Jimma University

College of Natural Sciences

School of Graduate Studies

Department of Biology

Impact of National Malaria Control Efforts on Prevalence of Malaria in Amhara Region, Oromia Special Zone, North-central Ethiopia

By

Selomon Tefera

A Thesis Submitted to the Department of Biology, College of Natural Sciences, School of Graduate Studies, Jimma University for the Partial Fulfilment of the Requirements of the Degree of Masters of Sciences in Biology.

December, 2020

Jimma, Ethiopia

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By:

Selomon Tefera

Advisor: Tsige Ketema (Prof.)

Co Advisor: Temesgen Bekele (MSc)

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Abstract

Malaria is the leading causes of public health problem in Ethiopia. Even though there are sustained control efforts, malaria still remains the major cause of morbidity, mortality and socio-economic problems in Ethiopia. The country set a goal to eliminate the disease in certain localities by 2020. To meet this goal continuous evaluation of malaria-situation nationwide is necessary. This study designed to contribute for such efforts, to assess impact of national malaria control efforts on prevalence of malaria in one of malaria endemic area, Oromia special zone in Amhara regional state of Ethiopia. A retrospective study was conducted on prevalence of malaria and implementation of malaria control effort from 2014-2019 in the study area. From a total of 524,722 clinically suspected malaria cases, about 65,463 (12.5%) were found positive for malaria and 99.8% were outpatients. 51,679 (78.9%) were due to plasmodium falciparum and 13,657 (20.86%) were due to Plasmodium vivax. Malaria status among patients in different age showed that the prevalence was highly significant (χ^2 = 124.2, P<0.0001) among population in age group ≥ 15 years (54.14%) than children <5 years (17.38%). Prevalence among pregnant women was 3.65% (n= 503). And also the peak malaria season was irregular and varied in different years. Generally the overall malaria prevalence showed a decreasing pattern. IRS and LLIN were distributed once per year for two years, in 2014 and 2017. Vector control interventional activities such as use of LLIN and IRS at the zone were not satisfactory. The distribution of LLIN was to not fair enough during 2017, as one LLIN per HH is difficult to be used by all the family numbers greater than one. Therefore, control activities should be continued in a strengthened manner in the study area considering both plasmodium falciparum and Plasmodium vivax to meet our goal of eliminating malaria in 2030.

Keywords: Malaria, Oromia special zone, Prevalence, *Plasmodium vivax, plasmodium falciparum,*

Acronyms and Abbreviations

ACTs:	Artemisinin-based combination therapy
DDT:	Dichloro Diphenyltrichloroethane
DHMOSH:	Division of Healthcare Management and Occupational Safety and Health
EFY:	Ethiopian Physical Year
EMIS:	Ethiopia National Malaria Indicator Survey
EPHI:	Ethiopian Public Health Institute
FMOH:	Ethiopian Federal Ministry of Health
HHs:	House Holds
IPT:	Intermittent Preventive Treatment
IRS:	Indoor residual spraying
ITN:	Insecticide-treated mosquito net
LLINs:	long lasting insecticidal nets
MES:	Malaria Eradication Service
MIS:	Malaria indicator survey
MPHS:	Ministry of Public Health and Sanitation
NMCEP:	Ethiopia's National Malaria Control and Elimination Program
NMSP:	National Malaria Strategic Plan
NOCMVD:	National Organization for Control of Malaria & other Vector Borne Diseases
PCR:	Polymerase chain reaction
PHEM	Public Health Emergency Management
PMI:	President's Malaria Initiative
RBM:	Roll Back Malaria
RDT:	Rapid Diagnostic Tests
RHB:	Regional Health Bureau
RSFMH:	Republic of Sudan Federal Ministry of Health
SAMEC:	South African Malaria Elimination Committee
USAID:	United States Agency for International Development
WHO:	World Health Organization

1. Introduction

1.1. Background of the Study

Malaria is one of the leading causes of morbidity and mortality (MPHS, 2019). A person becomes infected with malaria after being bitten by an infected female Anopheles mosquito. The mosquito feeds on blood to nourish its eggs. When the infected mosquito bites, it injects saliva that contains parasites into the person's bloodstream. The parasites then travel quickly to the liver cells, where they hide from the immune system and begin to multiply (USAID, 2018). It is caused by infection of red blood cells with protozoan parasites of the genus *Plasmodium*. The human *Plasmodium* species transmitted from person to person are *plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and Plasmodium *malariae* (Teku and Kathmandu, 2019).

An estimated 228 million cases of malaria occurred worldwide in 2018. Between 2010 and 2018, estimated deaths due to malaria globally declined from 585 000 to 405 000 cases (WHO, 2018). Malaria is second cause of morbidity and the sixth cause mortality in Ethiopia in 2012/13 and about 52 million people live in malaria endemic areas (Jama, 2015). It is prevalent in three-quarter of the country's landmass with seasonal and geographic variations (FMOH, 2018). Interventions against malaria in Ethiopia first started in the late 1950s in response to the 1958 epidemic. The Malaria eradication service provided malaria diagnosis and treatment with chloroquine and spraying of houses with DDT (FMOH, 2008)

The WHO global malaria Program recommends are diagnosis of malaria cases and treatment with effective medicines, distribution of ITNs—more specifically, LLINs—to achieve full coverage of populations at risk of malaria and IRS to reduce malaria transmission, which must continue to be scaled up if countries are to move toward achieving the United Nations Sustainable Development Goals by 2030 (USAID, 2018). As a result of malaria prevention and controls interventions, Ethiopia has experienced a 66% decline in confirmed malaria cases between 2001 and 2011. Motivated by this decline, the country set a plan to eliminate malaria in selected low-transmission districts by the end of 2020 (Migbaru *et al*, 2017). Due to sustained high coverage of these interventions, the country observed a 50 percent reduction of hospital malaria morbidity and 60 percent reduction in mortality between 2006 and 2011 (PMI, 2019b). A bold strategy from Ethiopia's National Malaria Control and Elimination Program (NMCEP) sets forth a roadmap to further reduce the malaria burden from 2017 to 2020 (FMOH, 2018a).

Many things have been taken to tackle the risk of malaria across the world. It is clear there are many efforts of preventing and controlling malaria in our country Ethiopia. But there are still substantial gaps on exact information of prevalence. Health systems are under-resourced and poorly accessible to those most at risk of malaria. In addition prevention and control without knowing prevalence of the disease across different associated factor like the risky areas, exposed groups in the community, bed net coverage and usage insecticide spraying coverage couldn't be that much effective. And also delivering IRS without prevalence information has economic and environmental effect.

The objective of this study is to access national malaria control effort on prevalence of malaria in Oromia special zone, north-central Ethiopia, which gives clue to know progresses of our national control efforts and the incidence of malaria.

1.2. Statement of the Problem

Many things have been made to tackle the risk of malaria across the world. It is clear there are many efforts of preventing and controlling malaria in Ethiopia. In the study period long-lasting insecticidal net (LLIN) and indoor residual spraying of insecticide (IRS) have been implemented to reduce the risk of malaria, but malaria is still the major public health problem in the study area. So there could be several reasons for this situation including capacity of testing and treating malarial cases, coverage of LLIN and IRS, limitation on effectiveness of these interventions than expected, and some socio demographic factors like age, seasonal epidemic prone and plasmodium species. In addition without knowing prevalence of the disease across different associated factor and districts, intervention couldn't be that much effective. Generally Impact of national malaria control efforts on our journey of eliminating malaria in 2030 needs to be assessed.

1.3. Objective of the Study

1.3.1 General Objective

- To access impact of national malaria control efforts on prevalence of malaria in Amhara region Oromia special zone, north-central Ethiopia.

1.3.2 Specific Objectives

- To determine the prevalence and yearly pattern of malaria among patients before implementation of malaria control efforts in each Woredas
- To assess the prevalence of malaria among patients with different socio-demographic characteristics and plasmodium species
- To identify effect of seasonal variation on prevalence of malaria infection in each year
- To assess the coverage of interventional activities such as indoor residual spraying, bed net coverage in each woredas

1.4. Significance of the Study

Strengthening malaria surveillance is fundamental to program planning and implementation and is a crucial factor for accelerating progress; it is one of the pillar global technical strategies for malaria 2016–2030 to prevent infection and reduce morbidity and mortality which enable to achieve the goal of creating global strategy of creating malaria free world (WHO, 2015a). Studying prevalence of malaria after implementation of national control efforts achieve objectives which gives clue about our national control efforts to reduce the incidence of malaria year to year, giving special attention for the venerable group and perform in better potential during risky season and fix the distribution of bed net and indoor residual spray depending on the pattern of malaria a cross the study area. Knowing the prevalence of disease across distinct, sociodemographic factor and species pattern enable the intervention to be more effective to meet the goal of elimination of malaria.

2. Literature Review

2.1. Malaria

Malaria is one of the leading causes of morbidity and mortality (MPHS, 2019). Effectively, Britain's Sir Ronald Ross, an army surgeon working in Secunderabad India, proved in 1897 that malaria is transmitted by mosquitoes (Grácio *et al*, 2019). The mosquito feeds on blood to nourish its eggs. When the infected mosquito bites, it injects saliva that contains parasites into the person's bloodstream. The parasites then travel quickly to the liver cells, where they hide from the immune system and begin to multiply (USAID, 2018). It is caused by infection of red blood cells with protozoan parasites of the genus *Plasmodium*. The human *Plasmodium* species transmitted from person to person are *plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and Plasmodium *malariae* (Teku and Kathmandu, 2019).

The parasite incubation period in the vector mosquito, known as extrinsic incubation, is temperature-dependent. *Plasmodium falciparum* takes 8–11 days to complete the mosquito phase at an optimal ambient temperature of 28°C and 22 days at 20°C. *Plasmodium falciparum* is unable to develop below 19 °C while *Plasmodium vivax* can develop in the mosquito at temperatures as low as 16°C; consequently *Plasmodium vivax* transmission is found in some areas where the average temperature is too low for *plasmodium falciparum* transmission. (WHO, 2012b).

2.2. Global Prevalence of Malaria

Globally 3.3 billion people are at risk of malaria infection. Eighty percent of the 219 million malaria cases in 2010 and 90% of 660,000 malaria-related deaths were from Africa (WHO, 2012a). In 2013, about 584,000 people globally died from malaria; nearly 90% of the deaths occurred in Sub-Saharan Africa where *plasmodium falciparum* is the most prevalent of the malaria parasites and the leading cause of malaria deaths (WHO, 2014). An estimated 228 million cases of malaria occurred worldwide in 2018. Between 2010 and 2018, estimated deaths due to malaria globally declined from 585 000 to 405 000 cases. About 82% of estimated vivax malaria cases in 2017 occurred in just five countries (India, Pakistan, Ethiopia, Afghanistan and Indonesia of the 87 countries that had an indigenous malaria case in 2017 (WHO, 2018). Almost 80% of all malaria cases globally were in 15 African countries and in India (WHO, 2019).

The WHO African Region still bears the largest burden of malaria morbidity, with 200 million cases (92%) in 2017 (WHO, 2018). Since 2000, substantial progress has been made in fighting malaria. According to the latest estimates, between 2000 and 2015, malaria case incidence was reduced by 41% and malaria mortality rates by 62%. At the beginning of 2016, malaria was considered to be endemic in 91 countries and territories, down from 108 in 2000 Countries with 3 consecutive years of zero indigenous cases are considered to have eliminated malaria (WHO, 2016).

2.3. National Prevalence of Malaria

In EFY 2009, the total number of laboratory confirmed plus clinical malaria cases were 1,747,251 with 14 %, decrease from total cases reported in 2008 EFY (FMOH, 2017). It is second cause of morbidity and the sixth cause mortality in Ethiopia in 2012/13 and about 52 million people live in malaria endemic areas (Jama, 2015). It is prevalent in three-quarter of the country's landmass with seasonal and geographic variations. It is the leading cause of death and in 2010 about 4 million cases of malaria were reported country wide with about 1,600 deaths attributable to malaria (FMOH, 2018a).

In Ethiopia, malaria is highly seasonal in many communities, but may have nearly constant transmission in some other areas; at the district-level, malaria outpatient caseloads may vary several-fold from year to year in an "unstable" epidemic-prone transmission pattern (PMI, 2018). In particular, the monthly trend showed an increase number of malaria cases in month October to December of the fiscal year reaching the high in October, whereas the malaria cases decreased from month January to May reaching the lowest in February (FMOH, 2017). The diverse eco-climatic conditions in the country make the malaria transmission pattern seasonal and unstable usually characterized by frequent focal and cyclic widespread epidemics. The high case fatality rates were particularly observed during the 2003 epidemics, particularly in the Oromia, Amhara, Tigray, and SNNP regions (FMOH, 2013).

The 2011 MIS demonstrated a remarkable demarcation of malaria risk at an altitude of 2,000 meters, with a13-fold higher malaria prevalence at lower altitudes compared to higher elevations. There was essentially no *plasmodium falciparum* detected by microscopy among persons surveyed within households having measured elevations above 2,000 meters in the 2011 MIS. The 2015 MIS data indicated that parasite prevalence in Ethiopia was 0.5 percent by microscopy and 1.2 percent by RDTs for areas below 2,000 meters and less than 0.1percent prevalence above 2,000 meters (PMI, 2017).

2.4 Life Cycle of Malaria

The malaria parasite has a complex, multistage life cycle occurring within two living beings, the vector mosquitoes and the vertebrate hosts (figure 1.1). The survival and development of the parasite within the invertebrate and vertebrate hosts and their specialized proteins that help the parasite to invade and grow within multiple cell type and to evade host immune responses (Laurence *et al*., 2008).

The growth and development of the parasite in the liver cells is facilitated by a favorable environment created by the circumsporozoite protein of the parasite. The entire pre-erythrocytic phase lasts about 5-16 days depending on the parasite species: on an average 5-6 days for *plasmodium falciparum*, 8 days for *Plasmodium vivax,* 9 days for Plasmodium *ovale,* 13 days for Plasmodium *malariae* and 8-9 days for *Plasmodium knowles* (Malcolm and Michael, 2006).

The parasite then undergoes growth through the ring and trophozoite stages, finally producing schizonts containing multiple merozoites (erythrocytic cycle). Matured schizonts destruct RBCs and release merozoites into the bloodstream, which re-invade new RBCs (Figure 1.1). Occasionally, parasite maturation will result in the production of gametocytes which may be released into the bloodstream and are subsequently taken up by the mosquito, via a bite (Lamb *et al*., 2006).

The molecular and cellular changes in the gametocytes help the parasite to quickly adjust to the insect host from the warm-blooded human host and then to initiate the sporogonic cycle (Carolina and Sanjeev, 2005). Then gametocytes undergo the sexual stage of development (sporogonic cycle) in the mosquito. When the mosquito takes the next blood meal, it canagain infect a human host (Lamb *et al*., 2006).

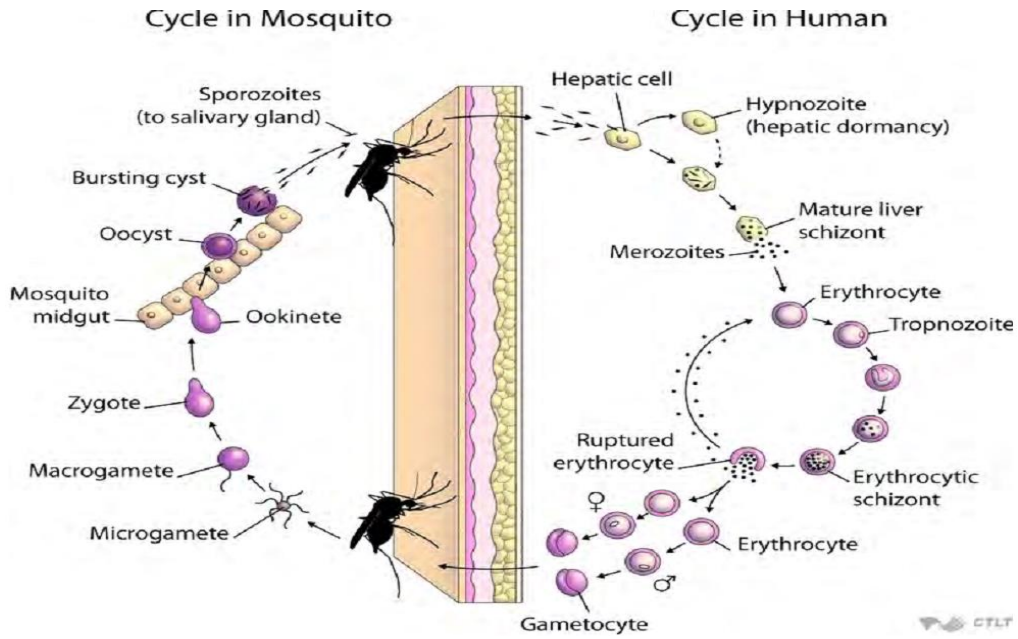

Figure 1. Life cycle of malaria parasites

2.5. Symptoms of Malaria

Common malaria symptoms and signs include: fever, chills, perspiration, rigors (cold shivers/hot sweats), headache, muscle/joint aches, malaise, lethargy, lassitude, fatigue, loss of appetite (in older children and adults), poor feeding (in young children), abdominal discomfort, diarrhea, nausea, vomiting, cough (in young children) and splenomegaly (in patients from areas of high intensity malaria transmission) (SAMEC, 2019). However, in severe malaria (mostly caused by *plasmodium falciparum*), the clinical findings of confusion, coma, convulsions, severe anemia, respiratory difficulties are more specific and may increase the index of suspicion for malaria (DHMOSH, 2019). Malaria is suspected when a patient presents with fever (or history of fever within 48 hours) with or without other symptoms and signs suggestive of malaria (e.g. headache, vomiting, sweating) (RSFMH, 2017).

2.6. Diagnosis of Malaria

All patients with fever or history of fever should be tested for malaria and only patients who test positive should be treated for malaria. All patients should also be assessed for other conditions that may cause fever and be managed accordingly the commonly used confirmatory tests to detect the presences of malaria parasites are microscopy or rapid diagnostic tests (RDTs). Quality assurance of microscopy and RDTs is vital for the sensitivity and specificity of the results (MPHS, 2019).

2.6.1 Microscopic

Microscopy is the standard method for parasitological diagnosis of malaria and is performed by examining a stained thick or thin blood smear for the presence of malaria parasites (MPHS, 2019). Laboratory diagnosis of Malaria infection can be detected by microscope examination of the client's blood, which is spread out as a thick or thin blood smear on a microscopic slide (USAID, 2018). Thick blood smears are more sensitive in detecting malaria parasites because the blood is more concentrated allowing for a greater volume of blood to be examined; however, thick smears are more difficult to read. Thin smears aid in parasite species identification and quantification. Blood films need to be read immediately; off-hours, qualified personnel who can perform this function should be on-call. A negative blood smear makes the diagnosis of malaria unlikely. However, because non-immune individuals may be symptomatic at very low parasite densities that initially may be undetectable by blood smear, blood smears should be repeated every 12–24 hours for a total of 3 sets. If all 3 are negative, the diagnosis of malaria has been essentially ruled out (CDC, 2019).

Whenever asked to do microscopy for suspected malaria cases, laboratory personnel have to prepare thick and thin blood films and stain with Giemsa. In the result form, laboratory personnel should state clearly the following: Presence of malaria parasite (seen or unseen), Parasite species, Stages of the parasite (ring stage, trophozoite, schizont and gametocytes) and Parasite count (RSFMH, 2017). Giemsa stain, an alcohol-based Romanowsky stain, is the "gold standard". It is the most commonly used stain and the best for routine diagnosis due to its applicability to both thick and thin blood films, its stability during storage and its constant and reproducible staining quality over a range of temperatures (WHO, 2012b).

2.6.2. Rapid Diagnostic Test (RDTs)

In addition to microscopy test Rapid diagnostic tests (RDTs) are immunochromatographic tests based on detection of specific parasite antigens. Tests which detect histidine-rich protein 2 (HRP2) are specific for *plasmodium falciparum* while those that detect parasite lactate dehydrogenase (pLDH) or aldolase have the ability to differentiate between *plasmodium falciparum* and non- *plasmodium falciparum* malaria (vivax, malariae and ovale). With the appropriate training, RDTs are simple to use and are sensitive in detecting low parasitaemia (MPHS, 2019). When microscopy is unavailable or unfeasible, a rapid diagnostic test (RDT) should be used (WHO, 2012a).

Since 2012, WHO has recommended that RDTs should be selected in accordance with the following criteria, based on the results of the assessments of the WHO Malaria RDT Product Testing program, these are: For detection of *plasmodium falciparum* in all transmission settings, the panel detection score against *plasmodium falciparum* samples should be at least 75% at 200 parasites/µL, for detection of *Plasmodium vivax* in all transmission settings the panel detection score against *Plasmodium vivax* samples should be at least 75% at 200 parasites/µL, the false positive rate should be less than 10%, and the invalid rate should be less than 5% (WHO, 2015b).

2.6.3. PCR (Polymerase Chain Reaction)

Parasite nucleic acid detection using polymerase chain reaction (PCR) is more sensitive and specific than microscopy but can be performed only in reference laboratories and so results are not often available quickly enough for routine diagnosis. However, PCR is a very useful tool for confirmation of species and detecting of drug resistance mutations. (CDC, 2019). It is useful to resolve difficult species identification, scanty mixed- species infections, and to detect very low-level infections, e.g. when treatment has already been given (SAMEC, 2019).

The polymerase chain reaction (PCR) uses enzymes to mass replicate and amplify a portion of a deoxyribonucleic acid (DNA) strand for easier analysis, such as searching for genes of interest. This technique may be used in certain situations, such as for identifying morphologically similar species (*plasmodium malariae* and Plasmodium *knowlesi*), for efficacy testing to distinguish new infections from relapses and recrudescences, and for population screening in special elimination or containment projects. It is presently not indicated in day-to-day clinical practice (WHO, 2012b).

2.7. Malaria Transmission

There are three main modes of malaria transmission: the bite of an infected female anopheles mosquito (the main method of transmission); accidental transmission via blood transfusion or needle stick injury; and congenital transmission from mother to child during pregnancy or parturition. The female anopheles mosquito is the vector of malaria parasites. There are more than 400 species of *Anopheles* mosquitoes throughout the world, but only some 60 of these are vectors of malaria under natural conditions, of which 30 are vectors of major importance (WHO, 2012b).

Transmission via blood transfusion, accidental needle stick, or needle sharing, leads to transfer of asexual stages of the parasite. The incubation period of the disease is therefore much shorter than it is after transmission of sporozoites by mosquito bite. Transfusion of blood infected with *Plasmodium vivax* and Plasmodium ovale parasites does not lead to clinical relapse because pre-erythrocytic schizogony does not occur and hence the dormant hepatic forms are not produced (WHO, 2012a).

There are many factors related to the vector, parasite, human host, and conditions within the environment that influence the transmission of malaria. For example, transmission is highly dependent upon the climatic conditions, such as the amount and pattern of rainfall in an area, the temperature and humidity. Transmission in many places is seasonal, meaning that it only occurs or occurs more frequently during certain times of the year. Thus, tracking transmission is very complex and requires information regarding many of the factors described above, including rainfall, temperature, and humidity, among others. Altitude is another factor that influences transmission. At higher altitudes, malaria transmission will not occur (Herrera *et al*., 2016).

2.8. History of Malaria Prevention in Ethiopia

Malaria control activity in Ethiopia was first launched as pilot projects in the 1950's and then launched in to a national eradication campaign in the 60's. In early 1970's, the Malaria Eradication Service was re-organized into a control program (FMOH, 2013). The service was organized by what was then called the Malaria Eradication Service, a pilot project established for 15 years. The Malaria Eradication Service provided malaria diagnosis and treatment with chloroquine and spraying of houses with DDT (FMOH, 2008). Following this, in 1976 the vertical organization known as the National Organization for the Control of Malaria and Other Vector-borne Diseases (NOCMVD) evolved from the Malaria Eradication Service (MES). Until 1993, this organization had been operating with one central office, 17 regional or zonal offices, consisting of 70 sector offices and more than 1,400 malaria detection and treatment posts (FMOH, 2013).

In 1993, the vertical Malaria Control Program was reorganized in line with the government's plan to democratize and decentralize the health services. In the decentralized system, planning and implementation of malaria prevention and control activities belong to the RHBs, while the federal level is mandated to handle policy and guideline development and

capacity building. During the eradication and vertical program era, malaria control personnel were trained in the Malaria Reference Training Center in Nazareth/Adama. Separate basic training for malaria control personnel is not currently provided, and training on basic malariology has little emphasis in the training curricula of health professionals. The newly engaged cadre of health extension workers does receive training on malaria as part of their training on the main 16 health packages that are part of their curriculum (FMOH, 2008).

In 2000, the Government signed the Abuja declaration in support of the Roll Back Malaria (RBM) commitments to halve malaria morality by 2010 (WHO, 2000). Following the launch of the Roll Back Malaria (RBM) Partnership, Ethiopia convened a national consensus-building workshop in March 2000 and started a coordinated action against malaria with its local and international partners. The RBM partners developed a five-year National Strategic Plan for Malaria Prevention and Control (2001–2005) and conducted an RBM baseline survey in 14 districts in 2001 to document baseline information prior to the launch of large-scale interventions (FMOH, 2008). Since 2005 Ethiopia has scaled up one of the largest malaria control programs in Africa, which has required the procurement and distribution of millions of LLINs, ACTs, RDTs, chloroquine, quinine and IRS insecticides (FMOH, 2018b).

The first five year strategic plan (2001 – 2005) and guidelines developed to provide technical guidance on malaria case management, scaling-up of selective control with special emphasis on Insecticide Treated Nets (ITNs) and Indoor Residual Spraying (IRS) and prevention and control of epidemics (FMOH, 2013). In Ethiopia the ownership and use of treated mosquito nets is the primary prevention strategy for reducing malaria transmission in Ethiopia, and since 2005 Ethiopia has been using LLINs. Furthermore, Ethiopia has adopted the goal of achieving universal coverage of LLINs, which involves free distribution so that there is one LLIN for every two persons in a household. To increase coverage, timely mass LLIN distribution campaigns are conducted in malarious areas (below 2,000m ASL) (FMOH, 2016). The status of coverage of interventions in 2005 stands at 5% for access to effective treatment within 24 hours, 24% households owning at least one ITNs and the rate of detection and containment of malaria epidemics within two weeks remains at 31% while the use of IPT during pregnancy has not been implemented at all (FMOH, 2013)

The National Five-Year Strategic Plan for 2006 – 2010 will focus on scaling-up of malaria control activities in the context of the Accelerated Expansion of Primary Health Care Coverage in Ethiopia with special focus on maximizing the role of Health Extension Workers in malaria

prevention and control. The malaria prevention and control strategic plan for the next five years, therefore will take this advantage and aims to rapidly scale-up access to early diagnosis and treatment service aiming to achieve 90% access by 2010 and selective vector control including the use and coverage of ITNs to achieve 90% coverage by 2007 (FMOH, 2013). The MIS in 2007 results indicate that in areas below 2,000m, 65.6% of households own at least one insecticide-treated net (ITN) and 65.3% of households own at least one LLIN. Nationally, 55.7% of the households own at least one net of any kind, 53.8% own at least one ITN, and 53.1% own at least one LLIN (FMOH, 2008).

The 2011-2015 national strategy plans towards achieving elimination in areas with historically low malaria transmission and near zero malaria deaths in all other parts of the country by 2015. The 2011-2015 National Strategic Plan (NSP) will build on the achievements of 2006-2010 strategic plan, and, through sustained control, will move towards malaria elimination through an integrated community health approach, especially in areas of unstable malaria transmission. This will be achieved through continued provision of malaria prevention methods (LLINs and IRS), increased diagnosis and case detection, increased access to treatment, and will only be possible as part of a community mobilization effort (FMOH, 2010).

PMI launched the next six-year strategy in 2015, setting forth bold and ambitious goals and objectives. The PMI Strategy 2015-2020 takes into account the progress over the past decade and the new challenges that have arisen. Malaria prevention and control remains a major U.S. foreign assistance objective and PMI's Strategy fully aligns with the U.S. Government's vision of ending preventable child and maternal deaths and ending extreme poverty (PMI, 2018). LLIN ownership from 2007 to 2015, the percentage of households in malarious areas owning at least one LLIN is higher in EMIS 2015 (64 percent) than in EMIS 2011 (55 percent), but lower than EMIS 2007 (69 percent) (EPHI, 2016).

A bold strategy from Ethiopia's National Malaria Control and Elimination Program (NMCEP) sets forth a roadmap to further reduce the malaria burden from 2017 to 2020. The framework for this plan stratifies districts by transmission level and assigns an appropriate package of interventions (FMOH, 2018a) As per the National Malaria Strategic Plan (NMSP) 2014-2020, the Ethiopian Federal Ministry of Health (FMOH) conducted a mass campaign in 2015-2016, distributing 29.6 million long-lasting insecticide-treated mosquito nets (ITN) to protect all Ethiopians living in areas with on-going malaria transmission, representing 60 percent of the total population. 2019 funds PMI plans to procure 500,000 ITNs for continues distribution

through community-based health extension program and 1,990,000 ITNs for mass distribution (PMI, 2019a). In Ethiopia among the regions, a higher proportion of households in Benshangul Gumuz (44 percent) and Amhara (40 percent) have been sprayed compared with households in Afar (16 percent) and Somali (5 percent), that is 29 percent of all households in malarious areas were sprayed in the previous 12 months in 2015 (EPHI, 2016). According to the new FMOH malaria risk stratification, 14.8 percent of the country's total population is targeted for IRS as compared to 17 percent in the 2014 stratification (PMI, 2019a).

2.8.1. The Current Status of Application of Interventional Activities

Ethiopia has launched sub-national malaria elimination in March 2017. To effectively implement the elimination efforts, it was necessary to develop and use guidelines to inform and guide implementers and health care workers. The availability of these documents will also standardize the work on malaria elimination across the country in both private and public sectors (FMOH, 2017a).

The National Malaria Elimination Roadmap has been developed with the aim of helping to further reduce the human suffering due to malaria and eliminate the disease from the country. In the past decade, the government of Ethiopia has given a high priority to the prevention and control of malaria. The commitment of the government, coupled with support from development partners, has enabled the scale-up of key antimalarial interventions including: distribution of long-lasting insecticide-treated nets (LLINs) through mass campaigns targeting the entire population at risk, indoor residual spraying (IRS) in designated epidemicprone areas, and expanded diagnostic testing and effective antimalarial treatment (FMOH, 2017b).

The effort towards eliminating malaria requires appropriate targeting and quality implementation of vector control interventions. As Ethiopia is committed for eliminating malaria by the year 2030, strengthening the existing vector control interventions and introduction of new vector control tools as appropriate are very crucial undertakings for ending the disease for good (FMOH, 2017c).

Prompt and accurate diagnosis will be performed for all suspected malaria cases using microscopy or RDTs. Microscopy is performed in health centers and hospitals where as RDTs are performed at health posts. In addition, specialized tests will be available for molecular diagnosis of cases, drug efficacy studies and contact screening (FMOH, 2017a).

The proposed goals for the 2017-2020 NMSP includes: By 2020, maintain near zero malaria deaths (no more than 1 confirmed malaria death per 100,000 population at risk) in Ethiopia, By 2020, reduce malaria cases by 40 percent from baseline of 2016 and by 2030, eliminate malaria from Ethiopia (PMI, 2019a).

The strategic Objectives are: By 2020, all households living in malaria endemic areas will have the knowledge, attitudes, and practice to adopt appropriate health-seeking behavior for malaria prevention and control, by 2017 and beyond, 100 percent of suspected malaria cases are diagnosed using RDTs or microscopy within 24 hours of fever onset, By 2017 and beyond, 100 percent of confirmed malaria cases are treated according to the national guidelines, By 2017 and beyond, ensure that the population at risk of malaria has universal access to one type of globally recommended vector control intervention, By 2020, malaria elimination program will be implemented in 239 districts and by 2020, 100 percent complete data and evidence will be generated at all levels within the nationally designated time periods to facilitate appropriate decision-making (PMI, 2019a).

2.9. Malaria Transmission Control Methods

Vector control is the main way to prevent and reduce malaria transmission. If coverage of vector control interventions within a specific area is high enough, then a measure of protection will be conferred across the community (Grácio *et al*, 2019). The WHO Global Malaria Program recommends diagnosis of malaria cases and treatment with effective medicines, distribution of ITNs—more specifically, LLINs—to achieve full coverage of populations at risk of malaria and IRS to reduce malaria transmission, which must continue to be scaled up if countries are to move toward achieving the United Nations Sustainable Development Goals by 2030 (USAID, 2018).

As a result of malaria prevention and controls interventions, Ethiopia has experienced a 66% decline in confirmed malaria cases between 2001 and 2011. Motivated by this decline, the country set a plan to eliminate malaria in selected low-transmission districts by the end of 2020 (Migbaru *et al*, 2017). Due to sustained high coverage of these interventions, the country observed a 50 percent reduction of hospital malaria morbidity and 60 percent reduction in mortality between 2006 and 2011(PMI, 2018).

2.9.1. Insecticide Treated Nets (ITNs)

Sleeping under an insecticide-treated net (ITN) can reduce contact between mosquitoes and humans by providing both a physical barrier and an insecticidal effect. Population-wide protection can result from the killing of mosquitoes on a large scale where there is high access and usage of such nets within a community. In 2017, about half of all people at risk of malaria in Africa were protected by an insecticide-treated net, compared to 29% in 2010. However, ITN coverage increased only marginally in the period 2015 to 2017 (Grácio *et al*, 2019). ITNs continue to be an effective tool for malaria prevention, even in areas where mosquitoes have developed resistance to pyrethroids (WHO, 2018). These insecticides are safe for humans and are being used in many countries throughout the world. The insecticides used in ITNs are diluted, and the quantities are too small to have effects on humans, including new-born (USAID, 2018). In Ethiopia the ownership and use of treated mosquito nets is the primary prevention strategy for reducing malaria transmission in Ethiopia, and since 2005 Ethiopia has been using LLINs. Furthermore, Ethiopia has adopted the goal of achieving universal coverage of LLINs, which involves free distribution so that there is one LLIN for every two persons in a household. To increase coverage, timely mass LLIN distribution campaigns are conducted in malarious areas (below 2,000m ASL) (EPHI, 2016).

The LLIN objectives are to ensure that 100% of households in malarious areas own at least one LLIN per sleeping space, and that at least 80% of people at risk of malaria use LLINs. (Figure. 2.1) illustrates that more than 45 million nets have been distributed in Ethiopia through 2012 (Carter Center, 2013).

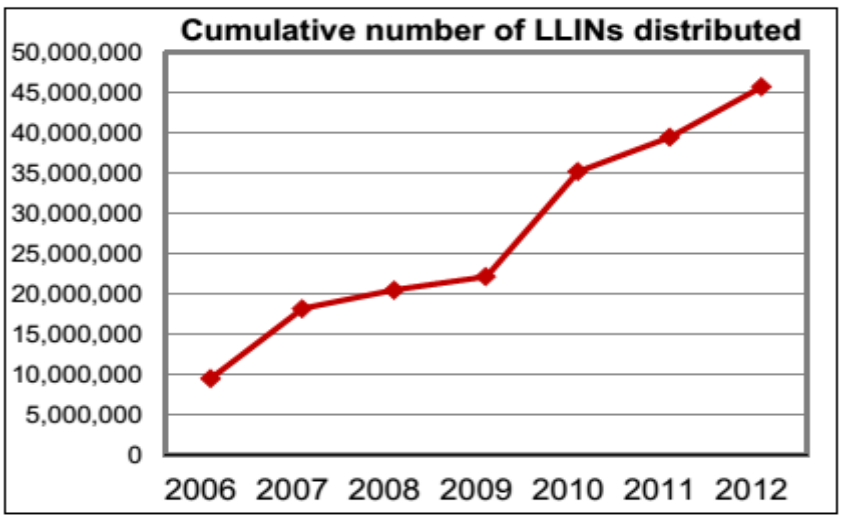

Figure 2. Cumulative number of LLINs distributed in Ethiopia, by year.

2.9.2. Indoor Residual Spraying (IRS)

Residents are encouraged to allow the interior walls of their houses to be sprayed annually with effective non-toxic long-acting insecticides to control the malaria vector mosquitoes. This intervention is known as indoor residual spraying (IRS) (NPD, 2019). Indoor residual spraying (IRS) with insecticides is powerful way to rapidly reduce malaria transmission. It involves spraying the inside of housing structures with an insecticide, typically once or twice per year. To confer significant community protection, IRS should be implemented at a high level of coverage. Globally, IRS protection declined from a peak of 5% in 2010 to 3% in 2017, with decreases seen across all WHO regions. The declines in IRS coverage are occurring as countries switch from pyrethroid insecticides to more expensive alternatives to mitigate mosquito resistance to pyrethroids (Grácio *et al*, 2019). In Ethiopia among the regions, a higher proportion of households in Benshangul Gumuz (44 percent) and Amhara (40 percent) have been sprayed compared with households in Afar (16 percent) and Somali (5 percent), that is 29 percent of all households in malarious areas were sprayed in the previous 12 months in 2015 (EPHI, 2016). According to the new FMOH malaria risk stratification, 14.8 percent of the country's total population is targeted for IRS as compared to 17 percent in the 2014 stratification (PMI, 2019 a). IRS increase over past years' performance (Figure 2.2). The goal was to reach 70% of targeted households by 2011 and 90% by 2013 (Carter Center, 2013).

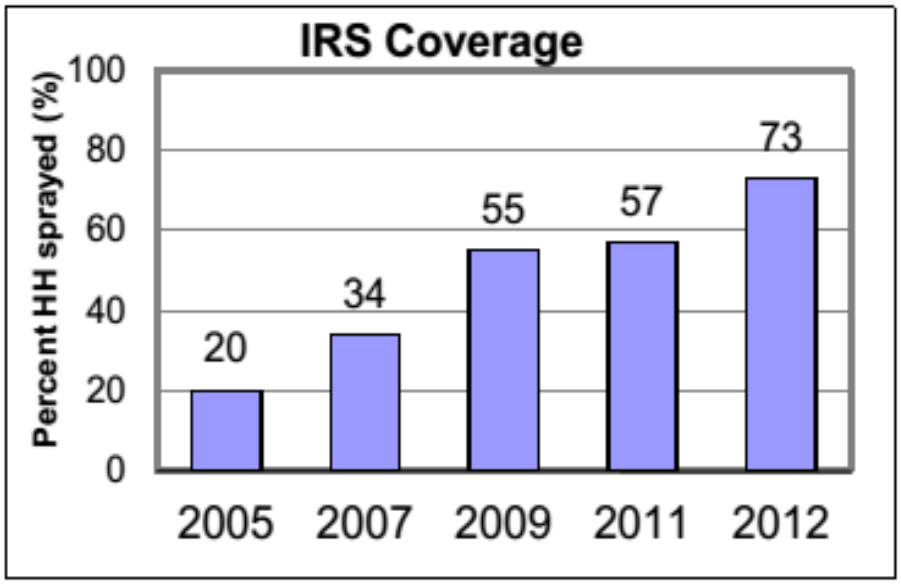

Figure 2. Percentage of targeted households in Ethiopia that received IRS, by year.

2.9.3 Prompt Treatment of Cases

There are a number of effective drugs available to treat malaria but speedy diagnosis and immediate treatment are essential. The majority of deaths from severe malaria in children are caused by not getting to a clinic in time. Some forms of malaria can be fatal within days or even hours once they develop, but malaria can usually be cured if treated quickly. Those who survive may still suffer lasting health problems. For people living in remote areas with little or no access to health services, more mobile staff and health outposts would reduce the time between diagnosis and treatment, and save lives (WHO, 2018).

3. Materials and Methods

3.1. Description of the Study Area

The study was conducted in Oromia zone in Amhara region and it is found in Kemissie administrative town with total population of 584882 which is located in northern part 325 km far from Addis Ababa, the capital city of Ethiopia. Capital city has a latitude and longitude of 10°43'N 39°52'E, 10.717°N 39.867°E with an elevation of 1424 meters above sea level. The climate of the zone can be generally categorized into Kolla 84%, Woyna dega 15 % and Dega 1%. The zone has a total of 7 woredas/districts namely Artuma fursi, Bati Wereda, Dewachefa, Dewie Harewa, Jilie timuga, Kemissie and Bati Towns. There were 28 health centers, 105 health posts and 2 hospitals in the zone. In this study data from all the health centers, health posts and the two hospitals were included in the study. This zone is known for its malaria endemicity and a total 558,471 populations in the zone are at risk of malaria. Weather condition of all the districts was Kolla and Woyna dega, which is favorable for malaria breeding. It have large area of breeding sites for malaria like Borkena river, different irrigation sites and dam are found in zone, and also Presence of stagnant water in chefa valley areas play great role in malaria endemicity in the zone. In addition Communities pastoral life which is not suitable to prevent malaria infection (Figure 3)

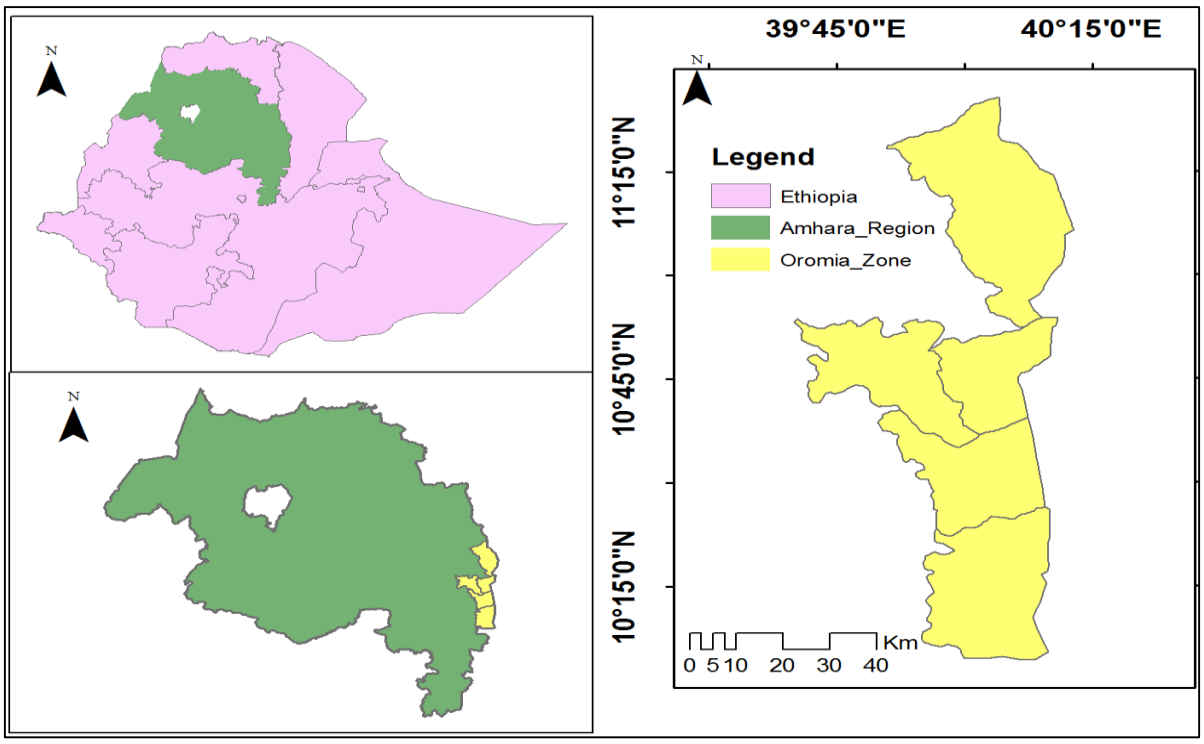

Figure 3. Study area

3.2. Study Design and Population

A facility based retrospective study design was employed. Accordingly a medical record of all patients diagnosed and treated for malaria infection in the last six years were included. In this study all cases which is tested for malaria in all the health center, health posts which is found in each woreda of Oromia zone were involved.

3.3. Data Collection Procedure

A facility based retrospective study design was employed. Accordingly a medical record of all patients diagnosed and treated for malaria infection in the last six years in the zone were included. A recorded data of all patients diagnosed for malaria such as socio-demographic characteristics (age and pregnancy), seasonal variation and plasmodium species were collected on pre-designed data collection format. In addition, data on the interventional activities employed in the zone such as distribution and coverage of long lasting insecticides treated bed net (LLIN), and frequency and coverage of indoor residual spray (IRS) were collected from the woreda and zonal health center office.

3.4. Data Analysis

Data retrieved from medical records were entered into Microsoft excel (Window 2010) sheet and checked for completeness. Then it was exported to statistical package for social sciences (SPSS) windows version 20 for possible analysis. Descriptive statistics was used to describe socio-demographic characteristics, seasonal and plasmodium species variables. Slide positivity was calculated by dividing number of malaria positive cases to total examined population (+ve/ total examined). Also, Pearson's Chi-squares test (X^2) was used to test differences in retrospective malaria prevalence between years, ages and seasons in the Woredas of Oromia zone.

3.5. Ethical Clearance

The study was ethically approved by ethical review committee of College of Natural Sciences Jimma University. The official letter was obtained from Jimma University and then handed to the concerned officials at the study area before commencement of data collection.

4. Results

4.1 Prevalence of Malaria

In the study years, 2014-2019, a total of 524,722 clinically suspected malaria cases were diagnosed using microscope (80.07%) and RDT (19.92%). From this, 65,463 (12.5%) were found positive for malaria and 99.8% were outpatients. It revealed that the overall positivity rate over the five year was 0.125, while the highest (0.15-0.19) documented in years from 2014-2016. In the recent years the positivity rate has shown reduction to 0.06. Infection with regard to plasmodium species showed that, 51,679 (78.9%) were due to *plasmodium falciparum* and 13, 657 (20.86%) were infected with *Plasmodium vivax* (Table 4.1).

Table 4. Overall prevalence of malaria in Oromia zone in Amhara region from 2014-2019

Year	Total test/clinically examined	Confirmed	Slide Positivity rate	*P.falciparum*	*P. vivax*	Mixed infection
2014	82986	13795 (16.6)	0.17	10667 (77.33)	3086 (22.37)	42 (0.30)
2015	101531	19627 (19.33)	0.19	15878 (80.9)	3702 (18.86)	47 (0.24)
2016	95559	13902 (14.55)	0.15	10332 (74.3)	3566 (25.65)	4 (0.03)
2017	78716	6017 (7.64)	0.08	4257 (70.75)	1758 (29.22)	2 (0.033)
2018	69987	3937 (5.63)	0.06	3193 (81.1)	738 (18.75)	6 (0.15)
2019	95943	8185 (8.53)	0.09	7352 (89.8)	807 (9,95)	26 (0.32)
Total	524, 722	65463 (12.5)	0.125	51679 (78.9)	13657 (20.86)	127 (0.2)

*P. falciparum-plasmodium falciparum, P. vivax- plasmodium vivax

The overall malaria burden showed varied magnitude from district to district, and year to year. The highest malaria prevalence, 27.1%, 28.56% and 29.08% was documented in Dewie harewa in years 2016, 2014 and 2015 respectively. The overall survey for the years, 2014-2019 also showed that the highest malaria prevalence was documented in the same district (22.53%) and followed by Jilie timuga (15.94%) and Artuma fursi (15.83%) districts. Comparatively, Bati and Kemissie towns have the lowest malaria prevalence in the six survey years (Table 4.2). In all districts, recorded mortality due to malaria in these years was null.

Table 4. Malaria prevalence (2014-2019) at different districts in Oromia zone in Amhara region

Districts/ Woreda's	2014		2015		2016		2017		2018		2019		Overall	
	Test	+ve (%)	Test	+ve (%)	Test	+ve (%)	Test	+ve (%)	Test	+ve (%)	Test	+ve (%)	Total test	+ve (%)
Artuma fursi	17615	3751 (21.29)	19159	5237 (27.33)	13466	2024 (15.03)	8829	595 (6.74)	7577	235 (3.1)	12394	764 (6.16)	79719	12620 (15.83)
Bati Town	9096	862 (9.48)	15042	2195 (14.59)	15663	1921 (12.26)	16865	1000 (5.93)	13298	688 (5.17)	17717	651 (3.67)	88447	7341 (8.29)
Bati Wereda	5904	1358 (23)	7268	1421 (19.55)	6857	1102 (16.07)	6382	588 (9.21)	6731	438 (6.51)	8887	877 (9.87)	42452	5793 (13.65)
Dewachefa	11683	1437 (12.3)	10193	1773 (17.39)	11008	2166 (19.7)	9597	553 (5.76)	7193	282 (3.92)	11390	1604 (14.1)	61814	7819 (12.65)
Dewie harewa	2955	844 (28.56)	4494	1307 (29.08)	3424	929 (27.1)	1703	294 (17)	1833	188 (10.26)	2226	209 (9.39)	16760	3776 (22.53)
Jilie timuga	20529	3900 (19)	26951	5754 (21.35)	22790	3563 (15.6)	17735	2177 (12.3)	18066	1654 (9.16)	22197	3514 (15.8)	129170	20588 (15.94)
Kemissie town	15204	1601 (10.5)	18424	1893 (10.27)	22551	2193 (9.72)	17605	808 (4.59)	15289	446 (2.92)	16846	540 (3.21)	106360	7526 (7.08)
Total	82986	13795 (16.6)	10531	19627 (19.33)	95559	13902 (14.55)	78716	6017 (7.64)	69987	3931 (5.63)	91657	8159 (8.53)	524722	65463 (12.5)

* +ve - positive

4.2 Distribution of Plasmodium Species

Pattern of plasmodium species distribution varies from in district to district, where in Jilie timuga and Dewie harewa the dominant Plasmodium spies was *plasmodium falciparum* (93.8%) and 87.8% respectively. While, in Bati town the two plasmodium spies were equally accountable for malaria infection (45% for *plasmodium falciparum* and 55% for *Plasmodium vivax*). Except slight difference in Kemissie town, in the remaining districts proportion of the two plasmodium species were similar to the overall distribution (Figure 4.1).

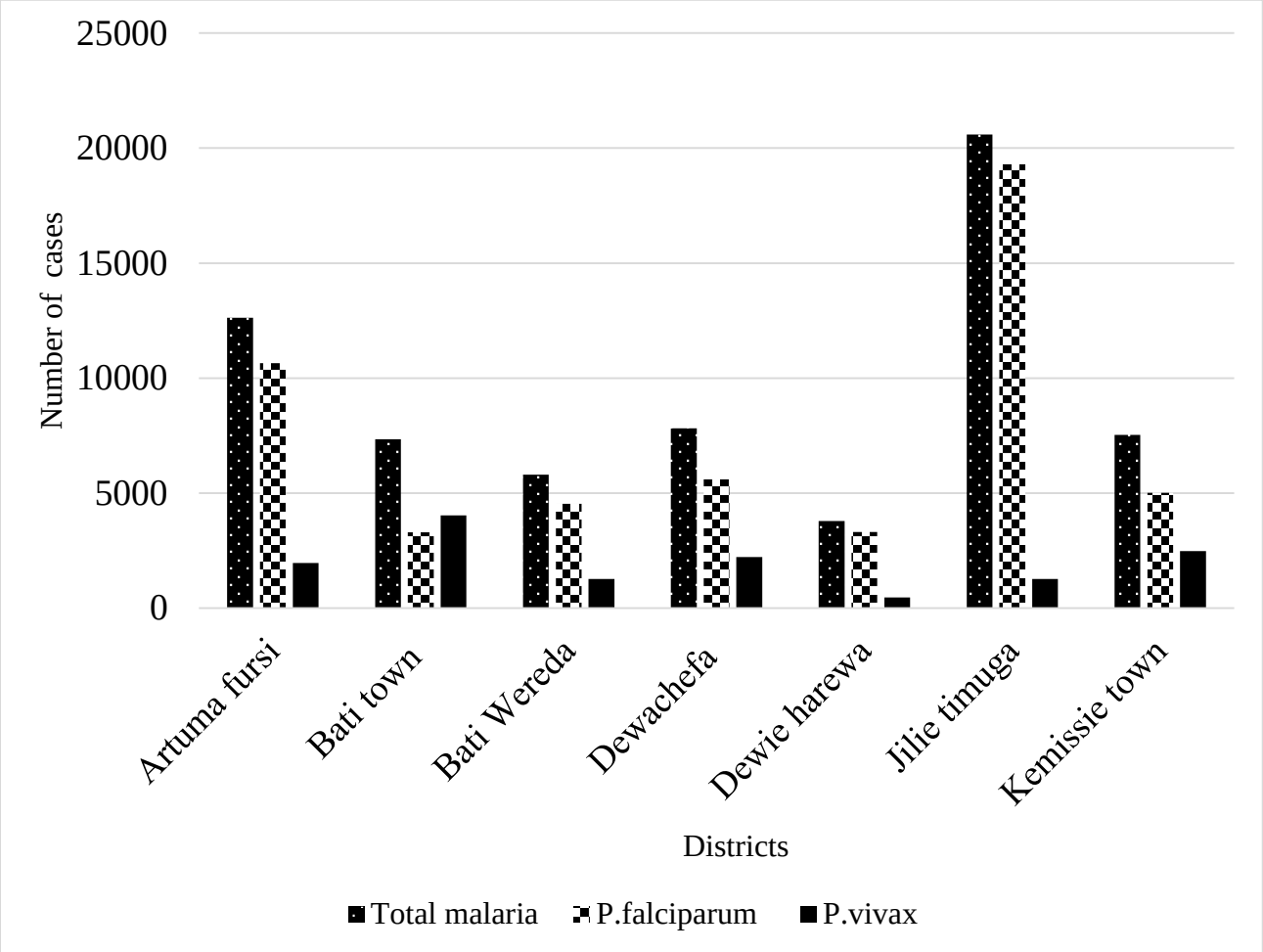

Figure 4. Plasmodium species distribution in different districts at Oromia zone in Amhara region.

Malaria status among patients in different age during the years from 2014-2019 showed that the highest significant prevalence ($\varkappa^2$ = 124.2, P<0.0001) was documented in adult patients (54.14%) in age group ≥ 15 years. Proportion of children <5 years was comparatively lowers (17.38%) than all age groups. Malaria prevalence among pregnant women was 3.65% (n= 503) and in the very recent year (2019), the proportion of pregnant women infected with malaria showed increased compared to other earlier years (Table 4.3).

Table 4. Malaria status with respect to different age groups in Oromia zone in Amhara region from 2014-2019

Patients category	Year						Total	Significance
	2014	2015	2016	2017	2018	2019		
<5 years	2272 (16.5)	3121 (15.9)	2414 (17.4)	1124 (18.7)	774 (19.7)	1677 (20.5)	11382 (17.38)	$\varkappa^2$= 124.2, P<0.0001
5-14 years	3906 (28.3)	5653 (28.8)	4050 (29.1)	1683 (28)	1046 (26.6)	2300 (28.1)	18638 (28.47)	
≥15	7617 (55.2)	10853 (55.3)	7438 (53.5)	3210 (53.3)	2117 (53.8)	4208 (51.4)	35443 (54.14)	
Pregnant women	76 (0.55)	69 (0.5)	34 (0.25)	15 (0.11)	6 (0.04)	303 (2.19)	503 (3.65)	

4.3 Effects of Seasonal Variation on Prevalence of Malaria Infection

The overall malaria prevalence showed a decreasing pattern from 2014 to 2019. In these different districts, the peak malaria season was varied in different years. In 2014, malaria prevalence reached its peak in April to June, while in the years, 2016 to 2019, highest malaria infection was observed in months from June to September, which is a rainy season in the area. While in 2015, irregular peak at different months was observed. In all years, the prevalence was relatively lower in dry season from January to May (Figure 4.2). The mean percentage of malaria cases recorded on months from June to October (12.7 to 13.54%) of all the years, were greater than the overall prevalence observed (12.5%), where in the two months of all years, June and July, relatively the highest prevalence (13.51 and 13.54% respectively) was documented . While for months, November to May the prevalence recorded was less than the overall prevalence (8.63 to 11.7%).

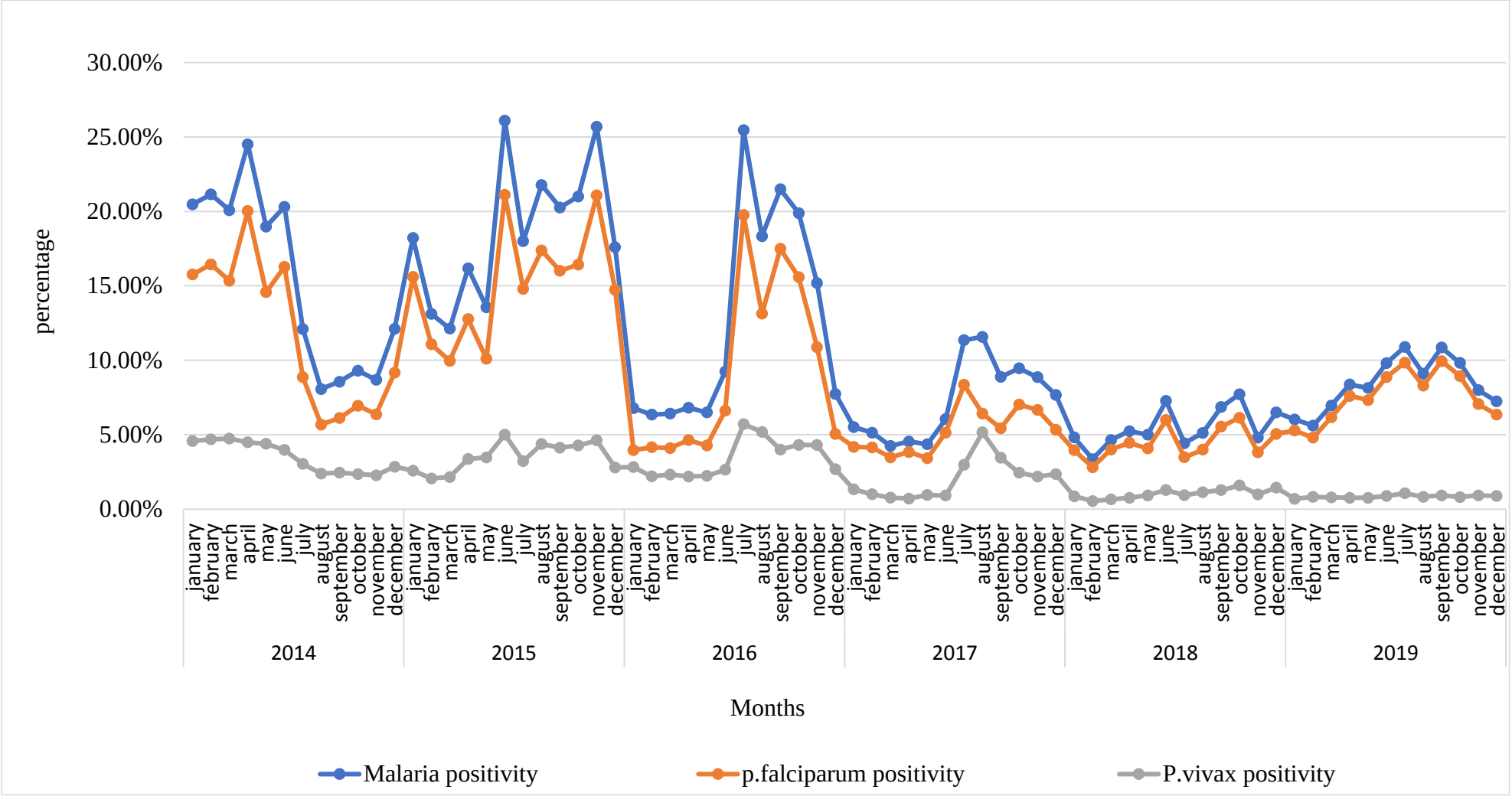

Figure 4. Distribution of malaria infection in different months of a year in Oromia zone, Amhara regional state

4.4 Distribution of Indoor Residual Spraying (IRS) and Long Lasting Insecticide Treated Bed Nets (LLIN) Coverage

According to information obtained from the zonal health bureau office of Oromia zone, IRS and LLIN were distributed once per year for two years, 2014 and 2017. Number of households (HH) sprayed in 2014 were 33,314, while in 2017 a total of 32,184 HH were sprayed, with the assumption that, 151,444 (25.9%) and 141,641 (24.2%) population were protected from 584,882 a total population of the district in year 2014 and 2017 respectively. Similarly, the number of LLINs distributed in 2014 was 271,719 (to address 116,839 HH), and in 2017 the number of LLIN distributed was reduced to 141, 697 (to address 132, 273 HH). From the number of LLIN distributed per house hold, around 50% of the population in the zone could get the bed net per head in 2014, while this figure has reduced to about 25% in 2017. While, the number of households sprayed in the two years were comparable (Table 4.4).

Table 4. IRS and LLIN coverage in Oromia zone, Amhara region, 2014 and 2017

Year	IRS		LLIN		
	Sprayed HHs	Protected population	HHs addressed	LLINs distributed	protected population
2014	33314	151444	116830	271719	509864
2015	-	-	-	-	-
2016	-	-	-	-	-
2017	32184	141641	132273	141697	568781
2018	-	-	-	-	-
2019	-	-	-	-	-

Coverage of IRS and LLIN at different districts showed that the highest HH covered by ISR and protected population in 2014 and 2017 were Dewachefa and Artuma fursi, while the lowest was in Bati town (Figure 4.3).

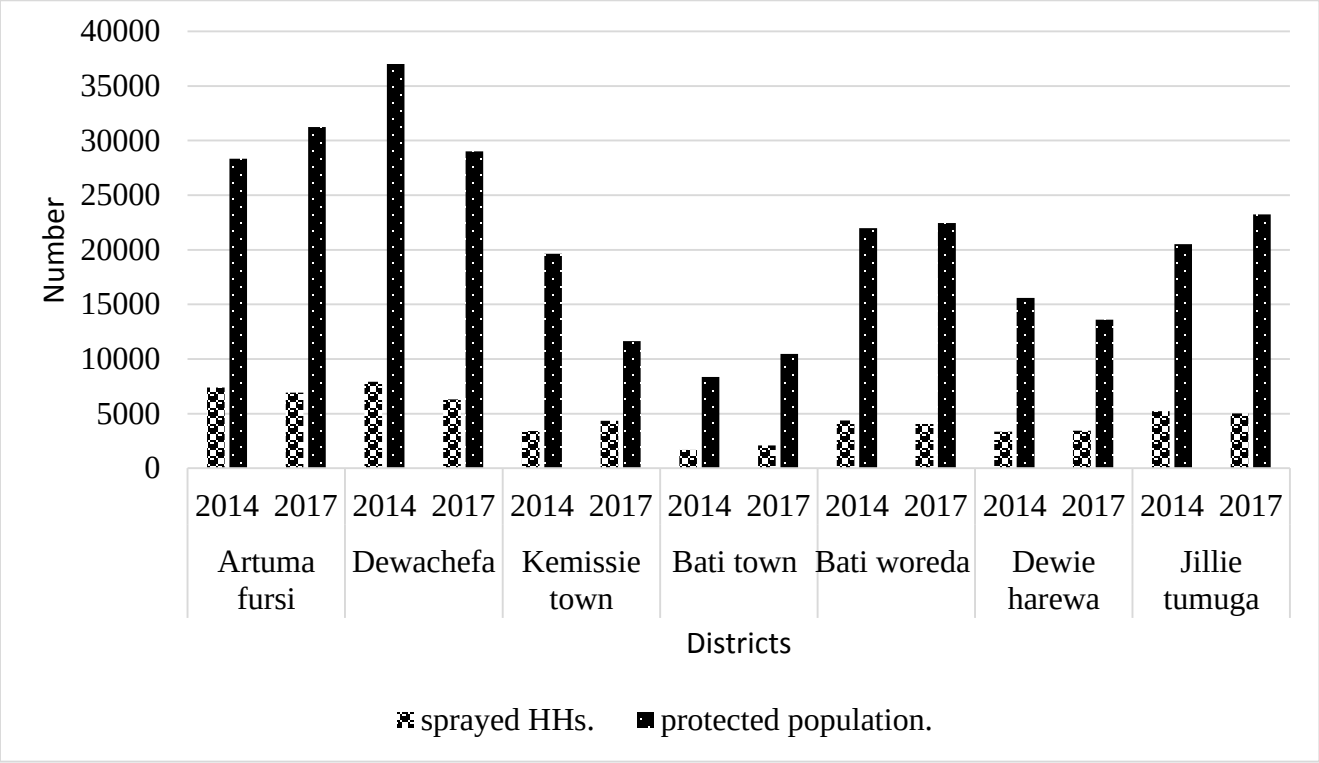

Figure 4. IRS coverage and protected population in different districts of Oromia zone, Amhara region in 2014 and 2017.

Similar to the IRS coverage, Artuma fursi and Dewachefa has got highest number of LLIN in both 2014 and 2017. In these woreda the number of protected population were also higher than the others. While the two towns, Bati and Kemissie have got lowest number of LLIN and the protected population were also lower in both 2014 and 2017 (Figure 4.4).

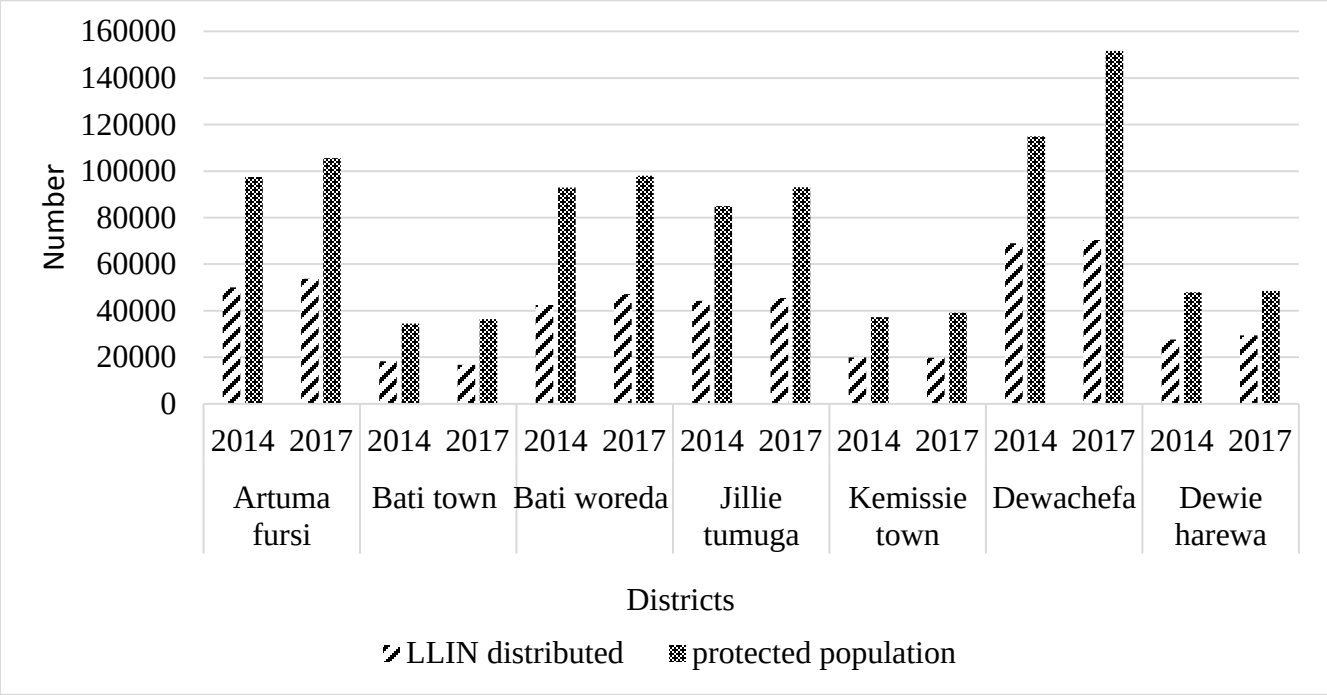

Figure 4. LLIN distribution and protected population in different districts of Oromia zone, Amhara region in 2014 and 2017.

5. Discussion

This study was carried out in Amhara region Oromia special zone where the primary objective of the study was to access the prevalence of malaria among in and out patients admitted in all health facilities, associated factors, and national control efforts done. This study was analyzed recorded patients data from 2014- 2019. Accordingly, a total of 524,722 clinically suspected malaria cases were diagnosed and from this, 65,463 (12.5%) were found positive for malaria. In the recent years the prevalence seems reducing from the highest 19.33% in 2015 to 5.63% in 2018. The pattern of malaria prevalence in the current study showed slow reduction compared a ten years malaria prevalence report from Asendabo Health Centre (2007–2016), in the different regional state and different place (Jemal and Ketema, 2019). In the report from Asendabo, the malaria burden reduction was sharp (reduce from 27.9% to 1.1%). The overall prevalence observed (2012-2018) in one of the neighboring region, Tigray, was comparable (6.96%) to the finding of this study (Berhe *et al*, 2019), with similar fluctuating trends. And also have better performance of reduction when it compare with the study done in Kola Diba health center from 2002–2011, same regional state but different place show relatively higher prevalence of malaria is 39.6% (Alemu et al, 2012)

According to the National Malaria Control and Elimination Program proposed goals for the 2017-2020, there is a plan that by 2020 to reduce malaria cases by 40 percent from baseline of 2016 and by 2030 eliminate malaria from Ethiopia (PMI, 2019a). In line to this proposal, the current malaria prevalence reduction observed in the study area showed a promising pattern as the reduction achieved so far is beyond 40% in 2019. It is hoped that if the same reduction pattern sustained in the zone, a possibility of achieving the 2030 malaria elimination goal will be succeeded in the study area. This is due to sustained high coverage of interventional activities implementing in different malaria endemic regions of the country. The country had a strategic plan which was built up on the achievement made so far to eliminate malarial through immense distribution of LLINs and implementation of IRS, increased diagnosis and case detection, increased access to treatment, and community mobilization effort (FMOH, 2010; PMI, 2018). In line to this plan, the zone has been distributing LLIN and spraying insecticides (IRS) one per year in 2014 and 2017 (OZHD PHEM case team, 2017). This might be contributed for the reduced malaria burden in the study area.

Overall the country has so far achieved a 50% reduction of hospital malaria morbidity and 60% reduction of malaria caused mortality between 2006 and 2011 (PMI, 2019b). A bold strategy from Ethiopia's National Malaria Control and Elimination Program (NMCEP) sets forth a roadmap to further reduce the malaria burden from 2017 to 2020 (FMOH, 2018a). According to the new FMOH malaria risk stratification, 14.8% of the country's total population is targeted for IRS as compared to 17% in the 2014 stratification (PMI, 2019a).

However, in the current study, the overall malaria burden observed showed that there is variability in magnitude from district to district, and from year to year. In Dewie harewa even though the number of reported cases were lower compared to other districts (Artuma fursi, Jilie timuga and Bati Woreda), the overall malaria prevalence recorded in this district from 2014 to 2019 was the highest (22.53%), and followed by Jilie timuga (15.94%) and Artuma fursi (15.83%) districts. This might be attributed by the limited number (small) of LLIN distributed and IRS implemented in this district compared to others. Malarial prevalence reduce from 16.6 in 2014 to 8.82 in 2017 and the decline of intervention in 2017 cause it to up to 8.9% in 2019 specially LLIN reducing by 25% from previous may be the case for the reducing rate of decling.

Unlike other areas, mainly central part of the country, where *Plasmodium vivax* is the dominant (86.5%) malaria parasite (Woyessa *et al*, 2012), in this zone *plasmodium falciparum* was the dominant parasite in most districts and responsible for majority of malaria infection (79.1%). This might be attributed to the hot climatic condition of the area, where 85% of the total area is Kolla, a region which has an average annual temperature of >27 ^{o}C with annual rainfall about 510 millimeters (Ethiopian Climate and Seasons (ethiopiantreasures.co.uk). This type of weather condition is more favorable for *plasmodium falciparum* incubation in vector mosquito (>19^{o}C) than *Plasmodium vivax* (WHO, 2012b). The 2007 Malaria Indicator Survey (MIS) indicated that parasite prevalence was 0.7 percent and 0.3 percent *plasmodium falciparum* and *Plasmodium vivax* below 2,000 meters (asl) respectively.

Malaria status among patients in different age during the years from 2014-2019 showed that the highest prevalence was observed among patients in age range >15 years, than children under five years, this might be due to pastoral life of the community, adults stay out side home more than childrens in day and night. Similarly in other retrospective studies conducted in different parts of

the country similar pattern was observed, where high malaria infection observed among patients that age group >15 years (Solomon *et al*., 2018; Gebretsadik *et al*, 2018; Dabaro *et al.*, 2020).

Generally, in the study years malarial prevalence in month was not similar, the peak malaria season was varied in different years. In the different districts, the malaria peak seasons were irregular and varied in different years. Similarly in Ethiopia, malaria is highly seasonal in many communities, but may have nearly constant transmission in some other areas; at the district-level and year to year in an "unstable" epidemic-prone transmission pattern (PMI, 2018). In 2014, malaria prevalence reached its peak in April to June, while in the years, 2016 to 2019, highest malaria infection was observed in months from June to September, which is a rainy season in the area. In all years, the prevalence was relatively lower in dry season from January to May. In contrast to this in particular, the monthly trend showed an increase number of malaria cases in month October to December of the fiscal year reaching the high in October, whereas the malaria cases decreased from month January to May reaching the lowest in February (FMOH, 2017).

6. Conclusion and Recommendation

The overall prevalence of malaria recorded in the recent years from 2014 to 2019 in Oromia zone in Amhara region was 12.5%. This figure showed that malaria burden is still high in the areas and need further attention and calls for interventional activities, specially the distribution of LLINs should be increased to address the whole family member in house holds. This might be due to epidemic prone of malaria in different districts and seasons, weather condition of the area and also limitation of intervention tools (IRS and LLIN). However, in line to the National Malaria Control and Elimination Program, reducing malaria burden to 40% by 2020 and eliminating by 2030, the observed reduction pattern is promising and hoped that it will be achieved, if the initiative is sustained in all districts. Unlike other regions of the country, malaria peak season in the study area showed an irregular pattern. This might require special attention by the concerned bodies, as there might be a possibility of heavy transmission at unexpected time/season. As the study area is more of hot region; the dominant plasmodium parasite was the deadly parasite *plasmodium falciparum*. Thus, control activities should be continued in a strengthened manner in the study area considering both *plasmodium falciparum* and *Plasmodium vivax* to meet our goal of eliminating malaria in 2030.

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