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

Angola Malaria Impact Evaluation Group

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U.S. PRESIDENT'S MALARIA INITIATIVE

Executive Summary

BACKGROUND AND OBJECTIVE

Malaria is a major public health problem in Angola and the primary cause of mortality, illness, and absence from school and work according to the Ministry of Health. Malaria represents about 35% of all outpatient visits and 20%of hospital admissions. Among children under five years of age, malaria-related illness accounts for 60% of hospital admissions and 35%of inpatient mortality. Between 2006 and 2011, the government of Angola and other international development partners invested extensively in malaria control activities such as insecticide-treated mosquito 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 President's Malaria Initiative (PMI) and Angola's Ministry of Health (MoH) to report on the impact of these malaria control interventions on malaria morbidity and mortality among children under five years of age during the evaluation period 2006–2011.

EVALUATION DESIGN

The evaluation was based on a before-and-after assessment to support a plausibility framework associating malaria control interventions with impact on directly measured outcomes, including, malaria-related morbidity, and all-cause mortality of 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. To bolster the plausibility evaluation design, further analyses, including a multiple logistic regression model investigating the association between household ITN ownership and malaria parasitemia, and a case study from Huambo Province were conducted.

DATA SOURCES

Data used in the report mainly come from two large population-based household surveys: the 2006/7 and 2011 Angola Malaria Indicator Surveys (MIS). These nationally representative survey data are supplemented, where relevant, by programmatic data from the Angola Routine Health Management Information System (HMIS) through 2011; National Nutrition Survey 2007/8 (UNICEF); Expanded Program on Immunization (EPI) Monitoring Data, 2007 (WHO/UNICEF); and Estimates of Immunization Coverage Data, 2010 (WHO/UNICEF). All data sources are clearly cited throughout the report.

IMPLEMENTATION OF MALARIA CONTROL INTERVENTIONS

From 2001 to 2009 ITNs were primarily targeted to women and small children and distributed through routine antenatal care (ANC) clinics, immunization clinics and municipal health days. There was an ITN campaign as part of the "*Viva a Vida com Saúde*" (Live Life with Health) campaign that distributed nets to households with children under five years of age in seven provinces in 2006. In 2010, the ITN strategy in Angola shifted to universal coverage; however, there were not enough nets available to

meet universal coverage targets during this evaluation period. Household ITN ownership increased from 28% in 2006/7 to 35% in 2011 nationwide. The increase in household ITN ownership was greater (from 21% to 35%) in the eleven provinces that had not participated in the massive ITN distribution campaign of 2006, implemented a few months before the 2006/7 survey. ITN use (the night before the survey) was 26% each among children under five years of age and pregnant women, and 19% in the entire surveyed population in 2011. Similar to the national trends, both ITN ownership (12–15 percentage point change) and use (11–18 percentage point change) increased in all malaria epidemiologic zones of Angola, except in the hyperendemic zone where both indicators decreased (19 percentage point change and 10 percentage point change declines in ownership and use).

IRS implementation was limited to specific municipalities only; every year between 2005 and 2011, IRS implementation covered a population of 500,000 to 800,000. Households with at least one ITN and/or IRS in the last 12 months increased significantly, from 29% in 2006/7 to 38% in 2011.

Implementation of IPTp (at least two doses of sulfadoxine-pyrimethamine) began in Angola in May 2006 and coverage increased significantly from 2% in 2006/7 to 18% in 2011. IPTp coverage also increased significantly in three out of the four epidemiologic zones.

Among children under five years of age, care-seeking for fever from formal health providers remained unchanged from 2006/7 to 2011 (54% and 57%, respectively). Treatment with recommended antimalarial was also unchanged, at 26% in 2006/7 and 22% in 2011. Artemisinin-based combination therapy (ACT) use among children under five years of age increased from 2% in 2006/7 to 22% in 2011. During this period, the national treatment policy changed the first-line antimalarial from chloroquine or amodiaquine to highly efficacious ACTs in 2004, but the rollout of this new policy began in 2006 and occurred throughout the period of this evaluation, reaching all public health facilities by 2011. ACTs were free for all ages in the public sector by 2005 and by 2010 parasitological confirmation was required before treatment with an ACT.

IMPACT RESULTS

Morbidity

Malaria parasitemia prevalence estimates (measured using rapid diagnostic tests) declined in children aged 6–59 months from 21% in 2006/7 to 14% in 2011. This was lower among children aged 6–23 months (the age group most likely to be affected by severe malaria) in 2006/7 and 2011 (14% and 11% respectively) compared to children aged 24–59 months (25% and 15% respectively), although none of the declines were statistically significant. Data from the HMIS showed that the number of reported malaria cases for all age groups, including children under five years of age, increased between 2006–2009/10. However, starting in 2009 for all malaria cases and 2010 for children under five years of age, the number of reported malaria cases started to decline, despite an overall increase in the percentage of health facilities reporting to the HMIS between 2009 and 2012. These trends should be interpreted in light of the policy for parasitological confirmation before treatment for all ages which was adopted in 2010.

Mortality
Mortality in children under five years of age fell by 21% between 2003–2005 and 2009–2011, dropping from 117 deaths per 1,000 live births to 92 deaths per 1,000 live births, based on retrospective estimates from the 2011 MIS. There was a greater decline in ACCM the years preceding 2006 (19% reduction), followed by stabilization between 2006 and 2011 (close to a 3% reduction). ACCM declined significantly in the hyperendemic zone (45% relative decline) but not in any of the other malaria epidemiologic zones in Angola. Consistent with the national declining trends in ACCM, data from the HMIS showed that the number of reported malaria deaths for children under five years of age also declined overall between 2006–2011, in particular from 2009 onwards.

A case study based on HMIS data from Huambo Province, where the HMIS has been performing strongly since 2010 and where malaria control efforts have been focused, showed that both suspected malaria cases (45% relative change) and malaria deaths (94% relative change) at health facilities declined substantially in the province between 2009 and 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. Non-malaria factors that could have contributed to reductions in ACCM, include: the end of the civil war in 2002, increases in Gross Domestic Product (GDP) and improvements in childhood vaccination coverage. Some determinants were unlikely to have affected ACCM, since they were unchanged between 2006/7 and 2011, including: housing conditions, maternal education, proportion of neonates protected from tetanus, births that were high risk or women who received ANC from a skilled provider.

Multiple logistic regression analysis
The results of the multiple logistic regression analysis showed that despite the overall low coverage of ITNs in Angola in 2011, ITN ownership by age of net, in particular if the ITN had been acquired between two and six months before the survey, was protective of malaria (parasitemia) in children under five years of age, even after controlling for potential confounding factors.

CONCLUSION

Despite major infrastructure and societal disruptions caused by the civil war that ended in Angola in 2002, progress was made in rolling out some of the malaria control interventions, evidenced by the significant increases in ITN ownership and use and IPTp in particular, between 2006/7 and 2011. However, it is unlikely that the overall changes in the coverage of malaria control interventions in 2011 were high enough to impact ACCM at a national level. Malaria parasitemia prevalence and malaria mortality in children under five years of age decreased nationally during the evaluation period, shown by the MIS surveys and the HMIS, respectively; the Huambo case study provided an example of this also occurring at the sub-national level. However, larger ACCM

decreases prior to 2006–2008 are likely due to other contextual factors, such as the end of the civil war, increases in GDP, and childhood vaccination coverage. Despite the overall low coverage of ITNs in 2011, multiple logistic regression analysis showed that household ITN ownership was protective against malaria parasitemia among children under five years of age under programmatic conditions. Therefore, if the implementation of malaria control interventions were to be further scaled-up and sustained in Angola, there is potential for a further decline in ACCM nationwide.

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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 of children under five years of age
ACT	Artemisinin-based combination therapy
AL	Artemether-lumefantrine
ANC	Antenatal care
ARV	Anti-retroviral therapy
BCG	Bacillus Calmette–Guérin (vaccine)
CDC	United States Centers for Disease Control and Prevention
CI	Confidence interval
CQ	Chloroquine
DDT	Dichlorodiphenyltrichloroethane
DOT	Directly observed therapy
DTP	Diphtheria, tetanus, pertussis (vaccine)
EPI	Expanded Programme on Immunization
GDP	Gross domestic product
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
HAMSET	HIV/AIDS, Malaria, STD & TB Control Project – World Bank
Hb	Hemoglobin
HBV	Hepatitis B vaccine
Hib	Haemophilus influenzae type B vaccine
HIV	Human immunodeficiency virus
HMIS	Health Management Information System
HSA	Health System Assessment
IBEP	Integrated Survey on the Welfare of the Population
IGME	Inter-agency Group for Mortality Estimation
INE	National Statistics Institute
IPTp	Intermittent preventive treatment (of malaria) in pregnancy
IRS	Indoor residual spraying
ITN	Insecticide-treated net
IUGR	Intrauterine growth retardation
KZ	Kwanza (Currency used in Angola)
LLIN	Long-lasting insecticide-treated net
M&E	Monitoring and evaluation
MERG	Monitoring and Evaluation Reference Group
MIS	Malaria Indicator Survey
NGO	Non-Governmental Organization
NHS	National Health Service
NMCP	National Malaria Control Program
NN	Neonatal mortality (first month), per 1,000 live births
PAB	Protection at birth (against tetanus)
PMI	U.S. 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
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 major public health problem in Angola and the primary cause of illness, absence from school and work, and mortality. It represents about 35% of all outpatient visits and 20% of hospital admissions according to the Ministry of Health[3]. It is the major cause for hospital admissions in children under five years of age. Due to the serious disease burden caused by malaria, and the extensive funding, both internal and external, which 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 morbidity and mortality. The objective of this report is thus to assess progress in Angola's malaria control efforts between 2006 and 2011, in particular the progress towards the malaria control goals set forth in the 2008 Global Malaria Action Plan, updated in 2011 [4,5], the Millennium Development Goals [6], and the Abuja Declaration on Roll Back Malaria[7].

The report was co-commissioned by the President's Malaria Initiative (PMI) and Angola's Ministry of Health (MoH) in support of the monitoring and evaluation activities conducted by the Roll Back Malaria Partnership (RBM) and Angola's MoH. The main objective of the evaluation is to assess the impact of malaria control interventions, such as insecticide-treated mosquito nets (ITNs), indoor residual spraying of insecticide (IRS), intermittent preventive treatment in pregnancy (IPTp), and malaria case management, on malaria morbidity and all-cause mortality in children under five years of age (ACCM), between 2006 and 2011 in Angola. The report does not aim to present a critique 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 between 2006 and 011 because this is the period over which most changes have taken place in malaria control interventions. Artemisinin combination therapies (ACTs) were purchased and distributed for malaria case management starting in May 2006, coinciding with the initiation of IPTp and the launch of IRS campaigns in southern Angola. Additionally, more than 6 million long-lasting insecticide-treated nets (LLINs) were procured and distributed in Angola between 2006 and 2011, however, not substantial enough to for nationwide coverage.

Evaluation Design

The evaluation is based on a before-and-after assessment, that measured changes in malaria control intervention coverage, malaria-related morbidity, and ACCM while accounting for other contextual determinants of child survival during the evaluation period in order to develop a plausibility case supporting the conclusion that malaria control interventions contributed to a public health impact [8,9].

This report, therefore seeks to describe 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 and direction of impact is consistent with intervention efficacy;

- if the age-pattern of change is consistent with malaria-mediated morbidity and mortality;
- if the timing of intervention scale-up 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 climate, 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 logistic regression model examining the relationship between ITN ownership and malaria parasite prevalence and a sub-national case study from Huambo Province.

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)	1. Proportion of households with at least one ITN
	2. Proportion of households with at least one ITN for every two people
	3. Proportion of population with access to an ITN within their household
	4. Proportion of population who slept under an ITN the previous night
	5. Proportion of children under 5 years old who slept under an ITN the previous night
	6. Proportion of households with at least one ITN and/or sprayed by IRS in the last 12 months
Prevention and control of malaria in pregnant women	7. Proportion of pregnant women who slept under an ITN the previous night
	8. Proportion of women who received intermittent preventive treatment (IPTp) with at least two doses of SP for malaria during ANC visits during their last pregnancy
Case Management	
Diagnosis	9. Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick
Treatment	10. Proportion of children under 5 years old with fever in the last 2 weeks for whom advice or treatment was sought from appropriate providers
	11. Proportion of children under five years old with fever in last two weeks who received any antimalarial treatment.*
	12. Proportion receiving first line treatment, among children under five years old with fever in the last two weeks who received any antimalarial drugs
	13. 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	14. All-cause mortality of children under five years of age (ACCM).
Morbidity Indicators	15. Malaria Parasitemia Prevalence: proportion of children aged 6–59 months with malaria infection.
	16. Severe Anemia Prevalence: proportion of children aged 6–59 months with a hemoglobin measurement of <8 g/dL
*These indicators are no longer recommended by the RBM MERG but are included here as they are still used to track NMCP and/or MDG targets. Source: Household Survey Indicators for Malaria Control[10]	

Insecticide-treated mosquito nets (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 target populations historically at greatest risk of malaria morbidity and mortality: children under five years of age and pregnant women.

Intermittent preventive treatment in pregnancy (IPTp)

Intermittent preventive treatment in pregnancy (IPTp) is another key tool of malaria control programs. The World Health Organization (WHO) recommends IPTp in highly endemic countries. IPTp was recommended in at least two doses of sulfadoxine-pyrimethamine (SP) after quickening and at least one month apart during the period under evaluation; however the WHO recommendations have since changed [11].

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 among 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 [12-14]. 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 other reasons as well, including: concerns about the sensitivity and specificity of the verbal autopsy method for detecting malaria deaths [15] 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 [16].

HIV-bias in Mortality Measurement

Mortality estimates presented in this report have not been adjusted for HIV. In high HIV prevalence countries, deaths of mothers due to AIDS result in an omission of birth histories that include children with elevated mortality risk. The United Nations Inter-agency Group for Child Mortality Estimation has developed methods of HIV-adjustment of child mortality estimates and recommends this adjustment in countries where more than 5% of adult women are infected with HIV. However, other analyses of potential HIV bias by Rajaratnam and colleagues [1] using Demographic Health Survey data from 21 countries shows substantial variation in effect on child mortality estimates in both directions, even in countries where HIV prevalence exceeds 20%.

Angola has one of the lower HIV prevalence rates in sub-Saharan Africa, with an estimated 2% of the adult population living with HIV. Over the past decade, HIV prevalence in Angola has remained stable and coverage of antiretroviral therapy (ARV) and prevention of mother to child transmission (PMTCT) has remained low, with an estimated 35% of people living with HIV/AIDS receiving ART in 2009 and 19% of pregnant women receiving antiretroviral drugs for PMTCT in 2010 [2]. Given the stability of HIV prevalence and treatment coverage rates, there is little evidence of a differential HIV bias during the evaluation period. Because of this, the mortality estimation methods in this evaluation do not take into account potential selection bias arising from high HIV prevalence, which could be considered a limitation of the report.

After a thorough analysis of the limited data options available to examine ACCM in Angola, the impact evaluation team chose to follow the methods used by Rowe and others [17] and use data from the most recent 2011 MIS to generate retrospective estimates. Estimates from the 2011 MIS were chosen over estimates produced by the Inter-Agency Group for Mortality Estimation (IGME) because IGME estimates do not permit the stratification needed to inform the plausibility argument (for example, by different age groups or malaria epidemiologic zones). Furthermore the IGME mortality models include multiple parameters that incorporate intervention coverage. Therefore, for this evaluation it is more appropriate to assess impact based on actual measured morbidity and mortality, rather than synthetic estimates. The 2011 MIS was also chosen because it provided direct estimates of the mortality of children under five years of age (as compared to the indirect estimates of earlier surveys), had a larger and more adequate sample size, and covered the necessary time period for this evaluation (from 2003 to 2011 specifically). Note that direct estimates use data on the date of birth of children, their survival status, and the dates of death or ages at death of deceased children. Indirect estimates use information on survival status of children to specific age cohorts of mothers. Further details are provided in Annex A.1.6.

Data Sources

No new primary data were collected for this evaluation. The data source for malaria control intervention coverage indicators and some of the contextual factors were the 2006/7 and 2011 MIS surveys. The 2006/7 MIS provided baseline estimates of malaria control intervention coverage, and the 2011 MIS provided a follow-up after five years of implementing malaria control interventions. While a Multiple Indicator Cluster Survey (MICS) was conducted in Angola in 2001, it was only representative of urban areas as most rural areas were not secure enough for data collection due to the civil war. Where applicable, 2001 MICS data are presented to supplement the 2006/7 and 2011 MIS data and to provide an earlier estimate for intervention coverage in urban areas. Though there was a national Integrated Survey on the Welfare of the Population (IBEP) in 2008/9 conducted in Angola, it was not included in this evaluation because the raw data were unavailable. As mentioned earlier, the 2011 MIS alone was used to generate estimates of ACCM. Additional data sources are referred to where relevant and included: Angola Health Management Information System (HMIS) data through 2012; National Nutrition Survey 2007/8 (UNICEF); and Estimates of Immunization Coverage Data, 2012 [18]. 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. A more detailed description of the data sets, survey methods, sample sizes and other statistical parameters can be found in Annex 1.

Country Context

Background

The Republic of Angola, the sixth largest country in Africa, is located on the west coast of southern Africa, and between the parallel latitudes of 4° 22' and 18° 02'. It is bordered on the west by the Atlantic Ocean and shares land borders with the Republic of the Congo, the Democratic Republic of the Congo, Zambia, and Namibia. The country occupies a land area of 1,246,700 square kilometers and is divided into 18 provinces (Figure 1), 161 municipalities, and 532 towns, with Luanda as the capital city. The name *Angola* derives from the Bantu word N'gola, the title of the rulers during the sixteenth century when Portugal started to colonize the region. The official language is Portuguese, though there are over 20 different local languages.

Figure 1: Map Angola and the 18 provinces

Source: MIS 2011, ICF International

Angola's climate varies widely, influenced by a diversity of factors, including latitude, altitude, and wind. Rain is common throughout the year in the north of the country. The highlands in the interior have a mild climate, with a rainy season from September to April, followed by a cooler, dry season from May to August. The south and southeast regions are a dry savannah, with little rain. The average annual temperature decreases from north to south, ranging from 24°C to 20°C.

The first census since 1970 was conducted in Angola in May 2014. Preliminary results revealed there was total population of 24,383,301, of which 52% were female[19]. About 62% of the population lived in urban areas and 27% in Luanda Province, Angola's capital city.

Some basic development indicators for Angola are presented in Table 2. Almost half (45%) of the estimated population was between 0–14 years of age, life expectancy at birth was 51 years, the total adult literacy rate was 70% (83% for males and 58% for females), and 49% of the population had access to an improved water source. In terms of child health, 88% of children 12–23 months old in 2011 had been immunized against measles, 29% of children under five years of age in 2007/8 were stunted, 15% were underweight and 8% suffered from wasting. The total fertility rate was 5.4 in 2010 and ANC from a skilled provider in 2011 was provided to 76% of women with a pregnancy in the two years preceding the survey.

Table 2: Basic Development Indicators for Angola, 2005–2012

Social Indicators	
Population aged 0–14 years, 2012*	46%
Life Expectancy at Birth, 2010**	51
Total adult literacy rate, 2005–2010**	70%
*Male****	83%
*Female (2010 est.)****	58%
Improved water source (% of population with access), 2011*****	49%
Child Health Indicators	
Children 12–23 months old immunized against measles, 2011******	88%
Children under five years of age who are stunted, 2007/8*******	29%
Underweight*******	15%
Wasted*******	8%
Maternal Health Indicators	
Total Fertility Rate (number of births per woman), 2010**	5.4
Antenatal care from a skilled provider, 2011*****	76%

Data Sources: *UN data[20]; ** UNICEF [21];***CIA World Factbook [22]; ****2011 MIS; *****UNICEF 2007/8 Nutrition Survey ; ******WHO and UNICEF estimates of immunization coverage [18]

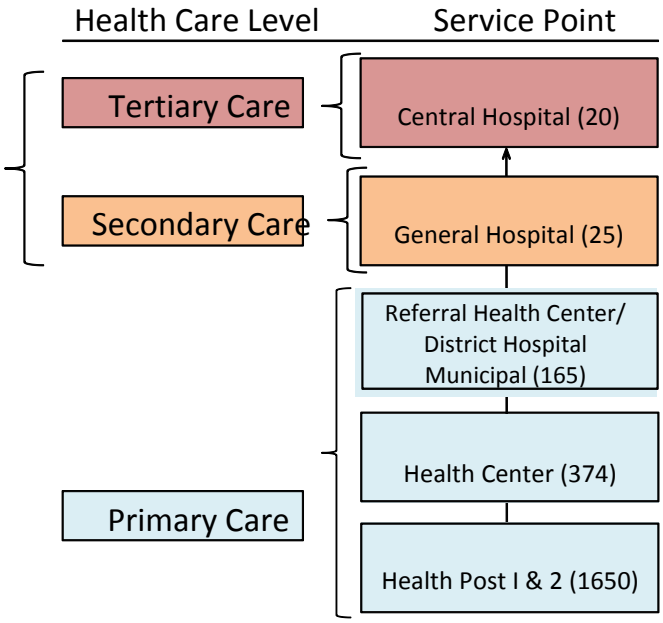
The Gross Domestic Product (GDP) of Angola was 104.1 billion (US$) in 2011 and the gross national income (GNI) was 79.7 billion (Atlas method, US$) [23]. In Angola, the GDP per capita (in 2000 US$) was US$ 655 in 2000, as compared to US$ 1,377 in 2011. Forty-four percent of the population was living below the international poverty line of US$1.25 per day between 2007 and 2011 [24]. Nevertheless, Angola has one of the fastest growing economies in the world; between 2001 to 2010, Angola's annual average GDP growth was 11.1 percent [25]. Oil production is the main contributor to the GDP (85%) and diamond exports account for a smaller but substantial portion (5%). Nonetheless, much of the population (85%) is employed in agriculture. The inflation rate has declined markedly, from 325% in 2000 to about 10% in 2010 [22].

Health Services

The National Health Service (NHS) in Angola is organized into three levels of care: primary, secondary, and tertiary. Primary care is delivered through health posts (or

clinics), health centers, and the district hospitals. General and central hospitals provide secondary and tertiary care services, respectively. Figure 2 summarizes the service delivery levels and the types of health facilities of the Angolan health system.

Figure 2: Summary of the service delivery levels of the Angolan Health System, 2011



In 2002, Angola emerged from nearly three decades of civil war. During this period of conflict, roughly 80% of Angola's health facilities were damaged or destroyed [26]. Table 3 shows that since 2003, there was a significant increase in the number of new health facilities. The total number of facilities almost tripled between 2003–2009, driven mostly by an increase in health posts, followed by health centers and district hospitals. By 2008, the health care network of the NHS was made up of 2,402 health facilities, of which 11 were central (national) hospitals, 45 were general (provincial) hospitals, 146 were district hospitals, 359 were health centers and 1,841 were health posts (I and II).

Table 3: Number of health facilities in Angola by type, 2003–2011

Facility Type	2003	2004	2005	2006	2007	2008	2009	2010	2011
Central Hospital	9	9	9	11	11	11	11	11	20
General Hospital	33	33	33	46	41	45	37	42	25
District Hospital	52	116	116	147	135	146	165	146	165
Health Center	162	272	272	292	324	359	365	364	374
Health Posts (I&II)	696	1,026	1,026	1,441	1,768	1,841	1,791	1774	1650
Other (missing information)									122
TOTAL	952	1,456	1,456	1,937	2,297	2,402	2,369	2,337	2356

Source: Ministry of Health National Health Statistics 2011

Similar to the increase in the number of health facilities, the number of health workers also increased rapidly in Angola during this period. The number of doctors, for example, more than tripled from 849 [27] in 2005 to 2,956 in 2009 [28]. Likewise, the number of nurses increased dramatically from 16,027 in 2005 to 29,592 in 2009. Despite this increase, however, there is an inequitable distribution of human resources as most health workers (85% of doctors, for example) work in urban areas. The rural areas, where the most vulnerable people live, have limited access to health services. While efforts to rebuild the health system have been underway, it was estimated in 2011, that only 30–40% of the population had access to public health care [26]. Thus, there continues to be a huge shortage of basic health services to meet the needs of the population.

Malaria in Angola

Malaria is endemic in all 18 provinces of Angola and transmission is highest in the northeastern, central, and coastal parts of the country, while the southern part of the country has the lowest transmission. The country has three malaria epidemiologic zones: hyperendemic, mesoendemic stable, and mesoendemic unstable [29]. This classification has been used by the NMCP since 1991. The northeastern part of the country, which is characterized by high rainfall and temperatures, high parasite prevalence and stable, year-round malaria transmission, is hyperendemic. The central and coastal areas of Angola, with moderate levels of parasite prevalence and seasonal malaria transmission, are mesoendemic stable. Mesoendemic unstable areas, which have short and unstable malaria transmission seasons and are prone to epidemics, include arid and semi-arid areas in the southern part of the country. The epidemiologic stratification of malaria in Angola, taking into account the heterogeneity of malaria transmission, is presented in Table 4 and Figure 3.

Table 4: Malaria Epidemiologic Zones in Angola

Endemicity level	Provinces	Vectors	Parasites	Population Affected	Transmission period
Hyperendemic	Cabinda Uíge Kwanza Norte Malanje Lunda Norte Lunda Sul	*An. funestus* *An. gambiae s.l.* *An. nili* *An. ziemani*	*P. falciparum*: 93% *P.vivax*: 7%	28%	Year round transmission Peak: March - May, Oct. - Nov.
Mesoendemic Stable	Zaire Luanda* Bengo Benguela Kwanza Sul Huambo Bié	*An. gambiae s.l.* *An. funestus* *An. ziemani* *An. nili* *An. obscurus*	*P. falciparum*: 93% *P.vivax*: 7%	55%	High transmission: Sep. - April Low transmission: May – Aug.
Mesoendemic Unstable	Moxico K. Kubango Kunene Huila Namibe	*An. gambiae s.l.* *An. funestus* *An. rhodesiensis*	*P. falciparum*: 88% *P.vivax*: 7% *P. malariae*: 5%	17%	Low transmission: May-Dec.

Note: *Luanda Province is located within the mesoendemic stable zone. However, for the evaluation, Luanda Province was analyzed as a separate zone due to the way the MIS surveys were sampled as well as it being a large urban area (for more details, please see the following paragraph).

Source: National Strategic Plan for Malaria Control in Angola, 2011–2015 [29]

Despite Angola having three malaria epidemiologic zones, the two MIS surveys (2006/7 and 2011) sampled and analyzed Luanda Province, which is in the mesoendemic stable zone, as a separate fourth zone. Luanda Province has a different malaria epidemiology because of the large urban setting, with an estimated population above 5 million; about 26% of the entire population [20]. A PMI-supported study conducted in 2008 found malaria transmission in Luanda City to be low, except in the periurban areas in Cacuaco, Viana, and Sambizanga municipalities [30]. Figure 3 below presents a map of the four zones as sampled by the two surveys.

Figure 3: Map of Malaria Epidemiologic Zones in Angola as Sampled in the 2006/7 and 2011 MIS

Source: MIS 2011, ICF International

Since this evaluation mainly uses data from the 2006/7 and 2011 MIS surveys, all the results pertaining to malaria epidemiologic zones presented in this report are stratified by four zones, defined as follows:

- **Hyperendemic:** High malaria transmission with rain throughout the year.
- **Mesoendemic stable:** Malaria transmission is seasonal, both high and low transmission periods, and the rainy season is from September to April.
- **Mesoendemic unstable:** Malaria transmission is seasonal, with a short rainy season, and is prone to epidemics. The zone includes arid and semi-arid areas.
- **Luanda province:** Low malaria transmission in the city, however, relatively higher in the peripheral areas compared to the city center.

The most recent parasitological study of 2007 conducted in five provinces (Malanje, Uige, Kwanza Sul, Huambo, and Cabinda), found malaria parasite infection through polymerase chain reaction (PCR) in 45% of asymptomatic children under five years of age, of which 87% was *P. falciparum,* 2% was *P. malariae* and almost 1% was *P. ovale* [31]. The remaining 10% of infected children had a mixture of these three species (Table 4) [29]. The main malaria vectors in high transmission areas are *Anopheles gambiae* and *An. funestus*, which are endophilic and prefer human blood and feed and rest indoors.

Malaria Control Strategy

The first attempts to control malaria in Angola began in the south in 1958 using residual spraying. By 1960, malaria control teams were organized in main cities and by 1970, a three-year pilot project was implemented to eliminate malaria in Benguela Province. Immediately after independence in 1975, the idea of a national-level service to fight malaria was proposed, but it was not until the early 1980s that most partners were in support of joining in the fight against malaria with WHO. In 1989, with support from WHO, the NMCP in Angola was established. Angola committed itself to the Global Malaria Control strategy endorsed by the 1992 Ministerial Conference on Malaria in Amsterdam and later signed the 1997 African Initiative to Accelerate the Fight against Malaria. As the worldwide fight against malaria continued, Angola endorsed RBM in 1999, and participated at the Summit of Heads of African States in Abuja, Federal Republic of Nigeria in 2000, and was signatory of the Abuja Declaration on Roll Back Malaria that year.

It was not until 2001, however, that the government provided its first specific budget for an Integrated National Program to Control Major Endemic Diseases, including malaria. This priority was reaffirmed in 2002 with the creation of a National Commission to Control HIV/AIDS, Malaria and Tuberculosis. The response to the malaria problem in Angola has been captured through three NMCP Strategic Plans: one for 2005–2010 [32], one for 2008–2012 [33], and one for 2011–2015 [29]. The implementation of ITNs, IRS, selective spatial spraying, and anti-larval control as integrated vector control interventions are highlighted in the National Strategic Plans, as well as the protocols for malaria case management and IPTp. The milestones in malaria control policies and implementation from 1998 to 2011 are summarized in Figure 4. Details of the implementation of specific malaria control interventions are presented in subsequent sections of this report.

Figure 4: Milestones in Malaria Control Strategy: Timeline with roll-out of policies and interventions

Survey		Milestones in Malaria Policy and Implementation
	1997	• Angola joined the African Initiative to Accelerate the Fight Against Malaria
	1999	• Angola endorsed the Global Initiative to Roll Back Malaria
	2000	• Angola signed the Declaration of Heads of African States and Governments in Abuja
2001 MICS	2001	• First specific government budget for an Integrated National Program to Control Malaria • **ITN**: Routine distribution through ANC and EPI began (focus on children under 5 and pregnant women)
	2002	• Creation of the National Commission to Control HIV/AIDS, Malaria and Tuberculosis
	2003	• First Global Fund Grant to Fight HIV/AIDS, Tuberculosis and Malaria was approved
	2004	• **IRS**: Limited implementation began in Benguela and Cabinda Provinces • **IPTp**: Two doses of sulfadoxine-pyrimethamine (SP) was approved as a national policy in September (roll out of policy only began in 2006) • **Case Management**: Artemether-lumefantrine (AL) and artesunate-amodiaquine (AS/AQ), two ACTs, were approved by the NMCP as first-line drugs for the treatment of uncomplicated malaria in October (roll out of policy only began in 2006).
	2005	• Angola was selected as a PMI focus countryin 2005 • NMCP 2005–2010 Strategic Plan implementation began • **IRS**: Two-large scale campaigns were implemented in Huila and Cunene Provinces • **IPTp**: WHO recommendations were included in the national strategy
2006/7 MIS	2006	• **ITN**: LLINs were distributed at no cost in seven provinces with high rates of malaria prevalence during a measles vaccination campaign in July • **IPTp**: Implementation began in May • **Case Management**: Implementation of new first-line treatment artemether-lumefantrine (AL) began in May • Distribution of Rapid Diagnostic Tests (RDTs) to facilities without laboratories began in July
	2008	• NMCP 2008–2012 Strategic Plan implementation began • **Case Management**: NMCP decided to move AL as the only first-line drug for the treatment of uncomplicated malaria
	2009	• Angola signed the Global Fund Round 7 Malaria grant in February • Angolan-Cuban Larviciding Program implemented
	2010	• **Case Management**: In April, NMCP launched AS-AQ (alternative first-line treatment) • **ITN**: Strategy changed to universal coverage; 1 LLIN per two people. Distribution focused on specific municipalities
2011 MIS	2011	• NMCP 2011–2015 Strategic Plan implementation began • **Case Management**: NMCP updated strategic plan (2011–2015) to be in line with WHO guidance, which recommends that all suspected cases of malaria be diagnosed parasitologically, using either microscopy or RDTs

Financial Resources & Inputs

This section reports on funding for malaria control in Angola in order to assess if resources were available to allow for the scale-up of malaria control interventions between 2006–2011. Angola's major sources of external funding, the Global Fund and PMI, have distinct mechanisms and timeframes for planning, disbursement and procurement that make analysis on a calendar year basis difficult. Commitments and disbursements appear when they were made and appear in official documents. Amounts for commodities were counted in the calendar year in which they actually occurred. It is possible that commitments and procurements may have occurred in different years for the same procurement.

The capital costs of malaria control—initial costs of scaling up interventions—are significant for any country to assume on its own. According to some estimates, ideally, a median per capita per annum amount of US$2.43 is necessary to scale up and maintain the necessary levels of coverage for the different interventions in African countries [34].

In common with other countries in the region, the sharp rise in funding for malaria control has enabled a partial expansion of key malaria control interventions in Angola. The significant boost in funding for malaria that started around 2006 came mainly from the Global Fund and PMI. Angola received $38 million over five years under a Round 3 Global Fund grant. In 2007, under Round 7, Angola received a $78 million Global Fund grant to fight malaria, and a further $111 million was granted under Round 10 in 2010. PMI has contributed nearly $130 million between 2006 and 2011.

Table 55 shows the increases in external funding Angola has received between 2006 and 2011 (in some cases amounts cited may be less than the commitment for a specific year). In addition to external funding, the Government of Angola has invested in health, particularly in the health infrastructure.

Table 5 External Donor Funding in US$, 2006–2011

Source	2006	2007	2008	2009	2010	2011	Total
Global Fund *	11,810,450	14,479,069	29,580,727	18,276,311	25,883,554	3,787,437	103,817,548
PMI**	7,500,000	18,500,000	18,846,000	18,700,000	35,500,000	30,614,000	129,660,000
Other***	10,540,225	21,500,000	205,930	261,722	679,569		33,187,446
Total	29,850,675	54,479,069	48,632,657	37,238,033	62,063,123	34,401,437	266,664,994

* Disbursements **Commitments *** Other (World Bank, WHO, UNICEF, other bilaterals and other contributions)

Source: PMI [35]; Global Fund[36]; WHO [37] and [38]

Table 6 shows commodity procurements by the NMCP in Angola between 2000 and 2011. There is a rise in malaria control commodity procurements starting in 2006 in line with the increase in funding from major donors around this time.

Table 6: Malaria commodity procurements in Angola, 2000–2011

Year	ITNs	ACTs	Structures Sprayed (IRS)	RDTs
2002	450,000	-	-	-
2003	430,000	-	-	-
2004	-	-	-	-
2005	45,889	-	118,000	-
2006	1,051,286	1,150,200	132,702	492,950
2007	1,495,165	2,031,760	110,826	492,500
2008	1,614,722	2,363,970	133,687	142,775
2009	936,762	3,297,453	120,000	1,350,000
2010	1,350,000	3,119,744	135,856	-
2011	1,720,738	3,698,070	145,264	2,528,750

Source: National Malaria Control Program

MALARIA CONTROL INTERVENTIONS

Insecticide-Treated Mosquito Nets (ITNs)

Background

ITNs are a highly effective tool for prevention of malaria both through direct and indirect insecticidal effects, and by reducing contact between vectors and humans, therefore lowering parasite loads at the community level [39-41]. Use of ITNs has been found to reduce child mortality [42], lower the risk of clinical malaria illness, reduce parasite prevalence, and reduce the risk of high-density malaria parasitemia [43]. ITN use also reduces the risk of severe anemia and splenomegaly and may improve anthropometric outcomes in children [44]. ITN use by pregnant women has been shown to reduce placental malaria parasitemia, improve birth weight, and reduce fetal loss and stillbirth [45,46]. The protective effects of ITNs are most pronounced in high transmission settings among groups with limited immunity to malaria such as children under two years of age and pregnant women[47,48].

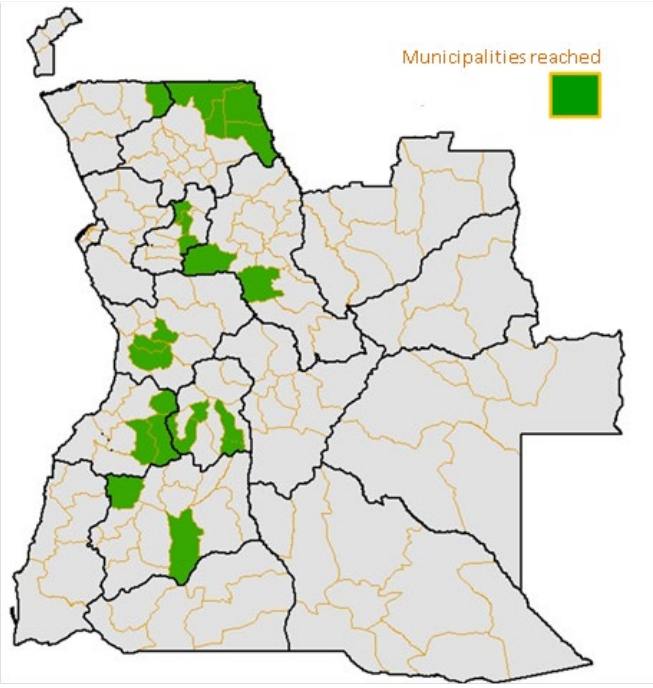
ITN Implementation

Beginning in 2001, through 2009, children under five years of age and pregnant women were prioritized for ITN distribution, primarily through routine antenatal and immunization clinics, and sometimes through municipal health days, depending on the availability of nets. Since the distribution of nets took place primarily through health facilities, people living in urban areas were more likely to receive nets than those in rural areas [49].

From mid-July to early August 2006 (a few months before data collection of the 2006/7 MIS began in November), a massive ITN distribution campaign took place through the national integrated "*Viva a Vida com Saúde*" (Live Life with Health) campaign, which focused on polio and measles vaccination and vitamin A supplementation. Free distribution of more than 800,000 ITNs to families with children under five years of age took place in seven provinces during the campaign; five in the hyperendemic zone (Cabinda, Uige, Malanje, Lunda Norte, and Lunda Sul), one in the mesoendemic stable zone (Zaire) and one in the mesoendemic unstable zone (Moxico).

In 2010, the ITN distribution strategy was changed to universal coverage with the aim that one ITN should be available for every two people. However, the campaign was focused on specific regions and the number of nets available for free distribution was insufficient to cover the entire country; universal coverage distribution focused on specific areas only. In 2011, for example, 630,000 LLINs were distributed for free in specific municipalities (Figure 5) of eight provinces; four in the mesoendemic stable zone (Benguela, Huambo, Kwanza Sul, and Zaire); three in the hyperendemic zone (Kwanza Norte, Malanje, and Uíge), and one in the mesoendemic unstable zone (Huila). In these areas, local NGOs distributed one net for every two people per household. These municipalities were chosen because the NMCP had implementing partners present there, who could help ensure the quality of the implementation.

Figure 5: Municipalities covered by the ITN universal coverage distribution in Angola, 2011



Source: Rivas [50], ICF International

Table 7 shows the number of ITNs distributed in Angola by the NMCP between 2001 and 2011. From 2001 to 2005 about 1.1 million ITNs were distributed nationally, with 204,600 nets distributed in 2001. The number of nets distributed nationally increased substantially to 430,000 in 2003, then dropped to 0 in 2004. Between 2006 and 2011, approximately 8 million free nets were distributed (LLINs started to replace ITNs in 2006). In urban areas, ITNs were also available through the commercial sector while in rural areas, they were sold at a subsidized price through local NGOs.

Table 7: Number of ITNs Distributed Annually in Angola, 2001 –2011

Year	Number of ITNs Distributed
2001	204,600
2002	450,000
2003	430,000
2004	0
2005	45,889
2006	1,051,286
2007	1,495,165
2008	1,614,722
2009	936,762
2010	1,678,365
2011	1,720,738

Source: National Malaria Control Program

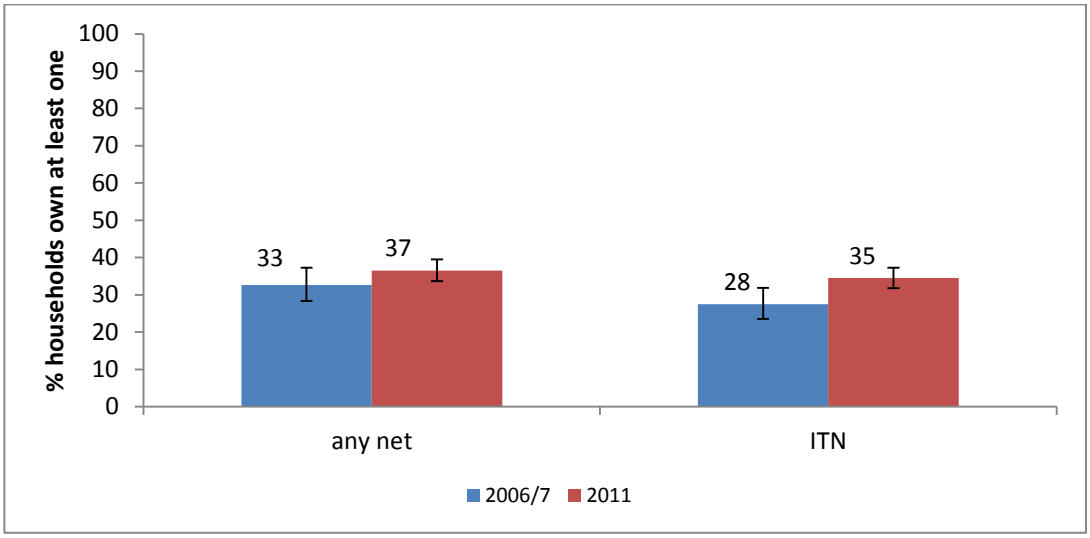
ITN Coverage Trends

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 IRS section. Unless otherwise stated, all data cited come from the 2006/7 and 2011 MIS surveys.

ITN Ownership

Figure 6 shows the percentage of households that owned at least one net (treated or untreated) and ITNs in 2006/7 and 2011. The percentage of households that owned at least one net increased slightly, from 33% (95% CI: 28–37%) in 2006/7 to 37% (95% CI: 34–40%) in 2011, however this increase is not statistically significant. Ownership of ITNs specifically rose by seven percentage points from 28% (95% CI: 24–32%) in 2006/7 to 35% (95% CI: 32–37%) in 2011, however this increase was not significant[1].

Figure 6: Household ownership of any nets and ITNs, 2006/7-2011



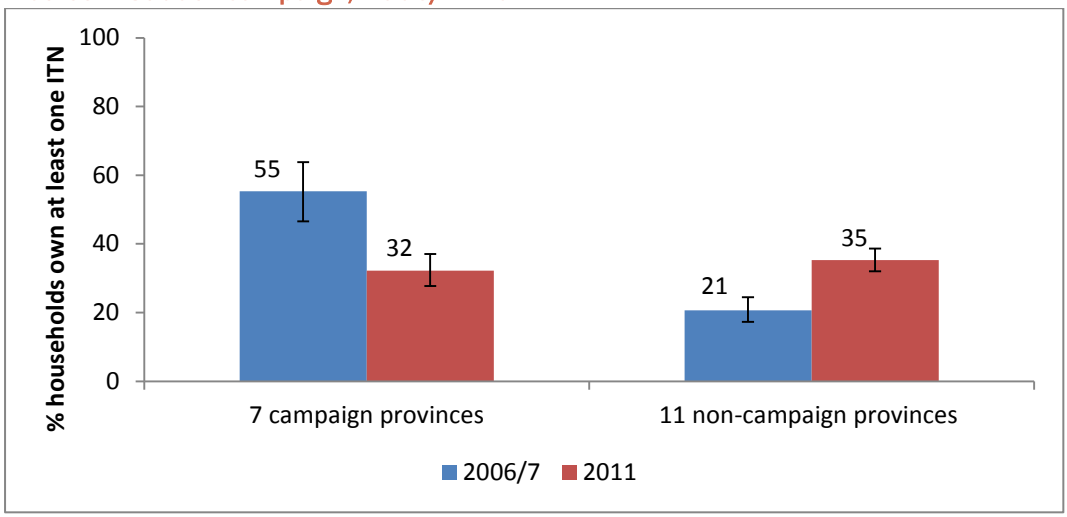
Source: MIS 2006/7, MIS 2011

To address a potentially inflated baseline ITN coverage level in 2006/7 due to the ITN campaign of 2006 (conducted about three months before data collection of the 2006/7 MIS began), the household ITN ownership was estimated for the seven provinces that participated in and the other 11 provinces that did not participate in the campaign (Figure 7). The percentage of households that owned at least one ITN in 2006/7 was 55% (95% CI: 47–64%) in the provinces that had participated in the campaign,

[1] 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. All point estimates and confidence intervals were calculated for each survey independently, using the "svyset" and "svy" commands in STATA 12, which corrected for the multi-stage sampling design of the surveys. For more details on the sampling and design of the surveys, please see Annex 1.

compared to 21% (95% CI: 17–24%) in the provinces that did not participate. By 2011, household ITN ownership had fallen significantly to 32% (95% CI: 28–37%) in the participating provinces, but increased to 35% (95% CI: 32–37%) in the non-participating provinces.

Figure 7: Household ownership of ITNs, by provinces and by participation in the "*Viva a Vida com Saúde*" campaign, 2006/7–2011

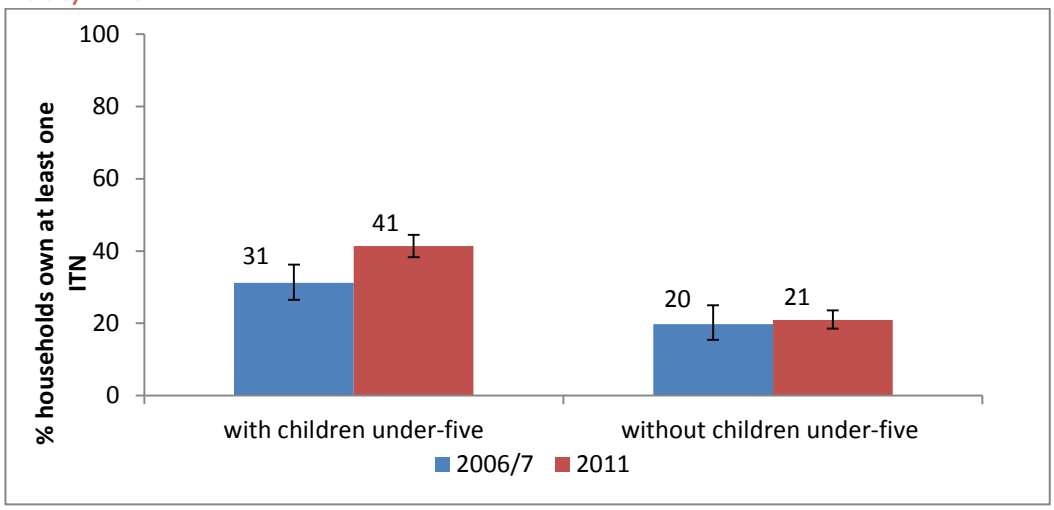


Note: The 7 provinces that participated in the campaign were: Cabinda, Uíge, Malanje, Lunda Norte, and Lunda Sul, Zaire and Moxico.

Source: MIS 2006/7, MIS 2011

Figure 8 shows ITN ownership in households with and without children under five years of age in 2006/7 and 2011. In households with children under five years of age, ITN ownership increased significantly from 31% (95% CI: 27–36%) to 41% (95% CI: 38–45%) between 2006/7 and 2011, while households without children under five years of age saw no change in ownership over the same period from 20% (95% CI: 15–25%) in 2006/7 to 21% (95% CI: 19–24%) in 2011.

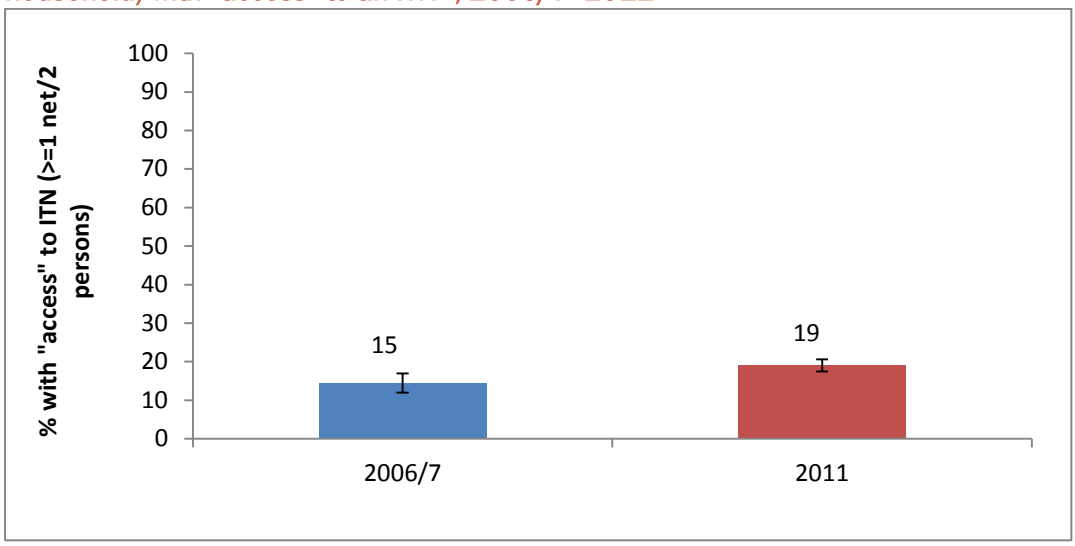
Figure 8: ITN ownership in households with and without children under five years of age, 2006/7-2011



Source: MIS 2006/7, MIS 2011

Figure 9 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 2006/7 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 15% (95% CI: 12–17%) in 2006/7 to 19% (95% CI: 17–21%) in 2011.

Figure 9: Percentage of *de facto* population (who spent the previous night in the household) with "access" to an ITN*, 2006/7–2011



*Access is defined as the proportion of the 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

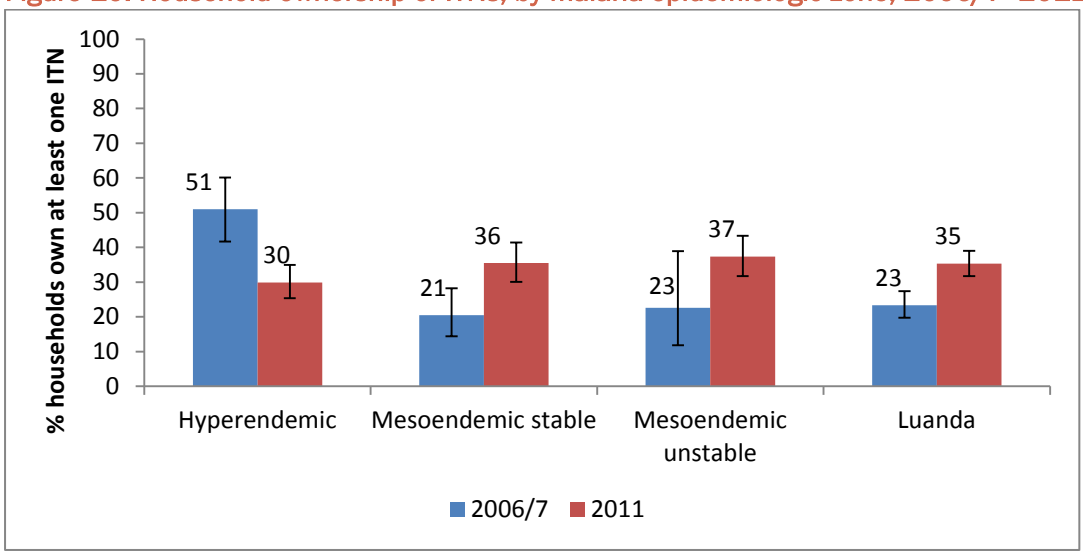
.

Source: MIS 2006/7, MIS 2011

ITN Ownership by Malaria Epidemiologic Zones in Angola

Figure 10 shows household ownership of ITNs in the four malaria epidemiologic zones in Angola in 2006/7 and 2011. ITN ownership increased in all zones between 2006/7 and 2011, except for in the hyperendemic zone where there was a statistically significant decrease from 51% (95% CI: 42–60%) to 30% (95% CI: 25–35%). The largest increase in ITN ownership occurred in the mesoendemic stable zone from 20% (95% CI: 14–28%) to 36% (95% CI: 30–41%). The coverage of ITN ownership across the four zones in 2011 was similar (with overlapping confidence intervals), ranging from 30%–37%.

Figure 10: Household ownership of ITNs, by malaria epidemiologic zone, 2006/7–2011



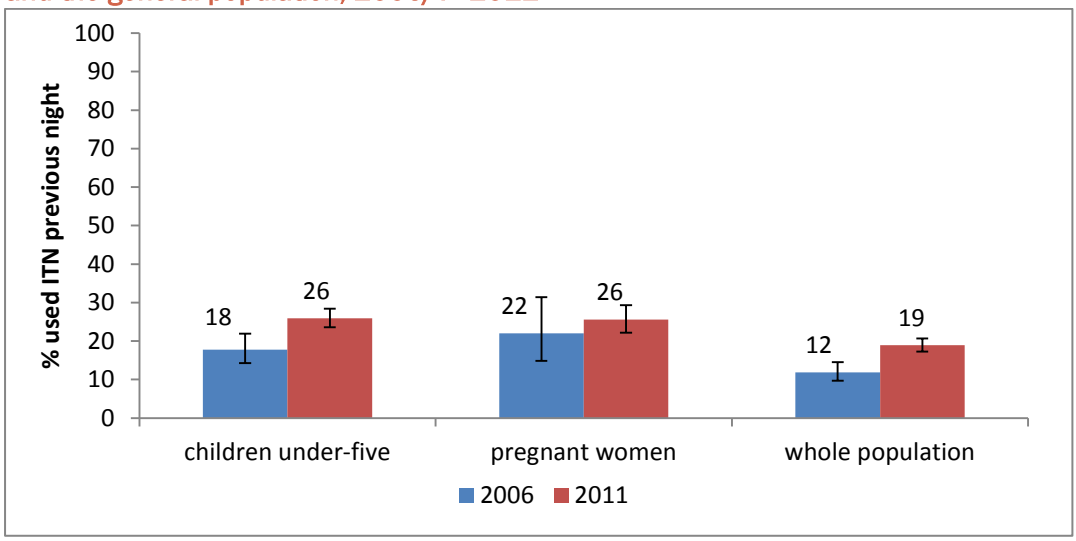
Note: In 2006, five (Cabinda, Uige, Malanje, Lunda Norte and Lunda Sul) of the seven provinces that participated in the massive ITN distribution campaign were in the hyperendemic zone. The other two provinces were in the mesoendemic stable (Zaire) and mesoendemic unstable zones (Moxico).

Source: MIS 2006/7, MIS 2011

ITN Use

Figure 11 shows ITN use among children under five years of age, pregnant women and the general population in 2006/7 and 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 18% (95% CI: 14–22%) in 2006/7 to 26% (95% CI: 24–28%) in 2011. For pregnant women, ITN use was similar at 22% (95% CI: 15–31%) in 2006/7 and 26% (95% CI: 22–29%) in 2011. For the population as a whole, ITN use had a very slight, but statistically significant increase from 12% (95% CI: 10–15%) to 19% (95% CI: 17–21%) over the same period.

Figure 11: Figure 12: ITN use among children under five years of age, pregnant women and the general population, 2006/7–2011



Source: MIS 2006/7, MIS 2011

Though ITN use among children under five years of age was low among all households surveyed in 2006/7 and 2011, among households that owned at least one ITN, ITN use was almost universal: 100% in 2006/7 and 96% in 2011 (95% CI: 95–97%).

Equity in ITN Use

Table 8 presents data on equity of ITN use by children under five years of age and pregnant women stratified by sex, residence, wealth, and mother's education. Disparities in use of ITNs are evident by residence, wealth, and mother's education in particular. For example in 2011, ITN use by children under five years of age in the least poor wealth quintile was 34% compared to 12% in the poorest quintile. A similar trend was found for pregnant women: ITN use was 33% among those in the least poor quintile compared to 14% in the poorest. In terms of mother's education, the higher the level of education, the greater the percentage of children who slept under a net in both 2006/7 and 2011. In 2011 for example, ITN use was 36% among children whose mother's level of education was secondary or higher, compared to 19% among those whose mother had no formal education.

Table 8: ITN use by children under five years of age and pregnant women by socio-demographic factors, 2006/7–2011

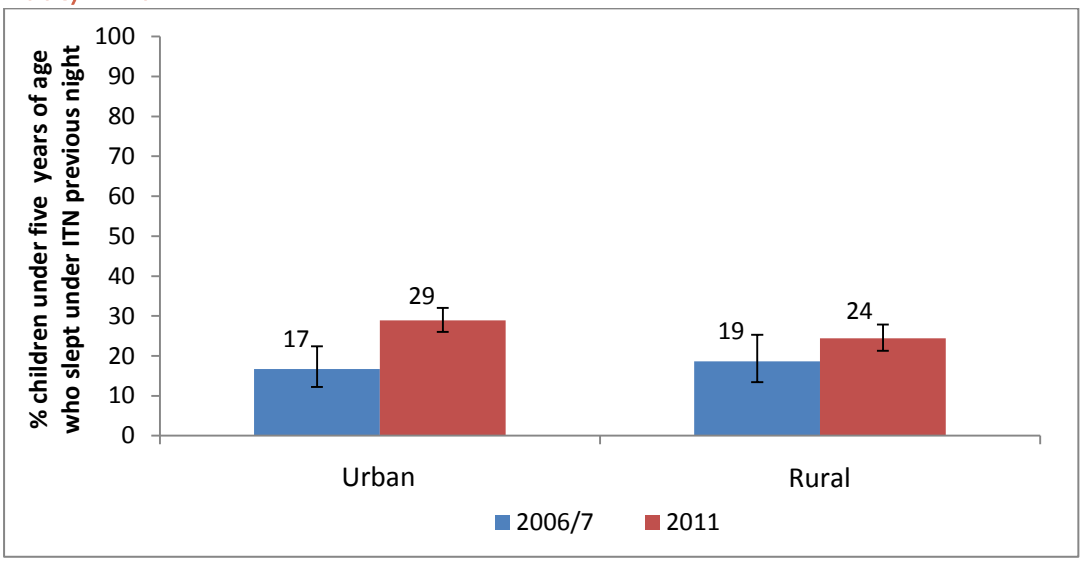
Background Characteristic	Children under five years of age					Pregnant women				
	2006/7 MIS		2011 MIS		Relative change (%)	2006/7 MIS		2011 MIS		Relative change (%)
	% (95% CI)	WN	% (95% CI)	WN		% (95% CI)	WN	% (95% CI)	WN	
Sex										
Male	18.0 (14.5-22.1)	1,372	25.4 (22.9-28.1)	4,187	41.4					
Female	17.5 (13.4-22.6)	1,368	26.4 (23.8-29.2)	4,325	50.7					
Residence										
Urban	16.7 (12.2-22.4)	1,287	28.9 (26.0-32.1)	2,811	73.2	14.8 (8.7-23.9)	101	28.1 (22.9-33.9)	436	90.3
Rural	18.7 (13.5-25.3)	1,452	24.4 (21.3-27.9)	5,702	30.9	26.4 (16.2-39.9)	168	24.5 (20.2-29.3)	948	-7.4
Wealth quintiles										
Lowest	17.3 (10.9-26.3)	641	11.7 (8.5-15.9)	1,196	-32.2	23.0 (11.6-40.4)	75	13.9 (9.3-20.2)	181	-39.7
Second	16.3 (11.1-23.4)	646	17.9 (14.5-21.9)	1,150	9.7	24.3 (10.6-46.7)	75	20.2 (13.9-28.5)	187	-16.9
Middle	22.0 (14.3-32.3)	631	23.4 (19.8-27.5)	1,590	6.3	26.9 (14.5-44.3)	53	21.1 (15.0-28.9)	237	-21.4
Fourth	17.1 (12.2-23.5)	485	31.0 (27.9-34.3)	2,400	81.2	14.4 (8.0-24.6)	40	28.5 (23.9-33.7)	376	98.2
Highest	14.3 (10.0-20.2)	337	34.2 (31.0-37.6)	2,173	138.8	*	26	33.2 (25.8-41.6)	404	n/a
Mother's Education										
None	16.8 (11.8-23.3)	767	19.4 (16.6-22.7)	2,546	15.7	22.0 (11.4-38.3)	87	22.5 (17.4-28.6)	366	2.3
Primary	19.6 (15.3-24.8)	1,425	30.8 (28.0-33.8)	4,240	56.9	20.5 (13.0-30.9)	170	26.6 (22.6-31.0)	821	29.8
Secondary & higher	25.2 (16.9-35.8)	165	35.7 (30.7-41.1)	825	41.9	*	11	27.0 (20.5-34.8)	198	n/a
Total	17.8(14.3-21.9)	2,739	25.9 (23.6-28.4)	8,512	45.5	22.0 (14.9-31.4)	269	25.6 (22.2-29.3)	1,384	16.4

Note: An asterisk indicates fewer than 25 unweighted cases and percentages were not computed; Information on mother's education missing for 368 children in 2006/7 and 589 children in 2011.
MIS =Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval, n/a = not available

Source: MIS 2006/7, MIS 2011

Figure 12 shows ITN use among children under five years of age by area of residence 2006/7 and 2011. From 2006/7 to 2011, ITN use in urban households rose significantly from 17% (95% CI: 12–22%) in 2006/7 to 29% (95% CI: 26–32%) in 2011. In rural households, ITN use in children under five years of age rose from 19% (95% CI: 13–25%) to 24% (95% CI: 21–28%) between 2006/7 and 2011. The change was greater in urban areas and in 2011 in particular, more children in urban areas had slept under an ITN the night before the survey than those in rural areas (29% and 24% respectively).

Figure 12: ITN use among children under five years of age, by area of residence, 2006/7–2011



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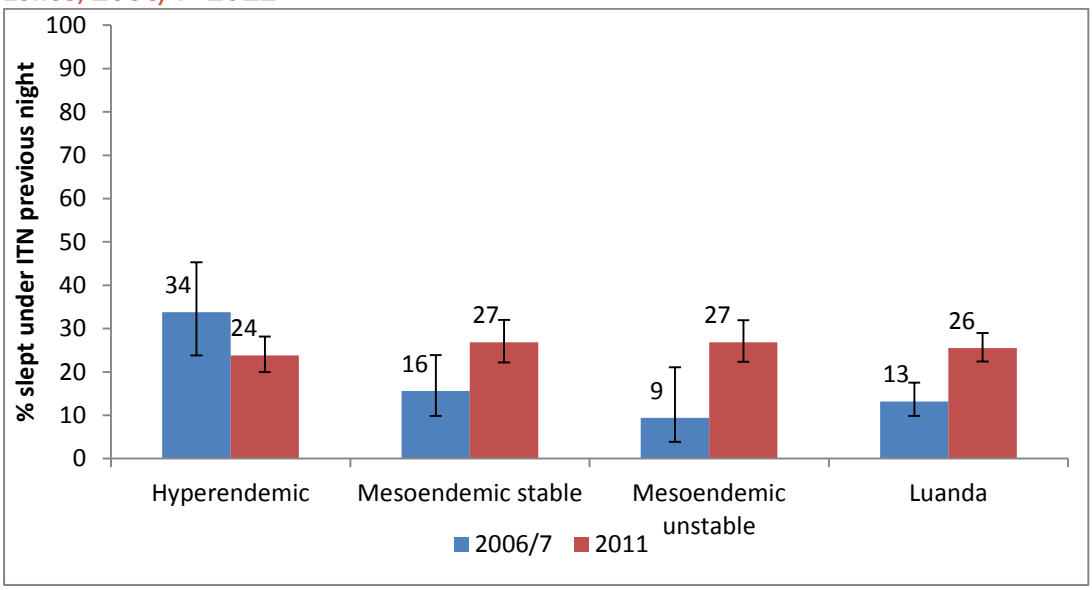
Source: MIS 2006/7, MIS 2011

ITN Use by Malaria Epidemiologic Zones in Angola

Similar to household ownership, ITN use increased in all malaria epidemiologic zones in Angola between 2006/7 and 2011 (Figure 13), except in the hyperendemic zone where there was a decrease from 34% (95% CI: 24–45%) to 24% (95% CI: 20–28%). These increases were found to be statistically significant in both the mesoendemic unstable zone and Luanda. In the mesoendemic unstable zone, ITN use increased from 9% (95% CI: 4–21%) to 27% (95% CI: 22–32%). In Luanda, ITN use increased from 13% (95% CI: 10–18%) to 26% (95% CI: 22–29%). ITN use was higher in the hyperendemic zone compared to the other three zones in 2006/7, but was similar across all four zones in 2011, ranging from 24%–27%.

Figure 13: ITN use among children under five years of age, by malaria epidemiologic zones, 2006/7–2011



Source: MIS 2006/7, MIS 2011

ITN Summary

Across Angola, estimates of household ITN ownership increased from 28% in 2006/7 to 35% in 2011, however the estimated increase was not statistically significant. The increase was greater among households in the eleven provinces that had not participated in the 2006 mass ITN distribution campaign (from 21% in 2006/7 to 35% in 2011). Household ITN ownership in the seven provinces that had participated in the 2006 campaign actually fell from 55% in 2006/7 to 32% in 2011, because ITNs distributed in 2006 would have worn out and been discarded before 2011 and had not been replaced. In addition, after the 2006 campaign, ITNs were mainly distributed through the routine ANC and immunization clinics which focused on the provinces that had not been targeted during the campaign and primarily occurred through services in larger cities. Since the ITN strategy targeted children under five years of age and pregnant women between 2006–2009, and universal coverage distribution beginning in 2010 was limited, it is not surprising that ownership rose more in households with children under five years of age (from 31% in 2006/7 to 41% in 2011) than in other households. As anticipated with the rise in ITN ownership, access to ITNs also rose from 15% to 19% over the same period.

ITN use among children under five years of age also rose significantly, from 18% in 2006/7 to 26% in 2011, as well as use among pregnant women, from 22% to 26%, respectively. Inequities in ITN use by children under five years of age and pregnant women were apparent for residence, wealth quintile, and mother's education in both 2006/7 and 2011. It should be noted that inequity increased from 2006/7 to 2011 with the least poor having better ITN use compared to the poorest. Though ITN use was slightly higher among children under five years of age in rural areas in 2006/7 compared to those in urban areas (19% compared

to 17%), by 2011, the situation reversed, with ITN use greater in urban areas (29% compared to 24%), although these differences were not significant.

Both ITN ownership and use rose in all malaria epidemiologic zones in Angola between 2006/7 and 2011, except for in the hyperendemic zone where both indicators fell. This was probably due to the massive ITN distribution campaign that was implemented primarily in the provinces in the hyperendemic zone, about three months before data collection of the 2006/7 MIS began; however, the higher levels of ITN ownership and use were not maintained.

Indoor Residual Spraying (IRS)

In 2006, WHO reaffirmed its recommendation for IRS with insecticides for malaria control in sub-Saharan Africa. A total of four insecticide classes are currently available for IRS [51]. A recent meta-analysis of IRS studies suggests that use of IRS reduces the prevalence of malaria parasitemia by 62% [52]. Despite its apparent effectiveness, no countries, except Zanzibar, in sub-Saharan Africa use IRS at national scale, as costs are often an impediment [53]; nonetheless, in 2009, IRS reached10% of the population of Africa [54].

IRS began in Angola in 2004, with limited implementation in the Benguela and Cabinda Provinces with support from local governments. In 2005, two large scale IRS campaigns were implemented in Huila and Cunene Provinces during the month of December, which covered a population of over half a million, in more than 100,000 households. IRS implementation continued every year and Table 9 shows the provinces that were targeted, the population protected and the insecticide used from 2005 to 2011.

Table 9: IRS Implementation in Angola: Targeted Provinces, Population Protected, and Class of Insecticide Used, 2005–2011

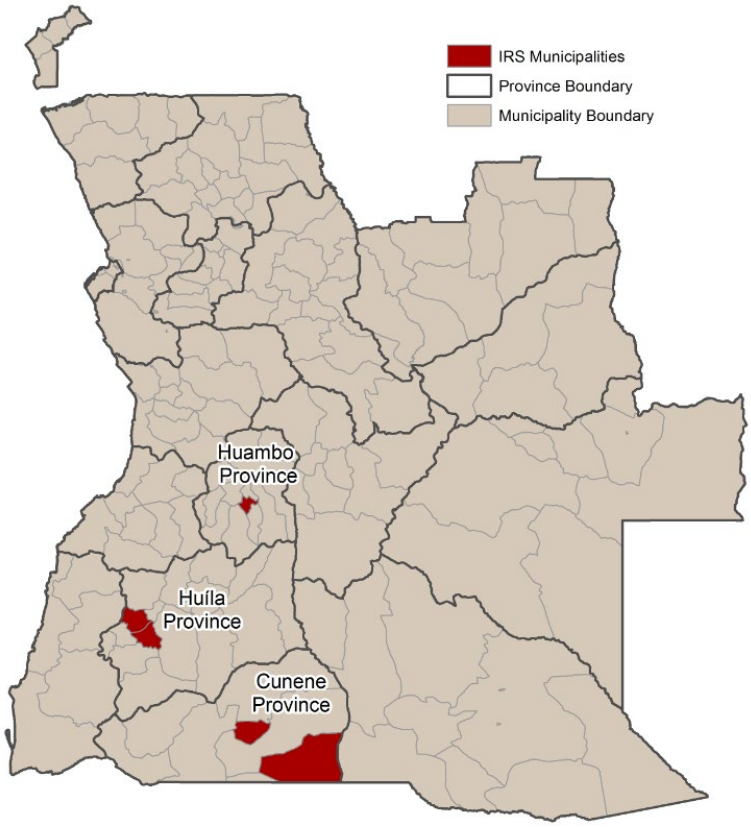
Round	Provinces	Population Protected	Insecticide
2005 (Round 1)	Huila and Cunene	726,000	Pyrethroid
2006 (Round 2)	Huila, Namibe, and Cunene	780,257	Pyrethroid
2007 (Round 3)	Huila, Namibe, and Cunene	745,061	Pyrethroid
2008 (Round 4)	Huila and Huambo	678,030	Pyrethroid
2009 (Round 5)	Huila and Huambo	485,974	Pyrethroid
2010 (Round 6)	Huila, Huambo, and Cunene	649,842	Pyrethroid
2011 (Round 7)	Huila, Huambo, and Cunene	689,668	Pyrethroid

Source: National Malaria Control Program

It is important to note that between 2005 and 2011, IRS was only conducted in some municipalities of the provinces targeted. Figure 14, for example, shows that the IRS program conducted in Huambo Province in 2009, 2010, and 2011 was in Huambo municipality and in Huila Province, it was in Lubango and Chibia Municipalities. The IRS program conducted in Cunene Province in 2010 and

2011 targeted Kwanhama and Namakude Municipalities, including Santa Clara locality, on the border with Namibia. Site selection was based on malaria burden, population density, and accessibility.

Figure 14: Municipalities targeted for IRS in Angola by Province, 2009–2011



Source: ICF International

In addition to the annual IRS, some provinces, such as Cabinda and Malanje, implemented IRS in selected areas at the initiative of the local governments [29].

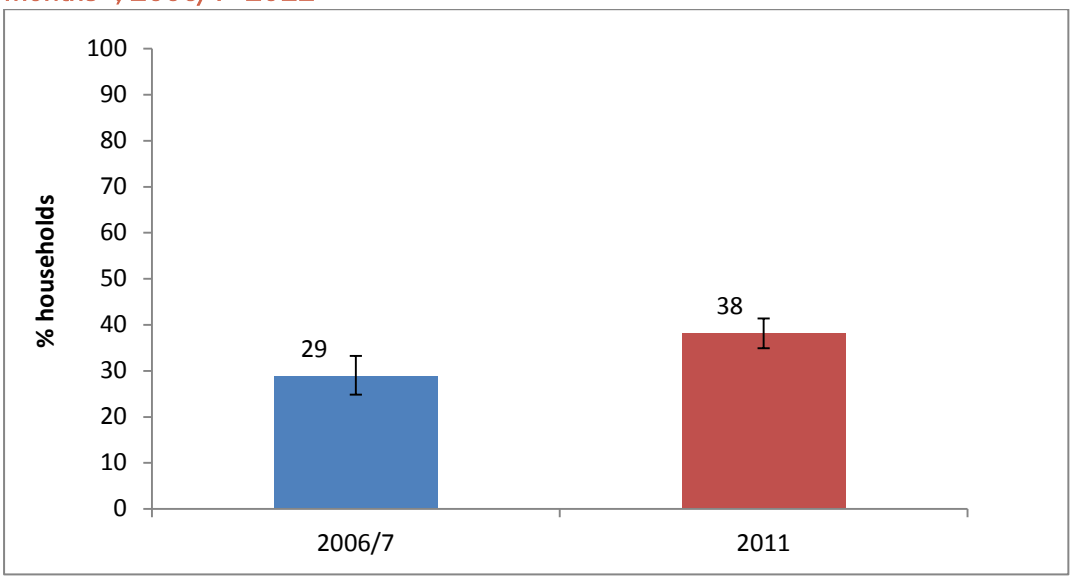
IRS Coverage

The two national surveys show an increase in IRS coverage (% of households that were sprayed in the 12 months before the survey) from 2% (95% CI: 1–4%) in 2006/7 to 7% (95% CI: 5–9%) in 2011 nationwide.

ITN Ownership and IRS

Figure 15 shows the percentage of households with at least one ITN and/or IRS in the last 12 months in 2006/7 and 2011. Coverage of households with at least one ITN and/or IRS in the last 12 months experienced a significant increase from 29% (95% CI: 25–33%) to 38% (95% CI: 35–41%) from 2006/7 to 2011.

Figure 15: Percentage of households with at least one ITN and/or IRS in the last 12 months*, 2006/7–2011



Source: MIS 2006/7, MIS 2011
Note: *This indicator was recommended during the evaluation period. Subsequently, to account for universal coverage strategy, this indicator was revised in 2013 to: Percentage of households with at least one ITN for two people and/or sprayed by IRS within the last 12 months".

IRS Summary

Nationally, IRS coverage increased from 2% in 2006/7 to 7% in 2011. Coverage of households with at least one ITN and/or IRS in the last 12 months experienced a significant increase from 29% in 2006/7 to 38% in 2011. It should be noted that the effect of the IRS intervention would only be expected in the areas covered representing a population of about 600,000 protected. Those who lived in households and communities that were sprayed almost certainly benefited, but the contribution to the national level in terms of impact on the reduction of malaria parasite infection is likely to have been insignificant.

Intermittent Preventive Treatment in Pregnancy

Background

Malaria prevention and control during pregnancy has been addressed through 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). 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 [55,56]. In high transmission settings, malaria is expected to be a significant indirect contributor to maternal death [57]. Malaria in pregnancy is thought to affect neonatal mortality risk via low birth weight and anemia in the newborn [58]. Use of ITNs and IPTp during pregnancy is protective against neonatal mortality and low birth weight [59].

IPTp Implementation

Administering two or more doses of SP to pregnant women was approved as a national policy in Angola in September 2004. In 2005, the WHO IPTp recommendations were included in the national strategy and IPTp implementation began in May 2006. IPTp is given to pregnant women attending antenatal clinics nationwide, starting in the 20th week of pregnancy and is administered under the direct observation of a health professional (Directly Observed Therapy - DOT). WHO revised its recommendations to give IPTp at each ANC visit after the first trimester, but this was after the evaluation period. Between 2006/7 and 2011, IPTp was scaled up (shown in Table 10). The government assumed leadership for SP procurement and rollout and SP is included in the essential drug kit (box of essential drugs distributed by the MoH for primary health care municipal health facilities). Furthermore, IPTp training is included in case management training. However, stockouts have been reported due to delayed procurement.

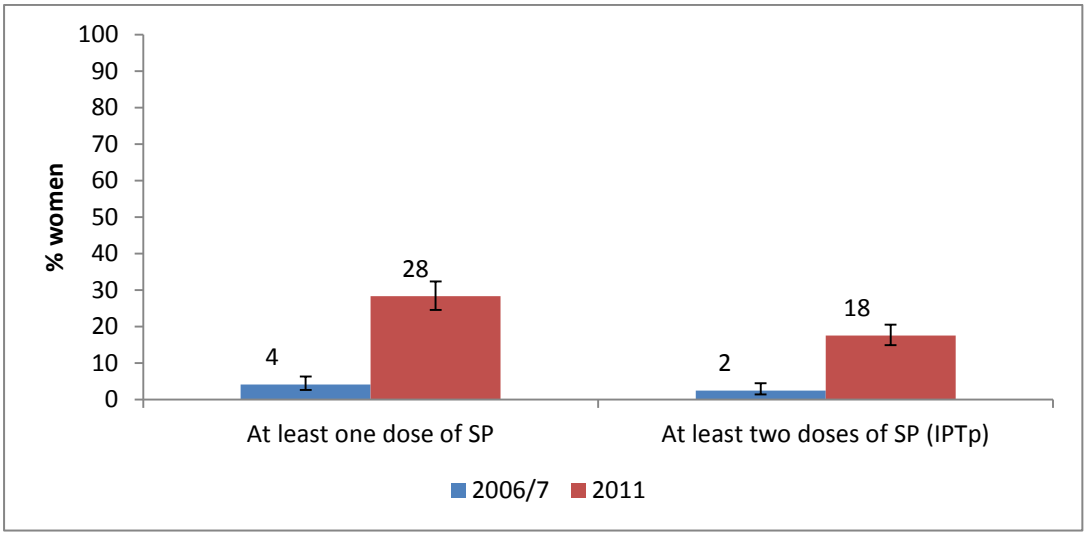
IPTp Coverage

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. The indicator is restricted to the most recent pregnancy that resulted in a live birth, 0–2 years prior to the survey.

Figure 16 shows the proportion of women (15–49 years) with a live birth 0–2 years prior to the survey who received IPTp (at least two doses of SP) in both 2006/7 and 2011. IPTp coverage increased significantly from 2% (95% CI: 1–4%) in 2006/7 to 18% (95% CI: 15–21%) in 2011. In both survey years, the proportion of women receiving at least one dose was higher than those receiving

two doses. In 2011 for example, the percentage of women receiving at least one dose was 28% (95% CI: 25–32%) compared to 18% (95% CI: 15–21%) for IPTp.

Figure 16: Proportion of women (15–49 years) with a live birth 0–2 years prior to survey who received at least two dose of SP forIPTp, 2006/7–2011



Source: MIS 2006/7, MIS 2011

Equity in IPTp

Table 10 presents data on equity of IPTp coverage by residence, wealth, and women's education in 2006/7 and 2011. In both survey years, overall IPTp coverage was very low, particularly in 2006/7 with no significant difference between subgroups. In 2011 the increase of 15 percentage points from 2006/7, although a significant progress, created disparities between subgroups. IPTp coverage among women living in rural areas was less than half those in urban areas (11% vs 30%). Similarly the IPTp coverage among women from the poorest wealth quintiles was three times lower compared to among the least poor women (8% vs 24%). Woman's education exhibited similar discrepancies whereby women with no education have 23 percentage points less IPTp coverage compared to those with secondary and higher education (11% vs 34%).

Table 10: Proportion of women (15–49 years) with live birth 0–2 years prior to survey who received IPTp by socio-demographic factors, 2006/7–2011

	2006/7 MIS		2011 MIS		Relative
Background characteristic	**% (95% CI)**	**WN**	**% (95% CI)**	**WN**	**change (%)**
Residence					
Urban	3.8 (1.9-7.4)	450	29.9 (25.1-35.2)	1,044	686.8
Rural	1.4 (0.5-4.2)	565	11.2 (8.5-14.6)	2,053	700.0
Wealth quintile					
Lowest	0.0	255	7.8 (4.3-13.8)	420	n/a
Second	3.3 (1.2-8.5)	253	11.3 (6.7-18.5)	402	242.4
Middle	3.0 (1.0-8.6)	235	13.2 (8.9-19)	590	340.0
Fourth	2.4 (0.7-7.9)	174	21.9 (18.2-26.2)	931	812.5
Highest	5.4 (2.3-12.2)	98	24.2 (19.7-29.4)	752	348.1
Woman's Education					
None	1.2 (0.4-3.5)	332	10.7 (7.8-14.6)	989	791.7
Primary Incomplete	3.2 (1.7-6.2)	531	18.1 (15.2-21.3)	1,712	465.6
Primary Complete	3.2 (0.7-13.6)	79	23.1 (14.7-34.4)	70	621.9
Secondary & higher	2.0 (0.3-13.3)	66	33.9 (27.5-40.9)	326	1595.0
Missing	*	6			n/a
Total	2.4 (1.4-4.4)	1,015	17.5 (14.9-20.5)	3,096	629.2

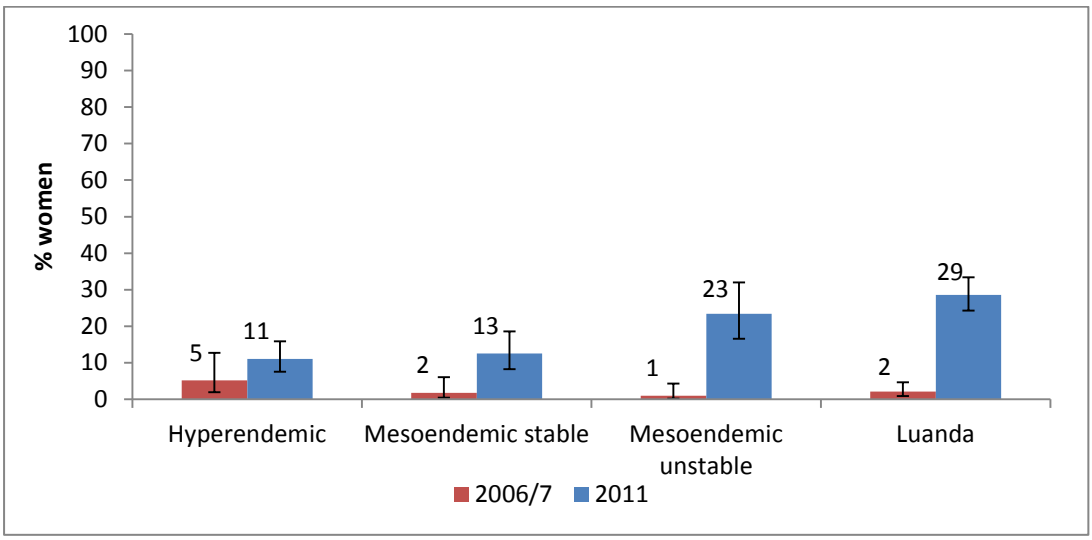
Note: An asterisk indicates fewer than 25 unweighted cases and has been suppressed; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval

Source: MIS 2006/7, MIS 2011

IPTp by Malaria Epidemiologic Zones in Angola

Figure 17 shows the proportion of women with a live birth 0–2 years prior to the survey who received IPTp by the four malaria epidemiologic zones in Angola in 2006/7 and 2011. IPTp coverage increased significantly in all zones between 2006/7 and 2011, except for in the hyperendemic zone.

Figure 17: Proportion of women (15–49 years) with a live birth 0–2 years prior to survey who received IPTp by malaria epidemiologic zones, 2006/7–2011



Source: MIS 2006/7, MIS 2011

IPTp from Routine Data

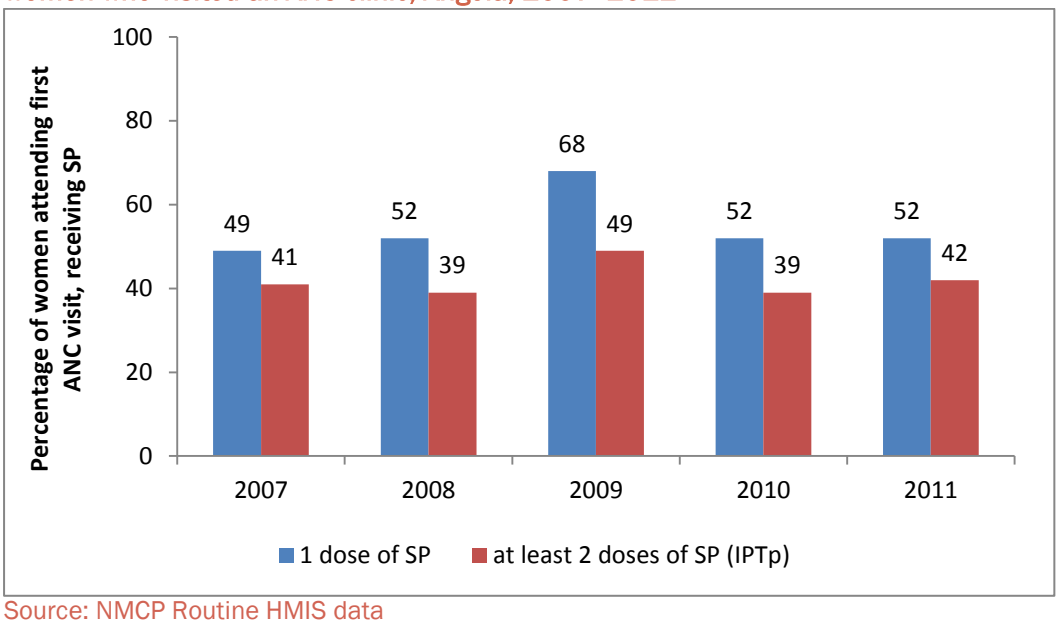
Routine HMIS data are available for women receiving IPTp at ANC visits. Based on the results presented in Table 11 and Figure 18, among the pregnant women who attended at least one ANC consultation, the percentage that received at least one dose of SP remained relatively constant between 2007 and 2011: around 50% (except for in 2009, where it peaked to 68%). Similarly, the percentage of pregnant women who received IPTp (at least two doses of SP) was around 40% (highest percentage was also in 2009, at 49%). Despite the similar percentages of pregnant women who received IPTp between 2007 and 2011, the actual numbers of pregnant women who received IPTp, for example, almost doubled in that time period (164,869 in 2007 to 323,477 in 2011 – Table 11).

Table 11: IPTp Implementation in Angola: Number of Pregnant Women Attending ANC and who Received At Least 1 or 2 doses of SP, 2006–2011

Year	Number of pregnant women who attended at least 1 ANC consultation	Number of pregnant woman who received at least 1 dose of SP	Number of pregnant women who received at least two doses of SP (IPTp)
2006	Not available	30,148	27,569
2007	406,389	200,160	164,869
2008	579,178	300,549	228,426
2009	573,287	387,389	281,394
2010	741,473	383,470	288,889
2011	773,691	401,762	323,477

Source: NMCP Routine HMIS Data

Figure 18: Percentage of pregnant women who received two doses of SP, of those women who visited an ANC clinic, Angola, 2007–2011



Source: NMCP Routine HMIS data

IPTp Summary

IPTp coverage increased significantly in Angola from 2% in 2006/7 to 18% in 2011. This increase was also shown by the NMCP routine HMIS data, where the numbers of pregnant women who attended ANC and received IPTp almost doubled between 2007 and 2011. This trend is as expected since IPTp was introduced in Angola in 2006 and implementation was expanded thereafter.

However, despite the rapid increase of IPTp, the overall coverage in 2011 remained far below the target of 80%. Furthermore, coverage of IPTp was lower than coverage with at least one dose of SP in 2011; 18% compared to 28%. These results are not surprising since it is common for pregnant women in Angola not to go to antenatal clinics until an advanced stage of gestation and not to have the opportunity to return for another dose. In terms of malaria epidemiologic zones, IPTp coverage increased significantly in all zones between 2006/7 and 2011, except for in the hyperendemic zone.

Inequities in IPTp were apparent for residence, wealth, and woman's education in both 2006/7 and 2011, and SES inequity dramatically increased. IPTp coverage was higher in urban areas, among those from the least poor households and those with a secondary or higher level of education.

Malaria Case Management

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 WHO [11]. 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

Effective antimalarial drugs are one of the principal tools for combating malaria today. Prior to 2003, Angola's malaria treatment policy recommended either chloroquine or amodiaquine as a first-line treatment, SP as a second-line treatment and quinine reserved for severe malaria cases. By 2003, resistance to chloroquine had been detected at levels above 50% [33]. In October 2004, the MoH, through the NMCP, changed its national malaria treatment policy to artemisinin-based combination therapy (ACT) with artemether-lumefantrine (AL) as the first-line drug, and artesunate-amodiaquine (AS/AQ) as the alternative first-line drug. Table 12 shows the malaria treatment policy that was approved in 2004; the rollout of the new policy however, only began in public health facilities in May 2006.

Table 12: Angola Malaria Treatment Policy, Effective Since 2004

First-line	Artemether +Lumefantrine (AL)
Alternative first-line*	Artesunate + Amodiaquine (AS/AQ)
Treatment for severe or complicated malaria	Quinine, Parenteral Artemether or Artesunate as alternatives
Pregnant Women:	
1st Trimester	Oral Quinine
2nd and 3rd Trimester	Artesunate + Amodiaquine or Artemether +Lumefantrine or Oral Quinine

*Dihydroartemisinine piperaquine phosphate is another alternative first line for treatment of uncomplicated malaria. It was introduced in 2010 on a small scale, and then submitted for clinical trials in 2011 and 2013 efficacy test.
Source: National Malaria Control Program

Angola began purchasing ACTs in 2006 and this increased rapidly from 1.2 million ACTs procured in the first year to 3.7 million in 2011 (Table 13). According to a gap analysis that the NMCP conducted in 2010 for the 2011–2016 period, it was estimated that close to 9.5 million ACTs would be needed in 2011. As a result, only 39% of the need of ACTs was filled in 2011 by the number procured that year (3.7 million).

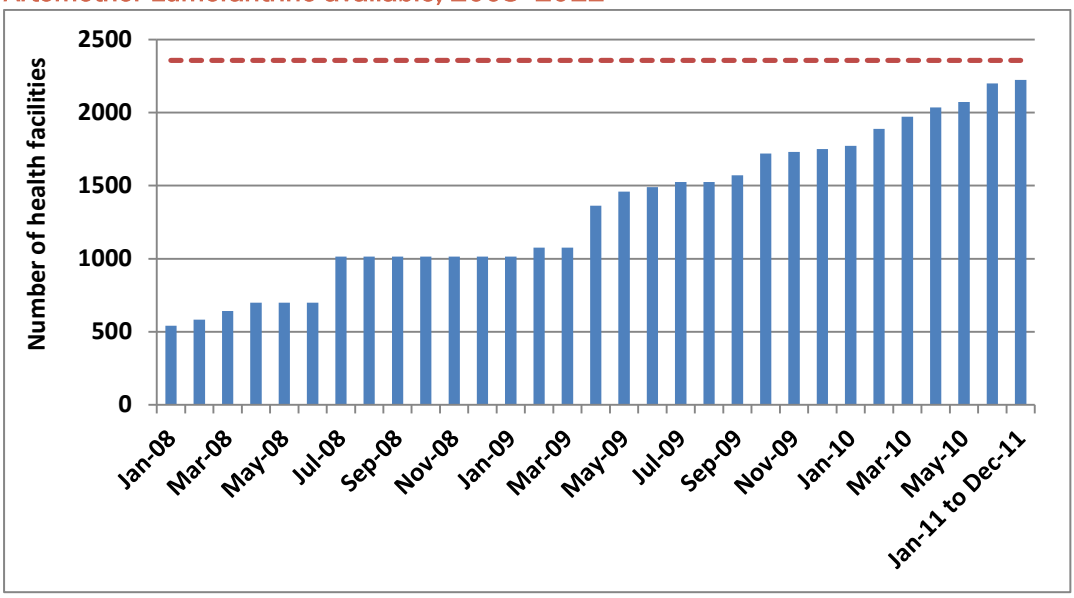
Table 13: Artemether-Lumefantrine (AL) Procured for Angola, 2006–2011

Year	Number of AL Treatments Procured
2006	1,150,200
2007	2,031,760
2008	2,363,970
2009	3,297,453
2010	3,119,744
2011	3,698,070

Source: National Malaria Control Program

From 2008 onwards, there was a rapid increase in the number of health facilities in Angola that received training on the use of ACTs and had AL available (Figure 19). By the end of 2011, treatment of malaria with AL had been implemented in almost all health facilities nationwide; however, every quarter, between 12% and 15% of health facilities reported having ACT stockouts lasting more than seven days (NMCP routine HMIS data). Figure 20 also shows that despite the implementation of ACTs beginning in 2006, it was not until about mid-2009 that at least half of all health facilities had been trained and received AL.

Figure 19: Health facilities in Angola that received training on the use of ACTs and had Artemether-Lumefantrine available, 2008–2011



Note: The total number of facilities in 2011 was 2356, shown as the dashed red line in the figure.

Source: National Malaria Control Program's routine HMIS data. Number of facilities from Ministry of Health National Health Statistics 2011.

Private drug shops are believed to treat between 40–60% of all suspected malaria cases in Angola [49]. A variety of antimalarial drugs, including chloroquine, artemisinin monotherapies, and generic formulations of ACTs, circulate in the private sector.

Diagnostics

The treatment of malaria in most MOH facilities was and continues to be based on clinical diagnosis. Microscopy has been used in health facilities since the start of the NMCP in 1989 and reporting of malaria cases confirmed by microscopy began in 2005. However, malaria microscopy is only available in hospitals and health centers. Furthermore, the quality of diagnosis varies considerably between sites, due to insufficient skilled laboratory technicians and low quantities of supplies. In August 2010, the NMCP updated their strategic plan (2011–2015) to be in line with WHO guidance, which recommends that all suspected cases of malaria, regardless of age, be diagnosed parasitologically, using either microscopy or rapid diagnostic tests (RDTs). However, the continued limited capacity for diagnostic testing means that presumptive treatment is still the *status quo* in most of the country.

RDTs were first introduced in Angola in 2006 and though procurement increased in 2009 and 2011 in particular (Table 14), coverage is still insufficient for all cases to be diagnosed with a test.

Table 14: Number of RDTs Procured for Angola, 2006–2011

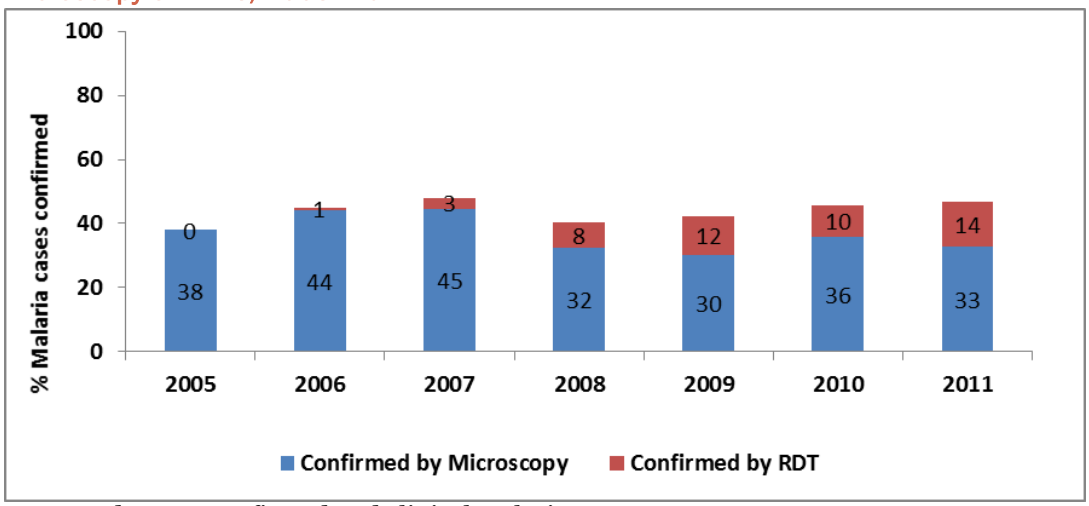
2006	492,950
2007	492,500
2008	142,775
2009	1,350,000
2010	0
2011	2,647,500

Note: The RDTs procured in 2010 only arrived in 2011.

Source: NMCP routine HMIS data

Between 2005 and 2011, 38% to 47% of all suspected malaria cases reported to the HMIS were confirmed, either by microscopy or RDT, depending on the year (Figure 20). In 2011 for example, only 47% of all suspected cases were confirmed (33% by microscopy and 14% by RDT), and therefore 53% were clinically diagnosed. In addition, testing rates were not available for all years (only 77% of all patients presenting with malaria symptoms were tested in 2010, for example). In general between 2005 and 2011, over half of the malaria cases were based on clinical diagnosis.

Figure 20: Proportion of all suspected malaria cases that were confirmed using microscopy or RDTs, 2005–2011



Suspected cases=confirmed and clinical malaria cases.
Source: NMCP routine HMIS data

Malaria Case Management in Children

Monitoring malaria case management in Angola is challenging. Correct and timely care of children with malaria depends on many factors including 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 2006/7 and 2011 MIS surveys asked mothers to report history of fever in children under five years of age during the two weeks prior to the survey (see Annex A.3.1 for fever trends). Of children who experienced fever, a series of further questions were 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.

Table 15 provides a breakdown of the specific antimalarials taken by children under five years of age with fever in 2006/7 and 2011. In 2006/7, the most frequently used antimalarials were amodiaquine (11%) and chloroquine (14%), while by 2011 it was an ACT (22%). This change reflects the policy shift in the recommended first-line treatment drug that occurred in 2004. Although ACTs became the first-line drug in 2004, implementation of the policy only began in 2006, thus explaining the low level of ACT use in 2006/7 (2%) and the higher proportions of the previous first-line drugs (amodiaquine and chloroquine). The percentage of children who were treated with ACT rose significantly from 2%

(95% CI: 0.7–3%) in 2006/7 to 22% (95% CI: 19–25%) in 2011. Similarly, prompt treatment with an ACT, within 24 hours, increased from 1% in 2006/7 to 12% in 2011.

Table 15: Proportion of children under five years of age with fever in the two weeks preceding the survey by type of antimalarial used for treatment, 2006/7–2011

	2006/7 MIS		2011 MIS		Relative
Antimalarial	**% (95% CI)**	**WN**	**% (95% CI)**	**WN**	**Change (%)**
ACT*	1.6 (0.7-3.4)	530	21.7 (18.9-24.8)	2,652	1256.3
Amodiaquine	10.7 (7.1-1.6)	530	n/a	2,652	n/a
Chloroquine	14.0 (10.6-18.3)	530	2.6 (0.7-9.0)	2,652	-81.8
SP	0.3 (0-1.1)	530	1.0 (0.6-1.5)	2,652	216.7
Quinine	2.9 (1.4-5.7)	530	2.7 (1.9-3.7)	2,652	-8.6
Other	0.8 (0.2-2.7)	530	2.2 (1.7-3.0)	2,652	180.0
Total "any antimalarial"	29.3 (24.2-34.9)	530	28.3 (24.8-32.1)	2,652	-3.4

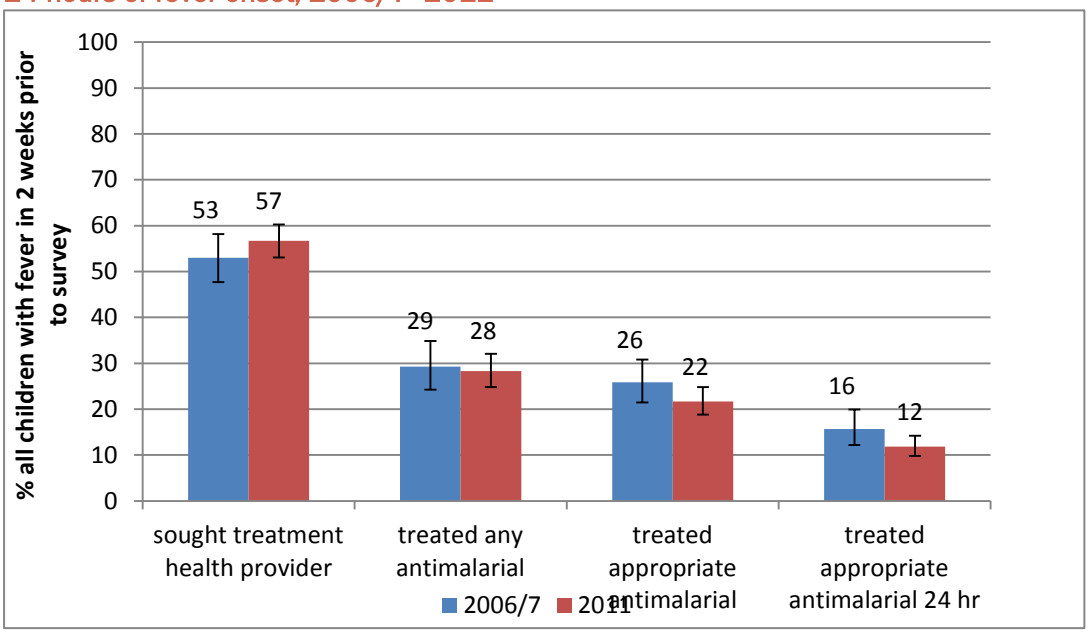
Note: Responses allowed multiple treatments to be selected, thus totals may exceed 100%; * First-line treatment in respective survey years; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval

Source: MIS 2006/7, MIS 2011

Figure 21 shows the percentage of children under five years of age with fever in the two weeks preceding the interview and their treatment in 2006/7 and 2011. The percentage of children under five years of age with a fever in the two weeks prior to the survey for whom treatment was sought from a healthcare provider did not change significantly between 2006/7 (54%) and 2011 (57%). Treatment with any antimalarials also did not change significantly (29% in 2006/7 and 28% in 2011).

As explained earlier, since ACT distribution was just beginning in 2006/7 and the previous first-line antimalarials (amodiaquine or chloroquine) were still the main drugs used (Table 15), Figure 21 also shows the percentage of children under five years of age with fever treated with an "appropriate antimalarial"; for 2006/7 this was either amodiaquine, chloroquine, or ACT, and for 2011, it was only ACT. Treatment with an appropriate antimalarial did not change significantly between the two surveys (26% in 2006/07 vs. 22% in 2011). Similarly, the percentage of children who were treated with appropriate antimalarials within 24 hours also did not change significantly (16% in 2006/07 12% in 2011).

Figure 21: Proportion 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 an appropriate antimalarial, and with an appropriate antimalarial within 24 hours of fever onset, 2006/7–2011



Note: "Health provider" includes all public and private options, but excludes other responses (shop, traditional, other). "Appropriate antimalarial" in 2006 was either amodiaquine, chloroquine or ACT; in 2011, it was ACT only.
Source: MIS 2006/7, MIS 2011

The 2011 MIS also found that 26% of children under five years of age who had a fever in the two weeks preceding the survey had a finger or heel stick (this question was not asked in the 2006/7 survey).

Equity in Treatment

Table 16 presents data on equity of treatment with an appropriate antimalarial, as defined earlier, of children under five years of age with fever in the two weeks before the survey by sex, residence, wealth, and mother's education. No differences were observed for sex, since a similar percentage of males and females had been treated with first-line antimalarials in both surveys. However, a clear urban/rural equity gap is shown for both survey years. In 2011 for example, 35% of children in urban areas had been treated compared to 15% in rural areas. Large disparities are also evident by household wealth and mother's education. In 2011, 36% of children from the least poor households had been treated compared to only 6% in the poorest households. Similarly, 46% of children whose mothers had a secondary or higher level of education had been treated compared to 12% of those whose mothers had no education.

Table 16: Percentage of children under five years of age with fever in the two weeks preceding the survey who were treated with an appropriate antimalarial, by socio-demographic factors, 2006/7–2011

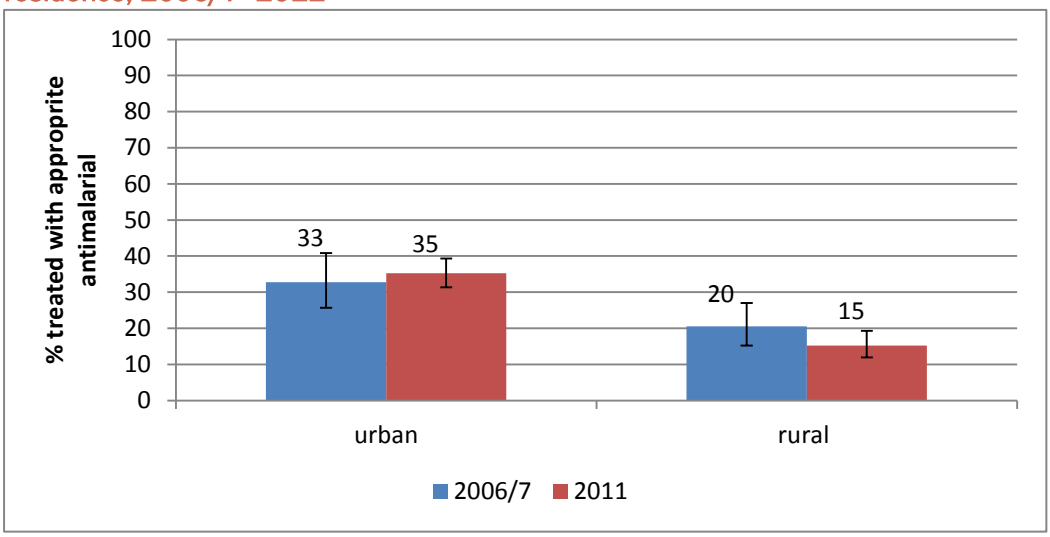
Background characteristic	2006/7 MIS		2011 MIS		Relative change (%)
	% (95% CI)	WN	% (95% CI)	WN	
Female					
Male	25.1 (19.5-31.7)	267	20.8 (17.9-24.1)	1,322	-17.1
Female	26.6 (20.2-34.2)	264	22.5 (19.2-26.2)	1,330	-15.4
Residence					
Urban	32.8 (25.7-40.8)	231	35.2 (31.3-39.3)	855	7.3
Rural	20.5 (15.2-27.0)	299	15.2 (11.9-19.3)	1,797	-25.9
Wealth quintiles					
Lowest	16.4 (10.3-25.2)	136	6.1 (3.6-10.2)	378	-62.8
Second	23.1 (14.4-34.9)	125	12.0 (8.4-16.9)	367	-48.1
Middle	24.6 (16.2-35.6)	110	15.9 (12.5-20.1)	523	-35.4
Fourth	33.6 (20.0-50.6)	97	26.3 (21.5-31.7)	760	-21.7
Highest	42.0 (28.5-56.9)	62	36.0 (31.5-40.8)	625	-14.3
Mother's education					
None	18.7 (12.8-26.5)	159	11.6 (8.6-15.5)	819	-38.0
Primary incomplete	24.6 (18.8-31.5)	277	22.5 (19.4-25.9)	1,500	-8.5
Primary complete	38.5 (22.5-57.5)	46	27.0 (16.1-41.6)	50	-29.9
Secondary and higher	40.7$ (20.4-64.8)	41	45.5 (37.3-54)	283	11.8
Total	25.9 (21.5-30.8)	531	21.7 (18.8-24.8)	2,652	-16.2

Note: "Appropriate antimalarial" in 2006/7 was either amodiaquine, chloroquine or ACT; in 2011, it was only ACT. $ Indicate 25-49 unweighted cases; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval; Information of mother's education was missing for 6 children in 2006/07

Source: MIS 2006/7, MIS 2011

Figure 22 also presents the urban/rural equity gap shown in Table 15 and described earlier. There was an increase in the percentage of children treated with an appropriate antimalarial in urban areas 33% (95% CI: 26–41%) in 2006/7, to 35% (95% CI: 31–39%) in 2011, but the change was not statistically significant. Similarly, treatment in rural areas did not change significantly between 2006/7 (20%) and 2011 (15%).

Figure 22: Proportion of children under five years of age with fever in the two weeks preceding the interview who were treated with an appropriate antimalarial, by area of residence, 2006/7–2011



Note: "Appropriate antimalarial" in 2006/7 was either amodiaquine, chloroquine or ACT; in 2011, it was ACT only.
Source:, MIS 2006/7, MIS 2011

Malaria Case Management Summary

Angola began purchasing ACTs in 2006 and this increased rapidly from 1.2 million procured in the first year to 3.7 million in 2011. This was followed by a rapid increase in the number of health facilities that received training on the use of ACTs and had AL available. Treatment of malaria with AL had been implemented in almost all health facilities nationwide by the end of 2011.

Between 2005 and 2012, the proportion of all suspected malaria cases reported to the HMIS that were confirmed, either by microscopy or RDT increased from 38% to 50%. In 2011 for example, only 47% of all suspected cases were confirmed (33% by microscopy and 14% by RDT).

According to the two national surveys, the percentage of children under five years of age with fever in the two weeks preceding the surveys for whom treatment was sought from a health provider, although above 50%, remained unchanged between 2006/7 and 2011, despite the rapid increase in the number of health facilities during that time period.

Treatment of children under five years of age with an appropriate antimalarial did not change significantly between the two surveys (26% in 2006/7 and 22% in 2011). However, treatment with ACTs specifically, the first-line treatment in both years, increased significantly from 2% to 22%. This increase in coverage is expected since the implementation of ACTs only began in 2006 and was followed by a rapid scale-up through 2011. According to the 2006/7 MIS results, amodiaquine and chloroquine were still the most commonly used drugs for

treating suspected malaria in children under five years of age, when the survey was conducted between November 2006 and April 2007 (roll out of ACTs began in May 2006 with two health facilities and reached 93 facilities by December, out of a total of 1,441 health facilities). By 2011 however, treatment with amodiaquine had been completely eliminated, while treatment with chloroquine had decreased from 14% to 3%.

Inequities in the proportion of children under five years of age treated with an appropriate antimalarial were evident by residence, household wealth, and mother's education in both 2006/7 and 2011. A larger percentage of children from urban areas, least poor households and those whose mothers had a secondary or higher level of education had been treated with an appropriate antimalarial.

Other Interventions

Larval Control Program

In 2009, Angola launched a larviciding program, with support from Cuban experts. Its objective is to help reduce the transmission of malaria and other mosquito-borne diseases through the use of bio-larvicides such as *Bacillus thuringiensis israelensis* (Bti) and *Bacillus sphaericus* (Bs) products, within the framework of integrated vector control.

The larvicide control program was implemented at the end of the impact evaluation period; therefore it is unlikely to have any measurable effect on the mortality in children under five years of age. The country is conducting a multicenter assessment of the effectiveness of the program. Results were not available before this evaluation was completed.

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. Few data on malaria parasitemia prevalence at the national level were collected until recently. In Angola, both the 2006/7 and 2011 MIS surveys collected malaria parasitemia data.

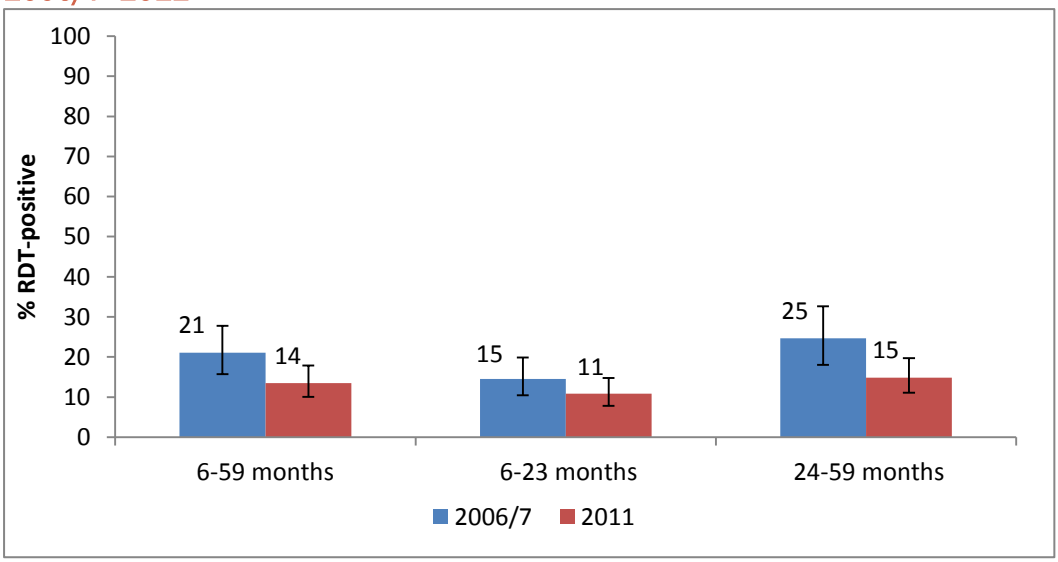
Interpreting malaria parasitemia prevalence estimates is a challenging task; malaria transmission dynamics are quite sensitive to climatic variability [60] and are heterogeneous over small areas [60,61], complicating interpretation of national trends. Thus, malaria parasitemia is a challenging impact measure to interpret in many settings, although it is arguably the most direct measure of success in malaria control efforts. To make the best use of malaria parasitemia prevalence data, many data points are needed for analysis of robust trends.

Trends in Malaria Parasitemia

The 2006/7 MIS tested children aged 6–59 months for the presence of *P. falciparum* parasites using RDTs (Paracheck Pf™, Orchid Biomedical, India). The 2011 MIS tested children aged 6–59 months, in one-third of the households surveyed, for the presence of *P. falciparum* parasites using a different RDT (SD Bioline Malaria Ag P.f/P.v®) and the presence of any *Plasmodium* sp. parasites using thick smears under light microscopy. Both surveys took place predominantly in the rainy season; the 2006/7 survey was between November 2006 and April 2007; the 2011 survey was between January and May 2011.

Figure 23 shows the trends in malaria parasitemia prevalence in children aged 6–59 months, 6–23 months, and 24–59 months, for both 2006/7 and 2011. Malaria parasitemia prevalence declined in both age groups between 2006/7 and 2011, though the declines were not statistically significant. For children aged 6–59 months, malaria parasitemia fell from 21% (95% CI: 16–28%) in 2006/7 to 14% (95% CI: 10–18%) in 2011.

Figure 23: Trends in malaria parasitemia prevalence* in children 6–59 months, by age, 2006/7–2011



*Testing by rapid diagnostic test: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011)
Source: MIS 2006/7, MIS 2011

As shown in Table 17, malaria parasitemia prevalence increased with age in both 2006/7 and 2011. For example, while malaria infection was 14% (95% CI: 8–23%) among 6–11 month olds in 2006/7, it was 26% (95% CI: 19–35%) among 48–59 month olds. A similar trend was found in 2011 in both RDT and microscopy results. The increase in malaria parasitemia by age is as expected and demonstrates some internal validity in the results.

Table 17: Malaria parasitemia in children 6–59 months, by age, 2006/7–2011

	2006/7 MIS		2011 MIS				
Age in months	Percentage of children with malaria parasitemia – RDT* (95% CI)	WN	Percentage of children with malaria parasitemia - (RDT)* (95% CI)	WN	Percentage of children with malaria parasitemia - microscopy (95% CI)	WN	Relative change (%)
6–11	13.7 (7.9-22.8)	262	10.3 (6.9-15.3)	415	8.3 (5.1-13.4)	415	-24.6
12–23	14.9 (10.7-20.5)	544	11.1 (7.9-15.5)	795	8.0 (5.8-10.9)	795	-25.8
24–35	22.7 (15.8-31.6)	476	14.7 (10.3-20.4)	784	10.3 (7.1-14.6)	784	-35.5
36–47	24.8 (17.2-34.3)	542	13.7 (9.9-18.6)	727	11.5 (8.1-16.1)	727	-44.9
48–59	26.4 (19.2-35.1)	478	16.3 (11.7-22.1)	777	11.8 (8.6-16.1)	777	-38.3
Total	21.1 (15.7-27.8)	2,302	13.5 (10.1-17.8)	3,498	10.1 (7.5-13.5)	3,498	-36.1

*RDTs used: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011)
MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval.
Source: MIS 2006/7, MIS 2011

Equity in Malaria Parasitemia

Disparities in the prevalence of malaria parasitemia in children aged 6–59 months, by socio-economic characteristics, are shown in Table 18. Malaria parasitemia prevalence was similar for males and females in both 2006/7 and 2011. However, malaria parasitemia was significantly higher in rural areas than in urban in both 2006/7 and 2011. For example in 2011, the prevalence of malaria parasitemia was 19% in rural areas compared to 2% in urban areas. Malaria parasitemia was also higher among children from poorer households and children of mothers who had less education in both 2006/7 and 2011. Among children age 6–59 months in the poorest wealth quintile in 2006/7, for example, 43% tested positive for malaria compared with 7% of children in the least poor wealth quintile. In 2011 however, children from the poorest households experienced the largest decrease in malaria prevalence (from 43% in 2006/7 to 20% in 2011; a statistically significant difference) than any other group. Children whose mothers had no education had a higher prevalence in 2011 (20%) compared to those whose mothers had at least a secondary education (3%).

Table 18: Malaria parasitemia in children 6–59 months, by background characteristics, Angola 2006/7–2011

	2006/7 MIS		2011 MIS		
Background Characteristics	Percentage of children with malaria parasitemia - RDT (95% CI)	WN	Percentage of children with malaria parasitemia - RDT (95% CI)	WN	Relative Change (%)
Sex					
Male	21.7 (16.3-28.2)	1,166	14.7 (10.9-19.4)	1,697	-32.2
Female	20.5 (14.6-28.0)	1,136	12.4 (9.0-16.7)	1,801	-39.8
Residence					
Urban	7.8 (4.4-13.5)	1,072	1.7 (0.1-3.1)	1,079	-77.8
Rural	32.7 (23.8-43.0)	1,230	18.7 (13.9-24.7)	2,419	-42.8
Wealth quintiles					
Lowest	42.9 (32.5-54.1)	532	20.3 (13.6-29.2)	554	-52.7
Second	26.1 (16.3-39.0)	549	24.6 (16.6-34.7)	487	-5.9
Third	12.3 (8.0-18.3)	545	19.6 (13.5-27.6)	663	60.2
Fourth	6.7 (2.8-15.5)	396	7.1 (4.4-11.4)	947	5.6
Highest	7.3 (4.1-12.8)	280	5.0 (2.4-9.8)	847	-32.6
Mother's Education					
None	31.9 (22.3-43.3)	662	20.3 (15.4-26.3)	1,032	-36.2
Primary	16.8 (12.2-22.8)	1,212	10.2 (7.3-14.1)	1,623	-39.3
Secondary and higher	3.9 (0.7-18.3)	139	3.2 (1-10.2)	287	-18.3
Missing	22.5 (15.9-30.8)	289	15.6 (9.2-25.1)	556	-30.9
Total	21.1 (15.7-27.8)	2,302	13.5 (10.1-17.8)	3,498	-36.1

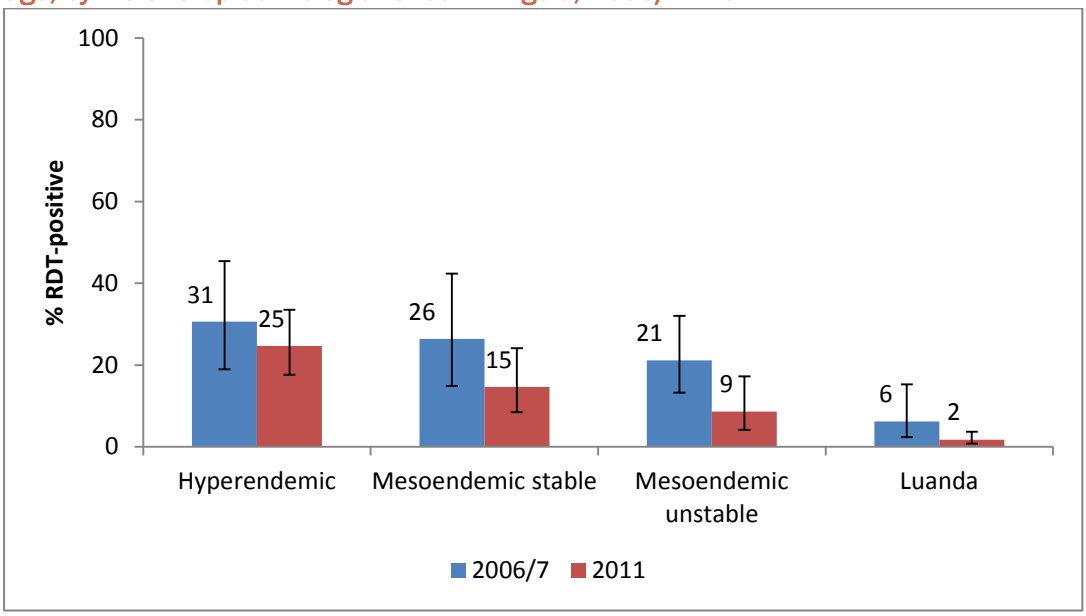
RDTs used: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011); MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval

Source: MIS 2006/7, MIS 2011

Parasitemia by Malaria Epidemiologic Zones

Figure 24 shows the trends in malaria parasitemia prevalence among children aged 6–59 months by the four malaria epidemiologic zones in Angola.[2] In both 2006/7 and 2011, the hyperendemic zone had the highest prevalence, followed by the mesoendemic stable zone, then mesoendemic unstable and lastly, Luanda. All areas experienced a decrease in malaria parasitemia prevalence between 2006/7 and 2011, though none were statistically significant.

Figure 24: Trends in malaria parasitemia prevalence (RDT) in children 6–59 months of age, by malaria epidemiologic zones in Angola, 2006/7–2011

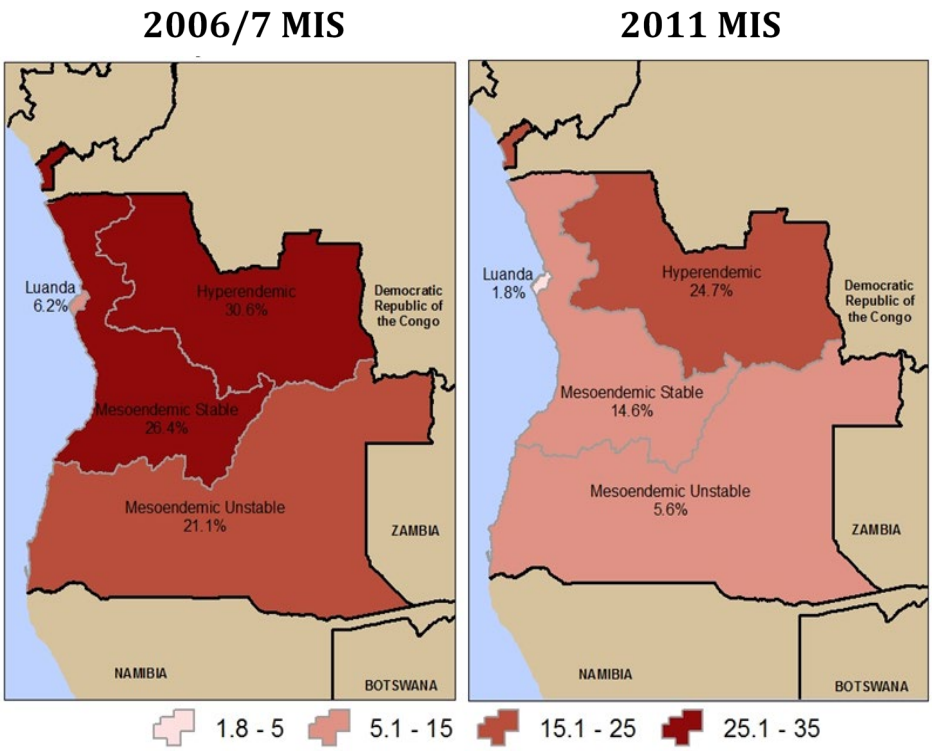


RDTs used: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011)
Source: MIS 2006/7, MIS 2011

The trends in malaria parasitemia prevalence in 2006/7 and 2011 by malaria epidemiologic zones in Angola are also presented in Figure 25.

[2] The confidence intervals for the malaria parasitemia estimates for the epidemiologic zones are large, indicating that the sample sizes were not adequate for measuring this indicator by region. Though the 2011 MIS had a larger overall sample size than the 2006/7 MIS, children age 6–59 months were tested in only one-third of all the households sampled (only 3493 of children were tested for parasitemia out of 8030 households sampled).

Figure 25: Malaria parasitemia prevalence (RDT) in children 6–59 months of age, by malaria epidemiologic zones in Angola, 2006/7–2011

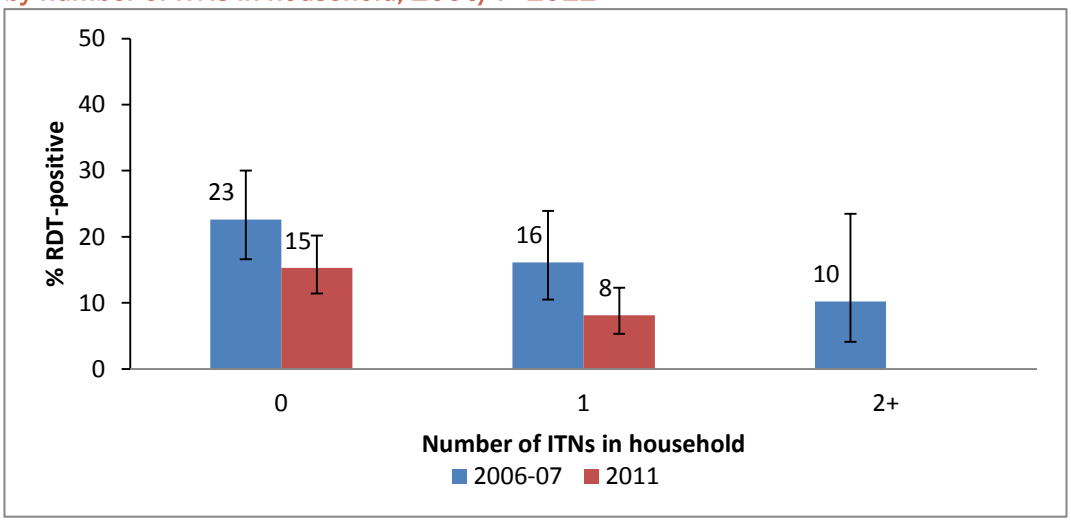


Source: MIS 2006/7, MIS 2011, ICF International

Parasitemia and ITN Ownership and Use

Figure 26 shows trends in malaria parasitemia prevalence among children aged 6–59 months, by the number of household ITNs owned. For both 2006/7 and 2011, the greater the number of ITNs owned by a household, the lower the malaria parasitemia prevalence was among children aged 6–59 months; however, the differences were not statistically significant. In 2011 for example, children aged 6-59 months living in households that had no ITNs had a malaria parasitemia prevalence of 16% (95% CI: 11–20%), those in a household with one ITN had a prevalence of 8% (95% CI: 5–12%), and those in a household with two or more ITNs had a prevalence of 6% (95% CI: 1–21%). A similar declining trend in malaria parasitemia prevalence was found in 2006/7, as the number of ITNs per household increased.

Figure 26: Trends in malaria parasitemia prevalence* in children 6–59 months of age, by number of ITNs in household, 2006/7–2011

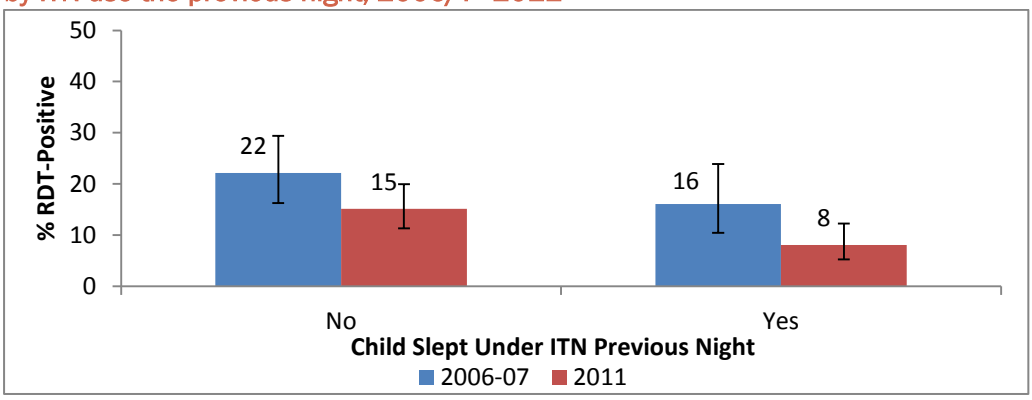


Note: *Testing by rapid diagnostic test: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011). Prevalence not calculated for 2011 2+ nets because the number of children (n) is below 25.

Source: MIS 2006/7, MIS 2011

Figure 27 shows trends in malaria parasitemia prevalence among children aged 6–59 months, by whether they slept under an ITN the previous night or not. Malaria parasitemia prevalence was lower among children who slept under an ITN the night before the survey than among children who did not in both 2006/7 and 2011. However, the differences were not statistically significant. In 2011 for example, malaria parasitemia prevalence was 8% (95% CI: 5–12%) among children who had slept under an ITN compared to 15% (95% CI: 11–20%), among those who had not slept under an ITN. It is also interesting to note that the decrease in malaria parasitemia prevalence between the two surveys was greatest among children who slept under an ITN (relative change of 50%) than among those who did not (relative change of 32%). Additional analyses assessing the association between ITN ownership and malaria parasitemia are reported in the Further Analysis section.

Figure 27: Trends in malaria parasitemia prevalence* in children 6–59 months of age, by ITN use the previous night, 2006/7–2011



Note: *Testing by rapid diagnostic test: Paracheck Pf™ (2006/7), SD Bioline Malaria Ag P.f/P.v® (2011)

Source: MIS 2006/7, MIS 2011

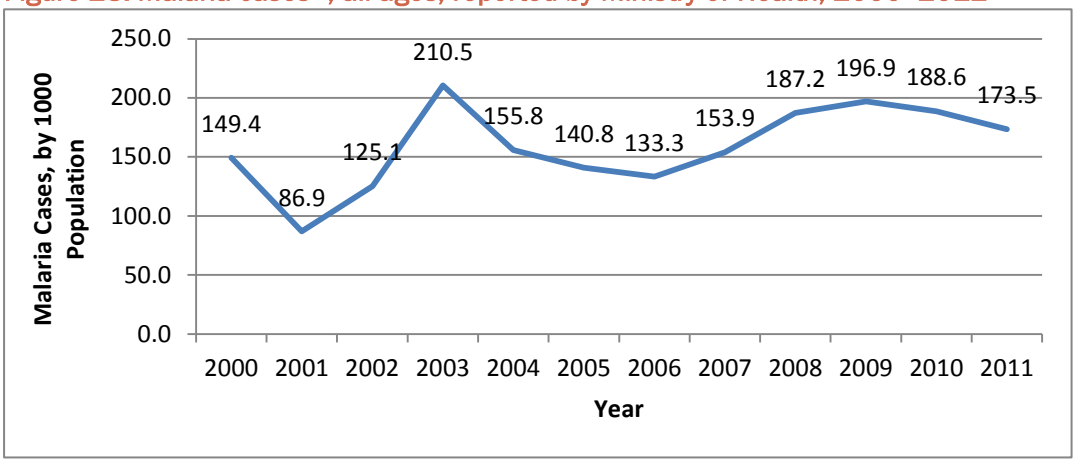
Facility-based Malaria Morbidity Data

Data from the HMIS were used to investigate trends in suspected malaria cases between 2000 and 2011. Although the Angola 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). These issues can be somewhat circumvented by longitudinal data, so the longer we can examine trends in HMIS data, the better.

According to the HMIS, the number of reported cases of malaria in all age groups fluctuated between 2000 and 2011 (Figure 28). In 2000, there were 149 reported cases per 1,000 population, followed by a decline in 2001 and then an increase in both 2002 and 2003, when it peaked at 211 cases per 1,000 population, as a result of an outbreak [49]. In relation to the evaluation time period specifically, the number of all reported malaria cases increased from 133 cases per 1,000 population in 2006 to 197 cases in 2009. Why this initial increase occurred during a period when the implementation of malaria interventions were also increasing is unclear, but one possible explanation is that reporting improved.

Between 2009 and 2011, the number of all reported malaria cases declined and reached 173.5 cases per 1,000 population in 2011. This decrease occurred despite there being an overall increase in the percentage of health facilities reporting to the HMIS during the same time period (from 66% in 2009 to 76% in 2012 [49]; this data was not available prior to 2009).

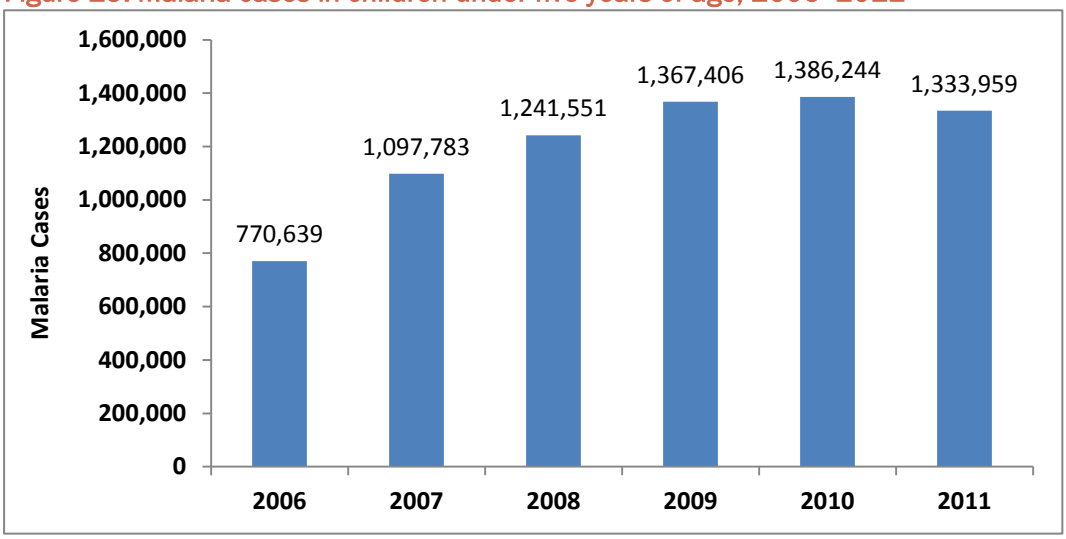
Figure 28: Malaria cases*, all ages, reported by Ministry of Health, 2000–2011



*Confirmed and non-confirmed clinical cases
Source: Health Management and Information System – MOH; Angola World Bank population data [62]

Figure 29 shows for children under five years of age, the number of reported malaria cases increased from almost 771,000 in 2006 to 1.3 million in 2011; with a peak in 2010, at 1.4 million cases, followed by a slight decrease in 2011. Similar trends were observed for persons 5–14 years of age, those over 14 years old, as well as for pregnant women (see Annex A.3.3). As mentioned earlier, these trends occurred despite there being an overall increase in the percentage of health facilities reporting to the HMIS between 2009 and 2012 (from 66% in 2009 to 76% in 2012 [49]; this data was not available prior to 2009).

Figure 29: Malaria cases in children under five years of age, 2006–2011



Source: Health Management and Information System – MOH

Severe Anemia

Background

Severe anemia, defined as blood hemoglobin levels less than 8 grams per deciliter[3], 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 with less seasonality than malaria parasitemia [12-14]. 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) [63]. In addition to malaria parasites, iron deficiency, deficiencies in other micronutrients, and diseases such as soil-transmitted helminthes are all causes of anemia [63]. Declines in the prevalence of severe anemia have been found to be associated with malaria control interventions [64]. 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%

[3] A hemoglobin cutoff of <7 g/dL is used to classify severe nutritional anemia, whereas a cut off of <8g/dL is used to classify malaria-related anemia. Intervention trials have shown that malaria control interventions reduce moderate-to-severe anemia (Hb <8g/dL).

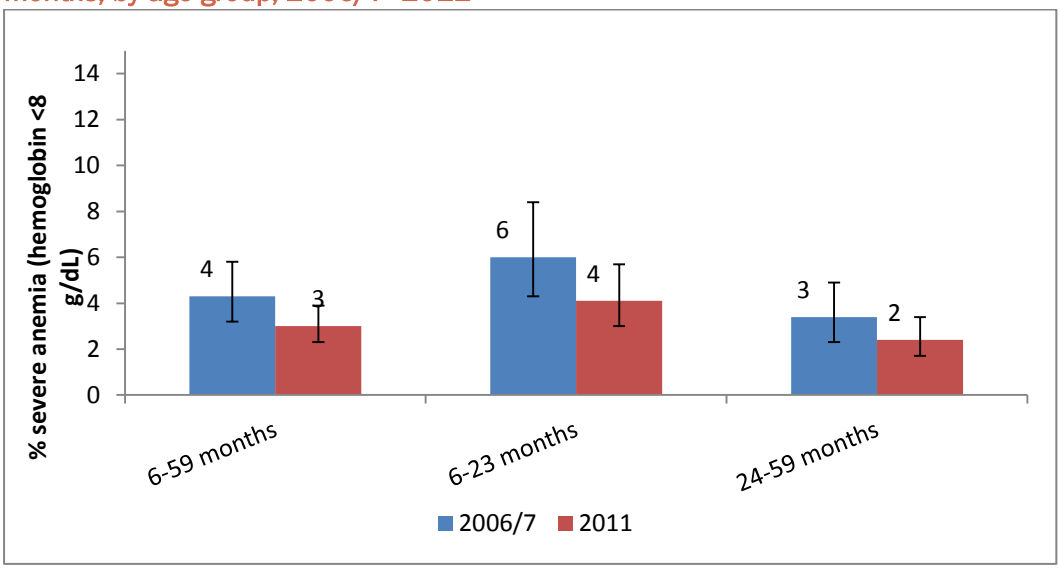
and 54% of malaria-attributable deaths are estimated to be due to severe anemia [64-67].

Trends in Severe Anemia

National estimates of the prevalence of severe anemia in children aged 6–59 months are available from the 2006/7 and 2011 MIS surveys. It is important to note that since the prevalence of severe anemia was found to be very low in both surveys, it was difficult to detect any statistically significant changes between the 2006/7 and 2011 results[4]; consequently, the findings should be interpreted with caution. In addition, more detailed stratification of the severe anemia indicator (for example, by socio-economic variables and epidemiologic zones) was not included in this section but can be found in Annex A.3.2.

Figure 30 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 in all age groups was low in both the 2006/7 and 2011 MIS surveys. Among children aged 6–59 months, the prevalence of severe anemia was 4% (95% CI: 3–6%) in 2006/7 and 3% (95% CI: 2–4%) in 2011.

Figure 30: Trends in severe anemia (hemoglobin < 8g/dL) prevalence in children 6–59 months, by age group, 2006/7–2011



Source: MIS 2006/7, MIS 2011

[4] The confidence intervals for the severe anemia estimates for both 2006/7 and 2011 are large, indicating that the sample sizes were not adequate for measuring this indicator with particularly low prevalence. Though the 2011 MIS had a larger overall sample size than the 2006/7 MIS, children age 6–59 months were tested in only one-third of all the households sampled (only 3485 children had a test for severe anemia out of the 8030 households sampled).

Summary of Malaria Morbidity

Malaria parasitemia declined in children aged 6–59 months, 6–23 months, and 24–59 months, between 2006/7 and 2011. For children aged 6–59 months for example, malaria parasitemia decreased from 21% in 2006/7 to 14% in 2011. Malaria parasite prevalence fell in all epidemiologic zones between 2006/7 and 2011. However, none of the declines in malaria parasite prevalence were statistically significant.

Malaria parasitemia varied by household ownership of ITNs and use of ITNs by children under five years of age the night before the survey. For both 2006/7 and 2011, the greater the number of ITNs owned by a household, the lower the malaria parasitemia prevalence among children aged 6–59 months. Malaria parasitemia prevalence was lower among children who slept under an ITN the night before the survey than among children who did not in both 2006/7 and 2011. These trends suggest that ITN ownership and use protects children from getting malaria; however, the differences noted here were not significant. To examine this further, the relationship between ITN ownership and malaria parasitemia was investigated in the multiple logistic regression analysis found later in the report.

Data from the HMIS showed that the number of reported malaria cases for all age groups, as well as children under five years of age, increased between 2006–2009/10; though this increase was likely the result of an increase in the number of health facilities and increased reporting of data. However, starting in 2009/10 the number of reported malaria cases started to decline, despite data showing that the proportion of health facilities reporting to the HMIS between 2009 and 2011 increased. This suggests that the number of malaria cases did in fact start to decline in the country in 2009/10.

Severe anemia was low in 2006/7 (4%) and remained low in 2011 (3%). However, since the prevalence of severe anemia was so low in Angola, it was not possible to detect any statistically significant changes over time.

MORTALITY

Mortality

Background

This section reviews recent trends in ACCM in Angola, with a view to assessing the magnitude, timing, and age-pattern of change between 2003 and 2011. In addition, it includes an ecological analysis that examines changes in mortality with respect to the malaria epidemiologic zones in Angola. After a thorough analysis of the limited data options available to examine ACCM in Angola, the evaluation group chose to use data from the most recent 2011 MIS to generate retrospective three-year period mortality estimates from 2003 to 2011. The 2011 MIS was chosen because it is the only survey which provided direct estimates of the mortality of children under five years of age (as compared to the indirect estimates of earlier surveys), had the most adequate sample size for calculating ACCM and covered the necessary time period for this evaluation (specifically from 2003, before the scale-up of malaria interventions, to 2011).

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

Mortality was assessed in successive three-year periods prior to the survey. Table 19 shows the estimates for ACCM for 2003–2005 (6–8 years before the survey), 2006–2008 (3–5 years before the survey), and 2009–2011 (0–2 years before the survey), estimated from the 2011 MIS. Overall, there was a significant decline in ACCM between 2003–2005 (from 117 deaths per 1,000 live births) and 2009–2011 (92 deaths per 1,000 live births), representing a relative reduction of 21%. The largest drop however, took place between 2003–2005 and 2006–2008 specifically (from 117 to 95 respectively, a decline of 19%); between 2006–2008 and 2009–2011, the decline was only 3%.

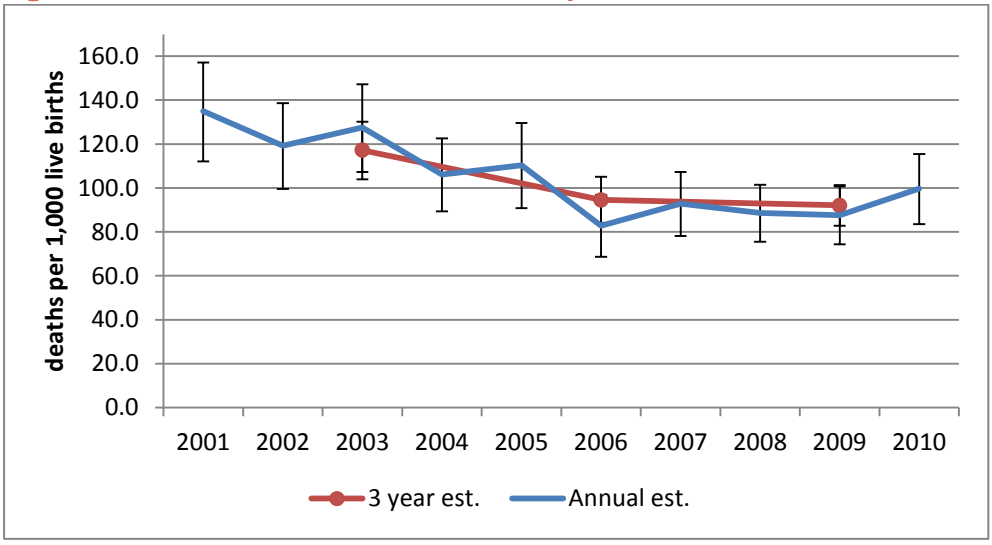
Table 19: Estimates for ACCM (per 1,000 live births) for three-year periods before the 2011 MIS and relative change

Estimate for 2003–2005 (6–8 years before 2011 MIS) A	Estimate for 2006–2008 (3–5 years before 2011 MIS) B	Estimate for 2009–2011 (0–2 years before 2011 MIS) C	Relative Change A-B (%)	Relative Change B-C (%)	Relative Change A-C (%)
5q0 (95% CI)	5q0 (95% CI)	5q0 (95% CI)			
117.2 (104-130.2)	94.6 (84.1-105.0)	92.1 (82.8-101.3)	-19.3	-2.6	-21.4

MIS = Malaria Indicator Survey; 95% CI = 95% Confidence Interval
Source: MIS 2011

Figure 31 shows the national trends in ACCM through both annual and three-year period estimates. The two lines show a similar trend: a greater decline in the years preceding 2006, followed by a stabilization of ACCM from 2006–2011. It should be noted that the MIS survey sample was not powered to calculate annual mortality rates, which is reflected by the wide confidence intervals. Therefore comparison of mortality rates between consecutive years should be done with caution.

Figure 31: Trends in ACCM, annual and three-year estimates from the 2011 MIS

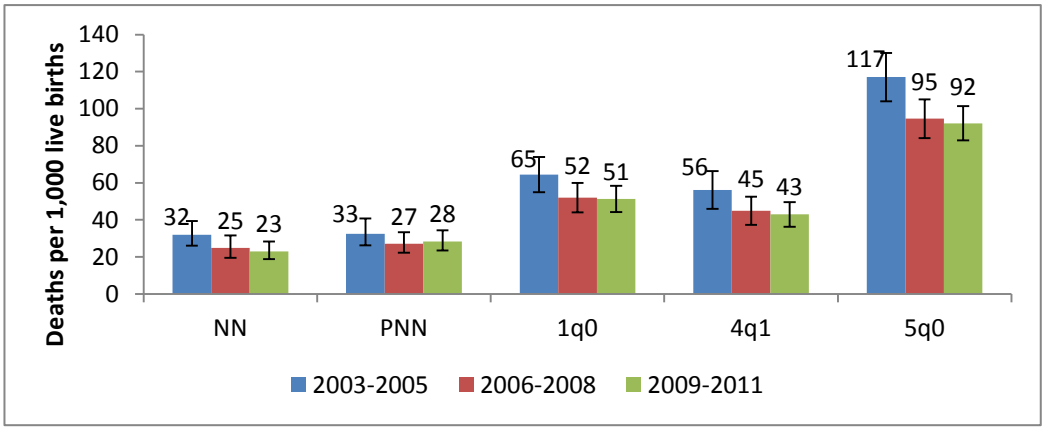


Source: MIS 2011

Trends in Age-Specific Childhood Mortality

Trends in age-specific childhood mortality for the three-year periods preceding the 2011 MIS are presented in Figure 32. The estimates show a similar trend for all the age categories as described earlier. That is, there was an overall decline in mortality but the decline was greatest between 2003–2005 and 2006–2008. From 2006–2008, mortality in all the age categories was virtually unchanged compared to 2009–2011. Decline in mortality was only statistically significant for ACCM (5q0) between 2003–2005 and 2009–2011.

Figure 32: Trends in age-specific childhood mortality for three-year periods preceding the 2011 MIS



Key: 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; $_5q_0$ = all-cause mortality in children under five years of age, per 1,000 live births. Error bars represent upper and lower 95% confidence limits for the estimates.

Source: MIS 2011

The mortality estimates and relative change in these estimates by age categories are shown in Table 20. Four additional age categories are included: 6–23 months (where malaria-related mortality would be expected to be concentrated) and 24–59 months, 1–59 months, and 6–59 months (for comparison). For all age categories, the greatest decline occurred between 2003–2005 and 2006–2008. Overall, neonatal mortality declined the most (28%) between 2003–2005 and 2009–2011 and post-neonatal mortality the least (13%). The relative decline between the 2003–2005 and 2009–2011 mortality estimates was comparable for children aged 6–23 months (22%) and children 24–59 months (23%).

Table 20: Estimates for age-specific mortality (per 1,000 live births) for three-year periods before the 2011 MIS and relative change

	Estimate for 2003–2005 (6–8 years before 2011 MIS) A	Estimate for 2006–2008 (3–5 years before 2011 MIS) B	Estimate for 2009–2011 (0–2 years before 2011 MIS) C	Relative Change		
Age category	**Rate (95% CI)**	**Rate (95% CI)**	**Rate (95% CI)**	**A-B (%)**	**B-C (%)**	**A-C (%)**
Neonatal (NN)	32.0 (26.1-39.4)	24.9 (19.6-31.7)	23.0 (18.8-28.3)	-22.2	-7.6	-28.1
Post-neonatal (PNN)	32.5 (26.3-40.8)	27.1 (22.2-33.3)	28.3 (23.5-34.4)	-16.6	4.4	-12.9
Infant (1q0)	64.5 (55.0-74.0)	52.0 (44.0-60.0)	51.3 (44.3-58.4)	-19.4	-1.3	-20.5
Child (4q1)*	56.2 (46.0-66.4)	44.9 (37.3-52.5)	43.0 (36.3-49.6)	-20.1	-4.2	-23.5
Under five (5q0)	117.2 (104-130.2)	94.6 (84.1-105)	92.1 (82.8-101.3)	-19.3	-2.6	-21.4
1–59 months**	87.9 (75.9-99.8)	71.5 (62.4-80.5)	70.7 (62.4-79.0)	-18.7	-1.1	-19.6
6–59 months***	73.2 (61.8-84.4)	58.3 (49.8-66.7)	56.9 (49.2-64.5)	-20.4	-2.4	-22.3
6–23 months***	36.8 (29.0-44.4)	31.0 (25.1-36.8)	28.7 (23.2-34.1)	-15.8	-7.4	-22.0
24–59 months****	37.8 (28.9-46.6)	28.2 (21.8-34.7)	29.1 (23.4-34.8)	-25.4	3.2	-23.0

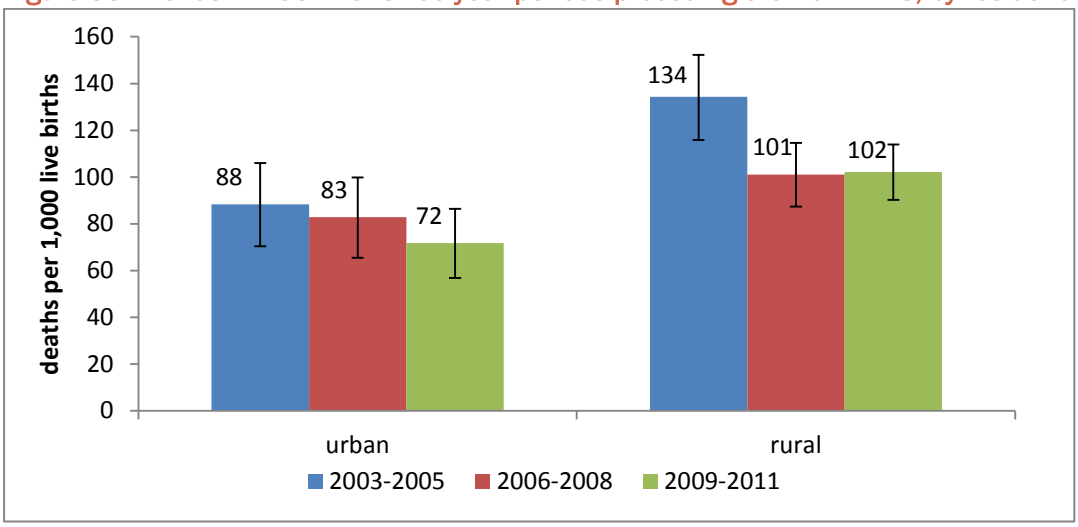
*Child mortality ($_4q_1$) is per 1,000 live-born children surviving to 12 months of age; **1–59 month mortality is per 1,000 live-born children surviving to 1 month of age; ***6–59 month mortality and 6–23 month mortality is per 1,000 live-born children surviving to 6 months of age; ****24–59 month mortality is per 1,000 live-born children surviving to 24 months of age; MIS = Malaria Indicator Survey; 95% CI =95% Confidence Interval

Source: MIS 2011

ACCM by Residence

If a major part of the decline in ACCM was malaria-related, we would likely expect to see a greater decline in mortality, among children living in rural areas compared to those living in urban areas [68]. Figure 33 shows mortality rates from 2003–2005, 2006–2008, and 2009–2011 stratified by rural and urban residence. ACCM in rural areas declined significantly from 134 deaths (95% CI: 116–152) per 1,000 live births in 2003–2005 to 101 deaths (95% CI: 87–115) in 2006–2008; representing a relative decline of 25%. From 2006–2008 to 2009–2011, ACCM in rural areas remained unchanged. Though ACCM was lower in urban areas compared to rural areas across the three-year periods, the decline that occurred between 2003–2005 and 2006–2008 was much smaller (6% relative change); however, there was an additional decline of 13% between 2006–2008 and 2009–2011.

Figure 33: Trends in ACCM for three-year periods preceding the 2011 MIS, by residence



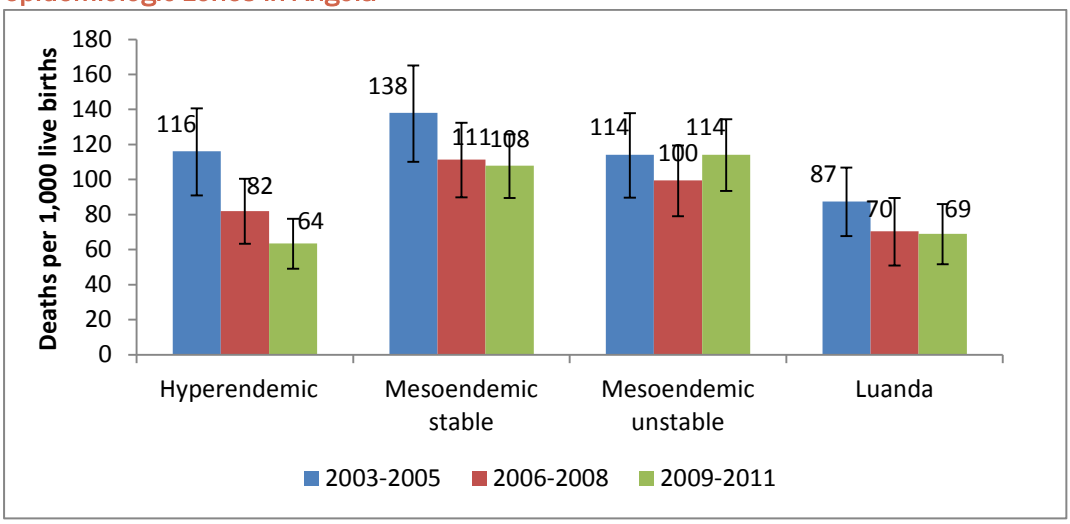
Source: MIS 2011

ACCM by Malaria Epidemiologic Zones

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 areas of greater malaria risk – as compared to areas of lower malaria risk [68,69]. Figure 34 shows the trends in ACCM for 2003–2005, 2006–2008, and 2009–2011, stratified by malaria epidemiologic zones in Angola. Though ACCM was not the highest in the hyperendemic zone in any of the three-year periods compared to the other zones, it experienced the largest decline over time: from 116 deaths (95% CI: 91–141) per 1,000 live births in 2003–2005, to 82 deaths (95% CI: 63–100) in 2006–2008 to 64 deaths (92% CI: 49–78) in 2009-2011. The decline between 2003–2005 and 2009–2011 was the only statistically significant decline found across all malaria epidemiologic zones in Angola; representing a relative change of 45%. It is also interesting to note that by 2009–2011, ACCM in the hyperendemic zone was slightly lower than Luanda: 64 deaths (95% CI: 49–78) per 1,000 live births compared to 69 (95% CI: 52–86).

The other zones to experience a general (nonsignificant) decline in ACCM were the mesoendemic stable zone and Luanda; however, the declines experienced there were similar to the national trends (initial decline of mortality between 2003–2005 and 2006–2008 followed by stabilization between 2006–2008 and 2009–2011). The mesoendemic unstable zone had a different trend: after an initial decline, ACCM in 2009–2011 increased to the level found in 2003–2005.

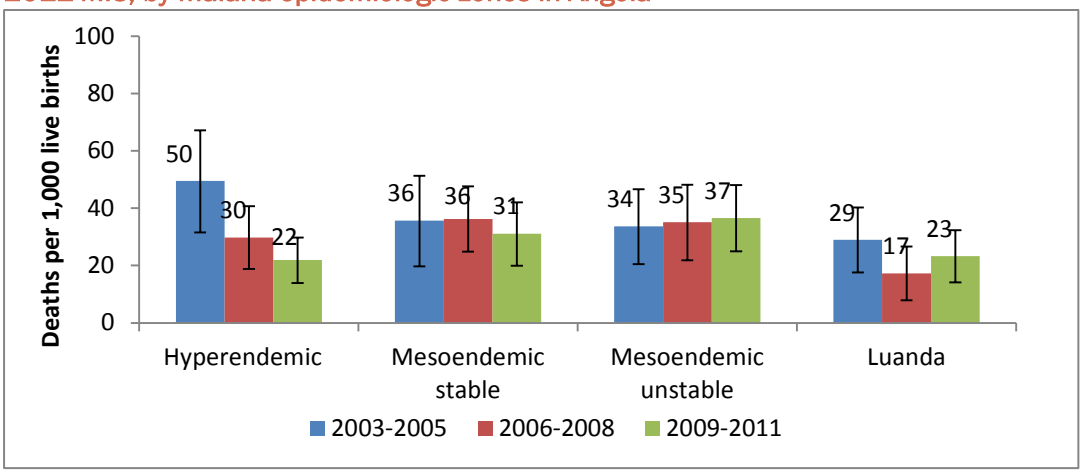
Figure 34: Trends in ACCM for three-year periods preceding the 2011 MIS, by malaria epidemiologic zones in Angola



Source: MIS 2011

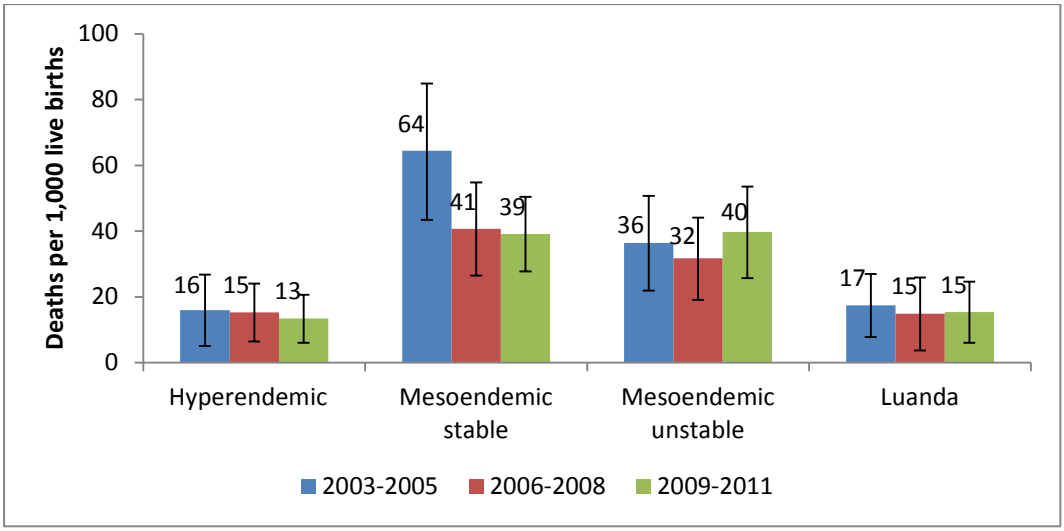
Trends in mortality in the three malaria risk zones were also stratified by two age groups: 6–23 months and 24–59 months (for stratification by infant mortality, see Annex A.3.4). If malaria interventions were responsible for any decline in ACCM, then a greater decline would be expected in the 6–23 months age group, which is at a greater risk of malaria mortality, than the older age group. As shown in Figure 35, for the 6–23 months age group, mortality declined significantly in the hyperendemic zone only, between 2003–2005 and 2009–2011. For the 24–59 months age group (Figure 36), mortality barely changed in the hyperendemic zone between the three three-year periods. In fact, the mortality among this age group was similar to that experienced in Luanda, while the other two zones experienced higher levels of mortality across the three-year periods.

Figure 35: Trends in mortality in 6–23 month olds for three-year periods preceding the 2011 MIS, by malaria epidemiologic zones in Angola



Source: MIS 2011

Figure 36: Trends in mortality in 24–59 month olds for three-year periods preceding the 2011 MIS, by malaria epidemiologic zones in Angola



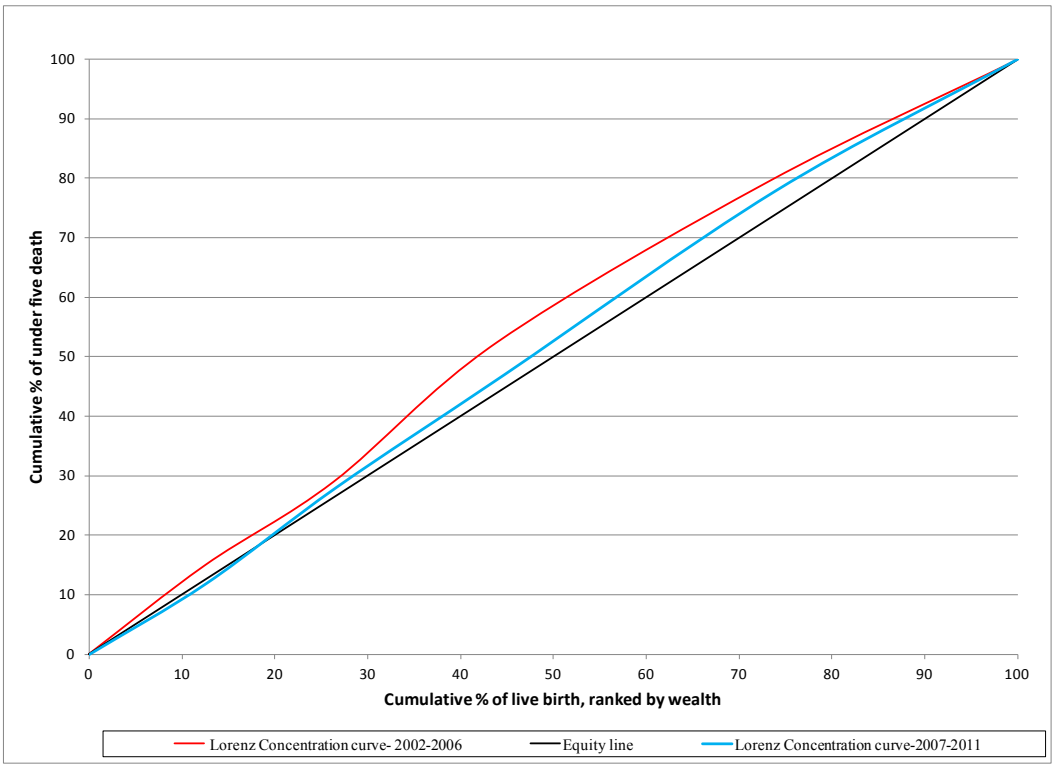
Source: MIS 2011

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 concentration curves – where the straight line represents perfect equality (with a concentration index of zero), and "upward" departure from the diagonal indicates excessive mortality in poorer population quintiles (with a negative sign on the concentration index).

Figure 37 shows the results of this analysis for ACCM estimates during the five-year time periods 2002–2006 and 2007–2011. The concentration index in 2007–2011 (-0.04) was closer to "equality" than that from 2002–2006 (-0.09), 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 37: Concentration Curves for ACCM in Angola 2002–2006 and 2007–2011



Concentration Index

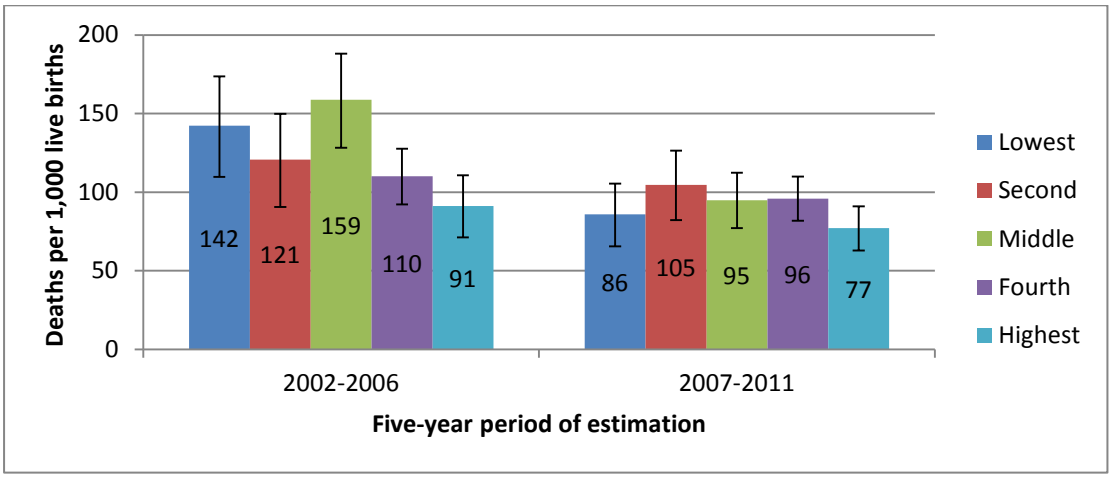
2002–2006: -0.09, 95%CI (95% CI: -0.14 – -0.04)

2007–2011: -0.04, 95%CI (95% CI : -0.09 – -0.02)

Source: MIS 2011

Another way to view these data is to look at trends in ACCM by wealth quintile in a simple bar graph. Figure 38 presents these data for the two five-year periods preceding the 2011 MIS. Whereas large differences in ACCM are evident between children in the highest and lower wealth quintiles in the 2002–2006 time period, this difference is not present in the most recent time period, from 2007–2011. Estimates and 95% confidence intervals are available in Annex A.2.1.

Figure 38: All-cause Childhood Mortality by Wealth Quintile, Angola, 2002–2006 and 2007–2011

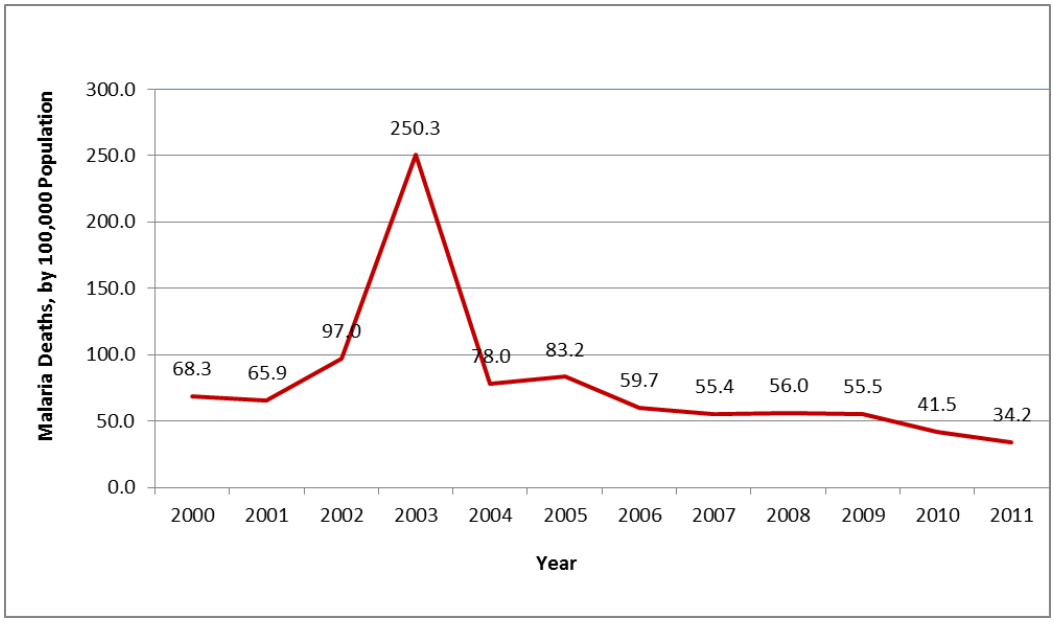


Source: MIS 2011

Facility-based Malaria Mortality Data

As with the malaria cases examined earlier, HMIS data were used to investigate trends in malaria deaths in Angola between 2000 and 2011. Figure 39 shows that the number of reported malaria deaths was close to 70 deaths per 100,000 population in 2000 and 2001, rose to 97 deaths in 2002, followed by a sharp increase to 250 deaths in 2003, which the NMCP attributes to a malaria outbreak [49]. The number of malaria deaths then decreased significantly in 2004, to 78 deaths per 100,000 population, and the decline continued through 2011, with a steady decrease from 55 deaths in 2009 to 34 deaths in 2011. The continued decrease between 2009 and 2011 occurred despite there being an overall increase in the percentage of health facilities reporting to the HMIS during the same time period (from 66% in 2009 to 76% in 2012 [49]; this data was not available prior to 2009).

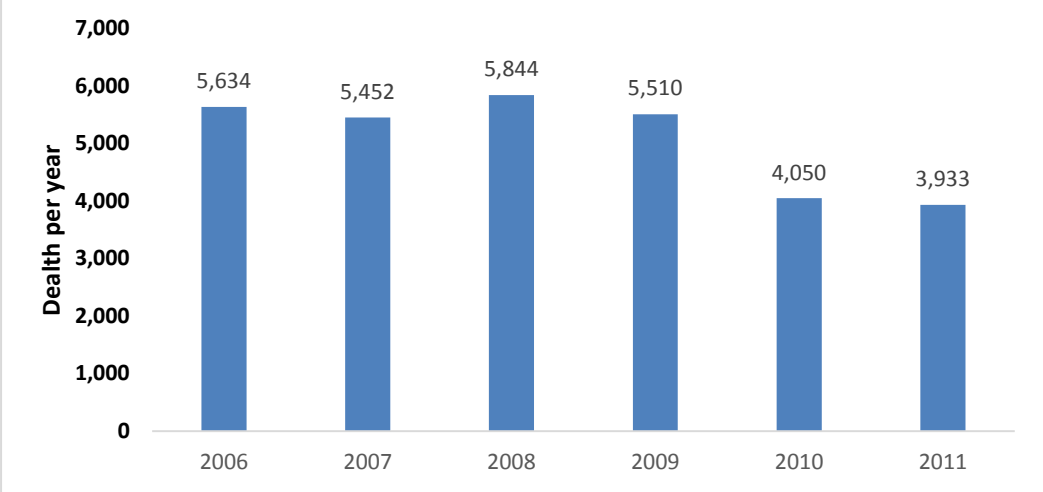
Figure 39: Reported Malaria Deaths in Angola per 100,000 Population, All Ages, 2000–2011



Source: Health Management and Information System – MOH; Angola World Bank population data [62]

In the case of children under five years of age (Figure 40), the number of reported malaria deaths was similar between 2006 and 2009, around 5,500. In 2010 and 2011, the number of deaths decreased to about 4,000. Similar trends were observed for persons 5–14 years of age and persons over 14 years of age (see Annex 3.4); since 2009, there has been an overall decline in the number of malaria deaths reported.

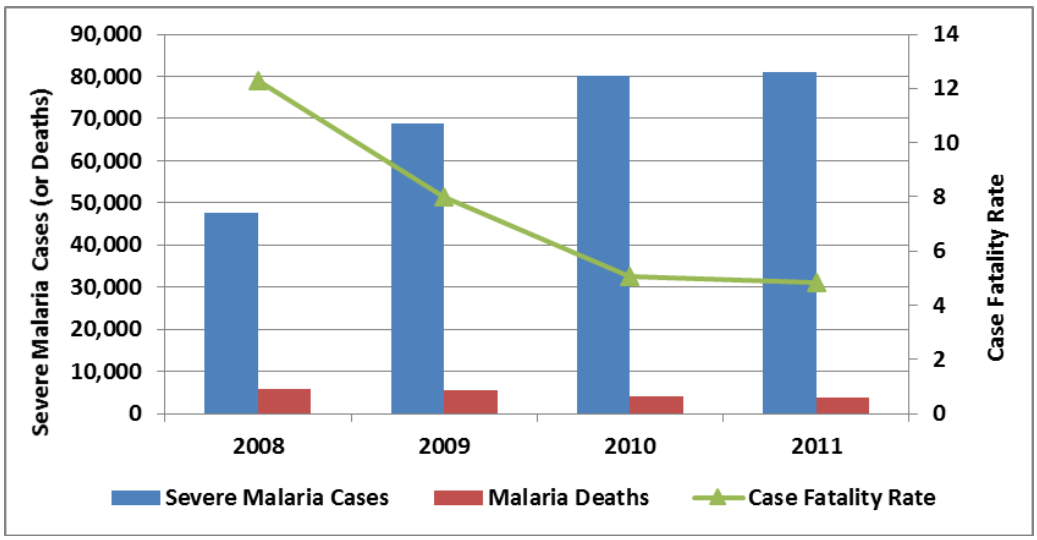
Figure 40: Malaria deaths in children under five years of age, 2006–2011



Source: Heath Management and Information System – MOH

Figure 41 shows the case fatality rate for malaria in children under five years of age between 2008 and 2011. Data were not available prior to 2008. There was an overall decline in the case fatality rate in the specified time period. A similar trend was seen in persons over five years of age (see Annex A.3.4).

Figure 41: Case fatality rate for malaria, children less than five years of age, 2008–2011



Note: The case fatality rate is calculated as the number of malaria deaths divided by the number of severe (hospitalized) malaria cases.
Source: Heath Management and Information System – MOH

Summary of Mortality

Overall, there was a significant decline in ACCM between 2003–2005 and 2009–2011, representing a relative reduction of 21%. There was a greater decline in ACCM in the years preceding 2006, but limited decline between 2006 and 2011. Similar national trends were also found for age-specific childhood mortality and

no distinguishing differences in the trends by different age categories were found.

ACCM in rural areas declined significantly from 2003–2005 to 2006–2008; representing a relative decline of 25%, but remained unchanged from 2006–2008 to 2009–2011. Though ACCM was lower in urban areas compared to rural areas across the three-year periods, the decline in mortality over time was not significant.

ACCM and mortality among 6–23 month olds declined significantly in the hyperendemic zone but not in any of the other malaria epidemiologic zones in Angola. Between 2003–2005 and 2009–2011, ACCM had a relative reduction of 45% in the hyperendemic zone and among 6–23 month olds, the decline was 55%. For the 24–59 month olds, however, mortality over the three-year periods barely changed.

Data from the HMIS showed that the number of reported malaria deaths for all age groups, as well as children under five years of age, had an overall decline between 2006–2011, in particular from 2009 onwards. The case fatality rate for malaria in children under five years of age between 2008 and 2011 also showed an overall decline.

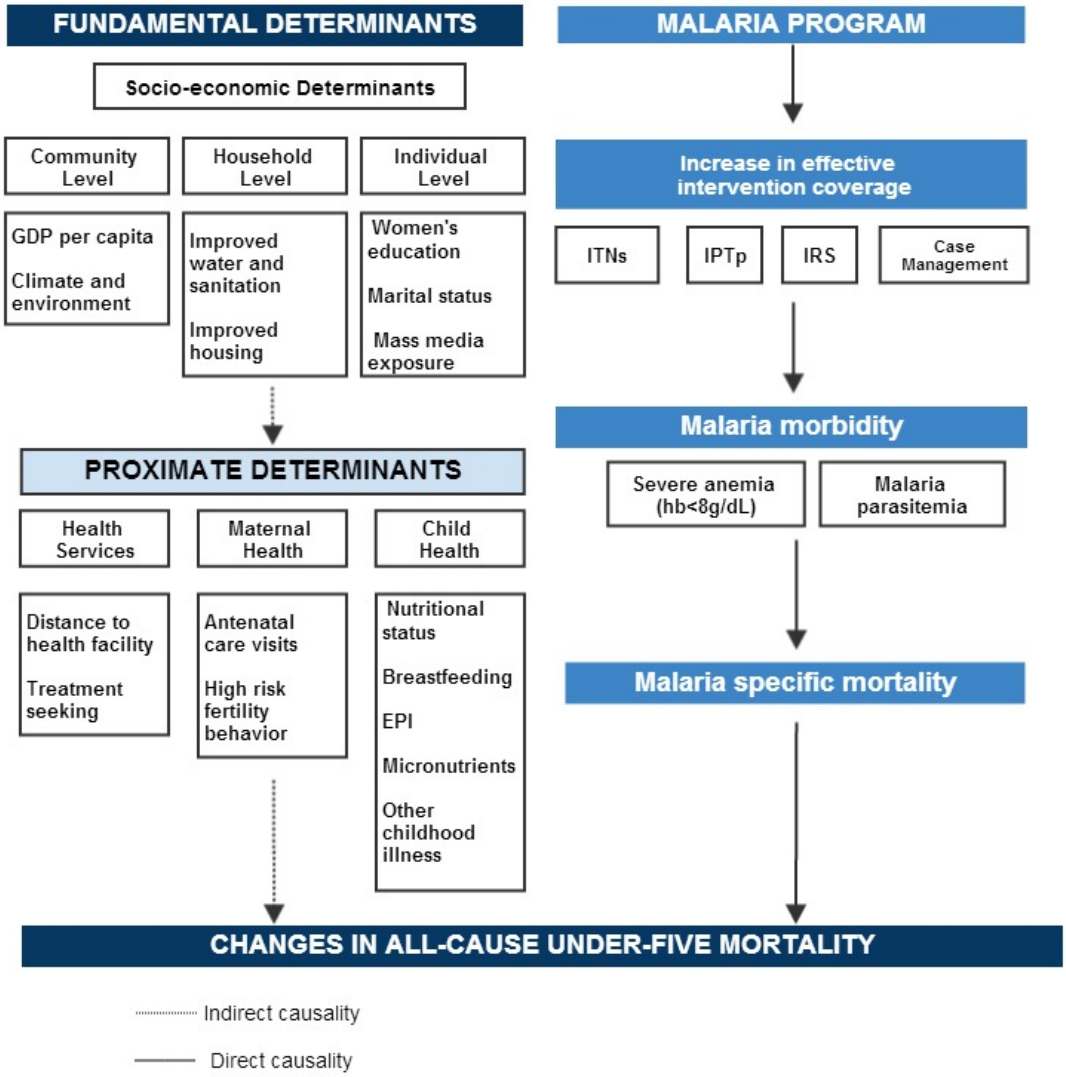
CONTEXTUAL FACTORS

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 [70], particularly for evaluations that are conducted when rapid changes are under way in many other aspects of health services [71].

Contextual factors associated with childhood mortality and illness, including malaria, can be broadly categorized into the fundamental and proximate determinants of disease [72-79]. Fundamental determinants are the social and economic conditions under which people live, while proximate determinants are biological risks. The conceptual framework [9,71,80,81] for the evaluation design in Angola, Figure 42, 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 of various contextual determinants – fundamental and proximate – of childhood mortality and illness are reviewed. Data on contextual factors were obtained from the large population-based household surveys (the 2006/7 and 2011 MIS), as well as other sources such as WHO, UNICEF, and World Bank.

Figure 42: Conceptual framework for the evaluation of the Angola malaria control program, 2000–2011.



Fundamental Determinants

Civil War

In 2002, Angola emerged from over thirty years of civil war, in which an estimated 1.5 million people died and left over four million people displaced [82]. Agadjanian and Prata [83] have analyzed the extent and locations of the Angolan war, and developed a map which showed that the country could be divided into two parts: one with a more direct and heavy impact of war, and the other with a more indirect and relatively mild impact (Figure 43). The part with a heavier war impact, (the provinces of Uíge, Zaire, Malanje, Lunda Norte, Lunda Sul, Moxico, Huambo, Bie, and Kuando-Kubango) was characterized by fierce fighting and bombardments, extensive destruction of the existing infrastructure, a paralysis of the economy and basic services (electricity, running water, and sewer), and a near complete collapse of the health and educational systems. The

part of the country with the lighter impact of war (the provinces of Luanda, Bengo, Cabinda, Kwanza Norte, Kwanza Sul, Benguela, Huila, Namibe, and Cunene) were largely controlled by government forces and saw only sporadic and isolated clashes. The effect of war there was largely indirect, manifested in economic stagnation and frequent and prolonged interruptions of basic services.

In relation to the four malaria epidemiologic zones, Figure 45 shows that the most affected zone was the hyperendemic zone, since almost the entire area (except for Kwanza Norte province) experienced heavier war impact. About half of the mesoendemic stable and mesoendemic unstable zones experienced heavier war impact, while Luanda province only experienced lighter war impact.

Figure 43: Map of Angola and the Regions of War Impact, by Malaria Epidemiologic Zones

Source: ICF International; map was adapted from Agadjanian and Prata [83]

The war is likely to have affected child mortality in several ways. It destroyed infrastructure and severely limited access to the most basic services, such as immunization programs. Through the devastation of roads and transport systems, there was less access to medicines, health facilities (which were themselves destroyed), food, schools, and other vital resources. There was also high prevalence of disease, use of contaminated water (due to poor sanitation), and high malnutrition. Agadjanian and Prata [83] found that children who resided in parts of the country that had experienced heavier war impact exhibited significantly lower levels of age-adequate immunization (complete vaccination for age) and higher levels of malnutrition, especially stunting, compared to children who lived in parts of the country which were less impacted by the war. The war in Angola also caused the forced migration of millions of people which directly affected child mortality through malnourishment and physical injuries, as well as indirectly, through psychological distress [84]. Forced migration has been shown, in other countries, to affect child health

outcomes [85]. In Angola specifically, war immigrants were found to have poorer child survival outcomes (age-adequate immunization in particular) relative to non-war migrants and those not migrating [84]. Lastly, the war contributed to the widespread poverty in Angola, which compounds child malnutrition and health problems.

Since the end of the war, the government has focused on rebuilding the country's infrastructure. Although the total number of health facilities in the country almost tripled between 2003 and 2009, most of these facilities are present in urban areas and only about 30% of rural areas most affected by the war are covered by health services. Transport systems, schools, and sanitation in rural areas are still undeveloped as a result of the war.

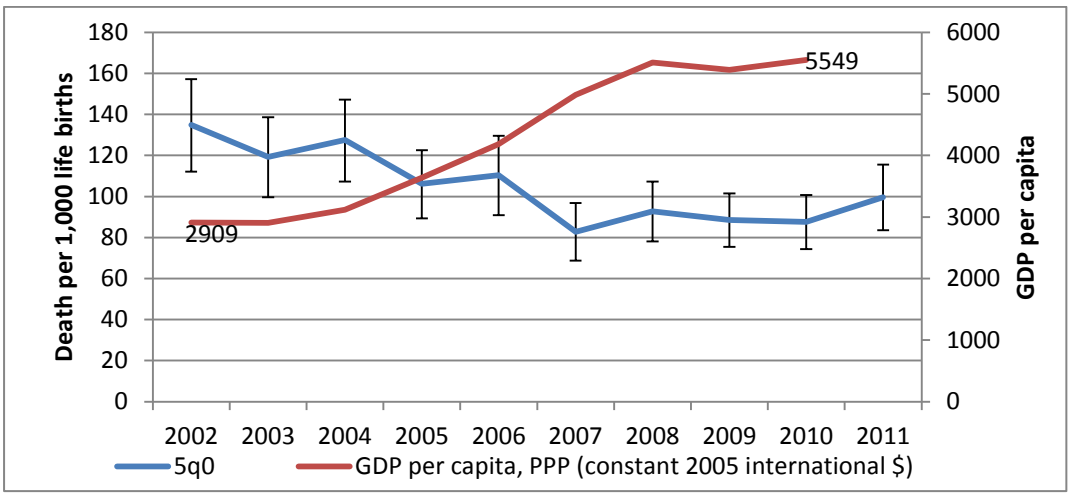
Socioeconomic factors

A range of socioeconomic determinants at the community, household, and individual level are associated with child survival [75,86,87], as shown in the conceptual framework in Figure 42.

Economic poverty, either at the country or individual level, strongly correlates with poorer health outcomes [88]. Gross Domestic Product (GDP) per capita, a measure of population wealth in a country, is considered to be a typical macroeconomic determinant of health [87]. Relationship between GDP per capita and ACCM indicate that a 1% annual increase in GDP per capita is associated with a 0.4-0.6% reduction in ACCM [89].

In Angola, the GDP per capita Purchasing Power Parity -PPP (in constant 2005 international $) was $2,909 in 2002, as compared to $5,549 in 2010 [23]. The economy of Angola is one of the fastest growing economies in the world, with 11% annual average GDP growth rate from 2001 to 2010 [25]. Trends in GDP per capita PPP and growth in Angola are shown in Figure 44, in addition to annual estimates of ACCM.

Figure 44: Trends in GDP per capita and annual estimates of ACCM, Angola, 2002 – 2011*



Source: *Mortality estimates presented in this figure are annual estimates derived from the 2011 MIS; GDP per capita estimates are World Bank data [23].

Household and microeconomic factors are important determinants of child health and malaria risk [86,90]. Socio-economic differentials at the household level are associated with access to malaria interventions [91-93], thereby increasing the vulnerability of the poorest to malaria [94]. Levels and trends in household attributes and other proxies of socio-economic status are summarized in Table 21.

Table 21: Household attributes and asset ownership, 2006/7–2011

	2006/7 MIS		2011 MIS		Relative change	
Indicator	**% (95% CI)**	**WN**	**% (95% CI)**	**WN**	**(%)**	**Sig.**
Improved water source* (% households)	46.4 (38.2-54.9)	2,599	48.5 (42.9-54.0)	8,030	4.3	NS
Improved toilet facilities** (% households)	47.8 (40.9-54.8)	2,599	44.1 (39.6-48.7)	8,030	-7.7	NS
Modern floor material (not earth/sand/dung) (% households)	48.2 (40.5-56.0)	2,599	40.5 (36.3-44.9)	8,030	-15.8	NS
Electricity, (% households)	37.5 (30.2-45.4)	2,599	34.6 (30.3-39.2)	8,030	-7.6	NS
Mobile Telephone*** (% households)	26.0 (19.0-34.3)	2,599	51.7 (47.3-56.0)	8,030	99.0	S

*Improved 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; ***This does not include households that have a landline, because in 2011 we only have data on mobile phone ownership; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval; Sig.= Statistical significance. Statistics with non-overlapping 95% CIs are considered significantly different; NS denotes not statistically significant and S denotes statistically significant.

Source: MIS 2006/7, MIS 2011

Safe water and sanitary facilities contribute to improved child health and survival [91]. Between 2006/07 and 2011, there was no change in household access to an improved water source (i.e., protected, borehole, piped); from 46% in 2006/7 to 49% in 2011. Improved toilet facilities (i.e., flushed-to-piped sewer system, ventilated improved pit (VIP) latrine) also did not change much; from 48% in 2006/7 to 44% in 2011.

Housing construction also can directly affect malaria risk [92,93]. Between 2006/7 and 2011, there was a decline (though not significant) in the proportion of households with modern floor material (i.e., not earth/sand or dung) from 48% in 2006/7 to 41% in 2011. 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 [95-98].

The proportion of households with electricity also remained virtually unchanged, from 38% in 2006/7 to 35% in 2011. The only significant improvement evident during this period was in mobile telephone ownership, which increased from 26% in 2006/07 to 52% in 2011.

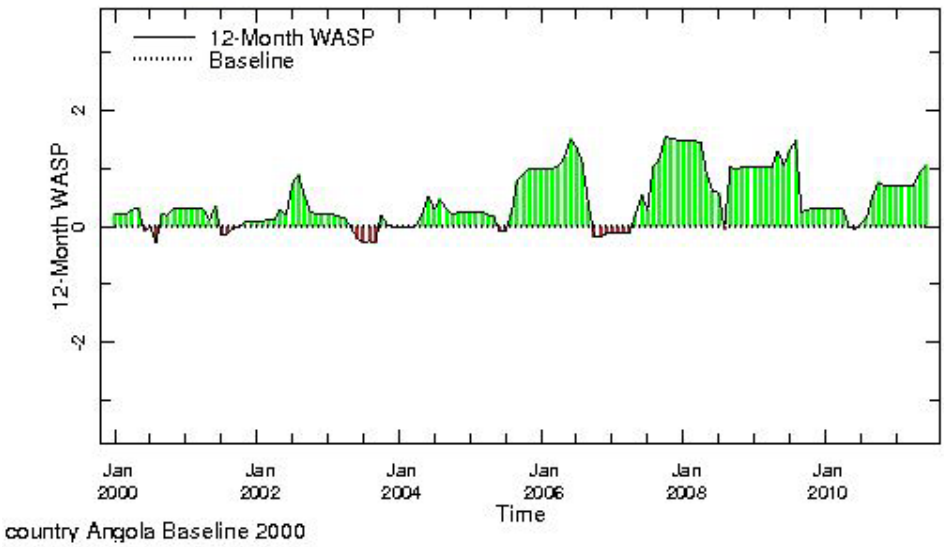
Climatic Variability

Malaria transmission in Angola, as in much of sub-Saharan Africa, is characterized by distinct seasonal trends. Although Angola has a tropical climate, temperatures remain relatively cool throughout the year, ranging between 20–25°C [99]. The southern part of the country is bordered by the Kalahari Desert which also influences temperatures and rainfall patterns [100]. Mean annual temperature has increased by 1.5°C between 1960 and 2006, an average rate of 0.33°C per decade. Daily temperature observations show significantly increasing trends in the frequency of hot days in all seasons, and hot nights in all seasons except winter [99].

The rainy season typically begins in October and continues through April, bringing in around 100–250mm of rain per month [99]. The months of June through August are very dry, receiving little to no rainfall. The north-east region receives the most precipitation, and the level of precipitation decreases moving southwards and towards the coast [100]. Mean annual rainfall over Angola has decreased at an average rate of around 2mm per month (2.4%) per decade between 1960 and 2006 (no data was available beyond 2006); no significant trends were found for available five-day maximum rainfall data [99]. 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 [101] 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 or longer term climate trends when evaluating trends in malaria morbidity and mortality.

Figure 45 displays a time series plot of standardized precipitation anomalies between 2000 and 2010, using the baseline year of 2000. Average annual rainfall was higher in 2006–2010 compared to 2000–2005.

Figure 45: Weighted Anomaly Standardized Precipitation, Angola 2000–2010



Source: The International Research Institute for Climate and Society [102]

In summary, both annual and daily temperature has increased in Angola between 1960 and 2006. In terms of rainfall, mean annual rainfall decreased between 1960 and 2006, though based on Figure 45, rainfall was higher between 2006 and 2010 than between 2000 and 2005, indicating conditions may have been more favorable for malaria in the later part of the evaluation period.

Mother's Education and Marital Status

At an individual level, maternal education is an important determinant of maternal and child health [87,103-108]. In Angola, the mean years of education for women was five for both 2006/7 and 2011 (Table 22). The percentage of women who completed primary education declined from 28% in 2006/7 to 22% in 2011. Similarly, women's literacy declined from 62% in 2006/7 to 60% in 2011. The decline in these two indicators, however, was not statistically significant.

Table 22: Women's* Education in Angola, 2006/07–2011

	2006/7 MIS		2011 MIS		Relative change	
Indicator	% (95% CI)	WN	% (95% CI)	WN	(%)	Sig.
Mean years of education(n)	4.9 (4.3-5.5)	2,946	5.2 (4.8-5.6)	8,589	6.1	NS
Completed primary education (%)	27.6 (22.1-33.9)	2,972	21.5 (18.2-25.3)	8,589	-22.1	NS
Literacy (%)	61.9 (55.6-67.9)	2,972	59.9 (56.4-63.2)	8,589	-3.2	NS

*Woman age 15–49 years; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval; Sig.= Statistical significance. Statistics with non-overlapping 95% CIs are considered significantly different; NS denotes not statistically significant and S denotes statistically significant.

Source: MIS 2006/7, MIS 2011

Proximate Determinants

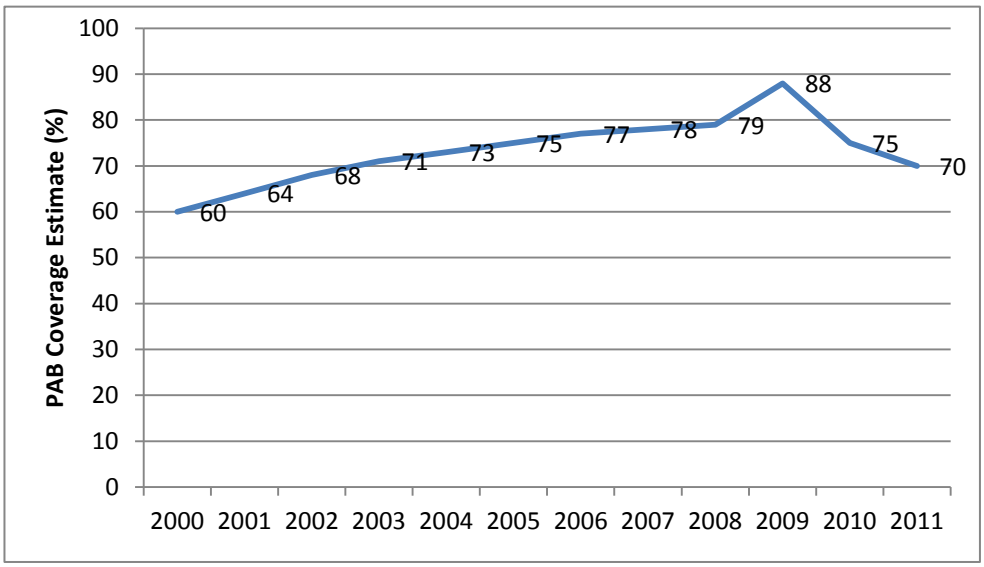
Maternal and Newborn Health

Ante and post-natal care visits are considered a key entry point for 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 [110]. 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. For Angola unfortunately, nationally representative data is not available on the number of ANC visits women attended between 2000 and 2011. According to the

UNICEF 2007/8 Nutrition Survey, 83% of pregnant women received iron supplementation, though there are no additional data points for this indicator.

Neonatal tetanus is often the result of infection from unhygienic cutting/cleaning of the umbilical cord at the time of delivery. To help prevent infection it is recommended for women who have never received the tetanus toxoid vaccine to receive a total of five doses: two doses given one month apart in the first pregnancy, then one dose in each subsequent pregnancy (or intervals of at least one year), to a total of five doses [111]. Maternal vaccination against tetanus creates antibodies that are passed to the child *in utero* thus providing protection in the first weeks of life [112]. A conclusive reduction in neonatal tetanus mortality has been demonstrated through the scale-up in tetanus vaccination of women of childbearing age [113]. WHO and UNICEF have developed a model that calculates the proportion of births in a given year that can be considered as having been protected against tetanus, called "Protection at Birth" (PAB). Figure 46 shows the protection at birth coverage estimates for Angola, between 2000 and 2011 [18]. There was a 10 percentage increase in PAB between 2000 and 2011; from 60% in 2000 to 70% in 2011. From 2006 to 2011 specifically, PAB increased from 77% in 2006 to 88% in 2009 and decreased to 70%.

Figure 46: Proportion of newborns with "Protection at Birth" against tetanus, 2000–2011



Source: WHO and UNICEF estimates of immunization coverage: 2012 revision [18]

Child birth at health facilities, usually attended by skilled attendants, can reduce the chances of maternal and newborn complications. The proportion of women who received any ANC from a skilled provider for their most recent live birth fell from 84% in 2006/7 to 76% in 2011; though the decline was not statistically significant (Table 23). About 49% of women with recent births in 2006/7 reported having a skilled attendant at birth; no estimate for this indicator was available from the 2011 MIS. However, the State of the World's Mothers report of 2012 [114], estimated the percentage of births attended by skilled health

personnel to be 47% (similar to the 2006/7 MIS estimate). There was no information on the proportion of births that took place in health facilities. Births in any high-risk fertility category remained roughly the same (43% in 2006/7, and 44% in 2011), as did births with avoidable fertility risk (41% in 2006/7 and 42% in 2011).

Table 23: Summary of key maternal health indicators in Angola, 2006/07–2011

	2006/7 MIS		2011 MIS		Relative change	
Indicator	% (95% CI)	WN	% (95% CI)	WN	(%)	Sig.
Antenatal care from a skilled provider (women, most recent live birth, 0–2 yrs)	83.6 (79.0-87.3)	1,622	75.6 (71.5-79.3)	5361	-9.6	NS
Skilled attendant at birth	48.5 (42.4-54.7)	1,622	n/a	n/a	n/a	n/a
Births in any high-risk fertility category†	42.9 (39.7-46.0)	2,246	43.7 (42.2-45.2)	8325	1.9	NS
Births with avoidable fertility risk††	41.0 (38.1-43.9)	2,246	41.8 (40.2-43.3)	8325	2.0	NS

†High-risk fertility categories include giving birth at a young or old age (<18 or >34), having a multiple birth, and/or having a short birth interval (<24 months). Birth order data is not available for 2006/7, so that factor is not included; ††Avoidable fertility risks include giving birth at a young or old age (<18 or >34) or having a short birth interval (<24 months). Birth order data is not available for 2006/7, so that factor is not included; MIS = Malaria Indicator Survey; WN = Weighted Sample Size; 95% CI = 95% Confidence Interval, Sig.= Statistical significance. Statistics with non-overlapping 95% CIs are considered significantly different. NS denotes not statistically significant and S denotes statistically significant

Source: MIS 2006/7, MIS 2011

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 [115,116]. Effective coverage of these vaccinations contributes substantially to reductions in ACCM. Angola's recommended EPI schedule for children includes immunization for Bacille Calmette–Guéri (BCG) and the first dose of polio within 14 days after birth; diphtheria, tetanus, pertussis (DTP), Hepatitis B (HBV), *Haemophilus influenzae* type B (Hib) and polio at 6, 10 and 14 weeks after birth, and measles at or soon after 9 months of age. Immunizations should be complete before one year of age and should be recorded on an immunization card [117].

Between 2002 and 2011, there has been improvement in child vaccination coverage in Angola (Table 24) [18]. BCG coverage in children aged 12–23 months increased from 82% in 2002 to 88% in 2011, a relative change of 7%. The coverage with three doses of DTP increased 83% from 47% (2002) to 86% (2011). Coverage with three doses of the polio vaccine increased 102% from 42% in 2002 to 85% in 2011. The measles vaccine increased from 74% in 2002 to 86% in 2011. Both HBV and Hib3 were introduced in 2007 into the DTP3 vaccine, and the average coverage between 2007 and 2011 was 84%. Table 27 also shows the relative changes in coverage between 2006 and 2011 (the same period in which the implementation of malaria interventions increased in Angola).

Table 24: Vaccination coverage in children aged 12-23 months in Angola, 2002–2011

EPI Coverage (%)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	A (%)	B (%)
BCG	82	62	72	61	65	88	87	83	93	88	7.3	35.4
DTP3	47	46	47	47	44	83	81	73	91	86	83.0	95.5
Polio3	42	45	46	46	44	83	75	73	92	85	102.4	93.2
Measles	74	62	64	45	48	88	79	77	93	88	18.9	83.3
HBV	n/a	n/a	n/a	n/a	n/a	83	81	73	91	86	n/a	n/a
Hib3	n/a	n/a	n/a	n/a	n/a	83	81	73	91	86	n/a	n/a

A: **Relative Change 2001-2011; B= Relative Change 2006-2011**
Source: WHO and UNICEF estimates of immunization coverage: 2011 revision [18]

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 globally. Interventions to control these two diseases mainly include immunizations against specific pathogens, early diagnosis and treatment, improvements in nutrition and feeding practices, and safer environments. Unfortunately, there is limited data from Angola regarding both ARI and diarrheal diseases. The UNICEF 2007/8 Nutrition survey found that 7% of children under five years of age showed symptoms of ARI (cough, and rapid breathing) while 26% had diarrhea during the previous two weeks. No other data points were available for these indicators, nor for treatment seeking for either illness.

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, both of which are leading causes of ACCM [79,118]. Early and exclusive breastfeeding is an important child survival intervention which reduces neonatal, infant, and child mortality [119]. Currently the WHO recommends early and exclusive breastfeeding for the first six months following birth [120]. In Angola, according to the UNICEF 2007/08 Nutrition Survey, 32% of children under six months of age were exclusively breastfed (Table 24). No additional data on exclusive breastfeeding was found.

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 [121]. The continuum of maternal, fetal, and child undernutrition has been estimated to result in 3.5 million preventable child and maternal deaths globally, per year [122].

In children under five years of age, the standardized anthropometric measures of undernutrition [123] are a) low birthweight resulting due to intrauterine growth restriction (IUGR); b) underweight, a reflection of low weight-for-age; c) stunting, a chronic restriction of growth in height indicated by a low height-for-age; and d) wasting, an acute weight loss indicated by a low weight-for-height. In Angola, there are few data sources for undernutrition prevalence in children

under five years of age. No data is available on low birth weight (less than 2500 grams). Table 25, presenting only one data point, shows that 29% of children under five years of age were stunted, 15% were underweight, and 8% suffered from wasting during 2007/8.

Table 25: Breastfeeding and under nutrition in children in Angola , 2007/8

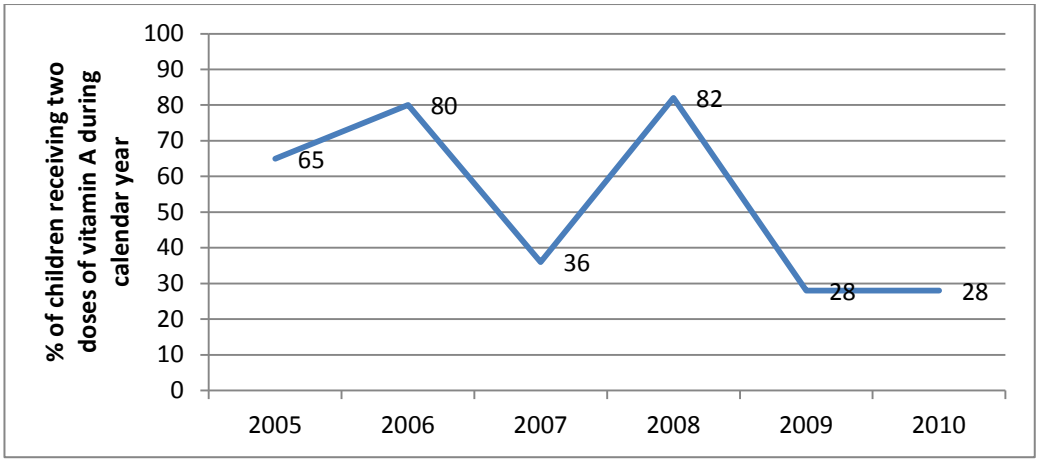
Indicators	%	N
Exclusive breastfeeding in children <6 months of age	31.5	7,099
Children under five years of age stunted*	29.2	10,055
Children under five years of age underweight*	14.8	10,225
Children under five years of age wasted*	8.2	10,040

* Definitions and methods per WHO reference population. Prevalence refers to moderate or severe cases.

Source: UNICEF Nutrition Survey 2007/8

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 [122]. 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% [124,125]. In Angola, vitamin A is commonly distributed with routine services and integrated with other vaccination/health campaigns. However the implementation of vitamin A has not been consistent between 2005 and 2010 as depicted in Figure 47. Indeed the percentage of children between 6–59 months receiving two doses of vitamin A fell from 65% in 2005 to 28% in 2010; though it was as high as 80% in 2006 and 82% in 2008 [24].

Figure 47: Vitamin A supplementation among children aged 6–59 months, 2005–2010



Source: UNICEF [24]

Summary of Contextual Factors

Angola experienced some positive developments during the evaluation period that would be expected to lead to improved child survival. A summary of these changes and the expected relationship with ACCM in Angola is presented in Table 26. It should be noted that changes in contextual factors are only being examined over a five-year period, and improvements may not have had time to fully impact ACCM. Only factors for which trend data was available are included in the table; other important factors related to child survival have not been incorporated, including: ARI and diarrheal diseases, number of ANC visits, presence of skilled attendant at birth, exclusive breastfeeding or early initiation of breastfeeding, nutritional status, and birth weight.

Table 26: Summary of changes in factors that could be associated with changes in ACCM in Angola, 2006–2011

	Trends Supporting Lower Mortality	Trends Suggesting No Change in Mortality	Trends Supporting Higher Mortality
Malaria Control Interventions	• Household ownership of ITNs increased • ITN use by children under five years of age increased • IPTp increased • Use of ACTs increased	• ITN use by pregnant women unchanged • IRS (in selected municipalities only) • Care seeking for fever unchanged • Proportion of children with fever who receive any antimalarial unchanged	
Other Contextual Determinants	Fundamental determinants • Civil war ended in 2002 • GDP per capita increased • Mobile telephone ownership increased Proximate determinants • BCG, DTP3, Polio3 and Measles vaccinations increased	Fundamental determinants • Housing conditions unchanged: safe water and sanitary facilities, flooring material and electricity • Maternal education unchanged Proximate determinants • Neonates protected from Tetanus unchanged (2006–2011) • Proportion of births that are high risk unchanged • Any Antenatal Care from a skilled provider unchanged • Vitamin A inconsistent	

In addition to the relative increases in some of the malaria control interventions, other favorable changes occurred in the fundamental and proximal determinants during the evaluation time period: the civil war ended in 2002, GDP and the use of mobile telephone ownership increased (an indication of increased wealth), and there were improvements in immunization coverage. All of these improvements are likely to positively influence child survival, although the relative importance of each factor is difficult to predict.

FURTHER ANALYSES

Multiple Logistic Regression Analysis

Background

The purpose of the multiple logistic regression analysis was to examine the relationship between household ITN ownership and malaria parasitemia (*Plasmodium falciparum*), adjusting for potential confounders. The question to be answered was: Is household ITN ownership protective again malaria parasite infection under programmatic conditions in Angola after controlling for potential confounders?

Household ITN ownership was chosen instead of ITN use the night before the survey because it covers a longer period of time and is therefore more likely to intersect with the timing of malaria parasite infection. Furthermore, household ITN ownership by age of net in particular was chosen as a predictor, instead of whether a household owned an ITN or not to take into consideration the age and the timing of when a net was obtained. ITNs that were only recently obtained may have not been in use when a child first got malaria, since the incubation period of the disease may take a few weeks to show a positive test result. Conversely, ITNs that had been owned for a longer period of time could be less protective due to wear and tear of the net, or a reduction in efficacy of the insecticide.

Model-building Process

The Angola MIS 2011 data was carefully examined to choose all independent variables that could be associated with malaria parasitemia, and that therefore needed to be adjusted for in the multiple logistic regression model. In addition to household ITN ownership by age of net, the predictor of the model, eight covariates were also included in the model-building process, irrespective of their significance levels: sex of child, age of child, mother's highest level of education, whether the household had been sprayed or not the 12 months before the survey, household size, household wealth quintiles, area of residence and malaria epidemiologic zones in Angola.

Correlations between the selected nine variables (predictor and eight covariates) were checked for collinearity and interaction. All of the nine variables were retained, since none were highly correlated with another (that is, at a level greater than 0.6). One significant interaction was found and included in the final model: between ITN ownership by age of net and malaria epidemiologic zones.

Results

The results of the multiple logistic regression model are presented in Table 27.

Table 27: Multiple Logistic Regression Model: The Effect of ITN Ownership by Age of Net on Malaria Parasitemia, Adjusted for Other Covariates

Independent Variables	N	Odds Ratio	p value
Predictor			
ITN ownership by age of net^			
No ITN	1,482	1.00 (reference)	
ITN owned for 1 month or less	56	0.27 (0.03-2.31)	0.232
ITN owned for 2-6 months*	246	0.28 (0.10-0.84)	0.023
ITN owned for 7-12 months	143	0.44 (0.12-1.60)	0.212
ITN owned for more than 12 months	78	0.29 (0.06-1.40)	0.124
Covariates			
Sex			
Male	975	1.00 (reference)	
Female	1,030	0.95 (0.71-1.28)	0.744
Age of child			
6-23 months	576	1.00 (reference)	
24-59 months	1,429	1.08 (0.96-1.21)	0.207
Mother's Education			
None	685	1.00 (reference)	
Primary	1,098	0.96 (0.71-1.32)	0.822
Secondary and Higher	222	1.3 (0.44-3.85)	0.642
Household sprayed last 12 months			
No	1,965	1.00 (reference)	
Yes	144	0.5 (0.23-1.08)	0.077
Household size			
3 or less members	182	1.00 (reference)	
4-5 members*	702	2.34 (1.25-4.36)	0.008
6-7 members*	631	1.92 (1.01-3.63)	0.044
8 or more members*	490	2.02 (1.04-3.92)	0.038
Wealth quintile			
Lowest	330	1.00 (reference)	
Fourth*	269	1.98 (1.00-3.86)	0.049
Middle*	345	6.87 (3.57-13.20)	<0.001
Second*	590	6.57 (3.37-12.82)	<0.001
Highest*	471	3.82 (1.94-7.55)	<0.001
Residence			
Rural	1280	1.00 (reference)	
Urban*	725	0.11 (0.05-0.24)	<0.001
Malaria Epidemiologic Zones^			
Hyperendemic	495	1.00 (reference)	
Mesoendemic stable*	540	0.47 (0.32-0.68)	<0.001
Mesoendemic unstable*	573	0.24 (0.16-0.37)	<0.001
Luanda	397	0.67 (0.21-2.07)	0.482

N = 1937 (Model restricted to one child under-five years per household to avoid cluster effects) Pseudo R2: 0.1925; *p < 0.05; 95% CI = 95% Confidence Interval; ^An interaction between "ITN ownership by age of net" and "Malaria Epidemiologic Zones" was found and the results presented are those of the interaction included in the model.

The final multiple logistic regression model consisted of nine independent variables: the main predictor studied, household ITN ownership by age of net, and eight covariates. Five variables were found to be significantly related to malaria parasitemia.

Household ITN ownership by age of net was found to be significantly protective, if the ITN had been acquired between 2–6 months before the survey (OR = 0.28 [95% CI: 0.10–0.84]). Specifically, children whose household had owned an ITN between 2–6 months were 72% less likely to have malaria parasitemia, compared to children whose households did not own an ITN. Interestingly, if the ITN had been owned for one month or less, or for more than six months, the protective effect of the ITN was not significant. A possible explanation is that nets that had been owned for a month or less may not have been present when the child first became infected; that is, ownership of the net was too recent and had occurred after the child had become infected. In the case of nets owned for more than six months, the lack of a significant protective effect could be an indication that nets older than six months may not have been in a good condition than nets that had been owned between 2–6 months. Nets may have been used more frequently when they were first acquired but over time were used less due to loss of interest. Lastly, the longer a household has owned an ITN, the more likely there might be errors of recall in relation to the reported age.

Individual level covariates (sex of child and age of child) and mother's education were not significantly related with malaria parasitemia. In terms of the household-level variables, two out of the three covariates were significantly related: household size and wealth. The relationship between malaria parasitemia and household size was not linear, overall, but children whose households had more than three members were more likely to have malaria parasitemia compared to children whose households had either three or less members in total. In terms of wealth, those from poorer quintiles compared to the least poor quintile were significantly more likely to have malaria parasitemia.

Area of residence was also found to be significantly related to malaria parasitemia. Children living in urban areas were less likely to have malaria parasitemia than children living in rural areas (OR = 0.11, 95% CI: 0.05-0.24). If the child lived in either the mesoendemic stable (OR = 0.47, 95% CI: 0.32–0.68) or mesoendemic unstable (OR = 0.24, 95% CI: 0.16–0.37) zones, they were significantly less likely to have malaria parasitemia compared to children living in the hyperendemic zone. The children living in Luanda were less likely to have malaria parasitemia compared to a child living in a hyperendemic zone, however the effect is not statistically significant (OR = 0.67, 95% CI:0.21-2.07).

Summary

Children from households that had owned ITNs for 2-6 months before the survey were significantly less likely to have malaria parasitemia compared to those from households without ITNs (OR = 0.28, 95% CI: 0.10-0.84). ITNs are protective against malaria in Angola for those who have access despite the

overall low coverage, however, when assessing their effects on parasite prevalence the age of the net in the household should be considered.

Case Study: Provincial and sub-provincial analysis of malaria morbidity and mortality and prevention measures – Huambo Province, Angola

Background

Because national surveys in Angola are only powered to provide estimates at the level of epidemiologic zone (Figure 3), they often provide an inadequate representation of the impact of control measures, which are routinely implemented in individual provinces rather than across entire epidemiologic zones. In order to more specifically measure the impact of malaria control programs in Angola, a sub-national analysis of the epidemiology of malaria in Huambo Province was conducted, where scaling up of malaria control programs at the provincial level was a priority during the evaluation period. Note that we included 2012 data even though beyond the evaluation period because in many instances there were just two data points 2011 and 2012.

Huambo Province is situated in the Mesoendemic Stable epidemiologic zone, approximately 450 km south east of the capital Luanda (Figure 48). It is composed of 11 municipalities, of which Huambo Municipality, the location of the provincial capital, Huambo, is the most populous. Huambo city was heavily affected by the civil war, which destroyed a great part of its infrastructure.

Figure 48: Huambo Province, Angola

Source: ICF International

Currently, the majority of externally-funded malaria control activities in Huambo Province occur within Huambo Municipality, including support in the four primary areas of malaria control: IRS, ITN distribution, case management and diagnostic training and supervision, and IPTp. The exceptions to the activities conducted in Huambo Municipality are Government of the Republic of Angola (GRA)-funded larviciding programs, GRA-supported management positions at the district level, and a universal LLIN distribution in Ekunha and Longonjo Municipalities. Malaria control activities occurring in Huambo Province since 2006 are summarized in Table 28.

Table 28: Summary of Malaria Control Interventions Occurring in Huambo Province, by Municipality, since 2006

Municipality	IRS	ITN	Larviciding	Case Management*	IPTp **
Bailundo			Since 2009	Since 2006	Since 2006
Caala			Since 2009	Since 2006	Since 2006
Ekunha		Universal LLIN distribution in April 2011	Since 2009	Since 2006	Since 2006
Huambo	Since 2007	Routine ANC distribution since 2007	Since 2009	Since 2006	Since 2006
Katchiungo			Since 2009	Since 2006	Since 2006
Londuimbali			Since 2009	Since 2006	Since 2006
Longonjo		Universal LLIN distribution in April 2011	Since 2009	Since 2006	Since 2006
Mungo			Since 2009	Since 2006	Since 2006
Tchicala Tcholohanga			Since 2009	Since 2006	Since 2006
Tchinjenje			Since 2009	Since 2006	Since 2006
Ukuma			Since 2009	Since 2006	Since 2006

*Case management implementation focused on training and support supervision but not in the distribution of commodities. Training was also provided for pharmaceutical management.
**IPTp implementation focused on training and support supervision but not in the distribution of commodities

Source: NMCP, PMI

Analysis

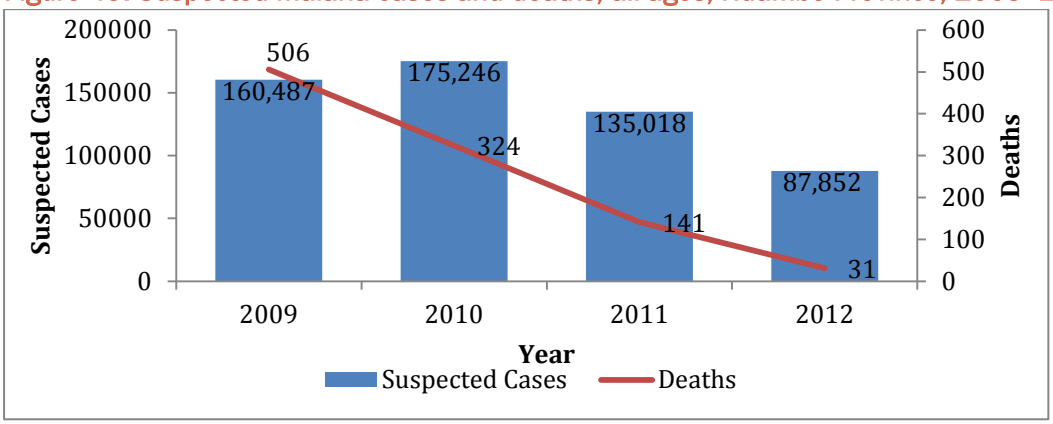
Malaria indicators are reported in Angola through the routine health information system (HMIS). This system was updated with new forms and indicators in 2009, and has been performing strongly in the Huambo Province since 2010. Data on total patients seen, total inpatients, laboratory-confirmed (RDT and microscopy) and suspected malaria cases, total patients admitted for malaria, total deaths due to malaria, by age group (<5, 5–14, 15–49, >49), are reported by each facility on a monthly basis. Facilities also report intervention indicators such as doses of IPTp received by pregnant women attending ANC clinics, total ITNs distributed to pregnant women and children under five years of age, and numbers and types of antimalarials given. Data are compiled by municipality in each province, and then reported to the central level to be compiled by province.

Results

Morbidity & Mortality

Analysis of provincial trends in suspected malaria cases and malaria deaths, for all ages, using HMIS data are shown in Figure 49. This analysis shows a slightly decreasing trend in suspected cases from 2009 through 2012 (45% relative decline), though also shows a significant drop in malaria deaths (94% relative decline) during the same time period: in 2009 there were 506 malaria-associated deaths reported in Huambo Province, compared with only 31 in 2012.

Figure 49: Suspected malaria cases and deaths, all ages, Huambo Province, 2009–2012

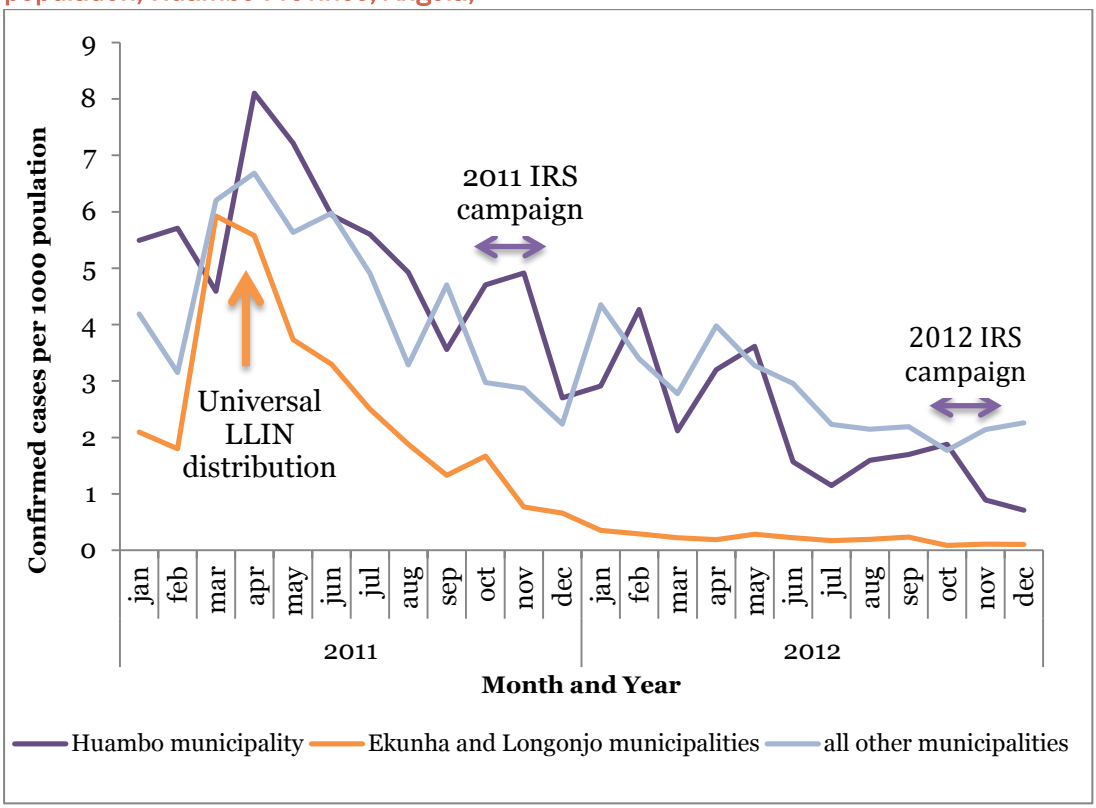


Source: HMIS

To better understand the effects malaria control activities have had on malaria cases in the province, municipalities were separated into three groups: 1) those that had IRS, 2) those that received universal ITN coverage, and 3) those that had neither IRS nor ITNs. The first group consisted only of Huambo Municipality, while the second group consisted of Ekunha and Longonjo Municipalities; all other municipalities were in the third group (see Table 27 for more information). The trends in laboratory-confirmed malaria cases, per 1000 population, from January 2011 through December 2012 were then compared between the three groups, as shown in Figure 50. This analysis shows that while there was a

decreasing trend in confirmed cases for all three groups of municipalities, there were variations in the decline between the municipalities.

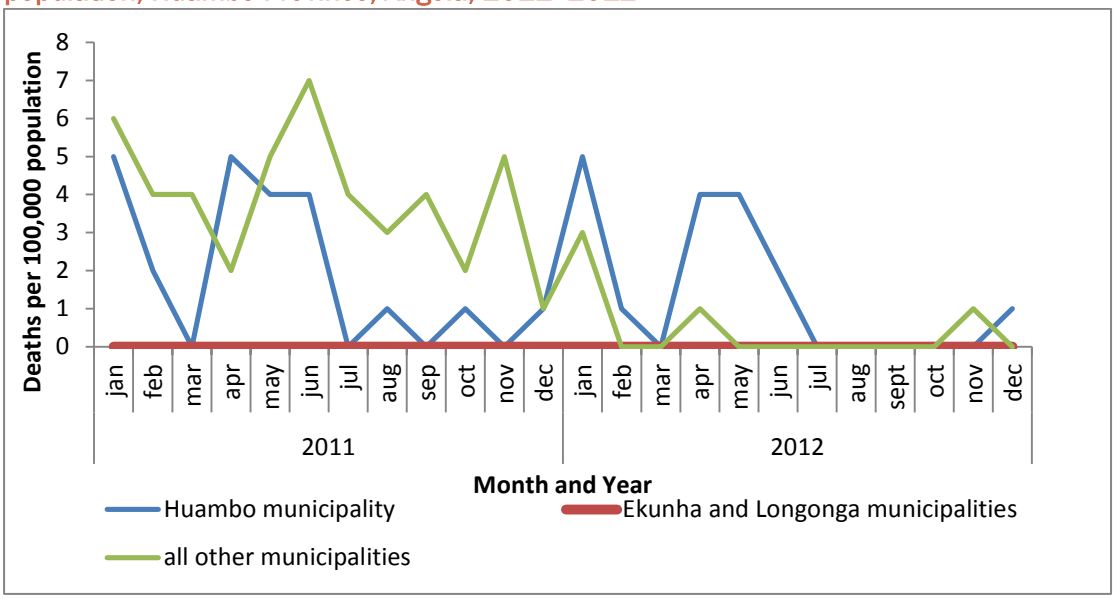
Figure 50: Sub-provincial laboratory-confirmed malaria cases, all ages, per 1000 population, Huambo Province, Angola,



Source: HMIS

Although the numbers of deaths in Huambo Municipality appear to be following seasonal trends (increases during the high transmission season) rather than decreasing like the other municipalities, it is important to remember that hospitals in Huambo Municipality serve as referral hospitals for the entire province, and when a patient dies of malaria it is recorded as a death in the municipality in which they died, rather than the municipality in which they resided. No deaths were seen at all in the universal ITN coverage group (Ekunha and Longonga Municipalities) (Figure 51).

Figure 51: Sub-provincial malaria deaths, children under five years of age, per 100,000 population, Huambo Province, Angola, 2011–2012

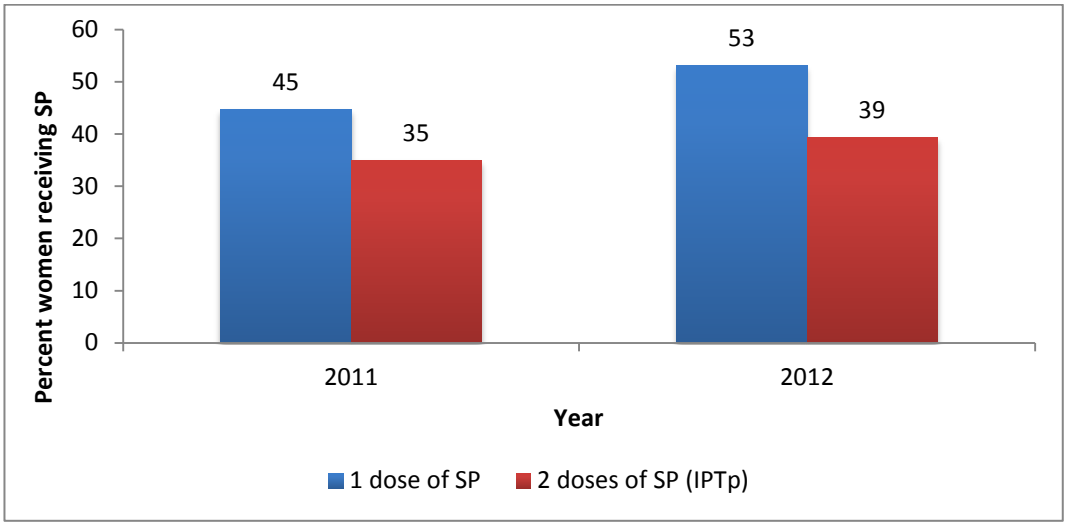


Note: The red line shows that no deaths occurred in Ekunha and Longonga Municipalities
Source: HMIS

Intervention Coverage Based on Routine Data

The percentage of women in Huambo Province attending their first ANC visit who received one and two doses of SP (IPTp) in 2011 and 2012 is shown in Figure 52. For both the first and second dose of SP, percentages increased slightly from 2011 to 2012, from 45% to 53% (one dose of SP) and 35% to 39% (two doses of SP), respectively.

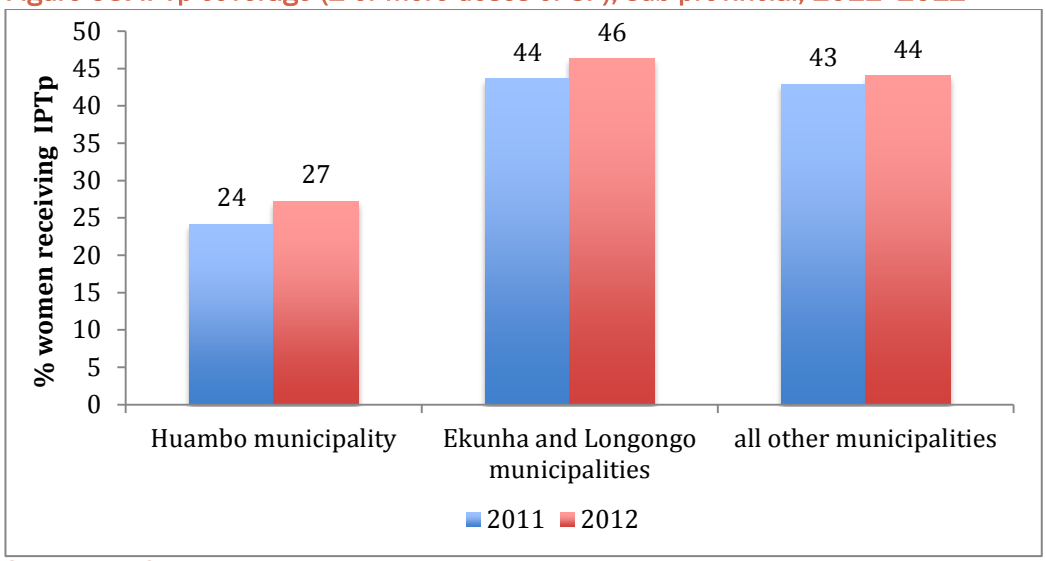
Figure 52: Percent of Women attending their First ANC Visit Who received One and Two Doses of SP, Huambo Province, 2011–2012



Source: HMIS

When IPTp trends are analyzed sub-provincially, the highest percentages of women receiving 2 doses of SP (IPTp) were found in Ekunha and Longonjo Municipalities, while Huambo Municipality had the lowest percentages (Figure 53). Although percentages increased in all groups, these increases were minor.

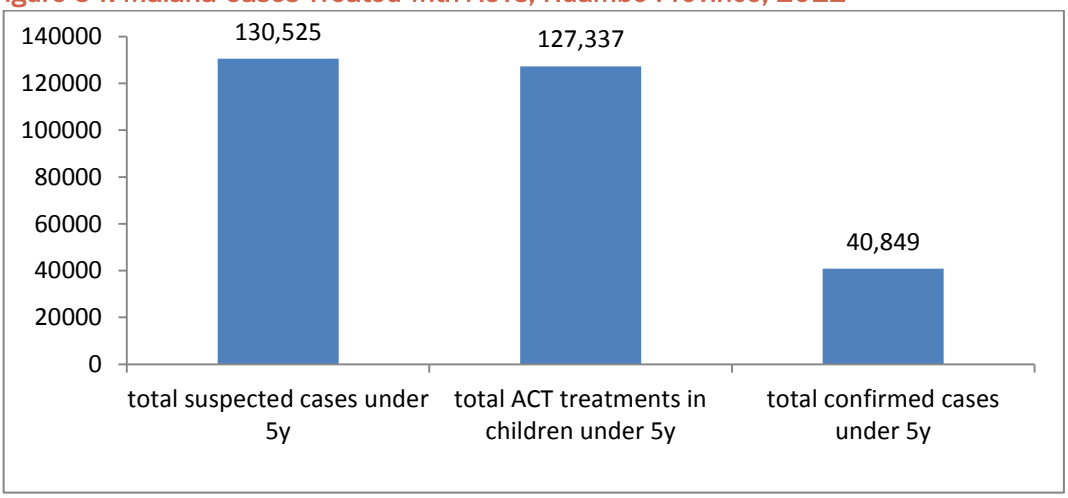
Figure 53: IPTp coverage (2 or more doses of SP), sub-provincial, 2011–2012



Source: HMIS

Data from 2011 show that the number of ACT treatments in children under five years of age was nearly equal to the number of total suspected cases (laboratory-confirmed and clinical cases, Figure 54). Owing to the fact that national guidelines were to treat all suspected cases under five years of age with ACTs, this number was nearly three times that of the total number of laboratory-confirmed cases in children under five years.

Figure 54: Malaria Cases Treated with ACTs, Huambo Province, 2011



Suspected cases include laboratory confirmed and clinical cases of malaria.

Source: HMIS

Summary

Donor-funded malaria control efforts in Huambo Province continue to cover the entire province in at least a limited scope, with the focus remaining on Huambo Municipality. Based on health facility data, malaria cases are decreasing for the entire province, with total confirmed cases and malaria-related deaths decreasing substantially province-wide from 2009 through 2012. At a sub-provincial level variation was seen in malaria cases and deaths between the municipalities in Huambo Province. In summary, high malaria control indicators such as percent of confirmed malaria cases receiving ACT treatment and percent of pregnant women receiving SP in addition to vector control interventions, could have contributed to a decrease in malaria morbidity and mortality in Huambo Province.

PLAUSABILITY ANALYSIS AND CONCLUSION

Plausibility Argument and Conclusion

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

To determine whether the increase in coverage of malaria control interventions could have contributed to the observed 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 25, Figure 44).

Coverage of Malaria Control Interventions

Ownership of ITNs by households increased modestly but significantly from 28% in 2006/7 to 35% in 2011. This increase was greater in the eleven provinces that had not participated in the massive ITN distribution campaign of 2006, implemented a few months before the 2006/7 survey (from 21% to 35%), as well as among households with children under five years of age (from 31% to 41%). Households with at least one ITN and/or IRS in the last 12 months also increased significantly, from 29% to 38%.

ITN use among children under five years of age increased only slightly but significantly from 18% in 2006/7 to 26% in 2011. Similar to the national trends, both ITN ownership and use increased in all malaria epidemiologic zones of Angola between 2006/7 and 2011, except for in the hyperendemic zone where both indicators decreased (likely due to how the implementation of ITN distribution changed between 2006 and 2011; first through the massive 2006 distribution campaign implemented primarily in the hyperendemic zone, then through the routine antenatal and immunization clinics in the provinces that had not been targeted during the campaign, followed by universal coverage which began in 2010, but was limited to only a few municipalities, most outside of the hyperendemic zone). Overall, though the increases observed in ITN ownership and use were statistically significant (at the national level and in two malaria epidemiologic zones specifically, Luanda and the mesoendemic stable zone), the low coverage reached by 2011 (35% nationally) may have only modestly contributed to the slight decline in ACCM at a national level.

IRS implementation was limited to specific municipalities of a few provinces (mainly Huila, Namibe, Cunene, and Huambo Provinces, though not all were targeted every year between 2006 and 2011); every year between 2005 and 2011, IRS implementation covered a population between 500,000 to 800,000. Given that IRS was only implemented in limited areas in Angola (national coverage in 2011 was 7%), it is unlikely that IRS scale-up contributed substantially to the overall national-level declines in mortality.

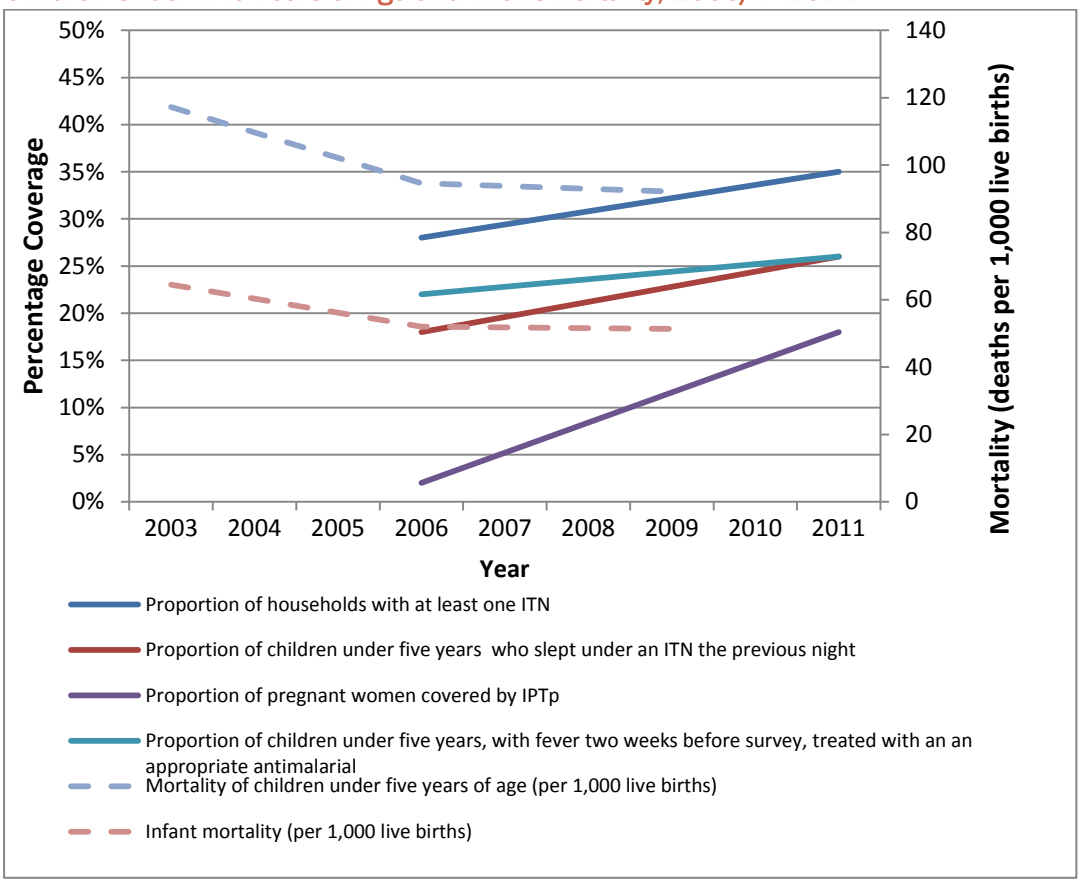
Implementation of IPTp began in Angola in May 2006 and coverage increased significantly from 2% in 2006/7 to 18% in 2011. IPTp coverage also increased

significantly in three out of the four epidemiologic zones. Despite the large increases found in IPTp coverage, the levels were still low in 2011 and therefore may have only modestly contributed to changes in neonatal mortality, birth weight, or ACCM.

Care-seeking for fever from formal health providers in children under five years of age remained unchanged from 2006/7 to 2011 (54% and 57% respectively). Among children under five years of age with fever, treatment with an appropriate antimalarial was also unchanged (26% in 2006/7 and 22% in 2011). Treatment with ACTs increased significantly from 2% in 2006/7 to 22% in 2011; this is as expected since the implementation of ACTs only began in 2006, despite it becoming the first-line treatment in 2004. As with the other malaria interventions summarized above, the relatively low coverage of treatment with an appropriate antimalarial may have contributed to the slight decline of ACCM at a national level. In addition, switching from a failing antimalarial treatment to a highly efficacious antimalarial treatment during the evaluation period may have had an impact on mortality.

A summary of trends of the malaria control interventions, as well as of ACCM and infant mortality, is shown in Figure 55.

Figure 55: Summary of Trends in Malaria Control Interventions and Mortality of Children Under Five Years of Age and Infant Mortality, 2006/7–2011



Source: 2006/7 MIS and 2011 MIS

Malaria-related Morbidity Declined

Malaria parasitemia declined in children aged 6–59 months from 21% in 2006/7 to 14% in 2011, although this decline was not statistically significant. As expected, malaria parasitemia prevalence was lower among children aged 6–23 months in 2006/7 and 2011 (14% and 11% respectively) compared to children aged 24–59 months (25% and 15% respectively). Since the malaria epidemiologic zones of Angola were classified based on malaria transmission, it is to be expected that malaria parasitemia would be highest in the hyperendemic zone in both 2006/7 and 2011, followed by the mesoendemic stable zone, then mesoendemic unstable and lastly, Luanda. All areas experienced a reduction in malaria parasitemia prevalence between 2006/7 and 2011, but were not statistically significant.

Data from the HMIS showed that the number of reported malaria cases for all age groups, as well as children under five years of age, rose between 2006 and 2009. However, starting in 2009, the number of reported malaria cases declined through 2011. This decline occurred despite there being an overall increase in the percentage of health facilities reporting to the HMIS during the same time period. The small increase in the use of RDTs between 2009 and 2011 may not have contributed much to the decline in malaria cases. As a result, the consistent trends observed may be an indication that the number of malaria cases did in fact start to decline in the country from 2009 onwards.

In terms of severe anemia, the prevalence found in both 2006/7 and 2011 was so low that it was difficult to detect any significant changes over time.

Mortality in Children Under Five Years of Age Declined

Mortality in children under five years of age fell significantly by 21% between 2003–2005 and 2009–2011, based on retrospective estimates from the 2011 MIS. There was a greater decline in ACCM between 2003–2005 and 2006–2008 (19% reduction), followed by limited decline between 2006–2008 and 2009–2011 (only a 3% reduction). To further examine the decline, child mortality was stratified by age categories, area of residence and malaria epidemiologic zones. The mortality decline between 2003–2005 and 2009–2011 was similar among children 6–23 months old (22%), who are at higher risk of severe malaria and mortality, to the relative decline in children 24–59 months old (23%). Neonatal mortality declined the most (28%) and post-neonatal mortality the least (13%). These age category trends suggest that the declines observed in child mortality were not a result of malaria control interventions. However, the mortality declines were larger in children residing in rural areas (25%) as compared to children living in urban areas (19%). In addition, ACCM and mortality among children 6–23 months old also declined significantly in the hyperendemic zone but not in any of the other malaria epidemiologic zones. These trends suggest that malaria may have contributed to decline.

It is important to highlight that ACCM declined the most between 2003–2005 and 2006–2008, irrespective of area of residence, age, and malaria epidemiologic

zones. Moderate coverage gains of malaria intervention started in 2006. Indeed, coverage of ITNs in 2006/2007 was already was 28% at the national level and 21% in the provinces targeted by the 2006 campaign. Therefore, ITNs may have contributed to the initial decline in ACCM, despite the overall low coverage level. Other contextual factors are likely to have played a larger role in this initial decline: the end of the war in 2002, increases in the number of health facilities, and increases in GDP and vaccination coverage.

ACCM decreased significantly only in the hyperendemic zone between 2003–2005 and 2009–2011 and the initial decline in mortality between 2003–2005 and 2006–2008 was followed by a continued decline in that zone until 2009–2011, as opposed to the general stabilization that was seen in other epidemiologic zones as well as nationally (Figure 36). It is possible that the massive ITN distribution campaign of 2006 which focused primarily in the hyperendemic zone influenced this continued decrease – the coverage levels of ITNs in this zone in 2006/7 was 51%, almost double that of the national level of 28%. However, because mortality continued to decline between 2006–2008 and 2009–2011 when ITN coverage actually decreased in this zone (from 51% in 2006/7 to 30% in 2011), it suggests that other factors may have contributed to the continued reduction in mortality.

Consistent with the national declining trends in ACCM, data from the HMIS showed that the number of reported malaria deaths for all age groups, as well as children under five years of age, also declined between 2006–2011. The steady decrease since 2009 in particular, occurred despite there being an overall increase in the percentage of health facilities reporting to the HMIS between 2009 and 2011.

Contextual Factors and the Plausibility Argument

To examine whether the reduction in ACCM could be attributed to the increase in coverage of the malaria control interventions, we reviewed other determinants of child survival that could offer alternate explanations for the observed changes in mortality between 2003–2005 and 2009–2011 (summarized in Table 25).

In terms of the fundamental determinants, the end of the civil war in Angola in 2002 is likely to have impacted ACCM because important infrastructure that was destroyed during the war, such as health services, roads, and transport systems, were rebuilt over the last decade. Access to immunization programs and food were also affected by the war [83]. Among the social and economic determinants of child survival, increases were seen in GDP per-capita as well as mobile telephone ownership. However, the dynamics of socio-economic determinants on population health are often complex [126,127] and these determinants, arguably [128], must operate through the proximate determinants to affect child survival [75].

Due to the high degree of temporal and spatial heterogeneity in meteorological variables, vector abundance, malaria intervention coverage, and health seeking behavior, the association between climate variability and malaria is also often

complex. Mean annual rainfall decreased between 1960 and 2006 in Angola, though it seems to have been higher between 2006 and 2010 compared to between 2000 and 2005. However, potential effects of climate on ACCM are difficult to quantify, although climatic conditions may have been more favorable for malaria transmission between 2006 and 2011 than between 2000 and 2005.

Due to a lack of data, the only proximate determinate favoring lower child mortality that is known to have changed, was the increase in immunization coverage (specifically BCG, DTP3, polio3 and measles vaccinations). The improvements in immunization coverage after the war ended are likely to have contributed to the reductions in ACCM.

Several trends in both fundamental and proximate determinants are unlikely to have affected ACCM, since they were unchanged during the evaluation period, including: housing conditions, maternal education, the proportion of neonates protected from tetanus, births that were high risk, or women who received ANC from a skilled provider. In addition, Vitamin A supplementation coverage was inconsistent throughout the evaluation period.

Multiple Logistic Regression Analysis

The multiple logistic regression analysis examining the relationship between ITN ownership and malaria parasitemia among children under five years of age only speaks indirectly to the overall question of whether malaria control interventions in Angola impacted ACCM – unfortunately, due to data unavailability, it was not possible to analyze the association between malaria control interventions and ACCM specifically. The results of the multiple logistic regression analysis however, showed that despite the overall low coverage of ITNs in Angola in 2011, ITN ownership by age of net, in particular if the ITN had been owned between 2–6 months before the survey, was protective of children under five years of age becoming infected with malaria, even when other important confounding variables were controlled for. Since malaria parasitemia lies on the causal pathway between malaria control and ACCM, it is likely that ITN ownership would have also been associated with ACCM, especially if the national coverage had been higher. In any case, despite the overall low coverage of ITNs in Angola in 2011, the multiple logistic regression analysis makes a case for increasing the coverage of ITNs in the country, since they were found to be protective against malaria parasitemia among children with access to them and are therefore likely to have led to a reduction in ACCM as well.

Case Study from Huambo Province

The case study from Huambo Province, where scaling up of malaria control interventions has been a priority and where HMIS data has been performing strongly since 2010, showed that both malaria cases and deaths decreased in the province between 2009 and 2011. It was also found that high levels of confirmed

malaria cases receiving ACT treatment and pregnant women receiving one or two doses of SP in addition to vector control interventions, could have contributed to declines in malaria morbidity and mortality in Huambo Province. The province as a whole has made significant progress in controlling malaria between 2009 and 2011.

Conclusion

Despite major infrastructure and societal disruptions caused by the civil war that ended in Angola in 2002, progress was made in rolling out some of the malaria control interventions, evidenced by the modest but significant increases in ITN ownership and use, and IPTp in particular, and implementation of ACTs, between 2006/7 and 2011. However, it is unlikely that the overall coverage levels reached by these interventions in 2011 were high enough to impact ACCM at a national level. Malaria parasitemia and child mortality decreased nationally during the evaluation period, shown by both the MIS surveys and the HMIS; the Huambo case study provided an example of this also occurring at the sub-national level. However, ACCM decreased the most prior to 2006–2008 and the initial decline is likely due to other contextual factors, such as the end of the civil war and increases in GDP. Despite the overall low coverage of ITNs in 2011, multiple logistic regression analysis showed that household ITN ownership was protective of malaria parasitemia among children under five years of age. Therefore, if the implementation of malaria control interventions were to be further scaled-up and sustained in Angola, there is likely to be an impact observed on ACCM nationwide in the future.

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