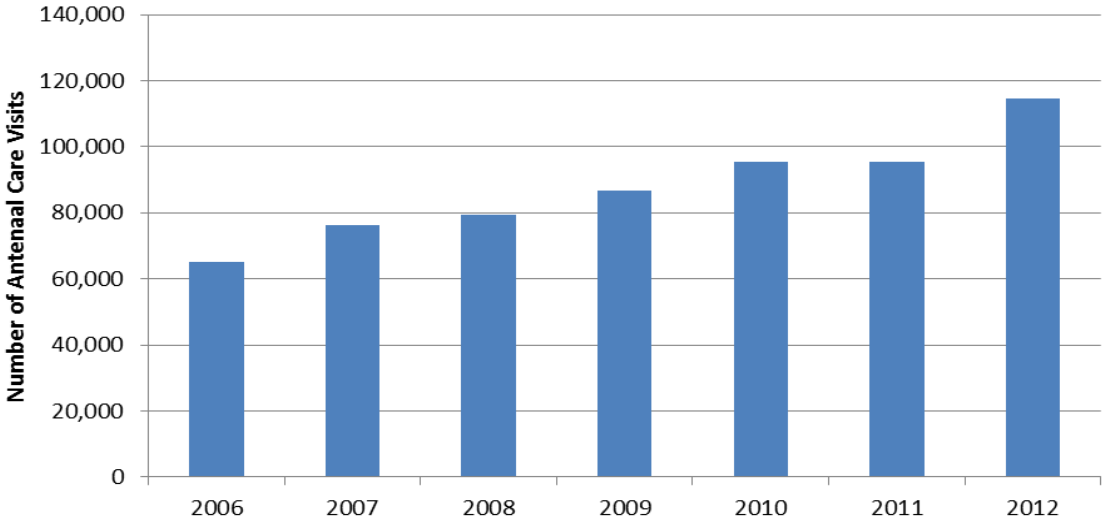
Disaggregating malaria case data at the district level shows that most districts observed a stable number of malaria cases until 2008-2009 when large decreases in the number of cases started occurring (Figure 55 and 56). The trend and pattern of decreases in the number of cases looks very similar comparing cases among those over five years of age to cases among children under five years of age. The absolute decrease in the number of cases across the province is dominated by decreases in districts with large populations and high malaria burdens (Nhamatanda and Dondo).

Figure 57: Number of pregnant women receiving the first dose of intermittent preventive therapy and the percentages of women attending a first prenatal visit that take their first, second, or third dose of IPT, pregnant women, Sofala Province, 2006-2012



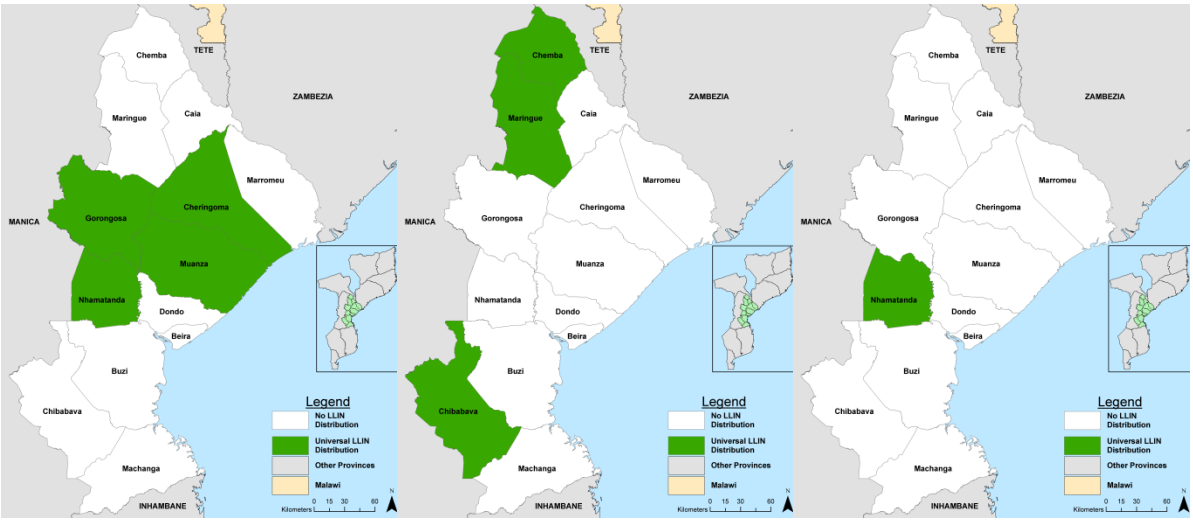
Intermittent preventive therapy for malaria was rolled out across all districts in Sofala Province beginning in 2006 and has had mixed success over the past seven years through 2012 (Figure 57). With minor setbacks in 2010 (due to a national stock out of Fansidar), 2012 has shown success in the absolute number of pregnant women who have been reached by the first dose of IPT (called TIP in Mozambique). However, since ANC attendance has increased over this same time period (2006-2010), the lack of progress in reaching more women with IPT during this time period shows that the absolute number of women reached was not keeping pace with the number of women attending ANC visits (Figure 58).

Figure 58: Number of women who attended their first prenatal visit, Sofala Province, 2006-2012



As can be seen in Figure 58, while the absolute number of women reached by the first dose of IPT has increased dramatically from 2011 to 2012, the proportion of women who are progressing to receive a second and third dose remains low, even lower than during initiation in 2006.

Figure 59: Map of LLIN Distribution, Districts of Sofala Province, 2009, 2011, & 2012



2009 2011 2012

Beginning in 2009, pilot universal distribution of LLINs was implemented in select districts of Sofala Province and in 2011, universal distribution of LLINs as part of the national expansion of the strategy was implemented in 3 districts of the province and one additional district in 2012 (Figure 59).

LLIN distribution throughout the districts of Sofala Province has been increasing since its inception in 2009 (Figure 60). With an overall population of 1.6 million, a cumulative distribution of approximately 498,000 ITNs through 2012 has been achieved. While LLIN distribution is limited to certain districts, the WHO guidelines suggest coverage with either ITN distribution or IRS. As seen in Table 29 (pg. 122), since 2011 all districts of Sofala Province have been covered by either IRS or mass LLIN distribution.

Figure 60: Number of LLINs distributed, Sofala Province, 2009-2012

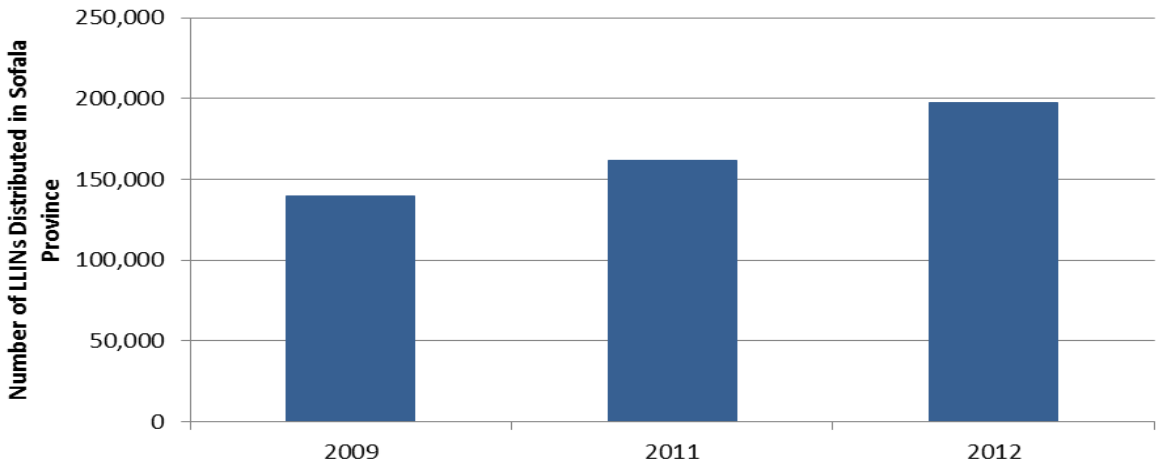
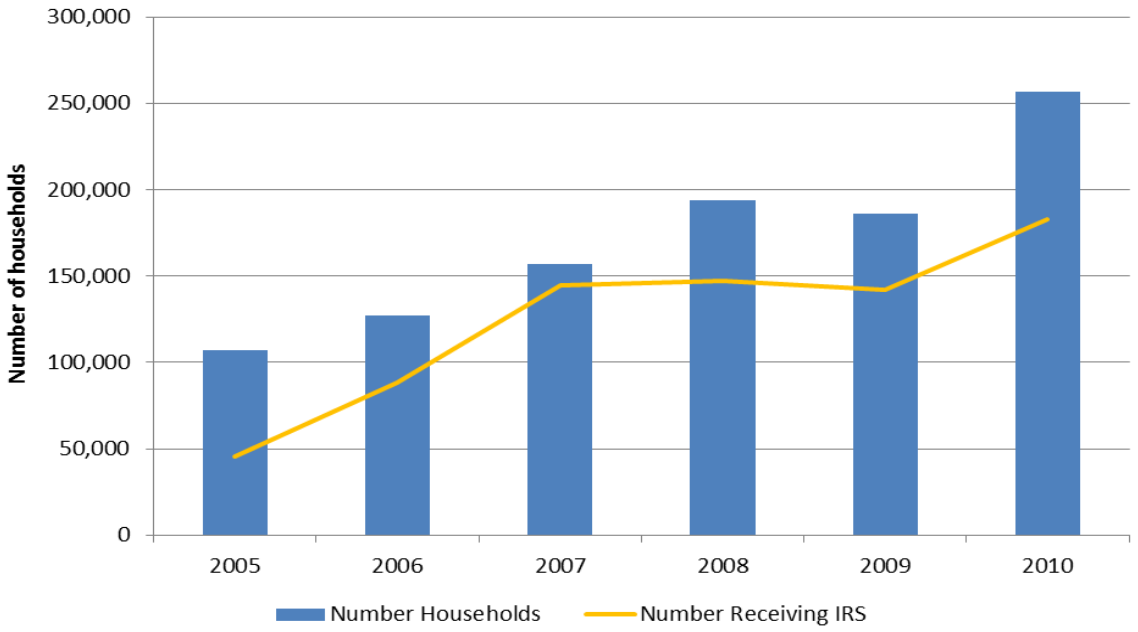


Figure 61: Number of households targeted for IRS and sprayed, Sofala Province, 2005-2012



The total number of households targeted by IRS in districts that receive this form of malaria vector control has increased nearly every year since 2005 to 2010, with a slight

decrease in the number of households targeted in 2009 (Figure 61). The number of households sprayed has overall increased approximately 2.5 fold from 2005 to 2010, with a large peak observed between 2005 and 2007, and then another peak in 2010.

Summary of Sofala Case Study

Malaria cases decreased dramatically in Sofala Province between 2007 and 2012, a major accomplishment likely related to the scaling up of a gamut of prevention and treatment interventions such as IRS, ITNs, case management, and IPT for pregnant women. The numbers of deaths due to malaria decreased at approximately the same rate as the observed decrease in overall number of malaria cases. Furthermore, these observed decreases in the number of cases and the number of malaria deaths at the provincial-level are mirrored at the district level. That is, gains at the provincial level also translate to the district level. Encouragingly, districts with the highest number of malaria cases have also showed the most improvement over the study period.

Progress was made in the absolute number of women that received the first dose of IPT during pregnancy, yet the proportion of women who progressed to the second or third IPT doses remained low or decreased, a concerning trend that requires more attention. The number of LLINs distributed in Sofala Province increased and mass distribution campaigns were conducted in 7 districts. Six of the districts not covered by mass LLIN distribution campaigns underwent IRS yearly just prior to the rainy season, with large increases in the number of households targeted and sprayed from 2005-2010. However, of the 13 districts in Sofala, only one had not been covered by any malaria prevention method by 2012.

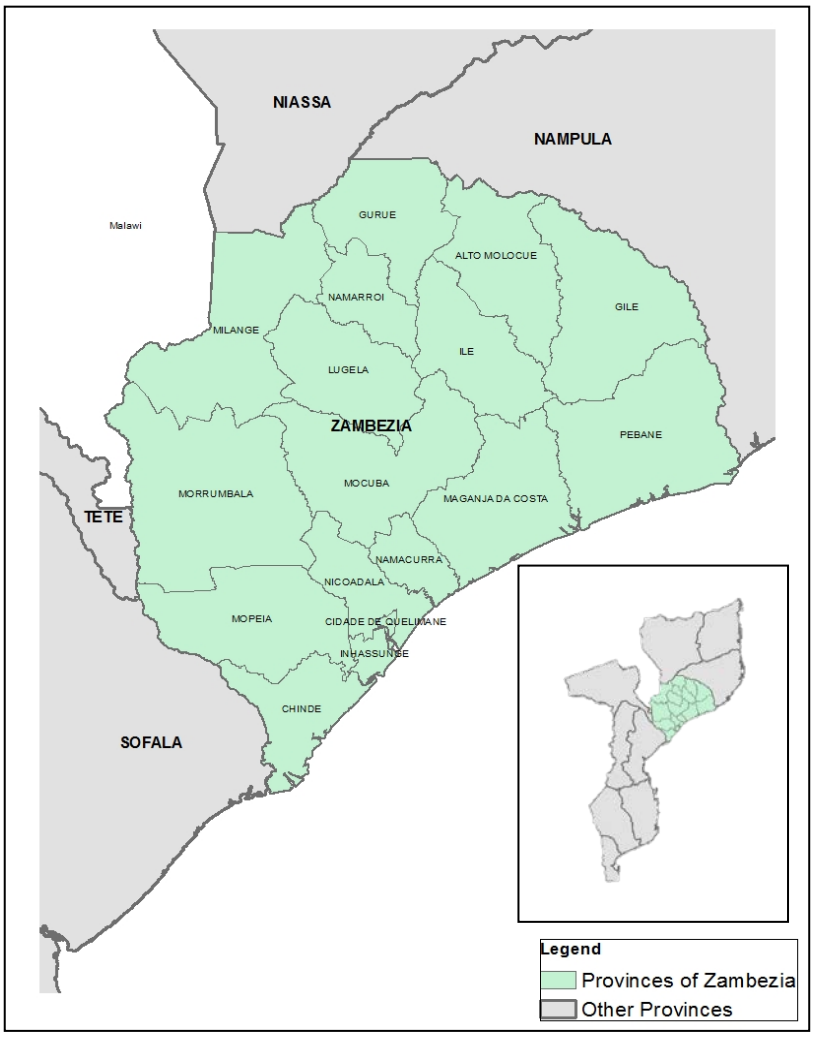
Case Study: Zambézia Province

Background

Zambézia is Mozambique's second largest province by population, with a 2012 estimated population of 4.4 million residing in 16 districts. Located within the central coastal region of the country, most of the province is drained by the Zambezi River, and is characterized by extensive mangrove swamps on the coast and forests inland. Less than 1% of the population has piped water in their household, and only 7% live in homes with electricity. According to the 2011 DHS, 43% of people in Zambézia live in the lowest wealth index, which is by far the highest percentage in the country. Literacy rate among women is low, at 25%, which in 2011 was the second lowest percentage in the country. The HIV rate was 13% according to the 2009 AIDS Indicator Survey.

Zambézia has a consistently high burden of malaria, with an estimated prevalence of 66.4% by RDT in 2007; as such it has been the focus of many malaria control efforts by external donors. Since 2007, PMI has focused the majority of its control programs in Zambézia, including all of its IRS activities (Table 32), and in 2011 the RDT positivity rate had decreased to 55%. For this reason, Zambézia was chosen as a case study for a sub-national analysis of the impact of malaria control programs in Mozambique.

Figure 62: Map of Zambézia Province



Summary of Malaria Control Activities

Since 2007, PMI has supported distribution of LLINs to antenatal care clinics, the purchase of SP for IPTp, and the purchase of RDTs and ACTs for proper diagnosis and treatment of malaria in Zambézia Province. In addition, PMI has also supported training for microscopists, supervision of laboratory and clinical personnel, and supervision of data collection and reporting within the province, also as part of its national-level support (Table 32). IRS, through the support of PMI, has been carried out in 6 of the 16 districts in the province since 2007, with an additional two districts being sprayed in both 2010 and 2011. No other IRS activities have been performed in the province during this time frame.

Health promotion and community mobilization to improve knowledge of the signs and symptoms of malaria, when to seek treatment, and how to prevent infection have been supported in Zambézia by a number of partners since 2007. This has involved radio spots, discussions with community and religious leaders, and door to door education campaigns.

Table 30: Summary of Malaria Control Interventions in Zambézia Province, by District, 2007-2014

District	IRS	ITN	Case Manage-ment	IPTp	Number of Health Facilities	Population Density (persons per m²)
QUELIMANE	Since 2007	2014	Since 2007	Since 2007	10	1649
ALTO MOLÓCUÈ	None	2012	Since 2007	Since 2007	16	41
CHINDE	None	2012	Since 2007	Since 2007	11	28
GILÉ	None	2012	Since 2007	Since 2007	10	19
GURUÉ	None	2012	Since 2007	Since 2007	13	54
ILE	None	2012	Since 2007	Since 2007	17	52
INHASSUNGE	None	2013	Since 2007	Since 2007	7	123
LUGELA	None	2013	Since 2007	Since 2007	12	22
MAGANJA DA COSTA	2010 and 2011	2013	Since 2007	Since 2007	18	37
MILANGE	Since 2007	2014	Since 2007	Since 2007	16	53
MOCUBA	Since 2007	2014	Since 2007	Since 2007	16	35
MOPEIA	2010 and 2011	2014	Since 2007	Since 2007	10	15
MORRUMBALA	Since 2007	2014	Since 2007	Since 2007	20	28
NAMACURRA	Since 2007	2013	Since 2007	Since 2007	11	99
NAMARROI	None	2012	Since 2007	Since 2007	8	42
NICOADALA	Since 2007	2013	Since 2007	Since 2007	15	65
PEBANE	None	2013	Since 2007	Since 2007	13	19

Data quality

As described in the Sofala case study, malaria case data are reported through the BES, while inpatient and mortality data are reported through the MB. In addition to the challenges to data quality laid out in the Sofala case study, Zambézia also suffers from poor data reporting: in 2012 only 68% of BES reports were received. For these reasons, these data and the trends observed must be interpreted with caution.

Trends in malaria cases

Based on the data available, the number of reported malaria cases has been decreasing in Zambézia since 2007; cases appeared to increase in 2011, then decrease again in 2012 (Figure 63). These trends are consistent for cases in children under the age of 5, as well as

cases in those aged 5 and older, as well as the overall incidence of reported cases per 1,000 population. After an initial increase in 2008, total consultations in Zambézia increased through 2011, followed by a slight decrease in 2012 (Figure 64). Taken together, these data suggest that the decrease in reported cases from 2007 through 2010 was not the result of a decrease in the number of overall reported consultations. However, it is interesting to note that the increase in consultations observed in 2010 and 2011 also coincided with a consistent malaria case rate. In other words, while total consultations increased, the percentage of these consults that were malaria remained the same, which in turn could explain the increase in total malaria cases seen during this time.

Figure 63: Provincial trends in reported malaria cases in Zambézia, 2007-2012

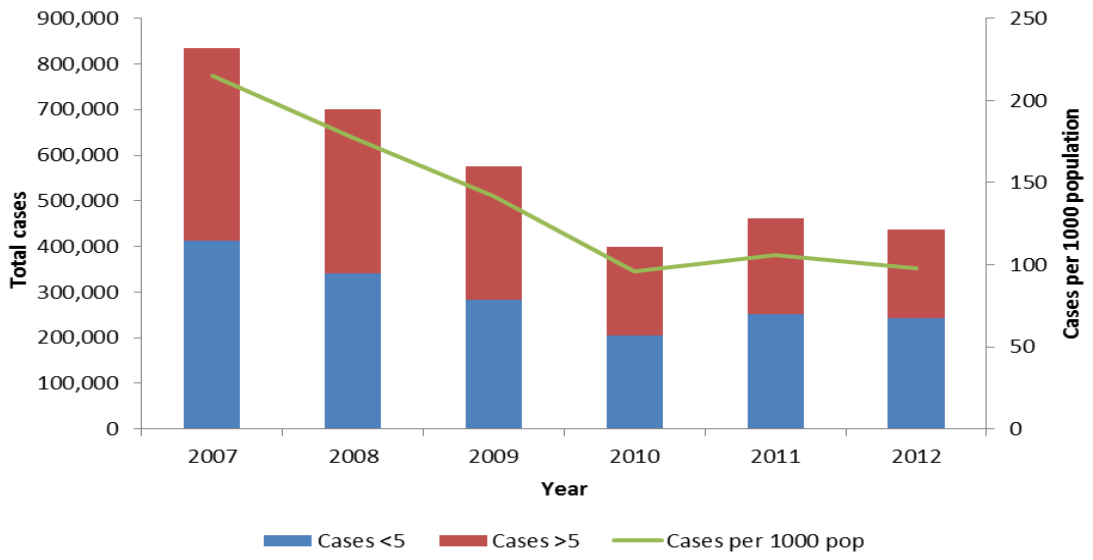
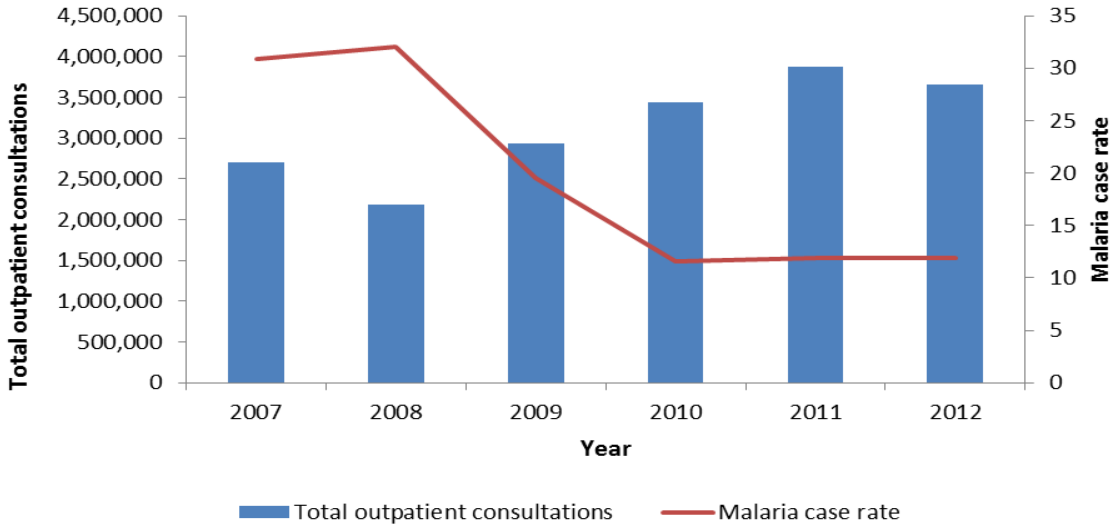


Figure 64: Total number of reported outpatient consultations in Zambézia, 2007 through 2012



Analysis of IRS impact

To better explore the potential impact of IRS in selected districts of Zambézia, provincial data on total reported cases were disaggregated into districts that did not receive IRS from 2007 through 2012, those that received IRS in 2010 and 2011 only, and those that received IRS annually from 2007 through 2012. Figure 65 shows the total number of reported cases per 1,000 population in districts that did not receive IRS during the study period. No discernable patterns are visible from 2007 through 2010 among all districts; in 2011 however most of these districts had an increase in reported cases per 1,000 population, followed by a decrease in 2012. This pattern follows what was seen at the provincial level.

Interestingly, both districts that received IRS in 2010 and 2011 had a decreasing trend in reported cases per 1,000 population through 2010, followed by an increase in 2011, which was substantial in one of the districts (Mopeia; Figure 66). It is unclear from the data available whether this increase is real or a data artifact resulting from increased reporting, change in case definitions, or some other reason.

In the 6 districts that received annual IRS during the study period, there was a consistent decreasing trend in reported cases per 1,000 population from 2007 through 2010. Although Mocuba showed the same general trend, it was excluded from this figure due to its likely artificial numbers (Figure 67). Interestingly, 3 of the 5 districts had an increase in reported cases per 1,000 population in both 2011 and 2012, while the remaining 2 (excluding Mocuba) had an increase in 2012. Again, because this trend mirrors what was seen in the province in general it could reflect a province-wide increase in transmission, or it could represent an artificial increase in reported cases, as described above.

To better compare the trends across these three groups, the average yearly number of cases per 1,000 population for the districts that did not receive IRS, those that received IRS in 2010 and 2011, and those that received IRS from 2007 through 2012 was calculated for the study period (Figure 68). These data show that while there appears to be a general decreasing trend in all districts from 2007 through 2010, this decrease is more drastic in the districts that received annual IRS. While not enough data exist to say that this decrease was the direct result of the IRS activities, the decrease is consistent with the results from a community case-control study done to examine the impact of IRS in these districts during the same time period [126].

Figure 65: Malaria cases per 1000 population in non-IRS districts, 2007-2012

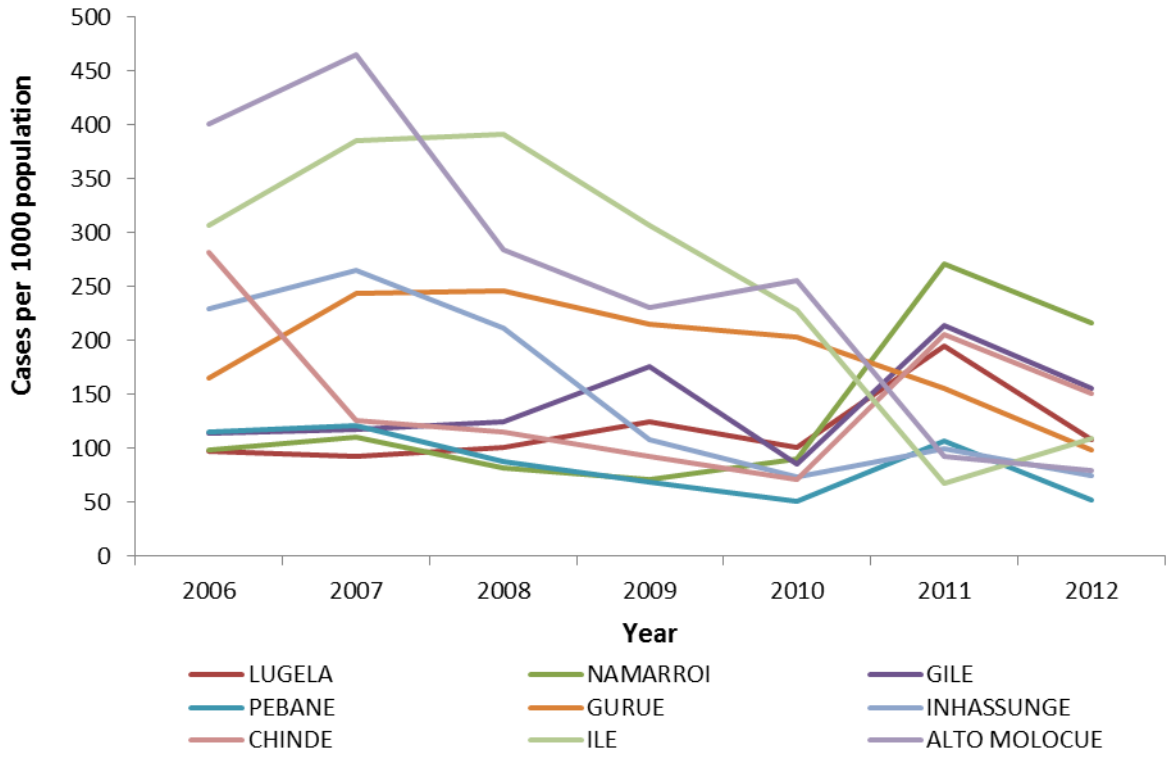


Figure 66: Malaria cases per 1,000 population, 2007-2012, in districts with IRS in 2011 and 2012

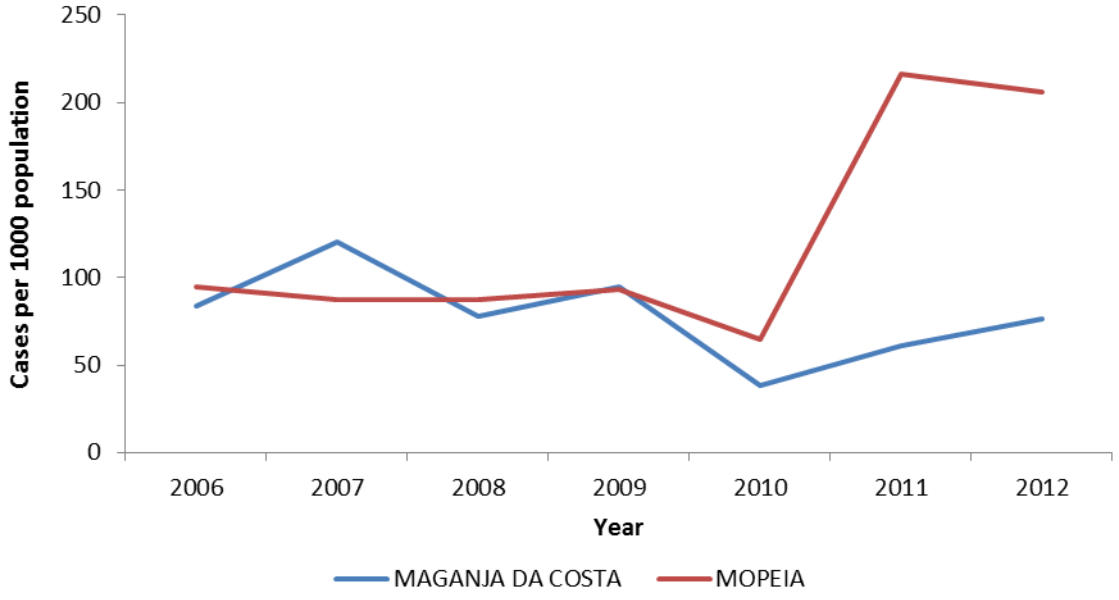
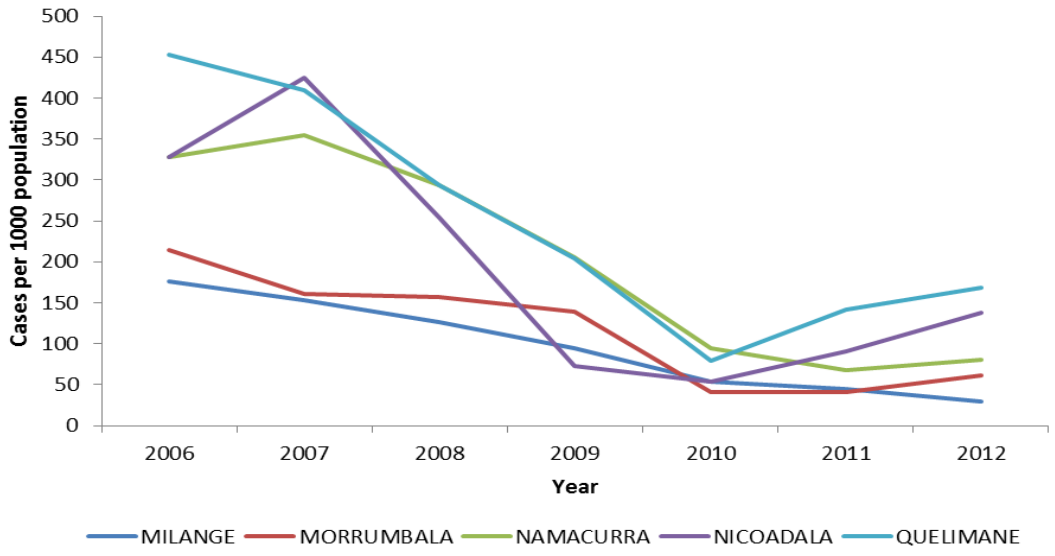
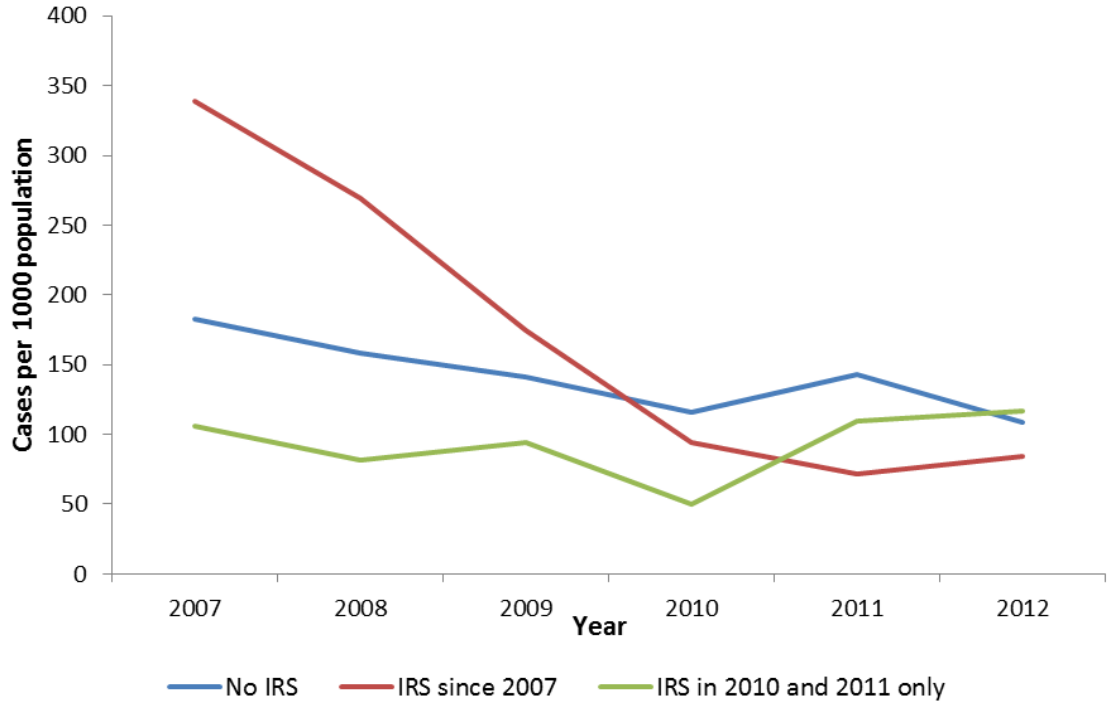


Figure 67: Malaria cases per 1,000 population in districts with IRS from 2007 through 2012*



* Excludes Mocuba District due to data quality concerns

Figure 68: Comparison of malaria cases per 1,000 population in IRS and non-IRS districts, 2007-2012



Summary of Zambézia Case Study

With the exception of IRS, malaria control activities were implemented throughout the entire province of Zambézia between 2007 and 2012. These activities were implemented in parallel with a decline in the number and incidence of reported cases of malaria during the same time period. While it is not possible at this point to ascribe this decline to the control activities themselves, the data do suggest a positive impact of the control activities.

As with the overall decline in cases in the province, the sharp decline in cases in districts receiving annual IRS cannot be directly attributed to the spraying itself. Nonetheless, the magnitude of the decline when compared with other districts that did not receive IRS suggests that IRS was having a positive effect on reducing malaria transmission in Zambézia. These data are backed up by a published study that showed IRS had significantly decreased community-level parasitemia from 2007 through 2010 [126].

The province-wide increase in reported cases in 2011 and 2012 is at least partially the result of an increase in the number of people seeking care at health facilities. Nonetheless, the increase warrants further investigation. Although the existing data do not support one individual cause for this increase, possible explanations could include insecticide resistance, an increase in transmission on a wide geographic scale (similar increases have been seen in other provinces as well), or artificial causes such as increased use of RDTs resulting in an increase in reported cases.

PLAUSIBILITY ANALYSIS AND CONCLUSION

Plausibility Argument and Conclusion

In this section, the success of malaria control intervention expansion and changes in malaria-related outcomes in Mozambique are summarized, and the plausibility that the expansion of malaria interventions led to changes in malaria-related outcomes and impact during the evaluation period is assessed.

To determine whether the expansion of malaria control interventions could have contributed to the observed 36% reduction in ACCM and if so, to what extent, we examined the fundamental and proximate determinants of child mortality that were in the causal pathways of the conceptual framework (Table 27, Figure 46).

Coverage of Malaria Control Interventions has Expanded

Household ownership of ITNs increased from 38% in 2007 to 54% by 2011, representing significant improvement over the evaluation period. Similarly, households with at least one ITN and/or IRS in the last 12 months rose significantly from 35% in 2007 to 60% by 2011, during which time ITN distribution and IRS efforts were significantly expanded in the country. ITN use in all populations increased significantly from 2007 to 2011. In children under five years of age, ITN use rose from just under 7% to 36%, in pregnant women, similarly it increased from 7% to 34%, while in the general population it rose from 5% to about 30%. Overall across all survey years, ITN use in children under five years of age was higher in urban areas compared to rural areas. ITN use was observed to be highest across all survey years in the high malaria risk zones, while use was found to be the same in low and medium risk zones from 2007 to 2011.

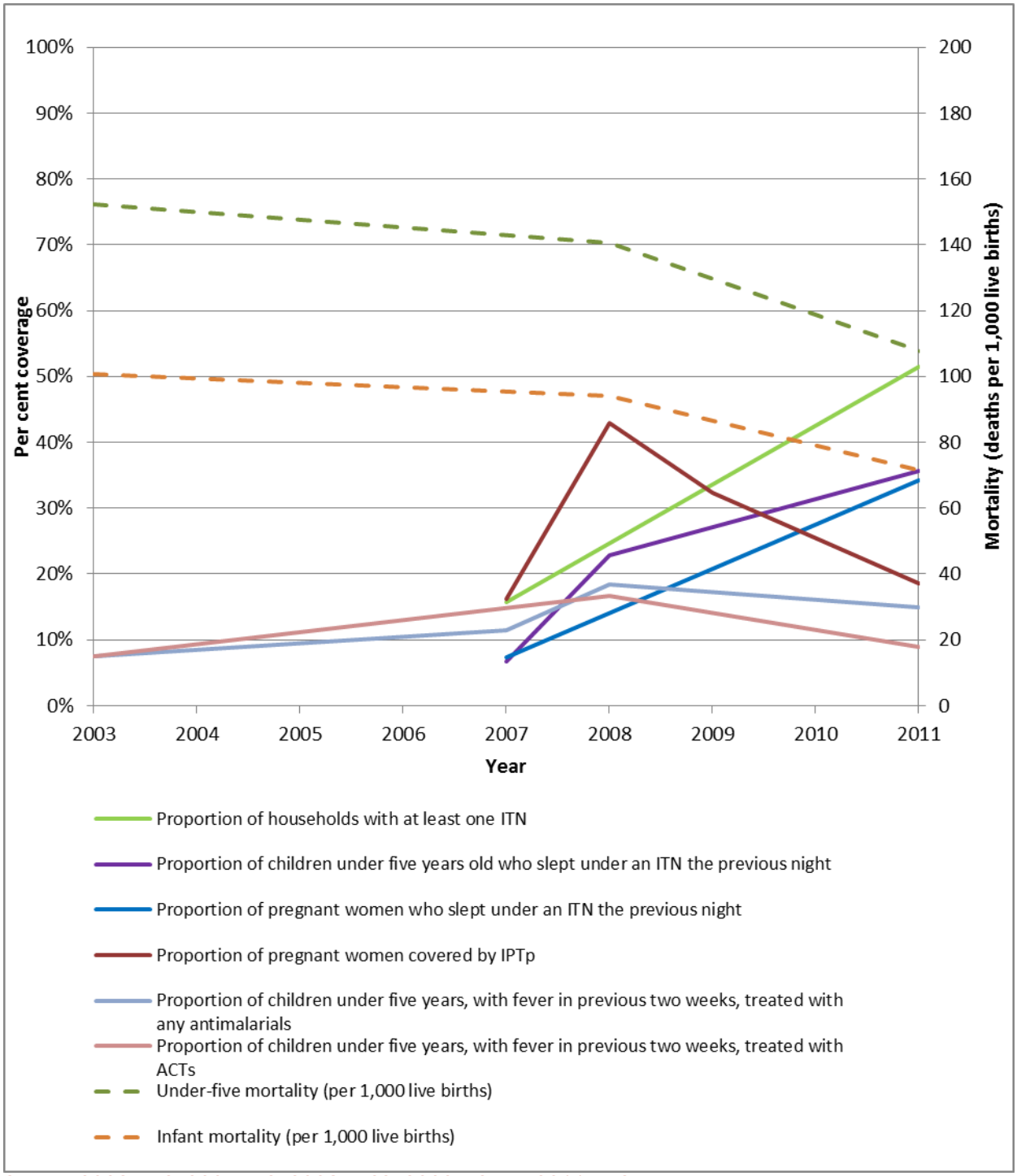
Overall, coverage of IRS steadily increased over the evaluation period; however national coverage data are only available from 2007 to 2011. During this latter part of the evaluation period, IRS coverage remained stable ranging from about 19-25% coverage. IRS was targeted in specific areas of the country and not at a national level, thus may have contributed to reductions in ACCM in the specific areas where it reached.

Implementation of IPTp began in Mozambique in 2006. Coverage increased significantly from 16% in 2007 to 43% in 2008, and then declined from 2009 to 2011, due to stock-outs of SP in the country. IPTp coverage across the three malaria risk zones varied across the different survey years, however, in general, IPTp coverage was higher in the low and medium risk zones compared to the high risk zones across all years. In terms of coverage by place of residence, IPTp coverage was significantly higher in urban areas than in rural areas across all survey years (2007-2011).

Care-seeking for fever from formal health providers in children under five years of age did not change over the evaluation period, staying stable at about 60%. Treatment with any antimalarial did increase two-fold however from 15% in 2003 to 30% in 2011, with a slight peak at 37% in 2008. Treatment with first-line antimalarials showed a significant improvement from 15% in 2003 to 34% in 2008, but then declined to about 18% in 2011. The decline from 2008 to 2011, likely reflects the 2009 policy change to AL as the first-line treatment.

While coverage of all malaria control interventions did improve over the evaluation period, all remained well below the targets for coverage. A summary of trends in malaria intervention coverage and ACCM and infant mortality are depicted in Figure 69

Figure 69: Summary of trends in malaria control interventions and ACCM and infant mortality, 2003–2011



Source: 2003 DHS, 2007 MIS, 2008 MICS, 2009 AIS and 2011 DHS

Malaria-related Morbidity has Declined

Malaria parasitemia declined significantly in children aged 6-59 months from 52% in 2007 to 36% in 2011. Malaria parasitemia prevalence was lower among children aged 6-23 months in 2007 and 2011 (44% and 31%, respectively) compared to children aged 24-59 months (56% and 39%, respectively). During the same time period, a reduction in malaria parasitemia was observed across all three malaria risk zones. The greatest relative decline was in the low risk zones (from 5% to 3%, a 49% relative decline), followed by the high risk zones (from 60% to 44%, a 26% relative decline). The only significant reduction observed however, was that in the high risk zones.

No data on malaria cases among children under five years of age are available, however in looking at HMIS malaria case data, there has been an overall decline in malaria cases from 2005 to 2012.

Severe anemia in children 6-59 months declined slightly between 2007 and 2011 (12% to 9%), however the decline was not statistically significant. A similar trend was observed for children 6-23 months and children 24-59 months. As expected, severe anemia was lowest in the low risk malaria zones and highest in the high risk zones across both survey years, with slight declines in severe anemia observed across all malaria risk zones.

Overall, trends in malaria parasitemia, severe anemia and malaria cases demonstrate an overall decline during the latter part of the evaluation period when malaria control interventions were expanded in the country.

Mortality in Children under Five Years of Age has Declined

Mortality in children under five years of age decreased by 36%, from 152 deaths in 1999-2003 to 97 deaths per 1000 live births in 2007-2011. This decline may be attributable to a number of child survival interventions, including the expansion of coverage of malaria control interventions. To further examine this decline, mortality in children under five years of age was stratified by place of residence and age (6-23 months and 24-59 months). The mortality declines were slightly larger in children residing in rural areas (37%) as compared to children living in urban areas (34%). Mortality declines from 2003 to 2011 were also larger in zones with medium- or higher-malaria risk than those with lower malaria risk. In addition, among children 6-23 months old, mortality declined the most in the higher malaria risk zone (44%) compared to children 24-59 months old (39%), whose mortality decreased the most in the lower risk zone (by 70%). It should be noted that the greatest decline (from 126 deaths per 1000 live births in the 2003 DHS to 97 in the 2011 DHS) in ACCM over the period 2003–2011 occurred in the latter part of the decade (from 2004-2008 to 2007-2011 time period), at a time when coverage of most malaria control interventions was expanded. Other child health interventions certainly played a role in the mortality decline as well.

Contextual Factors and the Plausibility Argument

To examine whether the marked reduction in ACCM could be attributed to the expansion of malaria control interventions, we reviewed other determinants of child survival that could

offer alternate explanations for the observed changes in mortality during 2003–2011 (summarized in Table 27).

Among the social and economic determinants of child survival, increases were seen in GDP per-capita, women's education, housing conditions (improved access to toilet facilities, modern floor material, electricity and access to telephone) and mass media exposure (television and newspaper), which could have contributed significantly to declines in ACCM between 2003 and 2011. However, the dynamics of socio-economic determinants on population health are often complex [127,128] and these determinants, arguably [129], operate through the proximate determinants to ultimately affect child survival [57].

During the evaluation period, several proximate determinants changed favoring lower mortality. Early initiation of breastfeeding and exclusive breastfeeding rose from 65% to 76% and from 30% to 43%, respectively over the evaluation period. Both postnatal and child vitamin A supplementation rose significantly from 2003 to 2011, from 21% to 68% and from 50% to 73%, respectively. Similarly, prevalence of suspected ARI declined slightly from 2003 to 2011. Lastly, HIV prevalence has been on the decline for most of the evaluation period. It reached its peak at about 16% in 2004 and had declined to about 12% in 2009 (2009 AIS). This decline is likely due to improved prevention and treatment efforts; both PMTCT and ART coverage have increased steadily in the country from 2006 to 2011. All of these trends suggest improvements in the prevention of childhood illness that are likely to have contributed at least in part to reductions in ACCM.

Coverage of other child survival interventions, such as immunization services, increased less dramatically between 2003 and 2011. Overall high coverage of BCG, DPT3/ Pentavalente 3, polio3 and measles were observed during the evaluation period, with coverage levels ranging from around 70% to as high as 91%. Coverage with these vaccines saved many lives over the evaluation period, but the further increases in coverage of these vaccines are unlikely to have had a great impact on the change in mortality in children under five years of age as sufficient levels for protection by herd immunity already existed in 2003. Furthermore, none of the changes in coverage of the different vaccinations were found to be statistically significant over the evaluation period. It is therefore possible that there was little or no relative increase in the contributions of these interventions on the observed reductions in ACCM.

Stunting in children under five years of age remained stable over the evaluation period, while the percentage of children under five years of age that are underweight declined significantly from 24% to 15%. It should be noted that nutritional improvement cannot be considered as a factor completely independent of malaria control. Recurrent illness is a major contributor to malnutrition and there is some evidence that malaria control interventions are associated with improved anthropometric indices [26]. Overall anthropometric indices remained unchanged or declined between 2003 and 2011, therefore it is not likely to have contributed to lower mortality over the evaluation period.

Maternal health interventions, including antenatal care attendance (4 or more visits), delivery at a health facility or by a skilled birth attendant, and tetanus toxoid vaccination

coverage overall remained stable or did not improve much over the evaluation period. With regards to care seeking for suspected ARI, coverage slightly declined from 2003 to 2011. Diarrhea treatment coverage with ORS did slightly increase over the evaluation period, but only by about 6%. The trends in these maternal and child health interventions suggest that they had little or no effect on the reductions observed in ACCM during the evaluation period.

There were very few trends in proximate determinants that suggest higher ACCM. The proportion of children under five years of age that are wasted slightly increased from 4% to 6%, during the evaluation period. Furthermore, while overall national HIV prevalence declined, HIV prevalence in the Southern region of the country actually increased during the evaluation period, which could have contributed to higher ACCM in that region.

Overall, Mozambique saw some improvements in the coverage of health interventions as well as socio-economic improvements between 2003 and 2011. Thus, improved malaria control was operating in this general improving environment.

Multiple Logistic Regression Analysis

The results from the multiple logistic regression models were inconclusive. When fully adjusted for all available factors that influence parasitemia, the models did not demonstrate an association between ITN ownership by age of net and parasitemia or between IRS and parasitemia prevalence among children 6-59 months. In both models, other variables, including place of residence, mother's education, wealth index and age of child were more strongly related to parasitemia than ITN ownership or household IRS.

Case Study from Sofala Province

The case study from Sofala Province demonstrated a significant decline in malaria cases between 2007 and 2012, which was likely related to the improving coverage of ITNs, IRS, case management and IPTp. The observed decline in overall malaria cases in the province was accompanied by a similar decline in deaths due to malaria. Progress in coverage of the first dose of IPTp was observed in Sofala Province since 2006, but coverage of second and third IPT doses remained low and in some cases decreased. Overall household coverage with at least LLINs or IRS improved during the period from 2007 to 2012.

Case Study from Zambézia Province

The Zambézia Province case study showed improvements in malaria control activities between 2007 and 2012 with an accompanying parallel decline in the number and incidence of reported malaria cases during the same time period. While it is not possible to attribute the decline in malaria cases directly to the increases in control activities, the data do suggest a positive effect. When specifically looking at the implementation of IRS and comparing districts within Zambézia that had annual IRS against those that did not receive IRS, the results similarly suggest that IRS had a positive effect on reducing malaria transmission.

Limitations of Evaluation

There are a few limitations with the evaluation that are important to note. First, the evaluation relied solely upon secondary data sources, thus was limited by what data was available. For example, for most of the malaria control intervention (ITN ownership, ITN use, IPTp and IRS) and morbidity indicators (malaria parasitemia and severe anemia), data were only available as of 2007, therefore it was not possible to assess their trends over the entire evaluation period. Second, there are known potential biases and limitations with many of the indicators that are reported and used to estimate intervention coverage, as well as malaria-related morbidity and ACCM. More detailed information on these potential biases and limitations for each of the indicators is presented within the annexes. Lastly, the quality of the HMIS data presented in the report, particularly in terms of completeness, reliability and validity over the evaluation period, is unknown and thus must be interpreted with caution.

Conclusion

Mozambique made progress over the evaluation period in rolling out and expanding coverage of many malaria control interventions, which is evidenced by significant increases in household ITN ownership and use, improvements in IRS coverage in targeted areas of the country, and overall improvement in treatment coverage of children under five years of age with antimalarials. There were some improvements in IPTp uptake; however, coverage since the roll out of IPTp in 2006 varied due to issues with stock-outs in the country. With regards to ITN ownership and use, and coverage of treatment of children under five years of age, the highest coverage was achieved in the high malaria risk zones, compared to the medium and low risk zones.

The majority of the improvements in malaria control intervention coverage were made during the latter part of the evaluation period, which is consistent with the progress observed in malaria morbidity and mortality in the country. Declines were observed in malaria parasitemia, severe anemia and malaria cases during the latter part of the evaluation period. Similarly, the greatest relative declines in ACCM also occurred in the latter part of the decade (from 2004-2008 to 2007-2011), compared to the beginning of the evaluation period. In addition, there were greater declines observed both with respect to malaria parasitemia, severe anemia and mortality in the high malaria risk zones compared to the low risk zones, which is consistent with some of the trends seen in terms of ITN ownership and use and treatment coverage. The case studies from Sofala and Zambézia Provinces also showed similar trends, with improvements in malaria prevention and control interventions and corresponding declines in malaria cases and deaths (in the case of Sofala Province).

During the evaluation period there were also

Estimated Deaths Prevented due to Scale-up of Malaria Control Interventions

Given the evidence shown in this report of a decline in all-cause mortality in children under five years of age, and in anemia and malaria parasitemia during the evaluation period, we used The Lives Saved Tool (LiST) to estimate the deaths prevented due to the scale-up of malaria control interventions (For more detailed information on LiST and the model presented see Annex 2).

It is estimated that over the period from 2007 to 2011, approximately **13,198** (range: 9,231-17,231) deaths were prevented in children 1-59 months, due to the scale-up of ITN household ownership and IRS, compared to what would have happened if no vector control scale-up had occurred. Under five mortality is also affected by interventions to control malaria in pregnancy, including ITN use by pregnant women and IPTp during pregnancy. The LiST model estimated that **663** (range: 507-97) deaths in children 0-59 months were averted due to the scale-up of ITN use by pregnant women in Mozambique during the latter part of the evaluation period, from 2007 to 2011.

The LiST analysis presented here models the direct effect of malaria interventions on reducing malaria-specific mortality. Given the conservative nature of the LiST model, the estimates presented are likely to be underestimates. **Overall, the LiST model conservatively estimates that the scale-up of malaria control interventions during the latter part of the evaluation period (2007 to 2011) prevented at least 13,861 deaths among children under five years of age in Mozambique.**

significant improvements observed in the coverage of some non-malaria health interventions, as well as socio-economic improvements, which likely contributed in part to the reductions observed in ACCM from 2003 to 2011. Taken altogether, this evidence suggests that malaria control interventions in Mozambique are likely to have contributed to reductions in ACCM, particularly the reductions that were observed during the latter part of the evaluation period.

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