TRENDS OF MALARIA EPIDEMIC AND THE DETERMINANTS IN TIGRAY REGION

NORTHERN ETHIOPIA

By: Neway Hiruy Ambelu (MD)

Advisor: Dr.Wakgari Deressa (BSc,MPH,PhD)

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School of Public Health, Faculty of Medicine, Addis Ababa University

Approved by the Examining Board

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Chairman, Dep. Graduate Committee Signature

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Advisor Signature

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Examiner Signature

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ABBREVATIONS

ACT- Arthemesinin based Combination Therapy

CHWs- Community Health Workers

FMOH- Federal Ministry of Health

ITN- Insecticide Treated Net

OPD- Out-Patient Department

WHO- World Health Organization

ABSTRACT

Background: The occurrence of malaria in Ethiopia has been documented since 1958. Since then epidemics with different magnitude have occurred that caused significant morbidity, mortality and considerable socio economic burden. The country has witnessed recurrent epidemics of the disease, resulting in grave consequences including in areas designated as highland fringe. Scrutinized analysis of trends of malaria over longer period of time gives valuable information to tackle subsequent epidemics and helps for evaluation of interventions and sound planning in a resource limited country like Ethiopia.

Objective: assess trend of epidemic malaria and its determinants in Tigray region between 2001 and 2008.

Methods: A Retrospective 8 years data were collected from health facilities in Tigray region between 2001 and 2008. Data were collected on structured and pretested tools by trained data collectors. Data were cleaned and entered in to SPSS, version15, and analyzed for results.

Results: Overall in the study area malaria accounted for 28% of all outpatient consultations made, 32.6% of all admissions and 22.6% of all deaths that had occurred in health facilities in the entire studied periods, between 2001 &2008. There were decreased admissions and deaths after late 2006. The cessations of treatment of febrile individuals by community health workers(CHW) at their vicinity since the late 2006, has increased the flow of outpatient consultations to health facilities ,inflating malaria specific consultations in all facilities and malaria specific admissions in health centers in the late 2006 and 2007. Prior to 2006 indoor residual insecticidal spray was mainstay of vector control in the region but later in 2006 long lasting insecticide treated nets(ITN) distribution became the mainstay and at the same time Arthemesinin based Combination Therapy(ACT) was deployed in most weredas under study.

Conclusions: The deployment of Arthemesin Combination Therapy (ACT) and scale up of distribution of long lasting insecticide treated nets (ITN) in 2006 was followed by the decreased trend of malaria outpatient consultations, admissions and death in the region in 2007. The preventive intervention being employed should be sustainable and ongoing surveillance is needed to monitor their effectiveness. Further studies are needed to evaluate other factors that affect the dynamic of malaria transmission.

1. **INTRODUCTION**

Malaria is a major cause of morbidity, mortality and poor economic development particularly in sub-Saharan African countries. It affects young and pregnant women in endemic areas and all age groups in moderately endemic areas. Population most at risk are those living in highlands, arid and desert fringe zones as well as those living in areas where successful control measures have not been consolidated or maintained.

In the last five decades malaria epidemics with different magnitudes that negatively affected the country`s economic development had occurred (1, 2). During those decades many efforts had been made to prevent and control the disease but ended with limited success. When control measures were taken, they were often too late and were implemented with minimal coordination and expertise, resulting in only a marginal benefit.

Infectious and communicable diseases account for 60-80% of the health problems in Ethiopia. Malaria, helminthes and respiratory infections are the major cause of out patient visit at health institutions in the country. For example between 2001 and 2005 the proportion of malaria outpatient consultation, admission and death showed progressive increment in the country. The highest proportion was observed in 2003 and 2004. In 2005, though slight reduction was observed relative to 2003 and 2004, malaria remained the leading disease reported from health facilities accounting for 48% of outpatient consultations, 20% of admissions and 24.9% of death (3).

In the country , in 2003, 3000 malaria deaths was reported , but considering non documented malaria death occurring out side the health facilities , it has been estimated that malaria has caused over 45,000 deaths. Tigray was one of the regions, among other three regions, that had exhibited high malaria fatality rate in the year mentioned (3).

In health facilities located in the north western and southern part of Tigray , malaria ranked first in all top new outpatient consultations ,admissions and deaths between 2003 and 2007 (4-8).

This study assess trend of malaria epidemic between 2001 and 2008 in Tigray region.

2. **LITRATURE REVIEW**

2.1. **Malaria**

Malaria is an infectious disease caused by a protozoal plasmodium species, which is transmitted to human beings through bites of infected anopheles mosquito. Though there are hundreds of plasmodium species only four are important in causing disease in humans. These are *P. falciparum*, *P.malariae, P. vivax*, and *P. ovale (9)*. The four species are not evenly spread across the malaria affected areas of the world and of these, *P. falciparum* and *P. vivax* are the most common, and almost all malaria deaths are caused by the species *P. falciparum* .Severe falciparum malaria has a case-fatality rate of around 10% in reasonably well-equipped hospitals. *(10)*.

Studies done in Ethiopia since the 1930s, have revealed that *P. falciparum* and *P.vivax* are the two epidemiological important parasites (11). They are prevalent in all malarious areas in the country and their relative composition generally is 60% and 40% of the malaria cases respectively. *P. malariae* accounts for less than 1% and *P.ovale* has never been reported from health facilities (3).

The female *Anopheles* mosquito is the vector of malaria parasites. There are more than 400 different species of *Anopheles* mosquitoes throughout the world, but only some 60 of these are vectors of malaria under natural conditions. Most areas have multiple species of *Anopheles*, and different ones occur in different parts of the world. Highly efficient species such as *A. gambiae, A. arabiensis and A. funestus* predominate in Sub Sahara Africa (10). The major malaria vector known in Ethiopia is *An. Arabiensis (3).*

2.2. **Burden of Epidemic Malaria**

Malaria remains one of the main global health problems of our time, causing at least 300 million acute cases of malaria and more than one million deaths per year, with about 90% of deaths and 60% of cases occurring in Sub-Saharan Africa. Malaria is Africa's leading cause of under-five mortality (20%) and constitutes 10% of the continent's overall disease burden.

It accounts for 40% of public health expenditure, 30-50% of inpatient admissions, and up to 50% of outpatient visits in areas with high malaria transmission (12, 13).

In Africa, malaria is a major cause of health and economic problems. Annual economic growth in countries with high malaria transmission is lower than in countries without malaria. It is estimated that in some African countries malaria is responsible for a growth penalty of up to 1.3% per year. Malaria also imposes a direct impact on human resources by resulting loss of life and lost productivity due to illness and premature death. It also hampers children's schooling and social development through both absenteeism and permanent neurological and other damage associated with severe episodes of the disease (10).

The impact of malaria on economic and social development is greater in a country where agriculture is the major economic activity, this is due to peak malaria transmission and disease occurs at the high times of planting and harvesting seasons. Fertile lowlands and major river valleys have not been fully inhabited and developed largely due to high malaria transmission in these areas. Due to fear of malaria in the lowlands the populations are largely settled on the highlands which has caused over- population, ecological degradation, and reduced productivity and hence famine and poverty. Malaria also impedes flow of trade, foreign investment and commerce. Health facilities are also overwhelmed with patients and a lot of resources are required to deal with the emergency situation (14).

In 1958 Ethiopia experienced an epidemic that caused 3 million cases and 150,000 deaths. Still after five decades, Over 5 million episodes of malaria cases are estimated to occur in Ethiopia. The number of malaria cases reported from health institutions are very much underestimated than the number of cases occurring every year due the fact that the rural majority has limited access to health facilities and also rural people tend to seek traditional remedies due to greater accessibility and low cost. Similarly malaria deaths from health institutions are underestimated for most malaria deaths occur at home even with out prior medical consultations (1, 15, 16).

A community based cross sectional study done in Ethiopia, in Butajira wereda, in 1998 indicated that malaria accounted for 26% of illness during a two week recall period and 9% of deaths with in the preceding two years (17). The disease has been consistently reported as one of the three top leading causes of morbidity and mortality over the past years. Between 1996 and 2006 malaria accounted for 10-40% of all new outpatient consultations, 13-26% of all admissions and 13-35% of institution deaths (11).

Similarly in Ethiopia, in2004/05, it has been reported as the first cause of morbidity and mortality accounting for 16.6% Out-patient consultations , 15.0% admissions and 29.0% deaths (3). A retrospective record review study done in one of regions of Ethiopia,Oromiya, showed that malaria cases had increased from 10.6% in 1995/96 to about 15% in 1998/99 (18). In the same region it has been indicated that there was a steady increase in trend of malaria cases since 1980, with exception of 1999/00 & 2000/01, until 2005, and the incidence of malaria in 2003 epidemic showed a six fold increase on average from the threshold level (19, 20).

In Ethiopia, majority of malaria diagnosis is made clinically for example , between 2001 and 2005, 9.4 million annual average number of malaria cases was reported while the annual average number of confirmed cases was 487,984. Health indicators from Ministry of Health have showed that proportion of malaria in out patient department, admission and in-patient deaths has been increasing with the highest being recorded in 2003 and 2004 particularly in the Oromiya, Amhara, Tigray, and SNNP regions. While a slight reduction was observed in 2005 (3).

2.3. **Pattern and determinants of malaria transmission**

Malaria epidemic can be described as a sharp increase in the frequency of malaria transmission that exceed by far the inter-seasonal variation normally experienced or as the occurrence of cases in excess of the number expected in a given place and time period. The term ‘normal’ or ‘expected’ is difficult to define and is largely depends on the previous experience of the eco-epidemiologic areas. A more strict definition is a rise in incidence by more than two standard deviations, above the historical monthly mean (2, 21).

Patterns of malaria transmission and disease vary markedly between regions and even within a country. A degree of diverse malaria prevalence was found to be associated with meteorological variations, geographical topography and human activity such as re-settlement and land-use (12, 22, 23).

Climate variability played an important role in initiating malaria epidemics in the East African highlands (24). Most of the major epidemics of malaria in Ethiopia have their cause in changes in meteorological conditions, such as abnormally high or low rainfall, unusually increased air temperature and humidity. The epidemics were significantly more often preceded by a month of abnormally high minimum temperature in the preceding months (2, 25).

Ethiopia has both epidemic and endemic malaria in the high and lowland regions, respectively. Sub-Saharan Africa countries with exception of those having highland areas have stable type of malaria transmission and Ethiopia contributing about 50% of highlands of Africa has mostly unstable type of malaria transmission. In Ethiopia, about 75% of the landmass is potentially malarious and about 2/3rd of the population are at risk of infection (11).

In Tigray region, apart from ecological and meteorological factors, settlement programs from overused highlands to fertile low lands, migration of large number of seasonal laborers to malaria endemic areas of the regions are some of the major population dynamics related factors that had contributed for increased malaria transmission. A study in Cameroon revealed that the distribution of major malaria vectors is strongly affected by the impact of humans on the environment and is inversely proportional with variables related to proximity to human settings (26).

Developmental activities often create suitable environment for malaria vector breeding and there by increase malaria incidence especially if health issues were not addressed in planning phase of projects. For example, in Tigray alone 90,000 ponds were dug and they contributed to at least one epidemic of malaria in the Raya Azebo district in 2005 (15, 27). A study done in Tigray that compared the incidence of malaria in children living in ,study, villages 3km and , control, village 8-10 km away from a micro dams , showed that the incidence of malaria in the study village has increased by seven fold compared with those in the control village (28).

2.4. **Malaria Control Interventions**

Malaria control activity in Ethiopia dated as early as 1950s. In 1960s national eradication campaign was started but later it was learnt that eradication was not realistic strategy and the program was reorganized in to malaria control program in the early in 1970s. In 1976 a vertical structured organization, known as National organization for control of malaria and other vector borne diseases, was established and was operating until the 1993`s decentralization of administrations , at which time the once vertical malaria control program was integrated in to other basic health services program and fell under the responsibilities of regional health bureaus (29).

Currently Ethiopia employs four main strategies for malaria control and prevention. These include early diagnosis and prompt treatment, selective vector control methods that include indoor residual spraying of houses (IRS) & personal protection measures including ITNs , malaria epidemics early detection and control and prevention of malaria during pregnancy (30).

Vector control methods in malaria prevention are taking place in the form of indoor residual spraying of houses and insecticide-treated mosquito nets. Both of these preventive interventions can result in major reductions in malaria transmission and related burdens (14).

IRS is the most widely used chemical method for vector control in the highland fringe areas that are prone to epidemics. To maximize effectiveness of IRS, spraying should be done at all individual houses with the appropriate insecticide, at sufficient concentration, on the right surface, completed near but before transmission period and at adequate intervals. In Ethiopia, DDT is widely used for IRS. In areas where vectors are DDT resistant, an alternative insecticide, Malathion is used. The insecticidal effect of DDT persists two to four times longer than that of Malathion (31).

ITN protects from mosquitoes by being mechanical barrier and through their effect of repellent and toxic effect of the insecticide used to impregnate the nets. ITN are effective more when the target vectors are primarily human biting (anthropophilic), when they selectively feeds indoor (endophagic) and when the peak feeding times occur when people are under protection of ITN. Deltamethrin and Premethrin are the insecticides used in Ethiopia to impregnate nets (31).

ITN are generally distributed in areas where malaria transmission occurs for more than 3 months of the year.

In 2005, a nationwide survey estimated that 3.4% of households in Ethiopia owned an ITN and 0.3% households owned more than one ITN. The same survey indicated that in Tigray 8.9% of households owned an ITN (32). However, the Tigray Regional Health Bureau had indicated that it had distributed high number of ITN soon after the nation wide survey was conducted (7).

In 2004, Federal Ministry of Health put a strategy to cover at least 60% of households in targeted areas with two ITNs by 2007. A nationally representative malaria indicator survey conducted in Ethiopia between September and December 2007 indicated that 65.6% of surveyed households owned at least one ITN (33).

A study done in Gambia has showed that Sleeping under impregnated nets was associated with an overall reduction in mortality of about 60% in children aged 1-4 years (34). Another study also indicated that ITN reduced the incidence of uncomplicated malarial episodes in areas of stable malaria by 50% compared to no nets, and 39% compared to untreated nets; and in areas of unstable malaria: by 62% for compared to no nets and 43% compared to untreated nets for Plasmodium falciparum episodes (35).

Anti-malarial medicines remain one of the most powerful tools in controlling and preventing malaria epidemics. The biological diversity of *P. falciparum and* its ability to develop resistance to a number of anti-malarial drugs has forced malaria endemic countries to revise their anti malaria drug treatment policy.

In Ethiopia, the high treatment failure rate of chloroquine for the treatment of uncomplicated falciparum malaria was indicated through a nationwide study conducted in 1997/98. Based on the study treatment policy change was made that recommended the use of Sulfadoxine-Pyrimethamine as first line drug for the treatment of uncomplicated falciparum malaria and chloroquine for the treatment of vivax malaria. At the time of the introduction, the treatment failure level of sulfadoxine-pyrimethamine was around 5%. After five years a nationwide study on the therapeutic efficacy of Sulfadoxine-Pyrimethamine for the treatment of uncomplicated falciparum malaria was conducted and the result showed a mean treatment failure rate of 35.9% on the 14-days follow-up and 71.8% on the 28-days follow-up (36).

Alarmed by the high level treatment failure of Sulfadoxine-Pyrimethamine to falciparum malaria and by the malaria epidemic that affected the country in 2003 and 2004, Ethiopia introduced the use of ACT as first line of treatment for falciparum malaria in july,2004 and full implementation was started in early 2005 (3).

Medication reduces morbidity and mortality by terminating a malaria infection in a patient and curtails malaria transmission by diminishing the parasite reservoir. Treatment with ACT significantly reduces infectiousness of individual patients with uncomplicated falciparum malaria compared to previous first line treatments (37).

A study done in four African countries in 2007, including Ethiopia, showed that after nation wide distribution of long lasting insecticidal nets and Arthimesine combination therapy (ACT) a significant reduction in the number of under-five in patient malaria cases and deaths have occurred (38).

In Kenya a decline in pediatric admission was showed after introduction of ITN and ACT (39). In Zanzibar following deployment of ACT in 2003, malaria-associated morbidity and mortality decreased dramatically within two years and additional distribution of LLINs in early 2006 resulted in a 10-fold reduction of malaria parasite prevalence (40) .

A review of malaria morbidity and mortality data between 2000 and 2003 at four sentinel health-care facilities within KwaZulu–Natal's province of South Africa, , indicated declination of malaria-related admissions and deaths both by 89%, and outpatient visits by 85% after the implementation of improved vector control and AL treatment (41).

3. STATEMENT OF THE PROBLEM

To decrease burden and impact of malaria, monitoring trend of morbidity and mortality of the disease based on accurate and timely data is necessary. Data from health facilities, though doesn`t reflect the real situation in the community, can be used to evaluate the impact of intervention and take measure accordingly. After 1993`s decentralization of administration, the once vertical malaria control program was integrated in to basic services and has been placed under the responsibility of regional health bureaus. As a result malaria related data reporting system has been altered.

In Tigray region, each primary care health institution, including health centres, clinics and health posts report indicators related to malaria program to Wereda Health Office on a monthly basis. Similarly, hospitals also report on the same time basis but to the regional health bureau. The compilation of the Wereda Health Offices and hospital reports comprise the routine data sets in the Regional Health Bureau.

Omission, delayed reporting and duplication of data when reporting to the higher ladder of regional health bureaus, have still been reported problems to generate reliable information. This study tried to decrease the gap by collecting malaria and intervention data from health facilities and wereda health bureaus, respectively.

Besides the operational studies done by Tigray Regional Health Bureau, few studies have been done to evaluate trend and impact of the intervention in the region. In 2003 Tigray Regional Health Bureau had prepared a three years strategic plan to reduce malaria prevalence by 25% in 2006. However, the report made by the health bureau in 2006 showed that malaria admission and death rate increased between 2004 and 2006 and the out patient consultation rate hasn't shown decrement to meet the target set in 2004 . It was reasoned that there was delayed deployment of ACT and the planned massive ITN distribution was partially too late to cover the major malaria season of 2005/06 and the bureau put assumption that the study done in 2006 might be too early to indicate the impact of the interventions made (8, 42). Thus this study tries to complement the gaps observed in 2006 by studying trend of epidemic malaria and impact of interventions between 2001 and 2008.

In another study done in 2007, in four African countries including Ethiopia, Tigray was one of the sampled four regions. But it was represented by multistage sampling by two hospitals and two health centers located in the southern and central part of the region (43).

Malaria distribution shows variations from place to place. Therefore it is important to study each epidemic prone area according to its topographic, socio-demographic, and ecological factors. In Tigray region, Population movement and man made ecological changes have been implicated as causes of increase malaria transmission and disease burden. Between 2003 and 2006 around 150,000 people were voluntarily resettled to the relatively fertile but malarious areas of north western Tigray , in addition hundred thousands of seasonal laborers migrate to this area in search of work .this movement of non or semi-immune people increases the incidence and severity of the illness (20, 44).

This study paper is prepared based on data collected from more than fifty health facilities, located in the fourteen malarious weredas of southern, central and north western part of Tigray, thus it can yield a complete picture of malaria trend in the region.

Analysis of data over long periods for trends allows using such information as an important input for control and prevention related sound planning in limited resource countries like Ethiopia. Scrutinized analysis of trends of malaria epidemic along with reasoned natural and man made factors gives invaluable information to combat subsequent epidemics

4. Objectives

4.1. General objective

- To assess the trend of epidemic malaria and its determinants in Tigray region between 2001 and 2008.

4.2. Specific objectives

- To assess the trend of out patient malaria consultation in Tigray region between 2001 and 2008.
- To assess the trend of malaria admission in Tigray region between 2001 and 2008.
- To assess the trend of malaria related deaths in Tigray region between 2001 and 2008.
- To overview the impact of interventions on trend of epidemic malaria between 2001 and 2008.

5. **METHODS**

5.1 Study design

A Health Facility based descriptive study was done to assess the pattern of epidemic malaria between 2001 and 2008.

5.2. Study area

The study was conducted in Tigray, one of the nine national regional states of Ethiopia which is located in the northernmost of the country between latitude of 12^o and 15^o north. The region covers 80,000 square kilometers and is bounded on the north by Eritrea, on the south by the Amhara Regional State, on the east by the Afar Regional State, and on the West by Sudan. It has seven zones and thirty five weredas (4).

The northwestern and southern parts of the region are lowlands, 700-1500 meters above sea level and the central part is mostly highlands measuring around 1500-3000 meters above sea level (27). The Population of the region according to the 2007 census is 4,314,456 and80.5 % of the population is rural (45).

Population density ranges from 5 per square kilometer in lowland areas to 120 per square kilometer in the highlands.

The main rainy season is from May to September, with most rains falling in June and July. In southeastern Tigray additional rain falls during January and February, providing sufficient moisture for a second harvest. Mean annual temperature is 18^oC (27).

Tigray has over 600 Health Posts, 42 Health Centers, 7 District Hospitals, 5 Zonal Hospitals and two Referral Hospital in Mekelle. The health service utilization rate of Tigray is 0.83 and ranges between 0.27 in Degua Tembein to 3.58 in Kafta Humera (4).

5.3. Target and Study population

The target populations are all microscopically and clinically diagnosed malaria patients in all health facilities that are found in malaria endemic weredas of Tigray region between 2001 and 2008. The study populations are all microscopically and clinically diagnosed malaria patients in the 51 selected health facilities that are found in the twelve selected malaria endemic weredas of Tigray region between 2001 and 2008.

5.4. Sampling procedure

Malaria epidemic weredas were identified from the regional health bureau health indicators. Twelve weredas were selected by non probability convenience sampling in such a way that they fairly represent the malaria affected northwestern, central and southern parts of the region. Health facilities were selected by quota sampling method so that all levels of health facilities available in each wereda are represented.

All four hospitals and thirteen health centers found in the 12 weredas were included in the study. In addition, 9 of 39 clinics and 26 of 120 health posts found in the 12 weredas were added in the study.

In general among 300 health facilities found in the 12 weredas, records of 51 health facilities were selected to collect monthly numbers of malaria and non-malaria out patient visit, admission and death.

5.5. Sample size

In public health, trend analysis is carried out at ecological level. In other words the observation or unit of analysis are time periods (years , months) and not individuals .from this point of view the sample size in this study is eight years periods of time.

5.6. Inclusion and exclusion criteria

Health facilities, which are governmental, with five years and above after establishment, found in malaria endemic wereda of Tigray and having good health information management system were included in the study. Health facilities, which are not governmental, below five years since establishment and with poor recordings were excluded

5.7. Data collection procedures

Data collection formats were arranged in accordance with the malaria related data collection format used in the health facilities and wereda health offices so that errors will be avoided in registration process.

Twelve data collectors, who have been working on malaria control and prevention office of the selected weredas were identified and recruited. A BSc degree holder in biology and who have worked as malaria control and prevention officer in the region was recruited to train data collectors, to supervise the data collection process and to insure the quality and completeness of the data collected. Five days training was given to data collectors on the data collection format and on Health Information and Management System. The data collection has taken an average of 15 days.

Monthly sum totals of clinically and microscopically confirmed malaria outpatient visits, admission and deaths and monthly sum total of non-malaria outpatient visits, admissions and deaths from the selected health facilities were collected on the pre-prepared data collection formats for the periods between 2001 and 2008.

Yearly sum total number of ITN, amount of insecticides used in each weredas and presence of ACT in each specific years were marked on the pre prepared data collection format for the periods between 2001 and 2008.

Data quality was maintained through five days training of data collectors and 10% of the data was cross checked randomly by the principal investigator. The data collection process was supervised by two supervisors. The data was compared with regional report.

5.8. Variables

The dependent variable is trends of epidemic malaria and the independent variables being monthly average rain fall, temperature, two years moving average of ITN numbers, two years moving average of amount of insecticide used for indoor spray, and presence or absence of ACT in the years specified.

5.9. Data analysis procedure

For data analysis SPSS soft ware program version 15 and Epi Info soft ware program version 3.3.2 were used. The data was cleaned and entered in to SPSS soft ware program. Monthly missed data values were approximated by linear interpolation. The numbers of the missed values were too few compared with the large number of monthly data collected for eight years and approximating them with linear interpolation has negligible effect on results. Linear chi-square trend analysis was done for malaria outpatient visit, admission and death using Epi Info soft ware program. For the trend analysis P value less than 0.01($p<0.01$) was used as cut of point for level of significance. Average annual percent change was calculated to estimate how fast or slow change had occurred from year to year. Natural logarithmic transformation was done to smooth the trend of the dependent and independent variables so that the spatial effect of the independent factors with respect to the trend of malaria out patient visit, admission and death was illustrated smoothly using diagrams.

5.10. Operational definitions

- *Out patient malaria consultation*-all new clinically or microscopically diagnosed malaria cases at out patient department of all types of health facilities.
- *Malaria admission*- all clinically or microscopically diagnosed malaria admission at hospitals and/or health centers.
- *Malaria deaths*- all deaths in hospitals and/or health centers that are caused by clinically or microscopically diagnosed malaria.
- *Malaria fatality rate*-percentage of, number of malaria deaths in a specified period divided by number of malaria admission in a specified period at hospitals and /or health centers.

5.11. Ethical considerations

Ethical clearance was obtained from Addis Ababa University Ethical Clearance Committee. Regional and wereda health bureaus permission was sought and was granted to do the study. Only cases of malaria with out specifying identity of individual clients was collected and data unrelated to the study objective was not collected and confidentiality of any information seen during data revision was kept.

5.12. Dissemination of findings

The result will be disseminated with out delay to the regional health bureau, and Federal ministry of Health, Addis Ababa University School of Public Health and to National Meteorological Agency and possibly published in peer reviewed journal.

6. RESULTS

6.1. Out-Patient Malaria Trend

In the study area, between2001 and 2008, outpatient malaria visits accounted for 20% of all outpatient visits in hospitals, 25% of all outpatient visit in health centers and clinics and 46% of all outpatient visits in health posts. Overall in the study area malaria accounted for 28% of all out patient consultations made between 2001 &2008 (Table-1).

Table-1: All causes and malaria specific outpatient consultations made in health facilities between 2001 & 2008, Tigray Region, Ethiopia.

YEAR	CAUSES	OUTPATIENT				Total
		Hospitals	H/Centers	Clinics	H/Posts	
2001	%Malaria	17.1	19.5	19.1	40.9	24.6
	Total Malaria	10,302	31,805	8,051	37,626	87,784
	All Causes	60,340	163,068	42,215	91,936	357,559
2002	%Malaria	17.8	22.8	22.4	47.5	25.8
	Total Malaria	14,576	31,558	9,112	26,648	81,894
	All Causes	82,084	138,570	40,679	56,147	317,480
2003	%Malaria	21.3	24.1	26.6	44.6	27.1
	Total Malaria	16,146	46,560	12,050	26,328	101,084
	All Causes	75,756	193,178	45,285	59,046	373,265
2004	%Malaria	20.8	27.7	25.5	48.2	29.3
	Total Malaria	17,496	53,178	10,614	29,831	111,119
	All Causes	83,944	192,291	41,653	61,917	379,805
2005	%Malaria	23.1	29.8	26.4	45.7	30.1
	Total Malaria	22,669	66,234	13,444	27,590	129,937
	All Causes	98,023	222,342	50,976	60,414	431,755
2006	%Malaria	20.7	29.0	33.4	50.4	30.6
	Total Malaria	19,905	68,023	20,126	29,033	137,087
	All Causes	96,215	234,334	60,325	57,581	448,455
2007	%Malaria	25.4	26.9	27.1	47.5	29.6
	Total Malaria	21,659	63,061	16,379	30,683	131,782
	All Causes	85,345	234,351	60,398	64,610	444,704
2008	%Malaria	15.4	20.1	21.2	45.9	23.3
	Total Malaria	12,254	39,665	11,665	28,464	92,048
	All Causes	79,519	197,682	55,030	62,053	394,284
Total	%Malaria	20.4	25.4	25.6	46.0	27.7
	Total Malaria	135,007	400,084	101,441	236,203	872,735
	All Causes	661,226	1,575,816	396,561	513,704	3,147,307

In all weredas of the region community health workers had been treating people presumed to have malaria since 1998. In the late 2006, CHWs in most weredas had discontinued treating people due to the decision made after emergence of drug resistance for Sulfadoxine-Pyremethamine. Therefore, it is worth to see the number and pattern of the people treated by CHWs to have complete picture of malaria situation in the region. The number of individuals getting treatment for presumed malaria from community health workers decreased dramatically from mid 2005/06, with exception of Alamata wereda where pilot study has still being conducted (Figure-1).

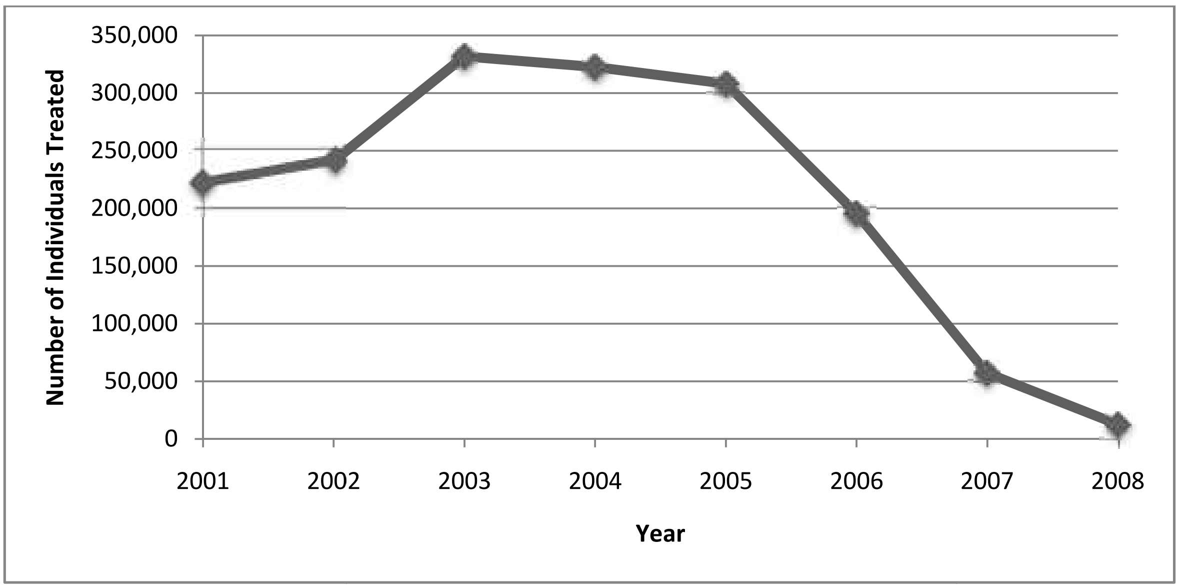

Figure-1: Trend of Annual Number of Individuals Treated by CHW for Presumed Malaria 2001 -2008, Tigray, Ethiopia.

There was steady increase of malaria outpatient consultations from 2001 to 2005 and then till 2007 it remained pleatu contributing around 30% of all outpatient consultations. In 2008 it dropped to 23% of all outpatient consultations. Over all the region had -0.25% of annual malaria OPD consultation percentage change through 2001 to 2008. (Figure-2)

With respect to type of health facility malaria OPD consultations contributed a range of 40-50 % of all OPD consultations for health posts with annual malaria out patient percent change + 1.99%, and 20-30% of all OPD consultations for both clinics and health centers with annual malaria out patient consultation percentage change of + 3 .07% and +1.4% respectively . for hospitals it contributed 20-25% of all OPD consultations with annual malaria OPD consultation change of +0.8%.(Figure-3)

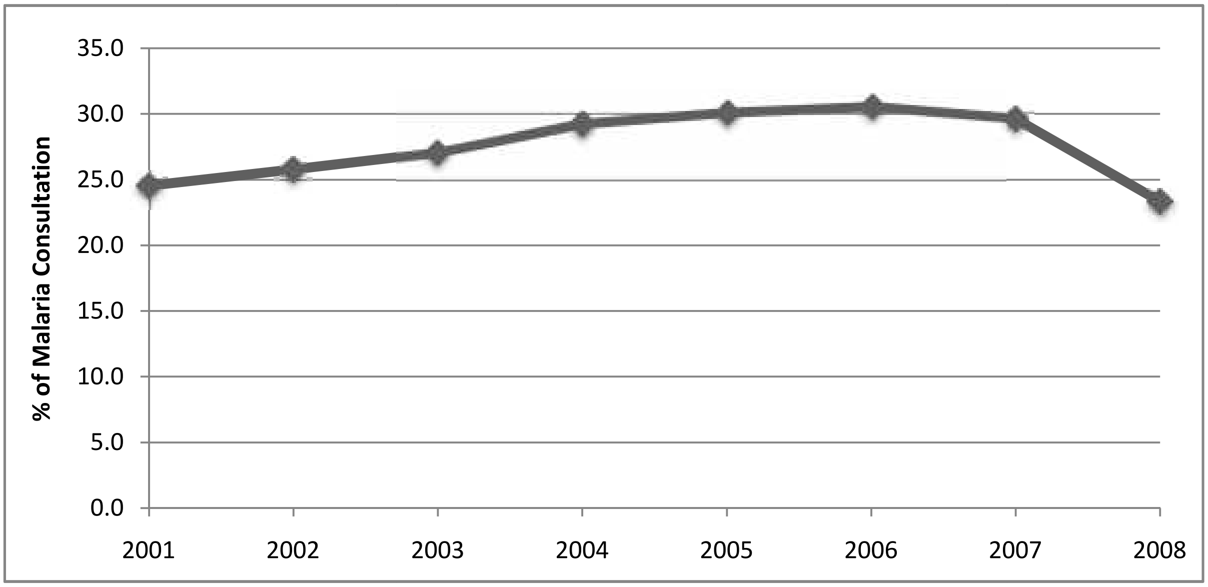

Figure-2: Overall trend of total malaria outpatient cases, 2001- 2008, Tigray, Ethiopia.

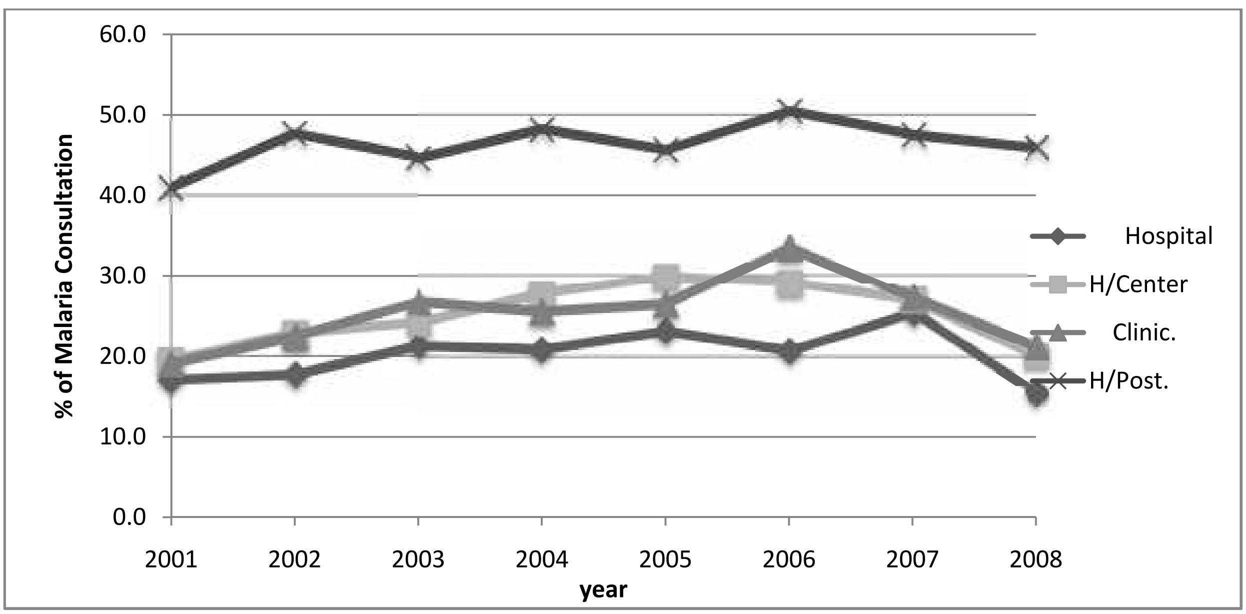

Figure-3: Trend of malaria outpatient cases in Health Facilities, 2001 – 2008, Tigray, Ethiopia.

Community health workers had rendered diagnosis and treatment at village level. In the study area, in each 2001 and 2002, they provided the service for 200 to 250 thousands of people and in each 2003, 2004 and 2005 they rendered the service for 300 to 350 thousands of people. In 2006, 2007 and 2008 the number of people receiving the treatment dropped down to 200 thousands, 50 thousands and ultimately to 10 thousands respectively. (Figure-1)

Through 2005 to 2008, as the number of people who had been receiving treatment from CHWs at village level was decreasing, the total numbers of all caused and malaria specific OPD consultations in the study health facilities steadily increased till 2007, then it steadily decreased till the end of the study period. The effect of the declined number of presumed malaria patients getting treatment from CHW was reflected on the trend of all outpatient and malaria outpatient consultation curves. (Figure- 4)

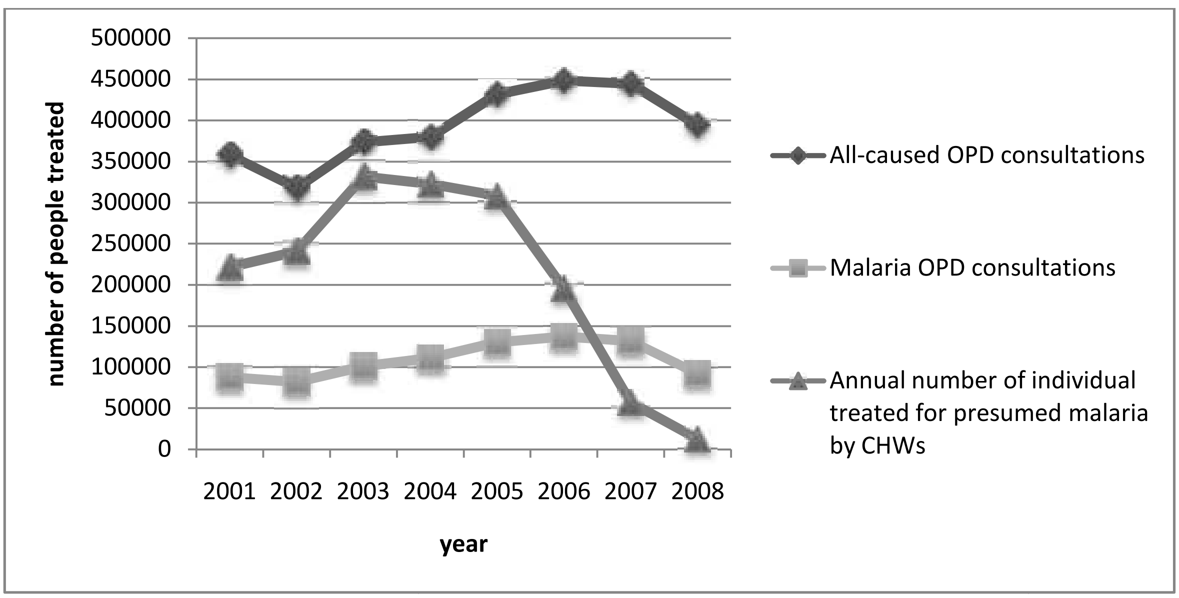

Figure-4: Trend of Total Number of All-Caused and Malaria-Caused Outpatient Consultations and Total Number of Presumed Malaria Cases Treated by CHWs, 2001 - 2008, Tigray, Ethiopia.

6.2. Trends of Malaria Admission & Death

In the study area, between 2001 and 2008, there were a total of 30,099 malaria admissions and 894 malaria deaths, which accounted for 32.6% of all caused admission and 22.6% of all caused deaths respectively. In the specified period 67% of the malaria admission and 81% malaria deaths occurred in hospitals, the rest 33% of malaria admission and 19% of malaria deaths occurred in Health centers that had inpatient service. Malaria accounted for 27.6% and 51% of all caused admission in hospitals and health centers respectively. Both types of facilities recorded higher rate of malaria admission between 2002 and 2006 (Table-2)

Table-2: All Causes and Malaria Specific Admissions and Deaths, 2001 - 2008, Tigray Region, Ethiopia.

Year	Causes	Hospitals		H/Centers		Total	
		Admission	Death	Admission	Death	Admission	Death
2001	%Malaria	21.3	23.2	48.5	26.9	28.5	23.4
	Malaria	1,612	86	1338	7	2,950	93
	All Causes	7575	371	2758	26	10333	397
2002	%Malaria	34.1	32.0	35.8	39.5	34.6	32.6
	Malaria	2,014	139	888	17	2,902	156
	All Causes	5913	435	2477	43	8390	478
2003	%Malaria	32.6	26.7	46.5	42.4	36.3	28.2
	Malaria	2,494	164	1303	28	3,797	192
	All Causes	7659	614	2805	66	10464	680
2004	%Malaria	34.3	21.5	64.5	55.6	41.3	26.2
	Malaria	2,693	109	1519	45	4,212	154
	All Causes	7,843	507	2356	81	10199	588
2005	%Malaria	37.5	16.6	56.6	42.2	40.3	19.8
	Malaria	4,873	75	1248	27	6,121	102
	All Causes	12,989	451	2206	64	15195	515
2006	%Malaria	29.2	14.6	55.7	53.6	36.5	17.2
	Malaria	3,041	56	2239	15	5,280	71
	All Causes	10,429	384	4023	28	14452	412
2007	%Malaria	16.9	13.2	60.8	36.5	23.9	15.9
	Malaria	1,599	52	1083	19	2,682	71
	All Causes	9,453	394	1782	52	11235	446
2008	%Malaria	16.5	10.4	29.8	36.4	17.7	12.4
	Malaria	1,828	43	327	12	2,155	55
	All Causes	11,056	412	1099	33	12155	445
Total	%Malaria	27.6	20.3	51.0	43.3	32.6	22.6
	Malaria	20,154	724	9945	170	30,099	894
	All Causes	72,917	3568	19506	393	92423	3961

In the health centers that had inpatient services, malaria specific admission shows more irregularities than that of hospitals through out the study period. In 2001, malaria was responsible for 48.5% of all caused admissions, and then in 2002 it dropped to account for 35.8%, in 2003 and 2004 it raised, to account for 46.5 and 64.5% of all caused admissions respectively. In both 2005 and 2006 the malaria was responsible for 55% of admissions but in 2007 it surged up to account for 60% of all admissions. In 2008 malaria contribution to all caused admission dropped to around 30%. (Table-2 and Figure-5)

In hospitals, from 2001 to 2002 malaria contribution for the all caused admission increased from 21 to 34%, then between 2003 and 2005, the contribution ranged between 32 and 37% of the total admission. In 2006 it dropped to 29% and for the subsequent two years, 2007 & 2008, the contribution further dropped to 16%. (Table-2 and Figure-5)

Overall in the study area, malaria contribution for the total admission progressively increased from 28.5% in 2001 to 40.3% in 2005, then in 2006 it declined to 36.5% and in the subsequent years of 2007 and 2008 malaria contribution for the total admission dropped to 23.9 and 17.7% respectively. (Table-2 and Figure-5)

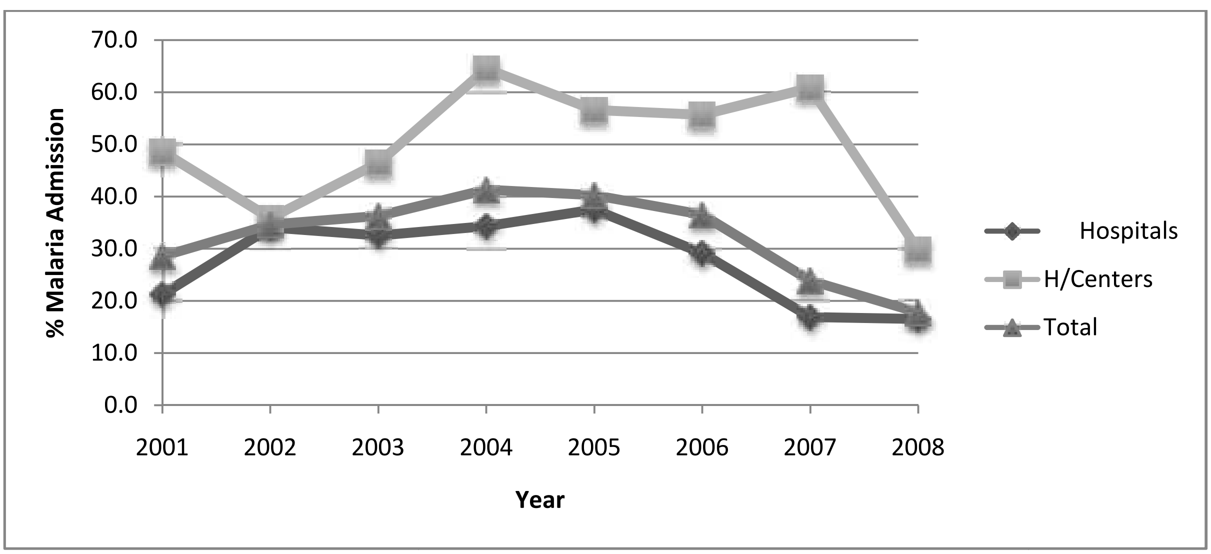

Figure-5: Trend of Combined and Type Specific H/Facility malaria admission, 2001 - 2008, Tigray, Ethiopia.

In the study area malaria death pattern was also more irregular in health centers than in hospitals through out the study period. In the health centers that had admission service, malaria contribution for the total death increased from 26.9 to 39.5% for the years of 2001 and 2002 respectively. In 2003 and 2005 malaria death was responsible for 42% of all deaths, and in 2004 and 2006 it was responsible for around 54% of all deaths. The contribution decreased and remained at 36% in 2007 and 2008. (Table-2 and Figure-6)

In the hospitals under study, malaria contribution for the total death increased from 23.2 to 32.0% for the years of 2001 and 2002 respectively. Then through 2003 to 2008 the contribution of malaria death to the total death decreased smoothly from 26.7 to 10.4% respectively. (Table-2 and Figure-6)

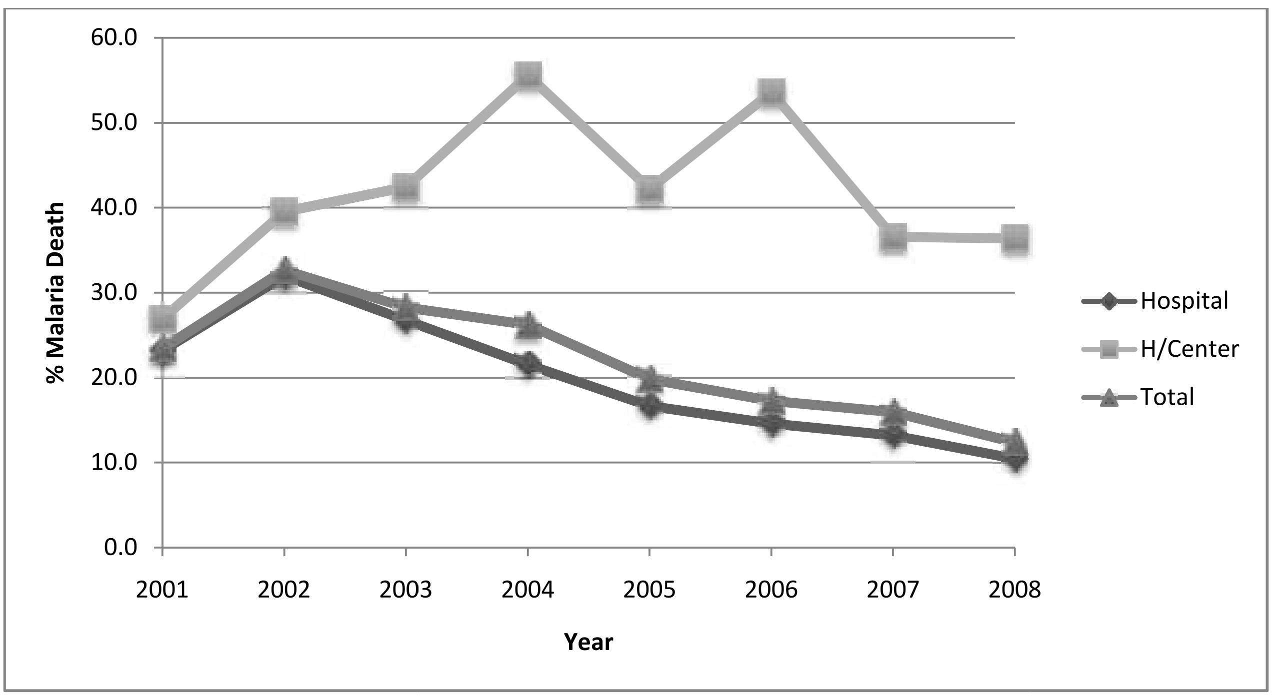

Figure-6: Trend of Combined and Type Specific Health Facility Malaria Death, 2001 - 2008, Tigray, Ethiopia.

Annual malaria admission percentage change through 2001 to 2008 was +0.55% and -1.92% for hospitals and health centers respectively but the overall combined annual percentage change was - 4.61%. The annual malaria death percentage change through 2001 to 2008 was -9.06% and +7.96% for hospitals and health centers respectively but the overall combined annual percentage for malaria was -6.97%. Chi-squares for trend analysis through 2001 to 2008, are significant for malaria OPD consultations, admissions and deaths with P-value <0.001. In 2008, there was 23.6%, 51.5% and 28% of reduction in malaria OPD consultations, admissions and deaths compared to 2005.

Malaria case fatality rates for hospitals understudy were 5.33, 6.90, 6.58, and 4.05 in 2001, 2002, 2003 and 2004 respectively. For the two subsequent years of 2005 and 2006 it dropped to 1.54 and 1.84 respectively but again increased to 3.25 and 2.35 in 2007 and 2008 respectively.

Malaria case fatality rates for health centers understudy that rendered admission service were 0.52, 1.91, 2.15, and 2.96 in 2001, 2002, 2003 and 2004 respectively. For 2005 and 2006 the case fatality rates were 2.16 and 0.67 respectively but again it increased to 1.75 and 3.67 in 2007 and 2008 respectively.

In general , the malaria case fatality rate for health facilities understudy that rendered admission service were 3.15, 5.38,5.06 and 3.66 in 2001,2002,2003 and 2004 respectively and showed decrement in 2005 and 2006 to 1.67 and 1.34 respectively. But in 2007 and 2008 the case fatality rate increased again to 2.65 and 2.55 respectively. (Figure-7)

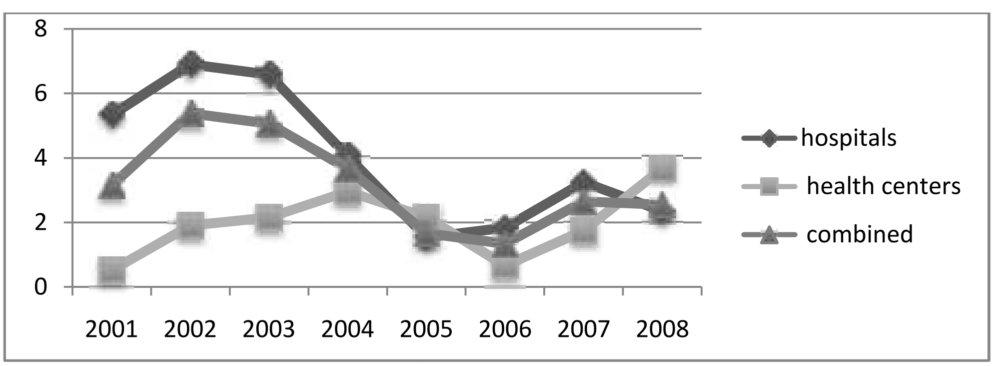

Figure-7: Trend of case fatality of malaria in hospitals and health centers between 2001 and 2008, Tigray Region, Ethiopia.

Between 2004 and 2007, as the logarithm function of total number of all-caused admission and total malaria admission showed increments, the logarithmic function of total number of all caused death and malaria caused death showed decrements. (Figure-8)

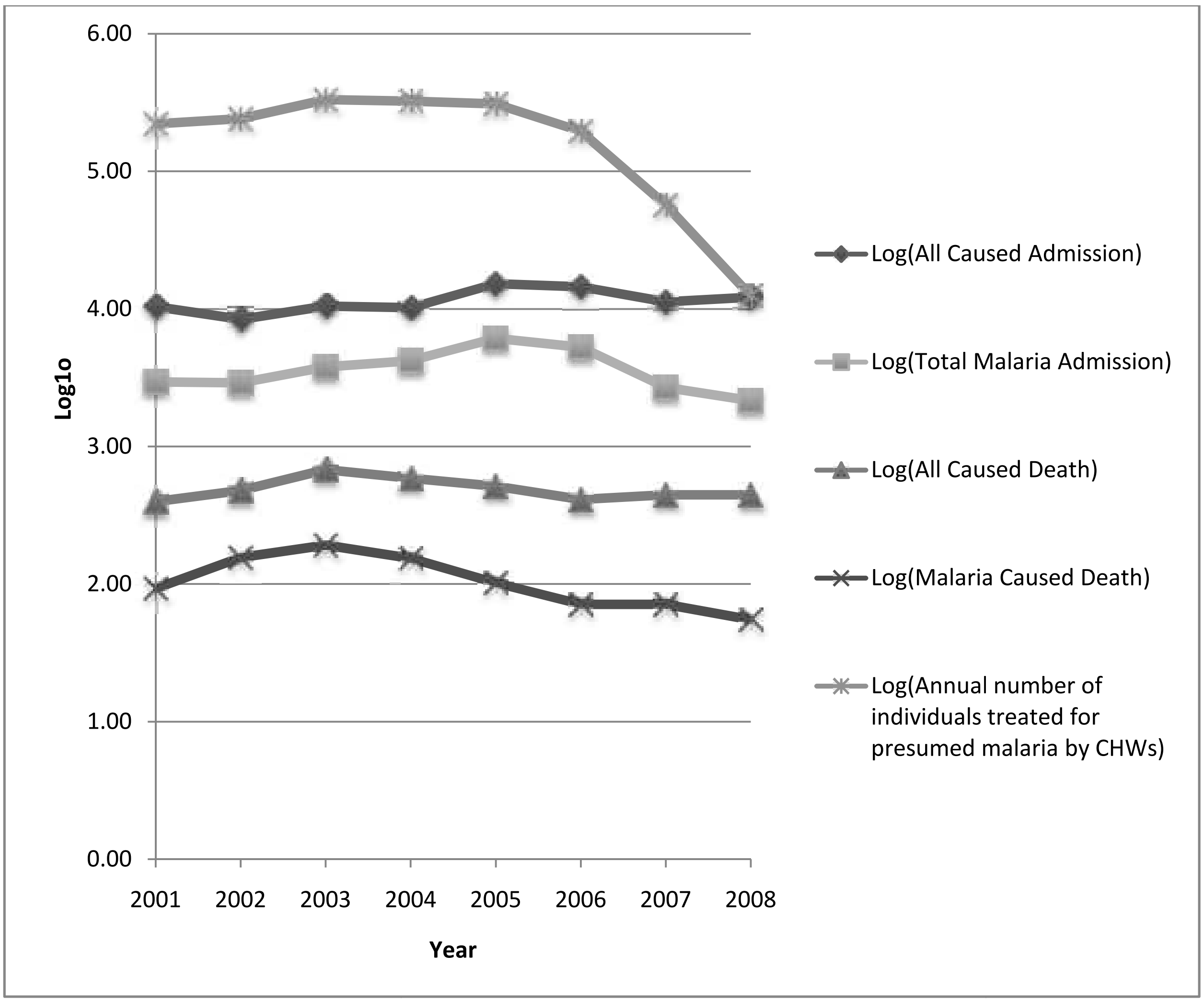

Figure-8: Trends of All Caused and Malaria Specific Admission and Death, 2001 – 2008, Tigray, Ethiopia.

6.3. Epidemic malaria and climate

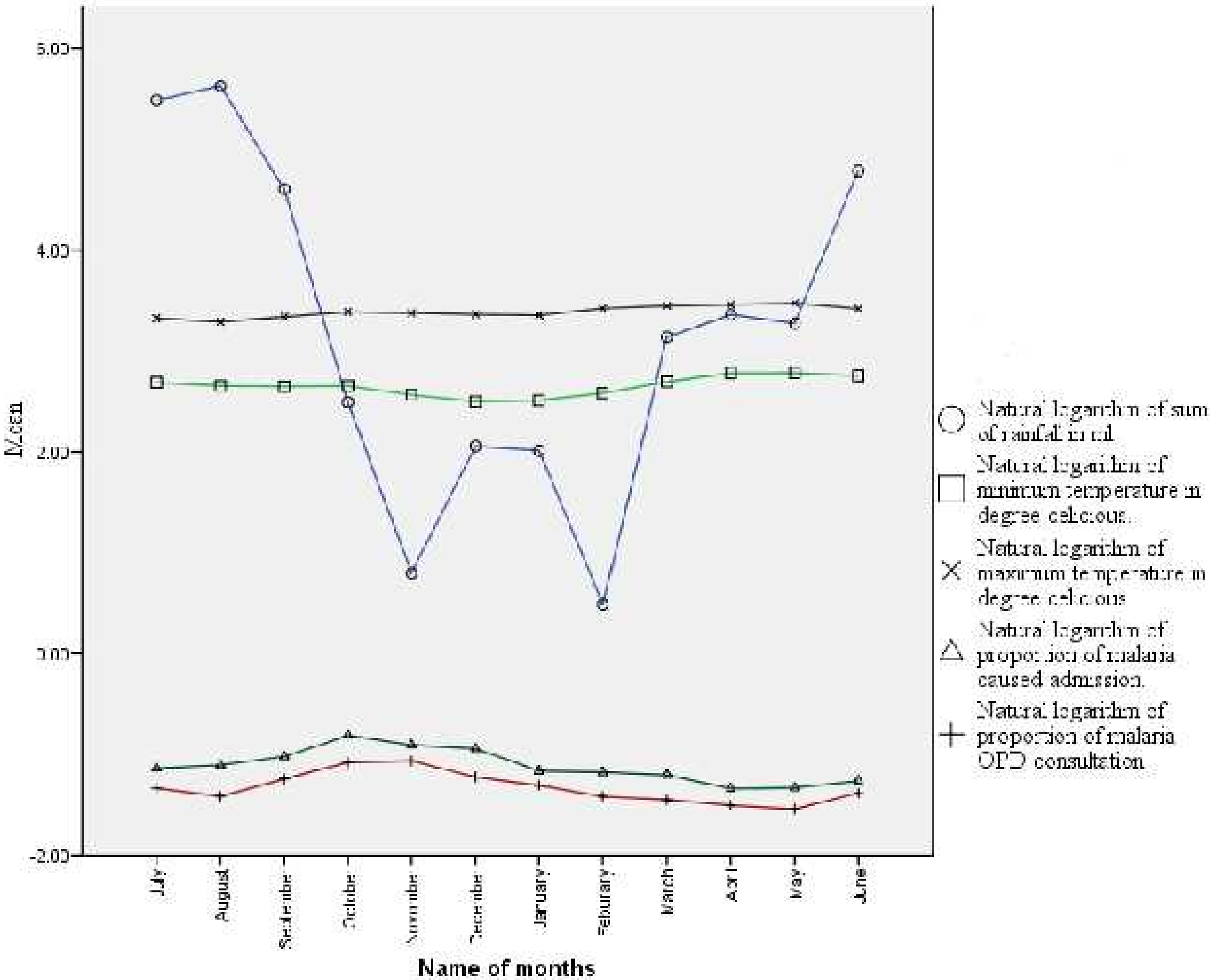

Figure-9: Comparison of trends of malaria OPD consultations and malaria admission, rainfall maximum and minimum temperature (^{o}C) with respect to months of a year, Tigray, Ethiopia.

There was higher number of outpatient visits, admissions and death in all types of health facilities between the month of September and December in the years under study. The number of individuals treated by community health workers was also higher in months of September, October, November and December. Peak malaria out patient visit & admission months were preceded by high rain yielding months. The same is true for peak of number of patients treated by community health workers. (Figure-9)

6.4. Malaria Epidemic and intervention

Indoor insecticide spray was one of the mainstays of malaria prevention strategies from 2001 to 2005. Distribution of ITN in the region has been started in 2001 and was used as malaria prevention strategy along with indoor insecticide spray. From 2005 onwards the number of ITN distributed in the region has increased whereas the amount of insecticide used for indoor spray has decreased. In most of the weredas ACT distribution was started in 2005 after resistant was proved for sulfadoxine-pyrimethamine.

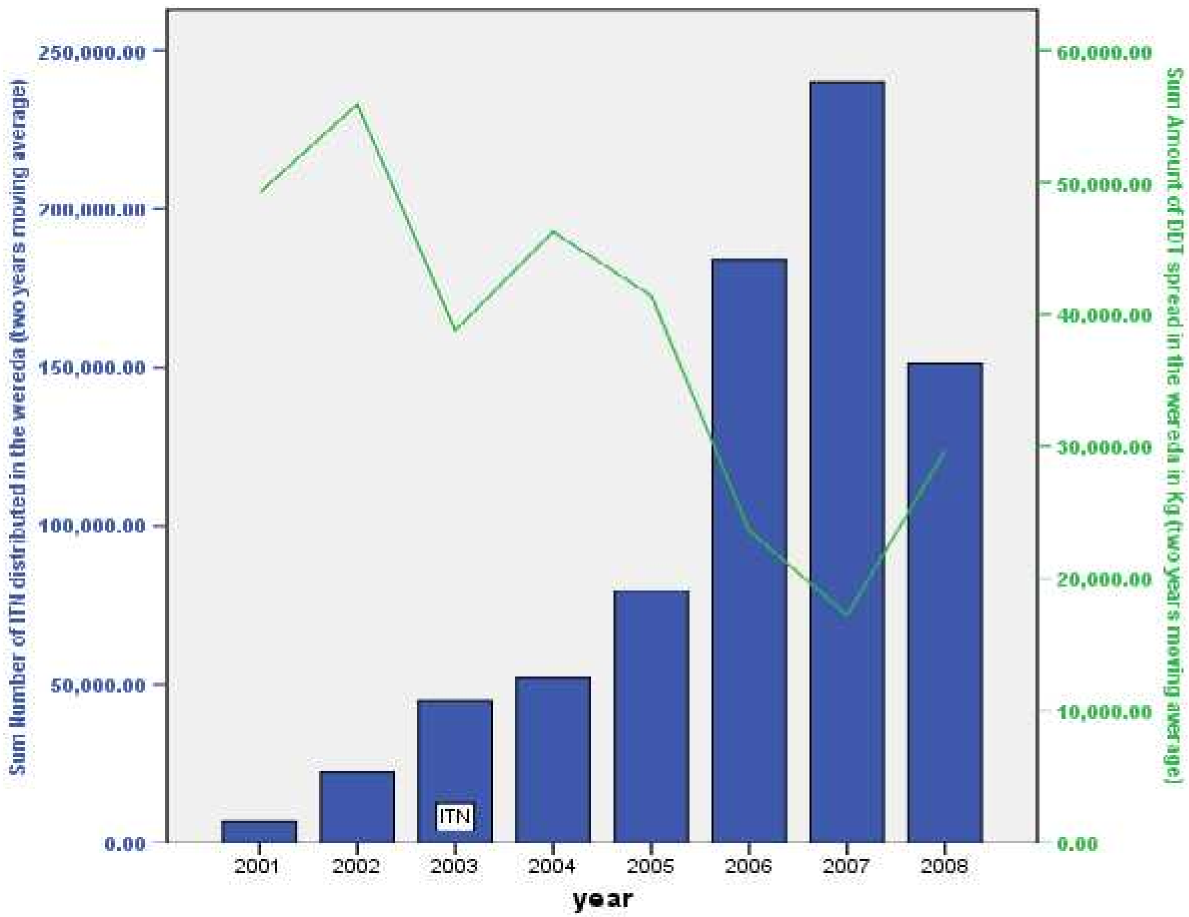

Figure-10: Two years moving average of yearly ITN distribution and amount of insecticide used for IRS , 2001- 2008,Tigray, Ethiopia.

The scale up of ITN distribution in the in 2006 and 2007 was followed by the decrement of trends of all-caused and malaria OPD consultations after 2007; though the decreased number individuals getting treatment from CHWs might affect the magnitude. (Figure-11)

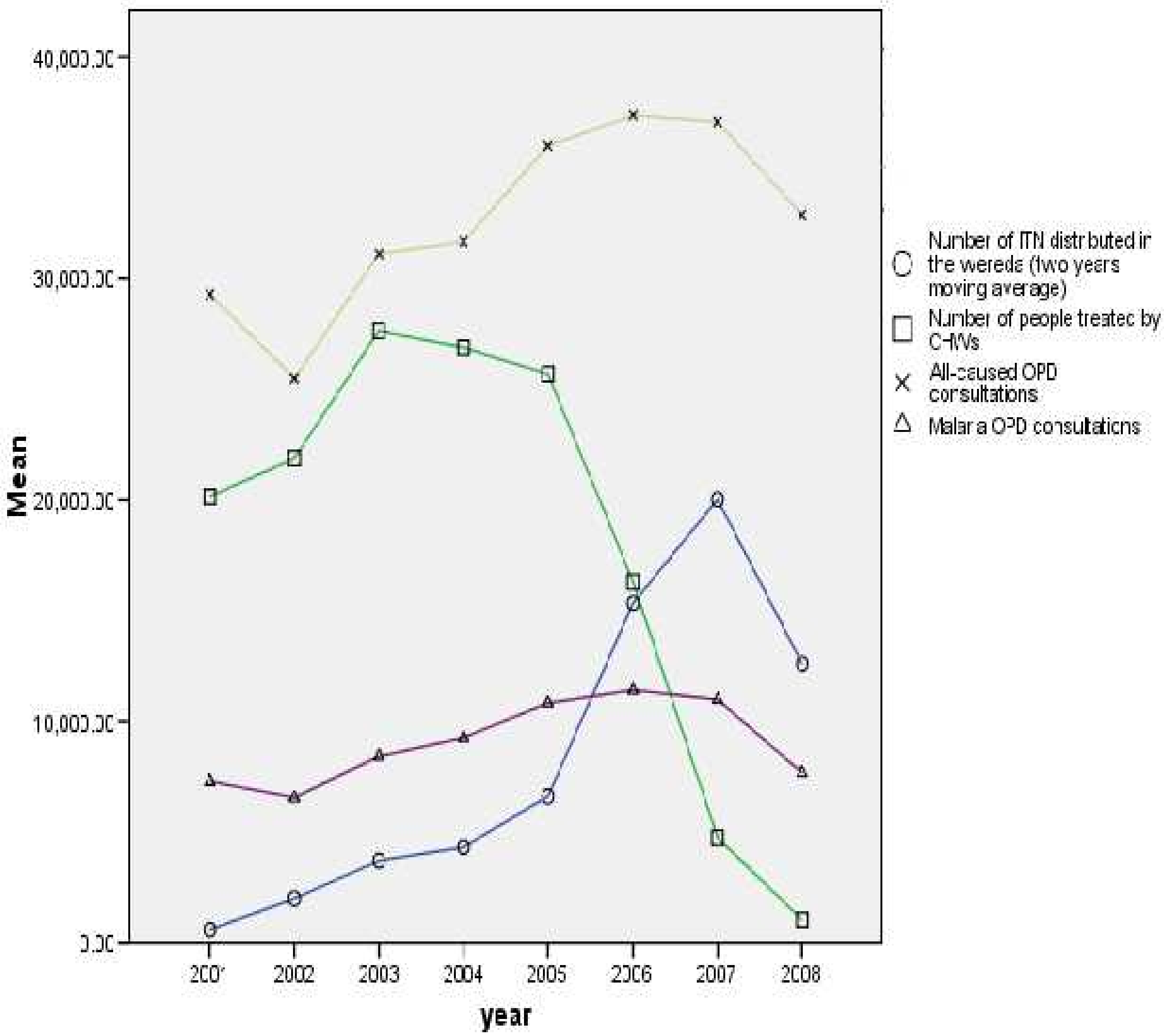

Figure -11: Comparison of mean number people treated by CHWs, mean number of all-caused and malaria specific OPD consultations with mean number two years moving average ITN distributed between 2001-2008, Tigray, Ethiopia.

7. DISCUSSION

Malaria has been a major health and economic problem in Ethiopia for decades. This study assessed the burden of malaria in Tigray region based on data collected from 51different health facilities found in 12 malarious weredas. Magnitude of problems derived from data collected from health facility shows only the ice-burg of the problem dwelling in the community, however, from such data one can see the trends of the problem and factors affecting it to allow empirical understanding of the problem.

All health facilities showed their peak of outpatient malaria consultation between 2003 & 2005 and 2006 & 2008 . In the first span of period, malaria had been epidemic in the region, while in the second span of period, the region had enjoyed relatively malaria free period though, paradoxically one observes peak of outpatient malaria consultation in the period. This paradoxical effect was due to the cessation of the service provided by community health workers after 2005 in 11 of the 12 weredas. A study done in the region in 2000 revealed that 65% - 71% of malaria patients treated each year were handled by CHW at village level (15).Another study showed that recognition of clinical malaria by CHWs was similar to that by health staff at institution where there is no access to microscopy (46). Thus Individuals getting treatment previously from CHW at village level, inflexed to health facilities causing increase in the out patient malaria consultations and malaria admission in this particular period.

Malaria admissions in the hospitals increased since 2002 and peaked in 2004 and slowly decreased through 2006 and 2007 below its previous base line level. For the health centers malaria admission rose slowly to reach peak at 2005 and slowly decreased through 2006 and 2007. Thus in the periods between 2006 and 2008, there was inverse relation ship between malaria outpatient consultations and admissions. The inverse relation ship was better reflected in the hospitals, which can be explained by the better diagnostic tests hospitals have than health centers. This relationship can be explained by the fact those individuals who previously were getting treatment by CHW at their village flowed to health facilities rising up the curve line of all outpatient and malaria outpatient consultations.

The overall annual percentage change of outpatient malaria consultation shows small negative change. This happened due to the influx of number of people, who previously had been treated by CHWs, to health institution when they no longer get treatment at their villages. The annual percent change of admission and death also could have been underestimated due the fact that health records might have not be done efficiently during the period of epidemics. The chi-squares for linear trend are significant (P-value < 0.01) for malaria OPD consultations, admissions and death. Taking 2004 as a control there was 26%, 57% and 60% of reduction in malaria OPD consultations, admissions and deaths respectively.

A study that compared malaria admission and death in under five years old children prior and after a nation wide implementations of ITN and ACT showed that, after the period of implementations malaria admission and death in Rwanda fell by 55 % and 67%, respectively and in Ethiopia by 73% and 62% (47).

The variation in malaria case fatality rate could be explained by the increased drug resistance of malaria parasites to Sulphadoxine pyrimethamine for the years between 2001 and 2004, and the subsequent decrement in 2005 and 2006 could arise from increased immunity of the population against malaria parasites due to wide segment of the population were exposed to the epidemic malaria that had occurred between 2003 and 2005. It could also be due to better treatment provision by the health facilities. On the other hand the increased case fatality in 2007 and 2008 could be due to wanning of population`s acquired immunity to malaria parasites, increased inflow of non-immune laborers to the region and/or delayed diagnosis and treatment, which are not unusual in relatively epidemic free period.

Indoor insecticide residual spray and insecticide treated nets were mainstay of malaria prevention in Tigray region. IRS was used predominantly prior to 2005, whereas number of ITN distributed has rapidly increased after 2005. A malaria indicator survey done in Ethiopia in 2007 has showed that 65.6% of households surveyed had at least one ITN (33). ACT was also distributed in most weredas after 2005 (7).

The deployment of ACT and Intensified distribution of ITN after 2005 was followed by the decreased trend of malaria outpatient consultations, admissions and death in the region. A three years field trial, in India, which has compared vector reduction rate of IRS and

Deltamethrine impregnated nets showed that the latter has decreased Anopheline mosquitoes density by 67.8% compared with IRS (48).

In Kenya a decline in pediatric admission was showed after introduction of ITN and ACT (39). A study done in four African countries in 2007, including Ethiopia, showed that after nation wide distribution of ITNs and ACT a significant reduction in the number of under five in patient malaria cases and deaths have occurred (43). Similar study results were observed in other studies done in Zanzibar and South Africa (40, 41) .

In Niger, after scaling up of ACT access to health facilities and distribution of ITN to the community the incidence and mortality of malaria substantially decreased for example, 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 1000population in 2003 to 0.09 per 1000 population in 2006.

Similar findings were reported in Tigray region that Indicators from health *institutions* show a progressive increase in malaria morbidity from 2002 to 2006 (15). But study done in four African countries in 2007, including Ethiopia, showed that after nation wide distribution of ITN and ACT a significant reduction in the number of under five in patient malaria cases and deaths have occurred (43)

8. STRENGTHS and LIMITATIONS

8.1. Strength

- This study has included fifty-one health facilities found in twelve malarious weredas and also used data from community health workers who provide treatment with anti-malaria at village level

8.2. Limitations

- Though data was collected since 1998, those prior to 2001 were not included in the study for significant numbers of the data were incomplete.
- There might be under registration or reporting of admission and death during epidemic period and this might affect admission and death related results in the study.
- The study hasn`t considered for how long the effect of ITN and IRS maintains their effectiveness after their introduction in the weredas.
- Other natural and human factors that affect the dynamics of malaria transmission and disease severity are not included in the study.

9. CONCLUSIONS

Epidemic malaria has been a major health and economic problem particularly in Sub-Saharan African countries. Ethiopia is one of the countries afflicted by the disease for the last several years. The country waged war against the disease since 1960s in collaboration with international organizations. Studies indicated that several epidemic of malaria occurred in the country in the last five decades. Tigray is one of the regions that are affected by the epidemic.

This study assessed malaria epidemic trend from 2001 to 2008, and showed that:

- Malaria has been a major problem in the Tigray region.
- Malaria admission and death were high between 2002 and 2006.
- There were decreased admissions and deaths after late 2006 .though the slope of the decrement might be masked by underreporting of deaths and admissions during epidemic periods and a relatively better documentation of the data during non epidemic period.
- Trend of malaria case fatality increased in 2007 and 2008 and that could be an indication for wanning of population`s immunity, increased immigration of non-immune laborers to the region or delayed diagnosis and treatment of malaria cases which is not unusual in times of relatively epidemic free periods.
- In 2007 and 2008 malaria out patient consultation rate dropped.
- After the introduction of ACT and scaling up of ITN distribution, malaria has showed decrement.
- The magnitude of the decrements in malaria out patient consultation and admission might be obscured, when people, who used to get treatment at their village by CHWs, influx to health facilities, when they no longer got the service after 2006.

10. RECOMMENDATIONS

Health information management system in the region should be encouraged and further strengthened to get accurate and reliable data that can reflect the trend of epidemic malaria and to predict it as soon as possible. The preventive intervention being employed should be sustainable and ongoing surveillance is needed to monitor their effectiveness. Further studies are needed to evaluate other factors that affect the dynamic of malaria transmission and disease severity.

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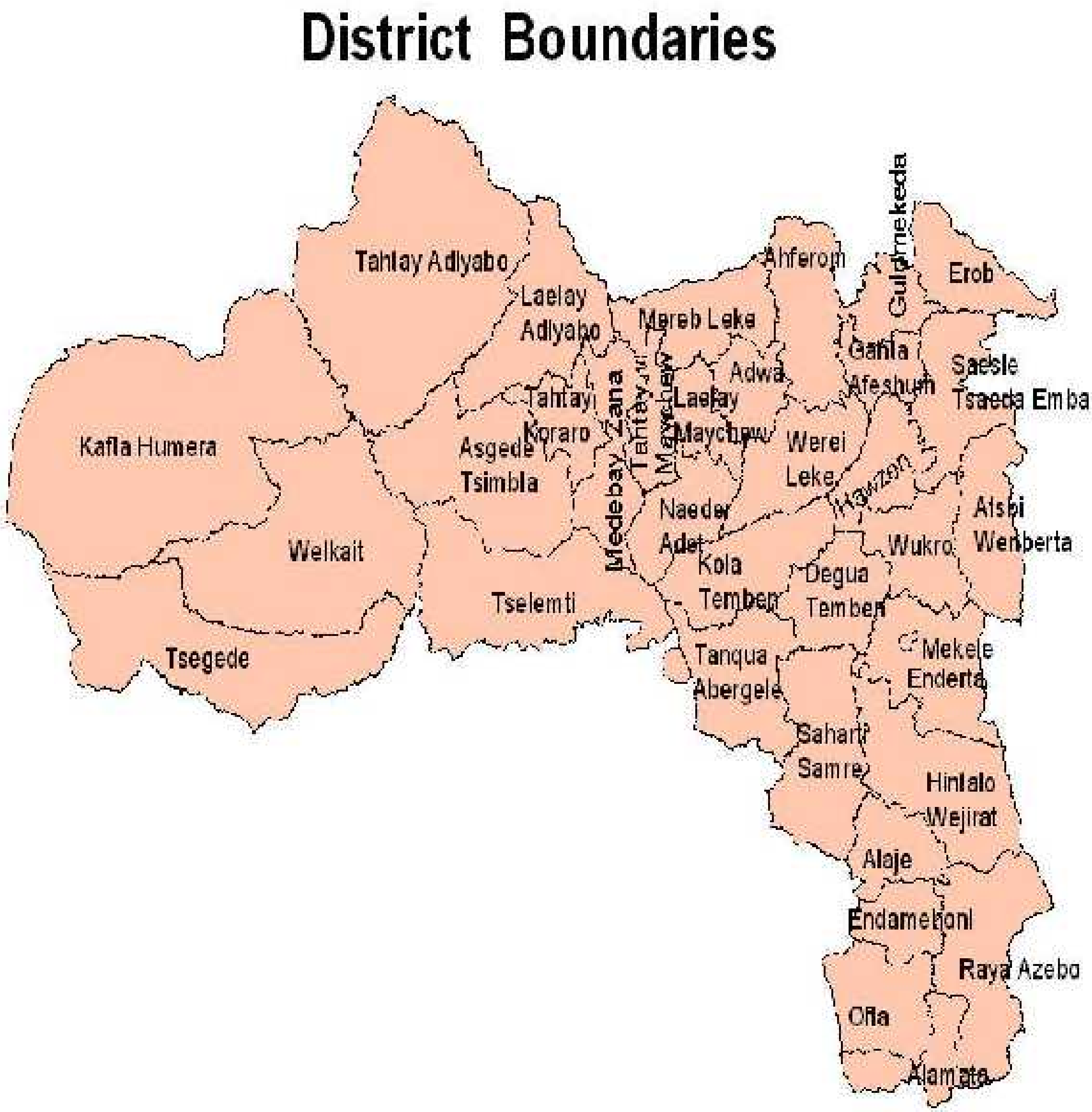
12. ANNEXES

ANNEX-1

<u>Tigray regional map</u>



Source-Tigray Health Bureau

ANNEX-2

Profiles of weredas included in the study ,Tigray.

	wereda		GOVERNMENT					
		Number of Tabias	Hospitals	Health centers	Nucleus health centers	clinic	Health posts	
							reporting	Non-reporting
1	Kafta humera	24	1	2	4	3	16	5
2	Tahitay adiabo	19	-	1	4	3	9	7
3	Laelay Adiabo	21	-	1	2	1	17	3
4	Tahitay Koraro	17	1	1	2	3	17	
5	Medebay Zana	20	-	1	3	1	15	4
6	Asgede tsimbla	24	-	1	2	5	14	5
7	Tselemti	21	-	1	3	4	15	2
8	Mereb leke	23	-	1	4	4	13	6
9	Kola temben	24	1	1	4	2	16	6
10	Tanqua abergle	16	-	1	4	3	9	4
11	Raya azebo	15	-	1	3	5	10	0
12	Alamata	26	1	1	3	1	6	9

Source: Tigray health bureau, 2006 profile

ANNEX-3

Name and number of Weredas and health facilities included in the study

No	Name of werda	Name of Hospital	No	Name ofhealth center	No	Name of Clinic	No	Name of Health Post	No	Total
1	Kafta Humera	Khasay Abera	1	Micarda	1	Adebay	1	Beaker	1	4
2	Tahitay Adiabo			Shiraro	1			Astsrega Aditsetser Seabel	3	4
3	Laelay Adiabo			Adi Deraro	1			Adikelete Terer Mai Anbessa	3	4
4	Tahitay Koraro	Midre Genet	1	Shire	1	Semema	1	Beles Tseada	2	5
5	Medebay Zena			Seleklaka	1			Adichegora kuluferha Tsegedena	3	4
6	Asgede Tsimbla			Endabaguna	1	Adi Gebru	1	Mai Aye Adi Mohammed	2	4
7	Tselemti			Mai Tsebri	1	Edega Dima	1	Mai Teklit Tsaeda Kerni	2	4
8	Merebe Leke			Rama	1	Haleluya	1	Adi Shumruh Shakoti Abak	3	5
9	Kola Tembein	Abi Adi	1	Abi Adi	1	Guya Gelebda	2	Jiwamar Akimera	2	6
10	Tanqua Abergle			Yechilal	1			Durkua Werek Tarbo	2	3
11	Raya Azebo			Mohani	1			Horda Chekon Karsolet	3	4
12	Alamata	Alamata	1	Alamata	1	Gerjele Merewa	2			4
		TOTAL	4		13		9		26	51

Source-Tigray Health bureau,2006 profile

ANNEX-4

TOOL-1

FOR HOSPITALS &H/CENTERS ONLY

Monthly OPD & Inpatient(admissions and deaths) Registration Form for Malaria and Nonmalaria Cases

Name of Wereda: ______________________

Name and Type of H/Facility: _________________________

Year (E.C):_________________

S.No	Months	Total No of new OPD Patients	Total No of new malaria OPD patien	Number of OPD Malaria Cases				Total No of Discharged In-patients	Number of Discharged malaria patients				Total Deaths	Total Malaria Deaths
				PF	PV	Mixed	Unspeci		PF	PV	Mix.	Unspeci.		
1	Hamle													
2	Nehase													
3	Meskerem													
4	Tikimt													
5	Hidar													
6	Tahisas													
7	Tir													
8	Yekatit													
9	Megabit													
10	Miaziya													
11	Ginbot													
12	Sene													

Name & Signature of The Data Collector: ____

ANNEX-5

TOOL-2

Monthly OPD Registration Form for Malaria and Non-Malaria Cases

Name of The Wereda: ______________________________

Name and Type of the H/Facility: _________________________________

Year (E.C): _________________

S.No	Months	Total number of new OPD Patients	Total new OPD malaria patients	Number of new OPD malaria patients			
				PF	PV	Mix.	Unspeci.
1	Hamle						
2	Nehase						
3	Meskerem						
4	Tikimt						
5	Hidar						
6	Tahisa						
7	Tir						
8	Yekatit						
9	Megabit						
10	Miazia						
11	Ginbot						
12	Sene						

Name and Signature of the Data Collector: ___________________________________

TOOL-3

Number of ITN & Amount of Chemicals used for IRS and Precence or Abcence of ACT Registration Form

Name of the Wereda:_________________________

	Year (E.C)										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
ITN (number)											
IRS											
DDT(Kg)											
Malathion(Kg)											
ACT*											

ITN- number of insecticide treated bed nets distributed each year

IRS- amount of DDT/Malathion (Kg)used for indoor residual spray

ACT- precence or abcence of arthemesine combination therapy(coartem)

*-write "**YES**" if ACT was available and "**NO**" if was not available at the particular year

Name and Signature of Data collector:______________________________

TOOL-4

Registration form for total number of patients treated by Community Health Workers (CHWs)

Name of Wereda:________________________

Months	Year (E.C)										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Hamle											
Nehase											
Meskerem											
Tikimt											
Hidar											
Tahisa											
Tir											
Yekatit											
Megabit											
Miazia											
Ginbot											
Sene											

Name and Signature of the Data Collector:_____________________________

TOOL-5

Average Monthly Meteorological Data Registration Form

Name of Wereda: ______________________________

Year(E.C)	Meteo.var.	Ham.	Neh.	Mesk.	Tik.	Hid.	Tah.	Tir	Yek.	Meg.	Mia.	Gin.	Sen.
	Max.temp(^{0}C)												
1990	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1991	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1992	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1993	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1994	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1995	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1996	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1997	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1998	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
1999	Mn.temp(^{0}C)												
	RF(ml)												
	Max.temp(^{0}C)												
2000	Mn.temp(^{0}C)												
	RF(ml)												

Annex-6

Declaration

I, the undersigned, declare that this is my original work and has not been presented for a degree in this or any other university and all sources of materials used for this thesis have been acknowledged.

Name: Neway Hiruy

Signature ________________

Place: Addis Ababa University

Date of submission: February 17, 2010

This thesis has been submitted with my approval as University advisor.

Name: Dr. Wakgari Deressa

Signature ________________

Place: Addis Ababa University

Date of submission: February 17, 2010