**Addis Ababa University**

**Faculty of Medicine**

**School of Public Health**

# Trends of Malaria Cases, Admissions and Deaths in Amhara Region of Ethiopia (2000-2008) and the Impact of Scale up Interventions

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## Abstract

**Background**: Health centre and hospital records are important sources of data on malaria cases, admissions and deaths, because they are readily available and can provide use full indications on the patterns of malaria at a low cost. However, there is only limited information on the health impact of expanded coverage of malaria control and preventative strategies in Ethiopia.

**Objective:** The core objectives of this study is to asses and document the trend of malaria cases, admission and deaths over the past 9 years (2000 -2008) period and describe the impact of anti malaria interventions performed during the period. It also aims to assess the relationship between meteorological factors and malaria.

**Methodology:** The study was conducted in Amhara region, north western Ethiopia. The present study utilized a retrospective record review on available medical records related to malaria from health facilities for nine years between 2000 and 2008 (except for Bahirdar health centre for 10.5 years: July, 1998-December, 2008) and metrological information for 9 years (July, 1998-December, 2007) from National Metrology Agency for Ethiopia. With the limited resource available, total of 14 health facilities (9 health centres and 5 hospitals) was purposively selected. Data was entered and cleaned using SPSS version 11.0 and analysed using excel 2007 and EPI INFO windows version and SPSS version 11.0 statistical software packages. To assess the trend of malaria and the impact of scale up interventions, the observed 2008 value for each indicator was compared with its corresponding, expected value for that year based on the linear trend over 2000 through 2005 (using SPSS Inc., version 11.0 for linear regression, excel 2007and 2-tailed Student's T-tests for assessing statistical significance of the difference between observation and expectation). The Chi squared test for trend was used to test whether the malaria cause outpatient cases, admission and death statistically significant decreasing over time (in years). Correlation statistical test was also applied to test for any association between malaria specific morbidity variables and meteorological factors.

**Result:** Malaria was responsible for 25.8 % of the total outpatient consultations, 13.9% of the total inpatient cases and 15.0 % of the total death between 2000 and 2008. Comparing 2008 against the average 2000-2005, observed declines were 30.2% for total malaria cause outpatient cases and 75.8% for microscopically confirmed malaria cause outpatient cases. After adjusting the pre-intervention trends over 2000-2005, the estimated decline in total malaria cause (62.2%; $P<0.05$) and microscopically confirmed malaria cause (85.1%; $P<0.05$) outpatient cases were significant. Significant positive correlations were found between microscopically confirmed malaria cause outpatient cases and 2-months lag average rainfall (Pearson correlation= 0.284, P-value=0.007) and 3-months lag average rainfall (Pearson correlation= 0.420, P-value=0.000).

**Conclusion:** malaria is one of the major public health challenges in the Amhara region. *Plasmodium falcipurum* and *Plasmodium falcipurum* are responsible for almost all malaria outpatient cases Malaria cause outpatient cases decreased in Amhara region after Long Lasting Insecticidal Nets (LLIN) and Artemisinin Based Combination Therapy (ACT) interventions are largely distributed (after the end of 2005). Malaria control offices/Bureaus, with partners of RBM, should keep on their effort to access LLINs to all at risk persons and ACT treatment in Amhara region as well in Ethiopia

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## Acronyms

| | |
|---|---|
| ACT | Artemisinin Based Combination Therapy |
| AL | Artemether-Lumefantrine |
| CFR | Case Fatality Rate |
| CI | Confidence Interval |
| DDT | Dichlorodiphenyltrichloroethane |
| EPI INFO | Epidemiological Information |
| FMOH | Federal Ministry of Health |
| HMIS | Health Management Information system |
| HSDP | Health Sector Development Program |
| IDS | Integrated Diseases Surveillance |
| IRS | Indoor Residual Spray |
| ITN | Insecticide Treated Nets |
| Kg. | Kilogram |
| LLITN | Long Lasting Insecticidal Nets |
| MoH | Ministry of Health |
| MIS | Malaria Indicator Survey |
| OR | Odd Ratio |
| RBM | Roll Back Malaria |
| SP | Sulfadoxine-Pyrimethamine |
| SPR | Slide Rositivity Rate |
| SPSS | Statistical Package for Social Sciences |
| UNICEF | United Nations children Fund |
| USAID | United States Aid for Development |
| US $ | United states Dollar |
| WHO | World Health Organization |

# 1 Introduction

## 1.1 Background

Malaria is an important social, economic and developmental challenge affecting individual, families, communities and countries [1]. Almost half of the world population is at risk of malaria infection[2].In endemic African countries, malaria accounts for 25–35% of all outpatient visits, 20–45% of hospital admissions and 15–35% of hospital deaths, imposing a great burden on already fragile health-care systems[3].

In Ethiopia, 68% of the population live in malarous areas, which cover three fourth of the total land mass[4-6]. In a non-epidemic year, 5 - 6 million clinical malaria cases and over 600,000 confirmed cases are reported from health facilities[4, 6].

The current malaria prevention and control in Ethiopia aims to reduce the overall burden of the disease by 25% by the year 2005 and by 50% by the year 2010.The national effort to prevent and control malaria is guided by a five year strategic plan developed in line with the Roll Back Malaria (RBM ) objectives and the Health Sector Development Program (HSDP) of the country[4, 6].The four main national strategies identified for malaria prevention and control are disease management, selective vector control, epidemic prevention and control, and prevention and control of malaria in pregnancy[4, 6].

Monitoring malaria morbidity and mortality is obviously one of the critical areas for evaluating the progress and impact of the current malaria control interventions. Roll Back Malaria needs report on progress and lessons learned, on reduction of mortality and needed

in relation to the intervention strategies and allocation of resources in subsequent phases of Roll Back Malaria at national, sub-regional, regional and global levels[7]. Thus, this study evaluated the trends in malaria morbidity and mortality from 2000 to 2008 and the possible impact of the introduction of Artemisinin Based Combination Therapy (ACT ) and Long Lasing insecticidal Nets LLINs on these trends was discussed.

## 1.2 Statement of the problem

In the face of increased malaria-related morbidity and mortality due to emerging resistance of *Plasmodium falciparum* to conventional anti-malarial drugs, World Health Organization

(WHO) has recommended adopting ACT for treating uncomplicated malaria [8]. Different studies reported that ACT had high efficacy and could decrease malaria transmission and morbidity [9-11]. Moreover, studies indicated that the use of LLINs and ACT as first line drug for *P.falcipurum* were largely associated with the decline in malaria morbidity and mortality in different African countries [9-14].

The Federal Ministry of Health (FMOH), with its Roll Back (RBM) partners, has intensified deployment of the effective anti malaria interventions mainly Impregnated Treated Nets (ITNs) and ACT in full scale [15]. By the end of 2007, the program has distributed nearly 20 million LLINs to reach 38 million people at risk. ACT has been available in full scale to all health facilities and communities with no stock outs throughout. However, there are remarkably few documentations of changes in disease burden associated with increases in access and use of interventions. Studies showed the impact of long LLINs and ACT provided by national governments and international partners was very limited.

Surveys alone were not providing sufficient and timely impact data for advocacy or to optimally inform management decisions at district, national, and international levels [15]. Health centres and hospitals records are important sources of data on malaria outpatient cases, admissions and deaths, because they are readily available and can provide use full indications on the patterns of malaria at a low cost [16].

Thus, this study was conducted in attempt to close these gaps by determining trend of malaria cases, admissions and deaths and the impact of scale up of interventions based on routinely collected data from different type health facilities in Amhara region of Ethiopia.

# 2. Literature Review

## 2.1 Health and Economic Burden of Malaria

Malaria in humans is a disease caused by protozoan parasites belonging to the genus *Plasmodium* and transmitted by the bite of infective female anopheles mosquitoes[1]. There are four types of human malaria – *Plasmodium falciparum, P.vivax, P.malariae, and P.ovale. P.falciparum and P.vivax* are the most common. *Plasmodium falciparum* is by far the most deadly type of malaria infection. Of these, *Plasmodium falciparum* and *P.vivax* are epidemiologically significant in Ethiopia that accounts 60% and 40%, respectively[4, 6]**.**The parasite is principally transmitted by the major mosquito vector known as *Anopheles Arabiensis*[4, 6].

Despite considerable progress in malaria control over the past decade, malaria remains a serious problem — particularly in Africa, south of the Sahara[17].The incidence of malaria worldwide is estimated to be 300–500 million clinical cases each year, with about 90% of these occurring in Sub-Saharan Africa, mostly caused by *P. falciparum*. Malaria is thought to kill between 1.1 and 2.7 million people worldwide each year, of which about 1 million are children under the age of 5 years in Africa, south of the Sahara[17, 18].

In Ethiopia, Malaria is one of the country's foremost health problems top ranking in the list of common communicable diseases. In 2002/03 malaria has been reported as the first cause of morbidity and mortality accounting for 15.5% out-patient consultations, 20.4% admissions and 27.0% in-patient deaths[4, 6]. In a community based cross sectional study in Butagira area in 1998, 13.7% 0f house holders were ill during the past two weeks recall period, and malaria accounts 26% of illness during this period ,and 9% of the death within the preceding two years[19].

A retrospective study done in Addis Ababa showed that total of 28,906 malaria cases were treated at different health facilities in Addis Ababa City from 1993 to 1999[20].Rise in the number of malaria cases treated at outpatient departments in Addis Ababa was noted from 1996 onwards. Another retrospective study, based on record review of routinely collected data,on malaria admission and deaths conducted at all hospitals and health centres located in Oromia in 2001,showed that malaria accounted for 11.2% of all admissions and 14.3% of all deaths[21].

The estimated annual direct and indirect cost of malaria in Africa alone is more than US$ 2000 million[17]**.** The disease is estimated to be responsible for an estimated average annual reduction of 1.3% in economic growth for those countries with the highest burden [18]**.**Malaria is also a significant impediment to socio and economic development in Ethiopia. The average estimated direct and indirect cost of malaria per patient was Birr 12.50 and 35.26 respectively [22]. Due to fear of malaria in the lowlands the population are largely settled on the highlands which has caused over- population, ecological degradation, reduced productivity and hence famine and poverty[4, 6]. In a study of subsistence farm households in western Ethiopia, malaria had a statistically significant effect on total revenue, reducing average income by 24%-45%[23].

## 2.2 Effect of Ecological and Climatic Factors on Malaria Incidence

Malaria is the most well known of the climate sensitive diseases. Epidemics of malaria are often triggered by climate anomalies. Mean daily temperatures above 30$^{o}$C will have a

negative impact on the survival of the vector. On the other hand, increased temperature is also known to accelerate the development period of the aquatic stages of the vector**.** Malaria epidemics were significantly more often preceded by a month of abnormally high minimum temperature in the preceding 3 months[24].

A study conducted in Tigray, northern Ethiopia, showed that the incidence of malaria for villages near (within 3 kilometres) to dams is much higher than to those villages that are far from the irrigation dams. The effect of altitude is also essential for incidence of the disease. The incidence was significantly high at altitude of below 1900 metre regardless of the distances of the village from the dams[25]. Another study conducted in Kenya, areas characterized by low altitude were strongly associated with the risk of malaria[26]**.**

Ethiopia showed a strong seasonal pattern of malaria transmission rate, which is related to the seasonal pattern of rainfall with a lag time varying from a few weeks at the beginning of the rainy season to more than a month at the end of the rainy season[27]. Relative humidity also affects malaria transmission. If the average monthly relative humidity is below 60%, it is believed that the life of the mosquito is so shortened that there is no malaria transmission[28].

## 2.3 Description of Anti Malaria Interventions in Ethiopia

The Federal Ministry of Health (FMOH) of Ethiopia, in collaboration with World Health Organization (WHO), United Nations children Fund (UNICEF),and United States Agency for International Development (USAID), developed National Malaria Control Strategic Plans in

line with the global RBM initiative and HSDP[4, 6].The core objective of the planes was 50% reduction in malaria burden (morbidity and mortality) by the end of 2010 from the 2000 level

Indoor Residual Spray (IRS) using Dichlorodiphenyltrichloroethane (DDT) is the major intervention applied to pre-empt and control malaria epidemics in malaria epidemic prone areas is scheduled to reach 60% of target areas by 2010[6].The annual coverage of IRS on average is roughly estimated at about 20-30% of epidemic prone areas [6]. Malaria Indicator Survey for Ethiopia in 2005 indicated that 2.3% of houses had been sprayed in the six months preceding the survey. In 2007, 14.5% of houses had been sprayed on average 5.1 months before the survey[29].

Insecticide Treated Nets (ITNs) are targeted to achieve 60% coverage of households in all highly malaria endemic areas by the end of 2007 primarily targeting the most vulnerable groups, pregnant women and children under five[6, 30]. By the end 2007,Long Lasting Insecticidal Nets(LLINs) are distributed to reach 38 million people at risk(at a ratio of one LLIN for two persons)[15]. National ITN coverage rates increased from 3.4% in 2005 to 53.3% in 2007. In malarious areas (below 2,000m), 65.6% of households now own at least one ITN[29].

About 18,000 health extension workers already trained and deployed in 2007. Malaria control program has been benefited from them in expanding early diagnosis and treatment[15].Furthermore, because of the widespread failure in the efficacy of the first line anti-malarial drug, Sulfadoxine-Pyrimethamine (SP),Ethiopia introduced and has fully

implemented Artemisinin based combination therapy as first line treatment for falciparum malaria since 2005[5]. In pre implementation in-vivo therapeutic efficacy and safety baseline study on artemether-lumefantrine, no treatment failure cases and drug side effects were reported[5]. Mac et al reported in their retrospective descriptive study that no stock out ACT was complained by health facilities in Ethiopia [12].

## 2.4 The Impact of Scale up Interventions on Malaria Burden

Randomized controlled trials suggest that the number of malaria cases can be reduced by as much as 50% through coverage of ITN. Indoor residual spraying is known to be similarly effective in preventing malaria. Provision of effective treatment, particularly artemisinin-based combination therapies, is known to reduce the parasite reservoir and subsequent transmission when coverage is high. In areas of stable, high transmission of malaria, recent experience in some African countries confirms that substantial reductions in transmission intensity can be achieved by full-scale use of current tools. Thus, strong malaria control, leading to reductions in both morbidity and mortality, is possible in high-transmission areas, given a minimum of political stability and the right socioeconomic conditions. As a consequence of the resulting high coverage with malaria interventions, especially in sub-Saharan Africa where the burden of malaria is greatest, the malaria burden is being reduced, albeit variably, in all regions of the world [31].

The study conducted in South Africa in the year following improved vector control and implementation of Artemether-lumefantrine (AL) treatment, malaria-related admissions and deaths both declined by 89%, and outpatient visits decreased by 85% at the sentinel

facilities[9]. Another study done in Eritrea in 2005 showed that during the period, 2000-2004, there was a steep decline in malaria morbidity and case fatality by 84% and 40% respectively. Malaria morbidity was strongly correlated to the numbers of ITNs distributed and the amount (kg) of DDT and malathion used for IRS[13]. In Rwanda, with a marked increase in coverage with ITNs and improved access to effective anti-malarial treatment, a significant reduction in both morbidity and mortality due to malaria was achieved[32]. Following deployment of Artemisinin Based Combination Therapy (ACT) in Zanzibar in 2003, malaria-associated morbidity and mortality decreased dramatically within two years.

Additional distribution LLINs in early 2006 resulted in a 10-fold reduction of malaria parasite prevalence[10].The preliminary report on the impact of the scale up anti-malaria interventions measured using health facility based data in Ethiopia showed that the decline in malaria admission and death in all age groups was strong (53% and 55% respectively)[15].Niger achieved rapid scaling up of all interventions between 2005 and 2007, increasing coverage with ACT to 100% of health facilities, achieving up to 86% coverage of households with long-lasting insecticidal nets and a coverage with intermittent preventive treatment in pregnancy of 65%[33]. Data for 2006 showed a decrease in malaria incidence to 48 per 1000 population from 75 per 1000 in 2003. Similarly, the incidence of malaria-related deaths dropped from 0.19 per 1000 in 2003 to 0.09 per 1000 in 2006.

Since January 1999 paediatric malaria admissions have significantly declined at all hospitals on the Kenyan coast[14]. This trend was observed against a background of rising or constant non-malaria admissions and unaffected by long-term rainfall throughout the surveillance

period. The most parsimonious explanation is an expansion in the coverage of interventions such as the use of insecticide-treated nets and the availability of anti-malarial medicines.

In general, strong monitoring and evaluation provide evidence of the health impact of rapid scale-up, which is essential to ensuring long-term support for high levels of nationwide coverage of proven malaria interventions[34]. It also allows decision-makers to stay aware of all problems and constraints which may slow down progress and provide the information they may need to refine their planning [35]. Furthermore, because the information is collected routinely(often monthly and quarterly), it provides information for time and seasonal trend analysis[36]. The present study will document trends of malaria cases, admissions and deaths in Amhara region of Ethiopia during the past ten years (2000-2008) and the impact of scale up interventions. Such information is crucial to increase utilization of facility-based information for decision making about investments in health systems and service [36].

## 3. Objective

### 3.1 General objective

Asses and document the distribution and trend of malaria cases, admission and deaths over the past 9 years (2000-2008) and the impact of scale up interventions using routinely collected surveillance data from health facilities (hospitals and health centres) in Amhara region.

### 3.2 Specific Objectives

1. To assess the trend of malaria cases, admission and deaths over ten years, 1998-2008
2. To describe age and species wise distribution of malaria cases and admission
3. To describe the impact of LLINs and ACT anti-malaria interventions
4. To elucidate how climatic factors influence incidence of malaria

# 4. Methods and Materials

## 4.1 Study design

The present study utilized a retrospective record review on available medical records related to malaria from health facilities for nine years from January, 2000 to January,2008 and metrological information from National Metrology Agency for Ethiopia for 9 years between July,1998 and June, 2007.

## 4.2 Study Area and Study Period

The study was conducted in north western Ethiopia Amhara region, which covers an estimated area of 159,173.66 square kilometres. Data were collected in one month at health facilities and regional health bureau from January 18, 2008 to February 18, 2009.

Based on figures from the Central statistics Agency (CSA) of Ethiopia, in 2007, Amhara regional state has an estimated total population of 17,214,056 consisting of 8,676,159 men and 8,482,312 women. 84% of the population is estimated to be rural inhabitants, while 16%

are urban. The majority of the population is Amhara in ethnic , which is estimated to be 91.4%; other groups include the Oromo (2.6%), and Agaw/Awi (3.5%)[37].

The north western Ethiopia can be characterized by high plateaus dissected by deep river gorgeous of the Blue Nile River and its tributaries. The rainfall pattern of the region is generally unimodal with the rainy season spanning between May and September. However, a significant amount of the rain falls in two months time between July and August. Temperature of the region is generally mild in the highland plateaus and warmer in the lowland valleys. The monthly average temperature is the highest in the dry months of March and April and lowest during the rainy season in July and August[27]

The potential health service coverage for Amhara region for the year 2006/07 was 88.8%.There were 19 hospitals,169 health centres ,380 private owner clinics and 2590 health posts in 2006/07. Regarding to human resource, there were 11,013 health professionals working in the region, consisting of 133 physicians,121 health officers,1 phamacist, 1973 nurses, 304 environmental health workers, 259 medical laboratory technician, 25 radiographer, 329 pharmacy technician,5950 health extension workers, 647 health assistant,and1274 front line health workers[38].

Communicable Disease like lower and upper respiratory infection, malaria , HIV/AIDS and tuberculosis are the major health problems in the region[39]. Between July 1,2007 and July 1,2008, the total of 659,149 malaria cases were diagnosed and treated in Amhara region, which accounts for 12.1% of the total out patients registered at all health facilities. During

this period, there were 243,337 confirmed malaria cases, and the Slide Positivity Rate (SPR) was 22.8%[39]. *Plasmodium falcipurm* accounted for 55.8% of infection, 38.6% *Plasmodium vivax* and 5.6%combined (*Plasmodium falcipurm* plus *Plasmodium vivax*) infection [39].

There was no change in criteria of outpatient consultation, malaria diagnosis and admission during the past 9 years (2000-2008) that to be considered in all health facilities located in Amhara region. Amhara region is the one which have been particularly active in the use of HMIS information in Strategic Planning and Management [40]. All health institutions collect data according federal Health Management Information System (HMIS). Malaria is reported by using International Classification of the Disease (ICD) codes listed with disease names [40].

## 4.3 Sampling Procedure

The present study utilised purposive non probability sampling technique. Initially, with the limited resource available, it was planned to include 16 purposively selected districts from 10 political administration zones, but Finoteselam and Kombolch towen administration excluded from the study because of incompleteness of the data. Thus, the data was accessed from the 14 districts. Selection of the districts was mainly based on knowledge of malaria burden and availability of complete of HMIS data. However, hospitals were included in this study though they are located in the place (district) that have little malaria burden. We abstracted data from 5 hospital and 9 health centre.

**Inclusion criteria**

- Health facility (one health centre and/or hospital) with laboratory and inpatient services for the last 8 years (2000-2008)
- Health facilities that are found in districts that are known in endemic malaria transmission

**Exclusion criteria**

- Health facility that have more than 2year –health facility incomplete data.
- In accessible health facilities

Table 1: The list of health centres and hospitals included in the this study February, 2009

| **Administrative zones** | **Selected Districts and Town administration** | **Selected Hosptals and Health centers** |
|---|---|---|
| North Gonder | Gonder towen administration | Gonder hospital |
| | Metema town administration | Metema Yohannes hospital |
| | Metema District | Shedie health centre** |
| South Gonder | Fogera District | Wereta health centre |
| West Gojjam | Mecha District | Merawi health centre |
| East Gojjam | Dejen District | Dejen health centre* |
| Awi | Chagni town Administration | Chagni health centre |
| North Shiwa | Ataye District | Ataye health centre |
| | Shiwarobiet town administration | Shiwa Robiet Health Centre |
| South wello | Dessie town administration | Dessie hospital |
| North Wello | Kobbo District | Kobbo Health centre |
| | Woldia town administration | Weldia Hospital |
| Bahirdar Special Zone | Bahirdar town administration | Felegehiwot Hospital |
| | Bahirdar town administration*** | Bahirdar health centre* |

*Health facilities that had no inpatient data

** Health facilities that had no death data

*** Town administration that had metrological data

## 4.4 Study Variable

## 4.4.1 Dependent Variable

- Number of outpatient malaria(clinical and confirmed) cases
- Number of malaria (clinical and confirmed) admissions

- Number of malaria deaths

### 4.4.2 Independent variable

- Malaria control activities:
    - ✓ Long Lasting Insecticidal Net(LLIN)
    - ✓ Artmesinin combination therapy (ACT)
- Time
- Age of patients
- Climatic factors
    - ✓ Rain(in mm)
    - ✓ Temperature

## 4.5 Data Collection

A special data collection format adopted and developed in English through reading relevant literatures, especially World Health Organization information collection format on national malaria control for the world malaria control[41], that can address the study's objective well and it was applied to collect data from monthly or / and yearly records of all-cause and malaria specific cases, admission, and deaths at health facilities (see Annex I).

Fourteen health professionals (man or woman who have an experience on malaria prevention and control and work in the respective district was preferable) recruited for data collection.

Close supervision of data collection process was done by two degree holder health professionals and the main investigator.

## 4.6 Statistical Analysis

Data was entered and cleaned using SPSS (version 11.0; SPSS Inc, Chicago Ill) statistical software package and analysed using excel 2007, EPI-INFO window version statistical software package and SPSS statistical software package. Frequencies and cross tabulation was carried out to check for missed value. The descriptive analysis such as proportions, percentages, measures of central tendency and measure of dispersion were used. Correlation statistical test was applied to test for any association between malaria specific morbidity variables and meteorological variables. The Chi squared test for trend was used to test whether the malaria cause outpatient cases, admission and death statistically significant decreasing over time(in years). Furthermore, the Chi squared test was used to calculate whether the differences in clinically diagnosed malaria cases and microscopically confirmed malaria cases between pre and post intervention periods was statistically significant and whether there was statistical significant difference in age groups of malaria patient between pre and post interventions.

To look the impact of scale up interventions of ACT and LLIN, We compared the average annual number of malaria and non-malaria cause outpatient cases, inpatient cases and death before scaleup interventions of LLIN and ACT (2005) with the outpatient and inpatient cases

and deaths in the most recent post- intervention period (2008). Similar method was applied in the study done in Ethiopia and Rwanda[12]. The year 2000-2005 was considered as pre-intervention period because ACT and LLIN have been largely distributed and implemented since the end 2005(possibly starting from September 2005).

But comparing numbers of malaria and non-malaria cases and deaths between pre and post intervention periods did not help us to control factors that are responsible for the time trend before the introduction of scale up interventions of LLIN and ACT. Thus, we controlled those factors which were unrelated to the interventions – such as population growth, improved health facility access and attendance as study done in Ethiopia and Rwanda[12]. The observed 2008 value for each indicator was compared with its corresponding, expected value for that year based on the linear trend over 2000 through 2005 (using SPSS Inc., version 11.0 for linear regressions and excel 2007and 2-tailed Student's T-tests for assessing statistical significance of the difference between observation and expectation). In this analysis, any decreases in malaria indicators observed in 2008 which could be predicted simply from a trend of decline in that indicator over preceding years were thus not attributed to the interventions, whereas decreases larger than those apparent over previous years and decreases that started in 2006 were attributed to the interventions.

**Imputation of data**: We imputed missed monthly and yearly data by averaging the month/year before and month/year after the missing data as the study done Rwanda and Ethiopia[12], and Ethiopia[15]. Out patient data was imputed for 23 of 1512 month- health facility data and 2 of 126 year -health facility data. Inpatient data were imputed for 35 of

1296 month-health facility data. Death data were imputed for 32 of 1180 month-health facility data

## 4.7 Data quality Assurance

Intensive training was given for data collectors and supervisors on contents of data collection format, malaria data collection at health care facilities, record review and health management information system for three days by the head of Amhara region malaria prevention and control department . Pre-test was done in merawi health centre ( included in the study since we found it was complete ) to check the clarity of the wording, consistency and completeness of the data collection format.

Very close supervision was undertaken during data collection process by supervisors and principle investigator. The collected data were checked by supervisors and principal investigators for its consistency and completeness daily. Again the data were rechecked for completeness and consistency before entering into the computer.

## 4.8 Operational Definition

- Total malaria cause outpatient cases: Number of malaria patients that is microscopically confirmed or patient with clinical malaria that is prescribed with antimalarial treatment but is not confirmed by microscopy
- Total all-cause outpatient cases: Total number of outpatient consultations (for all dieseases or causes of consultations)
- Microscopically confirmed malaria cause outpatient cases: Number of malaria patients confirmed by microscopy
- Malaria cause inpatient cases/admission: Number of admitted patient with severe symptoms who is either microscopy confirmed or clinically admitted and receives anti-malarial treatment
- Total all cause inpatient cases/admission- total number admission/inpatient cases (for all disease or cause admission)
- Total all-cause death-total number death(for all disease and cause death)
- Malaria cause death-total number of malaria death that can confirmed microscopy or clinically attributable to malaria
- Case-fatality rate: proportion of probable and confirmed malaria deaths among patients admitted with severe malaria to a health facility per unit time
- Slide positivity rate: proportion of total microscopically confirmed malaria outpatient cases to the total blood firm done at laboratory department.

## 4.9 Ethical Considerations

Ethical approval and clearance requested and obtained for the study from the ethical committee of the Addis Ababa University Medical Faculty and publication committee. All concerned bodies were officially contacted through letters and permission was obtained at all level. Access to medical records in hospitals and health centres was secured after discussing and getting permission from their medical directors or heads from the respective health facilities.

## 4.10 Dissemination of Research Findings

Final copy of this study finding will be submitted to School of Public Health Faculty of Medicine Addis Ababa University, Federal Ministry of Health, Amhara Regional Health Bureau, hospitals and health centres that participated in the study, and to those who have a stake in malaria prevention and control program in Amhara region as well in Ethiopia. Efforts will be made to present the findings of the study in different seminars, workshops, and conferences. Publication on the scientific journals will also be considered.

## 5. Result

We found complete outpatient data from all fourteen sampled health facilities. Both total malaria cause outpatient cases and microscopically confirmed malaria cause outpatient cases were accessed in both persons younger than 5 years and 5 years or older. Inpatient data was abstracted from the 12 health facilities (5 hospitals and 7 health centres) by age groups (< 5 years and ≥5 years). Eleven health facilities (5 hospitals and 6 health centres) had complete death data for all age groups.

Complete records of monthly rainfall and temperature for 1 town administration ( Bahirdar town administration ) from 9 districts/town administration we requested were obtained from official registers of National Metrological Agency for Ethiopia from 1998–2007. In addition, records from regional health bureau traced back to obtain data on malaria and intervention measures taken.

From all fourteen health facilities we visited a total of 824,548 malaria cases, which accounts 25.8% of the total outpatient cases, were treated and diagnosed in Amhara region of Ethiopia from 2000 to 2008 (Table 2). There were mean of 91,616 total malaria cases (SD 25,291.4, 95%C.I 72,175.7- 111.057.1) and 33,825 microscopically confirmed cases (SD 15,042, 95%CI 22262.06 - 45,388.17) per health facility per year. Of the total malaria cases, 304,426(36.9%) were microscopically confirmed (Table 2 and Table 3). The rest 520,122

malaria patients, which accounts 63.1 % of the total malaria outpatient cases, diagnosed based on clinical signs and symptoms.

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A total of 168,417 children under the age of five contributed about 20.4 % of total outpatient malaria cases were also diagnosed and treated for malaria during the study period (Table 2). The total number of outpatient cases under the age of five registered during 2000-2008 period was 543,086 with 31.0 % accounted for malaria. Of the total malaria cases in children aged less than five years, 67568 (40.1%) were microscopically confirmed. In children under the age of five, there were mean of 18,712.9 total malaria cause outpatient cases (SD 5999.5, CI 14101.3 – 23324.6) and 7507.5 microscopically confirmed malaria cases (SD 3120.8, 95%CI 5108.7 - 9906.33) per health facility per year. Persons aged five years or older represented 78.9% of the total malaria cases. (Table2).

The proportion of total malaria cases and microscopically confirmed malaria cause outpatient cases relative to the total outpatient cases was peaked during 2003-4 and declined from 2006 onwards (Table 2). The proportion of total malaria cause outpatient cases got maximum 33.8% in 2003 and minimum 19.8 % in 2000 in 2008(table 2). In children under the age of five, the relative contribution of total malaria cases to the total outpatient cases reached peak 36.4 % in 2004 and 2005 and lowest 24% in 2008

| | All age groups(including children under the age of five) | | | | Children under the age of five | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Total outpatient cases | Total malaria cases (%)* | Microscopically confirmed malaria cases (%) ** | SPR (%) | Total outpatient cases | Total malaria cases (%) *** | Microscopically confirmed malaria cases (%) **** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2000 | 301623 | 59450(19.7) | 29847(50.2) | 28.97 | 45144 | 12169(27.0) | 7707(63.3) |
| 2001 | 305690 | 67116(22.0) | 29591(44.1) | 31.57 | 51157 | 14057(27.5) | 7277(51.7) |
| 2002 | 327992 | 89196(27.2) | 42697(47.9) | 42.04 | 55236 | 18736(33.9) | 9137(48.8) |
| 2003 | 361232 | 121965(33.8) | 51427(42.7) | 42.75 | 69401 | 24348(35.1) | 10213(41.9) |
| 2004 | 405480 | 115529(28.5) | 44832(38.8) | 37.07 | 74469 | 27075(36.4) | 9718(35.9) |
| 2005 | 428299 | 128281(30.0) | 52596(41.0) | 39.78 | 74080 | 27092(36.4) | 11751(43.4) |
| 2006 | 361522 | 91733(25.4) | 26991(29.4) | 25.87 | 59071 | 17432(29.5) | 5811(33.3) |
| 2007 | 357181 | 83661(23.4) | 16303(19.5) | 16.17 | 61293 | 14359(23.4) | 3692(25.7) |
| 2008 | 340865 | 67617(19.8) | 10144(15.0) | 14.95 | 53235 | 13149(24.7) | 2262(17.2) |
| **Total** | **3189884** | **824548(25.8)** | **304426(36.9)** | | **543086** | **168417(31)** | **67568(40.1)** |

**Table 2: Total outpatient cases for all causes, outpatient malaria diagnoses, and microscopically confirmed malaria cases in Amhara region of Ethiopia, between 2000 and 2008**

*Relative contribution of malaria cases to the total outpatient cases
** Relative contribution of confirmed malaria cases to malaria outpatient cases
*** Relative contribution of malaria cases to the total outpatient cases in children under the age of five
**** Relative contribution of confirmed malaria cases to malaria outpatient cases in children under the age of five

Of the total microscopically confirmed malaria cases, 223,760 (73.5%) of the cases were due to *P.falciparum*, followed by *P. vivax* 70,178 (23.1%) cases, mixed infection 10,197 (3.3%) and rarely *P. malariae(291).* Table 3 shows the distribution *plasmodium* species during the study period (2000-2008).

| year | *P.falcipurum(%)* | *P.vivax(%)* | *Mixed(%)* | *P.malariae(%)* | Total |
|---|---|---|---|---|---|
| 2000 | 22133(74.2) | 6953(23.3) | 757(2.5) | 4(<0.1) | 29847 |

| | | | | | |
|---|---|---|---|---|---|
| 2001 | 21953(74.2) | 6725(22.7) | 910(3.1) | 3(<0.1) | 29591 |
| 2002 | 32773(76.8) | 8427(19.7) | 1497(3.5) | 0(0.0) | 42697 |
| 2003 | 38993(75.8) | 9723(18.9) | 2678(5.2) | 33(<0.1) | 51427 |
| 2004 | 33961(75.8) | 9437(21.0) | 1329(2.9) | 105(<0.1) | 44832 |
| 2005 | 38698(73.6) | 12500(23.8) | 1296(2.5) | 102(<0.1) | 52596 |
| 2006 | 17281(64.0) | 8663(32.1) | 1022(3.8) | 25(<0.1) | 26991 |
| 2007 | 10722(65.8) | 5108(31.3) | 471(2.9) | 2(<0.1) | 16303 |
| 2008 | 7246(71.4) | 2643(26.1) | 238(2.3) | 17(<0.1) | 10144 |
| **Total** | **223760(73.5)** | **70179(23.1)** | **10198(3.3)** | **291(<0.1)** | **304426** |

Admission Death

**Table 3: Microscopically confirmed outpatient malaria cases in hospitals and health Centres in Amhara region of Ethiopia from 2000 to 2008**

A total of 288,979 admissions were seen from the twelve health facilities at which nine years longitudinal admission data obtained (Table 4). Of these, 13.9% (28,963) had total malaria cause outpatient cases, ranging from 25.9% in 2003 to 5.1% in 2008. Children under the age of five accounted for 20.6 %( 8,516) of the total malaria cause inpatient cases. There were mean of 4589.1 malaria cause admission (2995.2, 95%CI 2286.8-6891.4) and 946.22 under five malaria cause admission (SD 583.3, 95%CI 497.85 – 1394.6) per health facility per year

Malaria-related deaths and death for all cause during the eight year study period are depicted in Table 4. Eleven health facilities, that had complete death data, reported that there were 15,906 deaths for any cause, out of which malaria related death contributed 15.8%(2519). There were mean of 279.9 malaria cause death (SD 176, 95%CI 144.6-415.2) and mean of 0.34 Case Fatality rate (SD 0.18, 95%CI 0.20 - 0.48).

| | All age groups | | under the age of five | | Malaria cause death | | |
|---|---|---|---|---|---|---|---|
| Year | Total Admission | Total malaria cause admission (%)* | Total admission | Total malaria cause admission (%) ** | Total death | Malaria cause death (%) *** | CFR (%) |
| 2000 | 28105 | 5659(20.1) | 4271 | 905(21.2) | 1488 | 289(19.4) | .58 |
| 2001 | 28296 | 5149(18.2) | 4359 | 993(22.8) | 1476 | 295(20.0) | 0.50 |
| 2002 | 29598 | 5218(17.6) | 4615 | 943(20.4) | 1490 | 208(14.0) | 0.27 |
| 2003 | 32961 | 8535(25.9) | 5813 | 1733(29.8) | 1737 | 568(32.7) | 0.54 |
| 2004 | 36690 | 5284(14.4) | 5885 | 1289(21.9) | 2114 | 362(17.1) | 0.37 |
| 2005 | 36962 | 5266(14.2) | 5646 | 1068(18.9) | 2071 | 269(13.0) | 0.23 |
| 2006 | 32735 | 1792(5.5) | 4853 | 502(10.3) | 1868 | 144(7.7) | 0.17 |
| 2007 | 32101 | 1765(5.5) | 4771 | 397(8.3) | 1721 | 110(6.4) | 0.14 |
| 2008 | 31531 | 1615(5.1) | 4912 | 454(9.2) | 1525 | 85(5.6) | 0.14 |
| **Total** | **288979** | **40283(13.9)** | **45125** | **8284 (18.4)** | **15490** | **2330(15.0)** | |

**Table 3: Total admission for all causes, malaria cause admission, total death for all causes and malaria cause death in Amhara region of Ethiopia, between 2000 and 2008**

*Relative contribution of malaria to the total admission
**Relative contribution of malaria to the total admission in children under the age of five
***Relative contribution of malaria to the total death

Microscopically confirmed malaria cause outpatient cases were significantly higher in the pre intervention period than during post intervention period (OR=2.43 95%CI 2.41-2.46) (Table 5). There was difference in age distribution of outpatient malaria cases between pre intervention period and post intervention. Malaria cases at outpatient department in children under 5 during the pre intervention period was significantly higher than during the post intervention period (OR=1.2 95%CI 1.19-1.22) (Table 5). Regarding to malaria cause admission in children under the age of five, there were less number of admission during the pre intervention period than post-intervention period (OR=0.77 95%CI 0.72-0.83) (Table 5).

**Table 5: Age distribution of malaria and type of malaria diagnosis during the pre and post intervention period**

| | Pre intervention* | Post intervention | OR(95% CI) |
|---|---|---|---|
| **Malaria diagnosis** | | | |
| Confirmed | 148,855 | 53,438 | 2.4(2.41-2.46)+ |
| clinical | 216,920 | 189,573 | |
| **Malaria outpatient** | | | |
| <5years age | 78,515 | 44,940 | 1.2(1.19-1.22)+ |
| >5 years age | 287,260 | 198,071 | |
| **Malaria admission** | | | |
| <5years age | 4090 | 1353 | 0.77(0.72-0.83)+ |
| >5 years age | 14,995 | 3819 | |

*only the latest three year (2003-2005) before the intervention are considered as a pre-intervention period
+Statistical significant: P-value = 0.000

## Malaria prevention and control interventions in Amhara region

ACT was introduced in Amhara national regional state in 2005, but, fully implemented as first line treatment for uncomplicated and severe malaria in all public health starting from early 2006. Table 7 describes amount of ACT (in Karton) distributed, amount of DDT or/and malathhion(in Kg.) sprayed and number of LLINs distributed by year.

The policy of scaling up ITNs to achieve primarily targeting the most vulnerable groups, pregnant women and children under five- free of charge-are launched in August, 2004. However, ITNs coverage and use remained low in Amhara region 2004/05 due to limited number of ITNs distributed (199,665). A total of 7,822,198 LLINs are distributed between July, 2004 and December 2008(Table 2).

**Table 6: Malaria prevention and control activities by year in Amhara region from July, 2004 to December, 2008**

| | 2004/05 | 2005/06 | 2006/07 | 2007/08 | 2008** |
|---|---|---|---|---|---|
| ACT(in Karton) distributed | *** | 93 | 659 | 1276 | 1162 |
| Number of patients treated with ACT | *** | 44,498 | 316,126 | 612,480 | 557,920 |
| DDT and Malthion (in Kg.) sprayed | 69,104 | 30,492 | 125,666 | 462,022 | 276,572 |
| Number of people protected by IRS. | 610,899 | 394,078 | 912,125 | 2,079,099 | 1,244,573 |
| Number of LLINs | 199,665 | 1,724,022 | 4,028,900 | 1,702,611 | 167,000 |

**2008 includes only 6 months (July-December, 2008).

Others years considered 12 months, example, 2004/05 is to mean between July, 2004-June, 2005

***ACT not started

## Trend of malaria and the impact of scale up interventions

**Outpatient:** Figure 1 and 2 show trends total malaria cause outpatient cases and non-malaria outpatient cases and trends of microscopically confirmed malaria cases and other illnesses other than microscopically confirmed malaria cases by year in all age groups. The data showed trends of increase in malaria cause outpatient cases over 2000–2005. But staring from the early 2006, sharp decline of microscopically confirmed malaria cases were observed in all age groups. But, non-malaria outpatient cases showed slight increment during the study period (2000 - 2008).

Outpatient malaria cases in children aged less than five years declined markedly since 2006 while non malaria cases increased slightly during the study period. Figure 3 and 4 show trends total malaria cause outpatient cases and non-malaria outpatient cases and trends of microscopically confirmed malaria cases and other illnesses other than microscopically confirmed malaria cases by year in children less than five years.

The test for trend was highly significant (chi-square = 8330.4; p = 0.000) indicating that total malaria cause outpatient cases is decreasing over the study period. A significant down trend was also observed in children under the age of five malaria outpatient cases. However, malaria cases in persons aged five years or older had no significant declined trend (chi-squared= 3.12 ; P=0.077) (Table 7).

Microscopically confirmed malaria cases showed a significant decreasing trend in both children under the age of five (chi-square=6382.4; P-value for trend=0.000) and persons the aged of five years or older (P-value for trend=0.000) (table7)

Comparing 2008 against the average 2000-2005, observed declines were 30.2% for total malaria cause outpatient cases and 75.8% for microscopically confirmed malaria cause outpatient cases (Table 7). Observed declines in children aged less than five years were 36.1% for total malaria cause outpatient cases and 75.7% for microscopically confirmed malaria cause outpatient cases.

After adjusting the pre-intervention trends over 2000-2005, the estimated decline in total malaria cause (62.2%; P<0.05) and microscopically confirmed malaria cause (85.1%; P<0.05) outpatient cases were significant (Table7) . In children under five years, There were significant decline in both total malaria cause outpatient cases (66.6%,P-value < 0.05) and microscopically confirmed malaria cause(83.6%, P-value<0.05) outpatient cases after controlling possible factors accounted for possible time trends started before the intervention.

Adjusting the pre-intervention trends, there were also significant reduction in total malaria cause (85.5%, P value < 0.05) and microscopically confirmed malaria cause (61%; P-value=0.05) outpatient cases in person aged five years or older.

Non-malaria outpatient cases are higher in 2008 compared to the average 2000-2005, except non malaria outpatient cases in children under the age of five which showed declines of 2.2% for non malaria cause outpatient cases and 2.5% for non microscopically confirmed malaria cases (all outpatient cases out of confirmed malaria cases) (Table 7). After controlling the possible factors accounted for trend started before the intervention, there were significant declines for non malaria cause outpatient cases (24.6%; P value <0.05 ) and non microscopically confirmed malaria cases (all outpatient cases out of confirmed malaria cases) (16.7%, P value < 0.05 ). In persons above five years of age, non malaria outpatient cases showed a significant reduction when possible confounders are controlled. But there was no significant decline in children less than five years.

The percentage decline of microscopically confirmed malaria cases in both age groups (less than and above five year) in 2008 compared to the average of the reference period (2000-2005) was 71% and 63.7% respectively. However, observed percentage decline in total malaria cause outpatient cases (24%) is much less than the percentage decline in microscopically confirmed malaria cases (65.6%). The non malaria outpatient cases were higher by 6.3% in 2008, compared to the average over 2000-2005. Table 7 shows percentage change in malaria and non malaria cases, admissions and deaths in 2008 compared to pre interventions reference period.

**Admission and Death:** Figure 5 show trends of malaria cause admission and non-malaria cause admission in all age groups by year. Longitudinal admission data also showed remarkable sharp decline after the intervention. The number of total malaria cause admission was stable during the pre intervention period, except sharp increment was observed in 2003(figure 5) and then declined sharply in 2006 and remains stable from 2007 to 2008. The number of non-malaria cause admissions increased during the study period (figure 5).

In children under the age of five, number of malaria cause inpatient cases increased between 2000 to 2003, but, starting from 2004, It showed remarkable decreasing trend. While, non malaria cause inpatient cases showed a slight increments during the study period (2000-2008) (figure 6).

Malaria cause admission decreased significantly over 8 years surveillance period (chi-squared value=7875.3; P-value for trend=0.000) (Table7). Comparing 2008 against the average 2000-2005, observed declines were 72.4% for total malaria cause inpatient cases. Observed declines in children aged less than five years were 60.7% for total malaria cause inpatient cases, while there were 75.3% decline in person > 5 years age. Adjusting for pre-intervention trends, the estimated declines of inpatient cases in both children under and above the age of five years were 66.6% and 85.5 % respectively, but none of them had no statistical significant (Table 7).

Non-malaria cause inpatient cases are higher (by 14.1 %) in 2008 compared to the average 2000-2005. Non malaria cause inpatient cases increased in children under the age of five years by 13.1%. But after controlling the possible factors accounted for trend started before the intervention, non malaria cause inpatient cases in children under the age of five showed a significant decline by 19.5 % (P-value < 0.05). There were also insignificant decline in persons aged less than five years and in all age groups in the two age groups after controlling the trends of pre-intervention period (Table 7).

The trend of malaria cause deaths and non malaria cause deaths are depicted in figure 7. A significant decreasing trend was observed in malaria cause death (chi-squared=365.4, P-value trend=0.000).Comparing 2008 against the average of 2000-2005, Observed decline in malaria cause death was 74.4%. For malaria cause deaths, no significant changes were apparent in 2008, when adjusting for prior time trends. The observed non-malaria cause death in 2008 was not also statistically different from that expected based on the trend of increase over 2000–2005(Table 7).

## Relationship Between meteorological factor and malaria outpatient cases

The number of malaria cause outpatient cases reached peak in October /December after rainy season and lowest in march/April (figure 9). Figure 10 shows the seasonality of malaria transmission over ten years surveillance period. The trend in rainfall (coefficient of year (trend) = -0.023,p-value=807) patterns remained relatively stable during the 9.5 years of surveillance period(july,1998- December,2007). There were no also significant changes observed in patterns of minimum temperature (trend=0.139,p-value=0.169) and maximum temperature(trend=0.068,p-value=0.503) over 7 years period.

Significant positive correlations were found between microscopically confirmed malaria cause outpatient cases and 2-month lag average rainfall (Pearson correlation= 0.284, P-value=0.007) and 3-month lag average rainfall (Pearson correlation= 0.420, P-value=0.000). However, no significant correlation were found between microscopically confirmed malaria cause outpatient cases and average minimum temperature (Pearson correlation= -0.027, P-value=0.822) and maximum temperature (Pearson correlation= -0.027, P-value=0.822).

## 6. Discussion

There were considerable number of malaria cases diagnosed and treated in public health facilities in Amhara region during the study period(2000-2008), accounting 25.8 % of the total outpatient consultation. There were also enormous number of malaria cause admissions and deaths in hospitals and health centres in the Amhara region. Thus, malaria is the major public health challenge causing significant morbidity and mortality in Ethiopia.

Regarding to species distribution, *P.falciparum* is the most important cause of malaria (73.5%) followed by *P.vivax* (23.1%). The least is *P.malarae* , this is consistent with national figure[3-5]. *P.falciparum* was predominant species followed by *P.vivax* in different places of Ethiopia [17, 39-41].

The observed decline in microscopically confirmed malaria cases is higher than the observed decline in clinically diagnosed malaria cases. In other words, the declining rate of microscopically confirmed malaria cases was faster than the declining rate of clinically diagnosed malaria cause cases during the study period. The reason for this might be other febrile illnesses can be misdiagnosed as malaria since clinical diagnosis of malaria is unreliable as the sign and symptoms used to verify malaria are non-specific and overlapping with signs and symptoms caused by other febrile illness[5].

There was an increasing trend of malaria burden during the pre-intervention period (2000-2005). The highest number of malaria cases, admission and death at health facilities was observed in 2003 and 2004 which is in agreement with malaria trend in the country [6]. The highest case fatality rate and slide positivity rate were also observed in 2003. There was malaria epidemic in 2003 and 2004 in Ethiopia[6, 42]. The 2003 and 2004 epidemic in Ethiopia might be associated with low efficacy of anti-malaria drugs. Results obtained from study on the therapeutic efficacy of Sulfadoxine-Pyrimethamine showed a mean treatment failure rate of 35.9% (range 21.7-53.4%) on the 14-days follow-up and 71.8% (range 53.8 – 85.7) on the 28-days follow-up[43].

Though this study was done at public health centres and hospitals where microscopic diagonistic facilities are available, significant number of malaria patients are diagnosed based on clinical signs

and symptoms so that type plasmodium species that causes malaria was not specified. This finding is similar with the study done in Oromia [16]. The possible explanation for this might be negligence of documenting type of plasmodium species and the diagoniasis are not confirmed by laboratory as is true in many situations [16]. In malaria endemic area, clinicians might assume any febrile illnesses as malaria and might be treated only with anti malaria medication[32]. This might have deleterious effect in making reliable diagoniasis to guide treatment decision and rational use of anti-malaria drugs.

In the present study, microscopically confirmed malaria cause outpatient cases were 2.4 times significantly higher during the pre intervention period than during post intervention period. The finding is consistent with the study done in Rwanda [32]. This indicates that scale up of LLINs and ACT anti-malaria interventions might lead to a decrease in the positive predictive value of clinical symptoms for the diagnosis of malaria.

Microscopically confirmed malaria cases at outpatient department tend to fall in older age groups. Microscopically confirmed malaria outpatient cases in children under 5 years during the pre-intervention period were significantly 1.2 times higher than during the post intervention period. This finding is consistent with the study done in Rwanda [32]. This might be due to scale up of LLIN distribution and utilization among high risk and priority groups (children under the age of 5 years and pregnant mothers) in Ethiopia after 2005. The 2007 Malaria indicator Survey (MIS) for Ethiopia shows that national ITN coverage rates increased from 3.4% in 2005 to 53.3% in 2007[29]. Only 1.5% of children under age five years were reported to have slept under an ITN the night preceding the survey in 2005, this percentage is now up to 33.1% nationwide and 41.5% in malarious areas [29]. An average of 60% of children under age five years had slept under an ITN the night preceding the survey in households that owned at least one ITN, in malarious areas and also nationwide [29].

In contrast to our expectation, our analysis indicates that malaria cause admission in children under the age of 5 years were lower in the pre- intervention period than the post-intervention (OR=0.77 95%CI 0.72-0.83). The possible explanation for our finding is that largely distributed LLITN targeted at risky groups might slow immunity acquired to malaria in children aged less than 5 years. It has

been recognized that measures which reduce the level of exposure may interfere with the natural acquisition of immunity to malaria[44]. The process of acquiring immunity to malaria in children is likely to involve interplay between the risk of infection with *P. falciparum* leading to a disease episode and the age at which children first encounter infection[45].

Between January 2000 and December 2008 (8 years) both total malaria cause and microscopically confirmed malaria cause outpatient cases have shown a dramatic decline in Amhara region of Ethiopia. The fact that the significance decline in malaria cause outpatient cases occurred against insignificant rise/decline in non malaria cause outpatient cases and the fact that decreases in malaria cases are higher than decreases in non malaria cases and coincidence of the time at which health facility impact and scaled up interventions (LLIN and ACT) started suggest that the decline of malaria cause outpatient cases is attributed to scale up LLINS and ACT anti malaria interventions. The percentage decline in microscopically confirmed malaria outpatient cases and total malaria cause outpatient cases were 75.8% and 30.2% in 2008 respectively (the latest post intervention period) as compared to the reference period (2000-2005). Our finding is in line with those reported from similar studies in Ethiopia and Rwanda [12], Eretria[13], South Africa[9], and Zanzibar[10].

The study done in Ethiopia and Rwanda[12] indicated that the combination of mass distribution of LLIN to all children less than 5 years or all households and nationwide distribution of ACT in the public sector was associated with substantial declines of outpatient malaria cases ,in-patient malaria cases and deaths in Rwanda and Ethiopia. Outpatient malaria cases in Rwanda and Ethiopia fell by 81% and54% respectively.

It may be argued that a decline in malaria cause outpatient cases might be due to progresses in health service accessibility, health service utilization and change in demographic variables throughout the eight years surveillance period. But, if that is the case, there should be no difference in percentage decline between malaria cause outpatient cases and non-malaria cause outpatient cases. Thus, change in health service accessibility, utilization, and other demographic factors seem unlikely explanation for the impact (trend) observed.

Comparing 2008 malaria cause inpatient cases and death against the average 2000-2005, observed declines were 72.4% for malaria cause admission in all age groups, 60% for malaria cause admission in children aged less than five years and 74.4 % for malaria cause death which is consistent with the study done in Kenya[14], Zanzibar[10], and Ethiopia and Rwanda [12] .

However, after adjusting the pre-intervention period 2000-2005, the estimated declines in malaria cause in patient cases were not significant and decreases started before the scale up of LLINs and ACT interventions in children under the of 5 years(figure 6). Therefore, it is difficult to establish causal relationship between observed declines and LLIN and ACT scale up interventions. This might be because the unstable nature of malaria transmission in Ethiopia and the large year-to- year fluctuations in health facility burdens[12]. Moreover, only 11 health facilities were included in the study and out of eleven health facilities, 9 of them are health centres where limited inpatient service is provided.

Malaria transmission reached peak in October /November after the main rainy season ‘’Kirmet’ . Similar result were found in different part of Ethiopia: Oromia[16] , Addis beba[20], and western Ethiopia[27]. it is also in agreement with monthly distribution of malaria in Ethiopia[4, 6]. The most possible explanation for this is tied to the high rainfall in the main rainy season between June and September. Once the main rainy season declines in intensity and frequency in September, the increasing average daily temperature and progressive dryness beginning mid-September creates a conducive environment for mosquito breeding in areas where water has been accumulating from the main season[27].

This study revealed that there were positive correlation between rain fall and microscopically confirmed malaria outpatient cases, when the data were adjusted for two and three month lag. This result is consistent with the studies done in Keneya[14], Zanzibar[10], Ethiopia[27, 46] , Eriterea [47] and India[48]. Many processes get accomplished between the onset of rains and appearance of malaria cases. After a heavy rain, there is a possibility for water to recede so as to provide new breeding sites. Further, time is needed for larvae to hatch, mature pupae and form adults, for the adult female to find an infected

host and become infected itself and for completion of sporogonic development of malaria parasite within the vector. Additional time may be required for the infected mosquito to bite an uninfected host[48]. Moreover, the appearance of a malaria patient to the clinic will play role in the observed lag time[27].The presence of a lag-time between peak malaria transmission and seasonal rainfall events is very important for forecasting malaria outbreak using observed weather data. However, the magnitude of the lag-time appears to depend on the season and location [27].

Despite being influenced by health-seeking behaviour and accessibility, surveillance are a valuable and often the only source of information on the most prevalent health problems of a community like malaria and to monitor interventions with high impact at the health facility, district, and national level. Health facility records are also use full to determine trends in morbidity and mortality, to establish the proportion of outpatient consultations, admissions, and deaths for a specific disease and determining the characteristics those attending health care facilities at low cost[16].

# 7 Strength and limitation of the study

## 7.1 Strength of the study

- The time considered in this study is relatively long to see trends of malaria
- The study was conducted based on a huge data collected from 14 health facilities which is in 12 districts/town administration and 9 administrative zones

## 7.2 Limitation of the study

- Health facilities were not randomly selected. Purposive sampling technique was applied to select those health facilities where malaria transmission is stable and health

facility data were of relatively complete. It is difficult to draw firm conclusion about the whole region based on these data. Also, while these results illustrate the benefits of rapid scale-up in the populations sampled, it would be inappropriate to extrapolate these findings to the region level or country level with more intense malaria transmission, where interventions at similar coverage levels may have lower impact().

- Incompleteness of the data was the major pit full in this study. Initially it was planned to include 16 outpatient and inpatient health facilities in the study, but only 14 0ut patient health facilities and 11 health inpatient health facilities were included. In addition, there were 2 year- health facility and 35 month-health missed data.
- It is a general fact that health facility data represent only those patients who have access and who utilize (public) health care system. It is largely influenced by health seeking behaviour of population. Especially for ACT, it is possible that their coverage and impact is largely limited to the catchment populations of the facilities providing these drugs – with population-level impact diminishing by distance from health facilities.
- Analyses related to climate are based on only one town administration (Bahirdar town administration) and one health centre (Bahirdar health centre). The research would be more powerful if metereological data all selected districts/towen administrations were accessed and analysed.

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# 8. Conclusion and Recommendation

## 8.1 Conclusion

- ✓ It can be concluded that there is high malaria burden on health facility in Amhara region of Ethiopia. *Plasmodium falcipurum* and *Plasmodium falcipurum* are responsible for almost all malaria outpatient cases
- ✓ Retrospective analysis of records of hospitals and health centres in Amhara region revealed that malaria is the major cause of outpatient cases, and admission in children under the age of five.
- ✓ This study provides evidence of a decreasing trend of malaria burden over eight years 2000-2008. In the year following scale up LLIN and ACT interventions, there was remarkable significant decreasing in malaria cause outpatient cases. However, the

study could not find strong evidence on impact of scale up LLINS and ACT interventions on observed decline malaria cause admission and death.

- ✓ Significant number of malaria patients were diagnosed and treated based on clinical signs and symptoms between 2000 and 2008
- ✓ Malaria transmission was highly seasonal in Amhara regional which is related to the seasonal pattern of rainfall with lead time varying from two to three months
- ✓ Health care facility data are useful to determine trends of malaria morbidity and mortality and important to assess the effectiveness of anti malaria interventions

## 8.2 Recommendation

- ➢ We are recommending all districts /zonal/ regional health bureau to determine relationships between rainfall and the timing and magnitude of malaria for forecasting malaria situation in their locality.
- ➢ Malaria control offices/Bureaus ,with partners of RBM, should keep on their effort to access LLINs to all at risk persons and ACT treatment in Amhara region as well in Ethiopia
- ➢ Since most malaria diagnosis was based on clinical signs and symptoms, providing appropriate equipments and reagents to the health facilities and giving training to the health professional might help to improve malaria diagnosis and management at different health care service level.

- National, regional and district malaria prevention and control offices should give emphasis in improving quality and coverage of surveillance data which is very important to assess the impact of interventions against malaria at low cost.
- Other findings at hospitals which have well inpatient services are needed to demonstrate the impact ACT and LLIN scale up interventions on malaria admission and death.

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# Annex-I

Annex-I Data Collection Format

Addis Ababa University

School of Public Health

This is a data collection format to determine the trend of malaria cases, admissions and deaths in Amhara region (1998-2008) and assess the impact of scale up interventions.

Name of Data Collector: _____ Date: _ _/_ _/_ _

Qualification: _____

Data collector agreement

'I certify that I have filled this questionnaire in accordance with the training I was given and instructions stated in it. I have confirmed that the information in it is correct.'

Signed_____ Date_____

**Instruction:** Information regarding to trend (part 2.1, 2.2, 2.3, 2.4, 2.5 and 4) should be completed for each year from 1998 to 2008.

## 1. Identification Information

1.1 Zone ……..

1.2 District ……

1.3 Name of the health facility……..

1.3 Type of health facility

1. Hospital
    a. Rural hospital
    b. Zonal hospital
    c. Regional hospital
2. Health centre

**2. Malaria Related Information at Health facility**

**2.1 Trends of Total Malaria Cases (Probable and confirmed) in the Year……..**

| Month | All age groups (including under 5 years of age) | | | Under 5 years of age | | | Remark |
|---|---|---|---|---|---|---|---|
| | Total all cause outpatient cases | Total outpatient malaria cases | Total confirmed malaria cases | Total all cause outpatient cases | Total outpatient malaria cases | Total confirmed malaria cases | |
| July | | | | | | | |
| August | | | | | | | |
| September | | | | | | | |
| October | | | | | | | |
| November | | | | | | | |
| December | | | | | | | |
| January | | | | | | | |
| February | | | | | | | |
| March | | | | | | | |
| April | | | | | | | |
| May | | | | | | | |
| June | | | | | | | |

2.2 Trends of Confirmed Malaria Cases in the Year……..

| Month | Microscopy | | Number of *P. falciparum* | Number of *P.vivax* | Number of *P.malarae* | Number of mixed infection | Remark |
|---|---|---|---|---|---|---|---|
| | Total examined | Total positive | | | | | |
| July | | | | | | | |
| August | | | | | | | |
| September | | | | | | | |
| October | | | | | | | |
| November | | | | | | | |
| December | | | | | | | |
| January | | | | | | | |
| February | | | | | | | |
| March | | | | | | | |
| April | | | | | | | |
| May | | | | | | | |
| June | | | | | | | |

2.3 Trends in Malaria Admission in the Year ……

| Month | All age groups (including under 5 years of age) | | | Under 5 years of age | | | Remark |
|---|---|---|---|---|---|---|---|
| | Total all cause inpatient cases | Total inpatient malaria cases | Total confirmed inpatient malaria cases | Total all cause inpatient cases | Total inpatient malaria cases | Total confirmed inpatient malaria cases | |
| July | | | | | | | |
| August | | | | | | | |
| September | | | | | | | |
| October | | | | | | | |
| November | | | | | | | |
| December | | | | | | | |
| January | | | | | | | |
| February | | | | | | | |
| March | | | | | | | |
| April | | | | | | | |
| May | | | | | | | |
| June | | | | | | | |

2.4 Trends of Total Malaria Deaths (probable and confirmed) in the Year…….

| Month | All age groups (including under 5 years of age) | | | Under 5 years of age | | | Remark |
|---|---|---|---|---|---|---|---|
| | Total all cause deaths | Total malaria cause deaths | Total confirmed malaria cause deaths | Total all cause deaths | Total malaria cause deaths | Total confirmed malaria cause deaths | |
| July | | | | | | | |
| August | | | | | | | |
| September | | | | | | | |
| October | | | | | | | |
| November | | | | | | | |
| December | | | | | | | |
| January | | | | | | | |
| February | | | | | | | |
| March | | | | | | | |
| April | | | | | | | |
| May | | | | | | | |
| June | | | | | | | |

3. Performance of the Intervention (From Amhara regional health bureau)

| Year | Number of ITN/LLITN distributed | Population Protected by ITN/LLITN | Number of ACT courses | DDT used(Kg) | Malathion(Kg) | Abate used (litre |
|---|---|---|---|---|---|---|
| 1990 | | | | | | |
| 1991 | | | | | | |
| 1992 | | | | | | |
| 1993 | | | | | | |
| 1994 | | | | | | |
| 1995 | | | | | | |
| 1996 | | | | | | |
| 1997 | | | | | | |
| 1998 | | | | | | |
| 1999 | | | | | | |
| 2000 | | | | | | |

4. Trends of Climatic Factors in the year…….. (From National Metrological Agency for Ethiopia)

| Month | Average monthly rainfall(mm) | Minimum temperature($^{o}$C) | Maximum temperature($^{o}$C) | Remark |
|---|---|---|---|---|
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |
| January | | | | |
| February | | | | |

| | | | | |
|---|---|---|---|---|
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |