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ADDIS ABABA UNIVERSITY



Addis Ababa University

College of Natural and Computational Sciences

Department of Microbial, Cellular and Molecular Biology

**Prevalence of Malaria Among Patients Attending Assosa General
Hospital, Western Ethiopia**

By

Tesfaye Meku

**A Thesis Submitted to the Graduate Programme of Addis Ababa
University in Partial Fulfillment of the Requirement for the Degree of
Master of Science in Biology**

Advisor: Mekuria Lakew (PhD)

Addis Ababa, Ethiopia

September, 2017

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Acronyms

ACT	Artemisinin-based Combination Therapy
BGR	Benishangul Gumuz Region
CDC	Centre for Disease Control and Prevention
CFR	Case Fatality Rate
FMOH	Federal Ministry of Health
HEWs	Health Extension Workers
HSDP	Health Sector Development Program
IRS	Indoor-Residual Spraying
ITNs	Insecticide Treated Nets
LLIN	Long Lasting Insecticidal Net
MIS	Malaria Indicator Survey
MOH	Ministry of Health
MOP	Malaria Operational Plan
PCR	Polymerase Chain Reaction
PMI	President’s Malaria Initiative
RBM	Roll Back Malaria (global partnership to reduce malaria)
RDT	Rapid Diagnostic Test
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

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Abstract

Malaria is a disease caused by Plasmodium parasite and is transmitted by females Anopheles mosquitoes. It is one of the leading causes of illness and death in the world. It is a leading public health problem in Ethiopia. The aim of this study was to assess the prevalence of malaria among patients who attended in Assosa General Hospital for the last five years, Western Ethiopia. A retrospective study was conducted to assess the prevalence of malaria infection from records of peripheral blood smear positive patients in Assosa General Hospital. All malaria cases reported between 2012 and 2016 were reviewed and analyzed. During the study period of five years a total of 13697 thick and thin with Giemsa stained blood films were examined for malaria diagnosis in Assosa General Hospital and 7353 (53.68%) microscopically confirmed malaria cases were reported with a fluctuating trend. *Plasmodium vivax* and *Plasmodium falciparum* accounted for 55.02 and 44.98% of the cases respectively. All cases were monoinfections. Malaria was reported in all age groups and both sexes. But the ≥ 15 year age group and males were more affected. The prevalence of malaria infection between males and females was not statistically significant ($P > 0.05$) and also the prevalence of malaria among age groups was not statistically significant ($P > 0.05$). Despite the apparent fluctuation of malaria trends in the area, the highest peak of malaria cases was reported during September to November within the last five years. Control interventions must be maintained and scaled-up to sustainably control the prevalence of malaria infection and eventually eliminate it in the study area, considering both *Plasmodium vivax* and *Plasmodium falciparum*.

Keywords/Phrases: Malaria, *Plasmodium*, Assosa General Hospital, Prevalence, Retrospective study

1. Introduction

Malaria is caused by a protozoan belong to the plasmodium species and is transmitted by female Anopheles mosquitoes which bite between dusk and dawn. There are five different types of plasmodium parasites that infect humans: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*. Of these, *P. falciparum* and *P. vivax* are the most prevalent, and *P. falciparum* is the most dangerous species and is responsible for almost all of the 1.7-2.5 million deaths worldwide caused by malaria (Getachew *et al.*, 2013). It is a major public health problem for people living in tropical and sub-tropical regions (Caraballo and King, 2014).

According to the World Health Organization report (WHO, 2015), there were 95 countries and territories having ongoing malaria transmission putting about 3.2 billion people - almost half of the world's population at a risk of infection. in the same year above 214 million new malaria cases were reported of which over 438,000 people died from the disease although there is a drastic global fall in malaria deaths in recent years. Sub-Saharan Africa carries a disproportionately high share of the global malaria burden. In the same year, the region was home to 80% and 90% of malaria cases and deaths respectively.

Malaria mostly affects children under the age of five years and pregnant women in developing countries (Alemu *et al.*, 2012). Pregnant women are more vulnerable because they experience depressed immunity during pregnancy, endangering both the lives of mother and the child (Getachew *et al.*, 2013). A similar problem arises with children below the age of five as their immunity systems are not fully developed. It is estimated that every 45 seconds a child dies of malaria worldwide (WHO and UNICEF, 2008).

It is the leading public health problem in Ethiopia where an estimated 60% of the population lives at-a risk of malaria infection (FMOH, 2015). Humans are infected through the bite of an infected female Anopheles mosquito that inoculates spindle shape sporozoites into the bloodstream (Kayser, 2005).

The first symptoms of malaria are nonspecific. It starts with loss of the lack of wellbeing, headache, fatigue, abdominal discomfort, and muscle aches followed by fever all similar to the symptoms of a minor viral illness (Nicholas and Joel, 2008). In malaria endemic areas, factors such as poverty, poor socioeconomic status, poor education and poor environmental sanitation have been attributed to availability of female Anopheles mosquito friendly environmental conditions which allow the emergence and rapid spread of resistance of both vector mosquitoes to insecticides and of pathogenic *Plasmodium* to anti-malarial drugs are other causes of severe disease and death from malaria in the affected areas (Oyewole and Ibidapo, 2007).

Malaria risk and disease burden is inequitably distributed, not only at global and regional levels but also different from one household to the other. That is because of differences in types of education and access to healthcare services the vicious cycle of enhanced vulnerability to malaria, high household medical costs, reduced ability to pay for treatment, and so on (Pamela *et al.*, 2007).

According to Ethiopia's Federal Ministry of Health (FMOH, 2008) report, malaria was the first cause of outpatient visits, health facility admissions and in-patient deaths, accounting for 12% of outpatient visits and 9.9% of admissions. However, as 36% of the population does not have

access to health care services, these figures probably under-represent the true burden of malaria in the country (USAID/CDC, 2010).

Human factors in Ethiopia contributed the spread of malaria population growth and movements, urbanization, water development schemes, agricultural development, conflicts, improper use of drugs and emergence of drug-resistant malaria. The low educational level of the people most of whom live in the countryside and have never been to school or received adequate guidance regarding dosage, fail to adhere to prescription requirements, or stop medication altogether upon feeling well (Aynalem, 2008).

Malaria in Ethiopia ranks among the most important causes of mortality and morbidity. The disease is distributed in most part of the country with varying degrees of intensities from place to place depending on local epidemiological factors. In most parts of Ethiopia, the intensity of malaria is unstable and seasonal because of the variations in rainfall distribution. Areas of altitudes below 2000 meters above sea level are epidemic prone hypodermic zones of malaria (Seble, 2016). It is estimated that about three - fourths of the land is malarious and two-thirds of the country's population is at risk of malaria infection (WHO, 2016). Occasionally malaria transmission occurs in previously malaria-free areas including areas above 2000 meters altitude when microclimate and weather conditions become favorable.

Due to the topography and climate of the country malaria transmission in most parts of Ethiopia is unstable and hence communal herd immunity to the disease is underdeveloped. Consequently, the population at risk is exposed to frequent waves of epidemics (MOH, 1999).

Benishangul-Gumuz Region (BGR) is one of such areas in Ethiopia where the threat due to malaria infection is so high. Though there is some degree of variation among the different districts of the region more or Assosa Hospital is found in Assosa Zone, one of the administrative Zone of region. Though the occurrence of malaria in Assosa Zone is relative less as compared to areas of lesser altitude bordering the zone from the west and northwest, its prevalence is so intense that the study of the case requires attention.

This study focuses on the prevalence of malaria among patients who get treatment in Assosa General Hospital for the last five years (2012-2016).

1.1. Statement of the Problem

Malaria remains the leading communicable disease seen in health services of all types in Ethiopia. Historically, malaria had forced people to inhabit the less agriculturally productive highlands and had liberated vast mass of the low land of the country and the peak malaria transmission seasons are in coincidence with the planting and harvesting season, has enable to become a heavy economic burden on the country's development.

This logic needs to change for the problem including the deficiencies in the health system that lead to lack of access to malaria control interventions and low effectiveness of these interventions than expected. Therefore, this research involves hospital-based study to confirm the prevalence of malaria among people attending Assosa General Hospital, determining the risk factors such as socio-demographic factors in the study area.

The study provides scientific evidence that would be an important data base of local, national and global relevance in advancing current knowledge on malaria situation. It is also useful to policy efforts while providing evidence driven public health action in preventing and controlling malaria prevalence makers and program planners at each level for assessing progress and focusing future.

1.2 Objectives of the Study

1.2.1 General Objective

- The general objective of the study was to assess the prevalence of malaria among patients who attended in Assosa General Hospital.

1.2.2 Specific Objectives

The specific objectives of the study were:

- To determine the prevalence and yearly pattern of malaria among patients who attended in Assosa General Hospital.
- To identify Plasmodium species involved in Assosa General Hospital
- To identify demographic factors that affects the proper prevalence of malaria infection in Assosa General Hospital.
- To assess the seasonal pattern of malaria transmission in Assosa General Hospital

2. Literature Review

2.1 Malaria Parasites and Their Life Cycle

Malaria is caused by protozoan parasites belonging to the genus *Plasmodium* (Phylum Apicomplexa). The plasmodium parasites are spread to humans through the bites of infected female Anopheles mosquitoes. More than 100 species of Plasmodium are known to exist. They produce malaria in many types of animals and birds, as well as humans (WHO, 2007). Four plasmodium species have been well known to cause human malaria, namely, *P. falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*. *P. knowlesi*, has also been recently documented to cause human infections. The disease is widely distributed in Africa, Asia and South America and found to be potentially life –threatening (Cox-Singh et al., 2008). They are found in more tropical and sub-tropical regions of the world and exhibit overlapping geographical distribution. The five plasmodium species belong to the same genus and each one has a distinctive appearance under the microscope and each one produce some what a different pattern of symptoms. *Plasmodium falciparum* is widespread in tropical and sub-tropical areas of central and South America, Africa and Asia. It results in most severe infections and is responsible for nearly 90% of malaria related deaths in sub Saharan Africa. *P. falciparum* predominates the warmer regions close to the equator, while *P. vivax* predominates in more temperate regions. Since *P. vivax* can tolerate cooler temperatures, it is more geographically widespread than *P. falciparum*, although transmission is usually low because it is season dependent (CDC, 2006).

Plasmodium malariae has a restricted distribution and ranks third in prevalence, but it also has a widespread distribution. It is not usually life threatening. *Plasmodium ovale* is the rarest of the four species, and is mostly confined to tropical West Africa (WHO, 2007). All four species of

plasmodium are known to occur in Ethiopia. However, *Plasmodium falciparum* and *P. vivax* are the most dominant malaria parasites in country, accounting for 60% and 40% of malaria cases, respectively. *Plasmodium malariae* accounts for less than 1% and *P. ovale* is rarely reported (Tulu, 1993).

The ring forms of *P. falciparum* as usually seen in the peripheral blood are very small. In many of the ring forms there may be two chromatin granules and marginal forms are fairly common. The succeeding developmental stages of asexual erythrocytic stage do not generally occur in the 5 blood, except in severe „pernicious“ cases. Although erythrocytic schizogony in *P. falciparum* is completed in 48 hours and periodicity of development is therefore of typically tertian type, there frequently occurs in this species two or more broods of parasites, the segmentation of which is not synchronized, so that the periodicity of symptoms in the patient tend to be irregular . It is estimated that every year 700,000 to 2.7 million people are died of *P. falciparum* especially in Africa where this species predominates (CDC, 2006).

Malaria is often classified as uncomplicated or complicated/severe. Uncomplicated malaria can be caused by all four species and is characterized by periodic fever and chills, mild anemia and splenomegaly. Uncomplicated malaria is rarely fatal unless it is left untreated and it progresses to severe disease. Severe or complicated malaria is almost exclusively caused by *P. falciparum* infections (although occasionally by *P. vivax* and other species) and is associated with higher parasite burdens and vital organ dysfunction including CNS (coma, seizures etc) and pulmonary compromise (pulmonary edema, ARDS, respiratory distress etc.), acute renal failure, severe anemia and metabolic acidosis (Elias, 2014).

Anemia arises in part from the destruction of erythrocytes when merozoites burst out of the infected RBC and RBC production of erythrocytes by merozoites results in exponential growth. As a result, the parasite distribution is further compromised by bone marrow suppression. In *P. falciparum* infection, anemia can be dramatic and life threatening. The rise in temperature is also correlated with the rupture of schizonts with release of pyrotoxins together with merozoites from the bursting infected RBCs. The pathogenesis of general malaise, malin and headache is still defined. The classic periodicity of the fever (*P. vivax/ovale* = every 2nd day; *P. malariae* = every 3rd day), based on synchronous infections, is often not observed particularly early in the course of infection. In the early phase of infection, the growth of the parasites is not synchronous, RBC rupture is more random and consequently fever can be erratic. In addition, some infections may be due to two or more broods of parasites, with the periodicity of one being independent of that of the others. This is more often seen in the case of severe *P. falciparum* infections (Moriya and Kevin 2009).

Most malaria deaths are associated with *P. falciparum* infections. RBCs infected with the maturing forms of these parasites express parasite proteins called PfEMP-1 associated with morphological structures (“knobs”) that permit them to stick to endothelial cells lining the blood vessels and result in sequestration of the infected RBCs within the vascular bed of vital organs. When this occurs in the brain, the resulting cerebral malaria may lead to coma and death. Renal, pulmonary and GI complications may also be seen. Congenital malaria and infection of the placenta may result in still birth, low birth weight infants, or prenatal mortality. After the initiation of blood stage infection by the parasite, the repeated infection (RBM, 2003).

The life cycle of malaria parasite involves both vector mosquitoes and human host. Female *Anopheles* mosquito that carry malaria causing parasites (*Plasmodium*) feeds on human blood. It injects the parasite in the form of sporozoites into the human blood stream. The sporozoites travel to the liver and invade liver cells over 5-16 days. Upon sporozoite replication in the liver, merozoites release into the blood stream. The merozoites bind to the surface then enter the Red Blood Cells (RBCs) via a receptor-ligand interaction. Some malaria parasite species remain dormant for extended periods in the liver (CDC, 2004).

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). 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. Then gametocytes undergo the sexual stage of development (sporogonic cycle) in the mosquito. When the mosquito takes the next blood meal, it can again infect a human host (Lamb *et al.*, 2006).

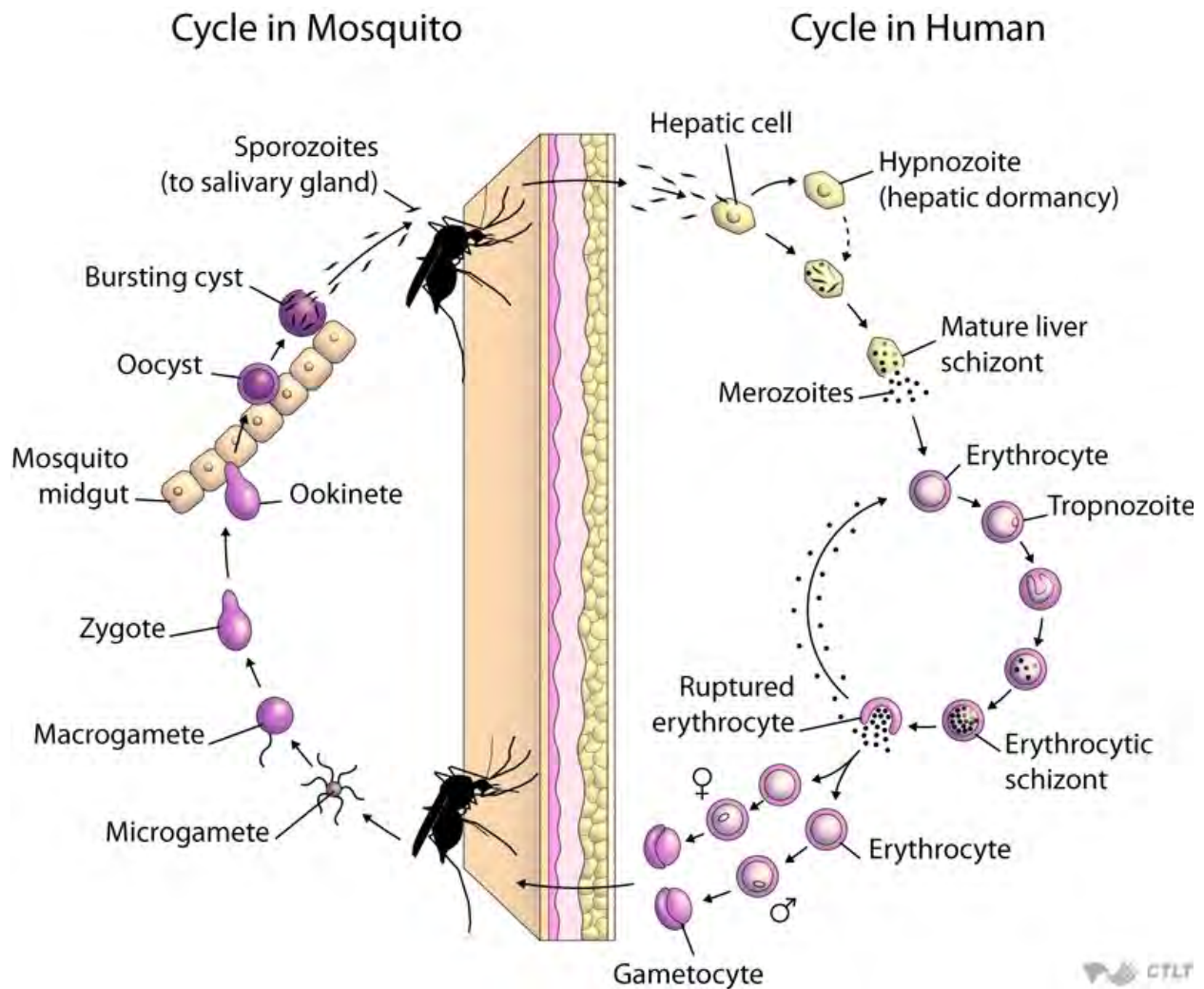


Figure 1. Life Cycle of Malaria Parasites (Source: Lamb *et al.*, 2006)

2.2. The Vectors of Malaria Parasites

Females of most species of mosquitoes require a blood meal for the eggs to develop. Species that usually feed on humans are said to be anthropophilic. *Anopheles gambiae* (African malaria vector) are mainly anthropophilic, pedophilic and endophilic. The resting and feeding behavior of malaria vectors is an important consideration in planning control measures (Service, 2000).

Temperatures from approximately 21°C -32°C and a relative humidity of at least 60% are most conducive for maintenance of transmission. In tropical regions temperature and humidity are

often mediated by altitude. In Africa, altitudes above 1,500m are considered safe from malaria. However, it must be cautioned that with continuing global climate change, these figures may change, extending the range of mosquitoes well above those altitudes as ambient temperatures rise. The malaria vector requires water to complete its life cycle: egg, larva, pupa, and the adult (Jaston, 2004). While between 200-1000 eggs can be laid, the quantity is influenced by the amount of blood taken in. Blood feeding usually starts at dusk and continuous until dawn (Aynalem, 2008).



Figure 2 *Anopheles* Mosquito (Source: World Malaria Report, 2005)

2.3. Global Epidemiology of Malaria

Malaria is the most important parasitic disease in the world. According to the World Health Organization report (WHO, 2015), there were 95 countries and territories having ongoing malaria transmission putting about 3.2 billion people - almost half of the world's population at a

risk of malaria infection. In the same year above 214 million new malaria cases were reported of which over 438,000 people died from the disease although there is a drastic global fall in malaria deaths in recent years. Sub-Saharan Africa carries a disproportionately high share of the global malaria burden. In that year, the region was home to 80% and 90% of malaria cases and deaths respectively.

The majority of *P. falciparum* cases imported into North America and Europe are acquired in Africa (85%) and travel to the African continent is currently on the rise. *P. ovale* infection can be distinguished from *P. vivax* infection in part by its epidemiology, i.e., the distribution of *P. ovale* is limited to tropical Africa and to discrete areas of the Western Pacific. Most West Africans are negative for the Duffy blood type, which is shown to be associated with receptor sites for *P. vivax* merozoites on the RBC. Therefore, many West Africans are not susceptible to infection with *P. vivax*. *P. falciparum* malaria which are generally confined to tropical and subtropical regions, particularly in sub-Saharan Africa, the Amazon region of South America, rural forested areas of Southeast Asia and urban and rural areas of the Indian subcontinent. Individuals with sickle-cell trait (AS) are more resistant to severe *P. falciparum* infection than normal homozygotes (AA). The SS individuals are also protected, but their sickle-cell disease leads to an early death. *P. malariae* has a wide, but spotty distribution throughout the world (Moriya and Kevin, 2009).

Epidemiology of malaria is highly dependent on the transmission pattern of the parasite. An area supporting active malaria transmission is termed endemic whereas sporadic outbreak determine epidemic areas (WHO, 2000). The variation of malaria epidemiology is not limited by continents or between countries. There is also variation in the distribution of plasmodium in a single country. Malaria is widely spread throughout the tropical belt into the sub-tropical lands, even to

the edges of the temperate zones. Even at present, it is endemic in most of tropical and sub-tropical ecosystem worldwide and exhibits great geographic diversity. This diversity is expressed in ecological and epidemiological characteristics in addition to the extensive polymorphism in the genes encoding antigenic proteins . It is the leading cause of death and disease in many developing countries, where young children and pregnant women are the groups most affected. Other risk groups are non- immune travelers, refugees, displaced persons and laborers entering endemic areas. Children particularly those under five, are at risk of developing severe malaria due to their relatively less developed immune systems, and the decline of passively acquired immunity (Alamirew, 2002).

About 90% of all malaria death in the world today occurs in Africa South of Sahara. It 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 admission, and up to 50% of outpatient visit in areas with high malaria transmission (WHO, 2002). The disease is directly responsible for one in five childhood death in Africa and indirectly contributes to illness and death from respiratory infections, diarrheal disease and malnutrition (WHO, 2000).

2.4 Symptoms and Signs of Malaria Disease

The first symptoms of malaria are nonspecific and similar to the symptoms of a minor systemic viral illness. They comprise; headache, fatigue, abdominal discomfort, muscle and joint aches, followed by fever, chills, perspiration, anorexia, vomiting and worsening malaise. This is the typical picture of uncomplicated malaria. Residents of endemic areas are often familiar with this combination of symptoms, and frequently self-diagnose. Malaria is therefore frequently over

diagnosed on the basis of symptoms alone. Infection with *P. vivax* and *P. ovale* more than other species, can be associated with well-defined malarial infected, in which fever spikes, chills and rigors occur at regular intervals (Eyob, 2015).

If infective drugs are given or treatment is delayed in *falciparum* malaria, the parasite burden continues to increase and severe malaria may ensue. A patient may progress from having severe disease within a few hours. This usually manifests with one or more of the following: coma (cerebral malaria), metabolic acidosis, severe anemia, and hypoglycemia in adults, acute renal failure or acute pulmonary edema. Usually at this stage, mortality in people receiving treatment has risen to 15 to 20%. If untreated, severe malaria is almost always fatal (Mmaduka, 2009).

2.5. Malaria Diagnosis and Treatment

Malaria is diagnosed by seeing the parasite under the microscope. Blood taken from the patient is smeared on a slide for examination. Special stains are used to help highlight the parasite. Sometimes, it is possible to identify the species of Plasmodium by the shape of the parasite, especially if gametocytes are seen. Whenever possible, smears should be reviewed by someone with expertise in the diagnosis of malaria. If the smears are negative, they can be repeated every 12 hours. Smears that are repeatedly negative suggest another diagnosis should be considered.

Other types of tests are available for diagnosis of malaria. One rapid test is the detection of antigenic proteins of Plasmodium species. This test takes less than 30 minutes to perform. However, the reliability of rapid tests varies significantly from product to product. Thus it is recommended that rapid tests can be used in conjunction with microscopy. A second type of test is the polymerase chain reaction (PCR), which detects malaria DNA. Because this test is not widely available, but it is important to get results in time (CDC, 2013).

Malaria is an entirely preventable and treatable disease. The primary objectives of treatment is to ensure a rapid and complete of the plasmodium parasite from the patients' blood in order to prevent progression of uncomplicated malaria to severe disease or death to chronic infection that emergence and spread of resistance to anti-malarial medicines (WHO, 2014). Most countries with *P. falciparum* malaria have adopted artemisinin-based combination therapy leads to malaria-related anemia. From a public health perspective, treatment is meant to reduce transmission of the infection to others, by reducing the infectious reservoir and to prevent the (ACTs) as a first-line treatment. WHO recommended that uncomplicated *P. falciparum* malaria should be treated with an ACT. In areas where chloroquine is still effective, *P. vivax* malaria should be treated with the drug. Where resistance to chloroquine has been documented, *P. vivax* malaria should be treated with an appropriate ACT (WHO, 2014).

2.6 Malaria in Ethiopia

About 75% the total landmass of Ethiopia is malarious and 60% of the population is exposed to malaria (FMOH, 2015). Ethiopia is generally considered as a low-to moderate malaria transmission intensity country. However, the health sector in Ethiopia is greatly affected by climate change which has profound climate change consequences on the transmission cycle of vector borne infectious disease like malaria. Due to the unstable and seasonal transmission of malaria in the country, protective immunity of the population is generally low and all the age groups are at risk, prevalence of malaria is currently estimated to be 1.3% (EMIS, 2011).

Ethiopia has achieved remarkable progress in the fight against malaria during the most recent decade through strong preventive and case management intervention with large engagement of the Health extension workers (HEWs) and providing community based cares at the household

level. In children under five years of age, malaria admissions and deaths fell by 81% between 2001 and 2011 and 73% respectively. The country is also one of the few sub – Sahara countries that have shown progress in the fight against malaria and in attaining the millennium development goal: halt and begin to reverse the incidence of malaria and other major diseases by 2015.

WHO has been actively supporting the Federal ministry of health of Ethiopia (FMOH) in the fight against malaria among other contributions, WHO has been providing technical support in building the capacity of health workers, programme monitoring, review and evidence generation, resource mobilization, supportive supervision at all levels, as well as supporting revision and updating of strategic documents and guidelines. FMOH and WHO have also jointly developed a new stratification map using health facility based surveillance data (WHO, 2015).

2.7. Malaria prevention and control in Ethiopia

Malaria transmission in Ethiopia is seasonal and largely unstable. During the major transmission season from September to December, following the main rains June through August, a large peak in malaria case occurs. A second but less pronounced peak occurs during the second transmission seasons in April and May following the short rains. (Tulu, 1993). Four of the human malaria parasites are reported in Ethiopia of these; *Plasmodium falciparum* and *P. vivax* are epidemiologically significant that accounts 60 and 40% respectively (FMOH, 2012).

Even though entomological findings conducted so far indicated the presence of 42 anophelines, only *An. arabiensis* is known to play a crucial role in malaria transmission in the country others such as, *An. funestus* and *An. pharoensis* playing a secondary role, while *An. nili* entails transmission in localized area (Abose *et al.*, 1998).

In Ethiopia, malaria control activities have been in action for long. The history of indoor residual spraying (IRS) and mosquito larval control dates back to the early 1960s. Patients of all ages are receiving malaria diagnostic test free of charge in the public sector since that time. But, cyclic malaria epidemics kept on unabated in the country with the latest epidemic in 2004 and 2005 (Guthmann *et al.* 2007).

In recent years, however, there has been heavy financial support by global donors and refreshed political commitment of governments in malaria endemic countries to curb the disease. Moreover, clear operational plans including a long-term vision for malaria control were formulated in which sustained scale-up of proven malaria control tools would progressively lead to malaria elimination in Africa, with the ultimate goal of worldwide malaria eradication by 2040-2050 (PMI, 2015). The proven malaria intervention tools being extensively used in Ethiopia, like elsewhere, are insecticide-treated mosquito nets (ITNs); IRS; prompt diagnosis and treatment with artemisinin-based combination therapies (ACTs). Although Ethiopia is still in malaria control phase it has set a plan to eliminate malaria in selected low transmission settings by 2020 (PMI, 2016).

The aggressive malaria intervention policies and strategies of Ethiopia are supported by major external funders (Global fund, World Bank, USAID/PMI, WHO/UNICEF and others) since 2005. The funding reached peak in 2013 and then declined in 2014 as federal ministry of health (FMOH) sources demonstrate. Mosquito nets are being distributed free of charge to all age groups since 2004. In 2014, the proportion of the at-risk population estimated to have access to an ITN in their household exceeded 50% (WHO, 2015).

IRS was used with the protected proportion of the at-risk population exceeding 60%. Pyrethroid resistance has been confirmed in Ethiopia since 2010 and dichlorodiphenyltrichloroethane (DDT) resistance is also common (Balkew *et al.*, 2010). Carbamate resistance has also been reported for at least one malaria vector, and organophosphate resistance has been reported for Ethiopia (Yewhalaw *et al.*, 2011). Currently, propoxur or bendiocarb are in use as per the WHO recommendation.

Ethiopia has adopted artemetherlumefantrine (AL), one form of ACTs as first-line treatment policy since 2004 (FMOH, 2004) for uncomplicated *P. falciparum* and for *P. vivax* chloroquineremains the drug of choice. AL is free for all ages since 2004, sell of oral artemisinin-based monotherapies is never allowed since 2004, no single dose of primaquine is used for gametocidal medicine for *P. falciparum*, no for radical treatment of *P. vivax*, no directly observed treatment with primaquine is undertaken. However, a system for monitoring adverse reactions to antimalarials has never been in existence. Surveillance for active case detection for case investigation, and active case detection of febrile cases at community level, mass screening, have never been there. The therapeutic efficacy of AL remains high in Ethiopia (Nega *et al.* 2016), with a median treatment failure rate of less than 10% observed.

The world malaria report 2015 reported that it was not possible to assess malaria trends between 2000 and 2014 because of inconsistent reporting, or changes in health service accessibility or diagnostic testing. However, a study of 41 hospitals with complete data for analysis (of the total 62 hospitals below an altitude of 2000 meters) found a 66% decrease in confirmed cases between 2001 and 2011 (Aregawi *et al.*, 2014), which is consistent with the WHO estimate of a 50-75% decrease in case incidence by 2015. Estimates of malaria case incidence inferred from surveys of

parasite prevalence suggested that Ethiopia had decreases in case incidence of more than 75% between 2000 and 2015 (WHO, 2015).

In its latest annual report (FMOH, 2015) the FMOH indicated that up to August 2015 a cumulative total of 75,876,866 LLINs were distributed nationwide to the at-risk population. The coverage was more than double compared to the status in September 2010 (35,237,701). A total of 5.3 million unit structures (89.8% out of the target) in malaria endemic areas were sprayed. A total amount of 6.8 million doses of ACTs, 35,000 vials of artesunate injection, 1.17 million doses of chloroquine and 13 million rapid diagnostic tests (RDTs) were distributed for malaria intervention previous year.

This latest report revealed not only high coverage of malaria vector control tools, diagnostics and drugs the country has also shown massive expansion of its health facility infrastructure and professional staff. Currently there are 16,447 health posts (HPs). The highest number of HPs is found in Oromia Region (6519), accounting for 39.6% of the total, followed by Southern Nations, Nationalities and People's Region (SNNPR) having 3,842 and Amhara (3336) Regions. The cumulative total of available health centers (HCs) is 3,586 in August 2015 with 180 under construction. The highest number of HCs was found in Oromia Region (1320), accounting for 36.8% of the total, followed by Amhara (834) and SNNPR (752) Regions. During the same period there were 189 functional hospitals and 147 under construction in eight Regions in addition to Federal hospital.

Health extension workers (HEWs) are the key resources for implementation of health extension program in Ethiopia. The aim of HEWs upgrading program is to improve the quality of health

extension services at community and household levels. A total of 8,647 Level III HEWs were enrolled to be upgraded to Level IV qualifications. Out of enrolled in last 3 years, a total of 3,667 graduated and deployed back to their respective HPs. The remaining 4,970 were on training and planned to graduate at the end of 2015. Level III replacement training had been continuing in line with the upgrading program in all Regions. Although there are major improvements challenges remain ahead. The report stipulated that there were budget constraints at woreda level to conduct IRS activities; delay in LLIN procurement to replace the “old” ones; and inadequate utilization of LLINs. So, malaria continues to be a major public health challenge although drastic reduction was achieved (Sani , 2016).

The aforementioned latest annual performance report presented that between September 2014 and August 2015 a total of 2,174,707 malaria cases (confirmed plus clinical) and 662 deaths were documented with case fatality rate (CFR) of 0.03%. The number of microscopy or RDT confirmed were 1,867,059(85.9%) of which 1,188,627(63.7%) were *P. falciparum* and 678,432(36.3%) *P.vivax*. The monthly pattern showed an increase in September through January peaking in November, followed by a decrease until April. There was no clear pattern of seasonal difference in the distribution of the two species although in October, November and December there was a sharp increase and a drop thereafter for *P. falciparum*, *P. vivax* appeared to show a lower profile and nearly a consistent pattern throughout. No mixed cases were reported. The highest number of total malaria cases was reported from Amhara (610,486) followed by Oromia (430,969) and Southern Nations, Nationalities and People's Region (375,746). The number of total malaria cases at national level was halved compared to the previous year.(FMOH , 2015).

Prevention and control activities of malaria in Ethiopia are implemented according to the National Strategic Plan (NSP) for Malaria Control and Prevention that operates in line with the WHO recommendations. The National Strategic Plan for Malaria Control and Prevention in Ethiopia, NSP 2011-2015, is aimed at strengthening and scale-up of malaria control interventions through prompt and effective diagnosis and treatment, case management through roll-out of the highly efficacious antimalaria drugs, Artemisinin-based combination therapies (ACTs), and selective vector control with special emphasis to scaling up of LLINs coverage and ensuring its utilization at household level, and targeted and timely application of IRS of households with insecticide and environmental management. The strategic plan has set goals to achieve malaria elimination in areas with historically low malaria transmission and near zero malaria deaths in all the remaining parts of the country by 2015. To attain these goals, it has set out the following specific targets: 100% of households in malarious areas own one LLIN per sleeping space, at least 80% of people at risk of malaria use LLINs, IRS coverage is increased and maintained to 90% of households in IRS-targeted areas, 100% have access to effective and affordable malaria treatment (FMOH, 2010).

3. Materials and Methods

3.1 Description of the study Area

The study was conducted in Assosa Zone, Assosa town in Assosa General Hospital. Assosa is a town in western Ethiopia and the capital of the Beneshangul – Gumuz Region (the home land of Ethiopia grand Renaissance dam). It is 670 kilometers away from Addis Ababa, capital city of Ethiopia. This town has altitude and longitude of 10°04' N 34°35' E/10.06°N 34.517°E and an elevation of 1570 meters above sea levels. It is bordered by kurmuk and Homosha in the north, by Menge in the northeast, by Oda Buldigilu in the east, by Bambasi in the southeast, by Mao and Komo special woreda in the south. Based on figures from the Central Statistical Agency in 2007, this town has an estimated total population of 37365, of whom 19232 are males and 18133 are females (CSA, 2007) .

There are no permanent rivers, there are a number of springs in and around the town as well as numerous seasonal streams and gullies that collect rainwater from different part of the town and drain it in to Selga , Shederia and Laga Belo rivers. It has a maximum and minimum temperature of 40°C and 14°C respectively. Its mean annual rainfall is 1166 mm and the raining season extends from April to November, but the maximum rainfall occurs in summer season in between June and August. Assosa town is organized under four administrative kebeles (01, 02, 03 and 04), the lowest administrative units. All four kebeles are considered as malaria risk areas.

Currently there is one general hospital and one health center in the town. According to health facility reports, malaria is one of the leading causes of morbidity in the town and kebeles nearest to the town. This could be associated with the availability of mosquito breeding sites and suitable of climatic condition for survival of the vector mosquitoes. The common malaria control

activities-prompt diagnosis and treatment, bed net use, chemical spray(using propoxur or bendiocarb), and environment management(mosquito larva source reduction)-were well-under ways in the town .

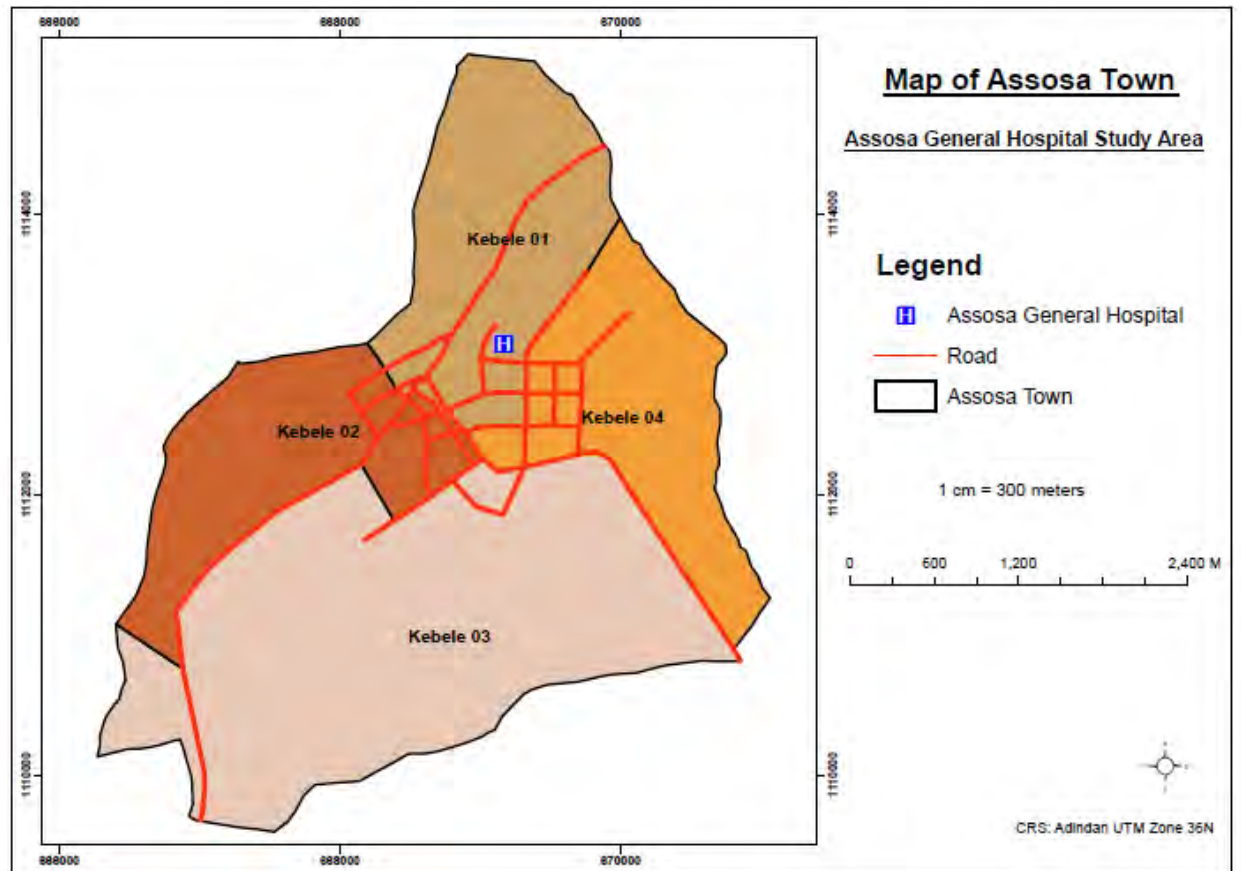


Figure 2. Map of the study area

3.2 Study Design

A retrospective design was employed using data from Assosa General Hospital. This was done by reviewing the five years (from September 2012 to August 2016) malaria morbidity records of the Hospital.

3.3 Study Population and Data Collection

The study participants were all malaria suspected individuals who had complains of febrile illness in Assosa General Hospital during the study period. Socio demographic and laboratory data were collected from patients' registration book. In this hospital, the staining technique and blood film examination for malaria parasite detection were conducted according to a standard operating procedure (SOP) adopted from WHO protocol (WHO, 2010).

3.4 Data Analysis

Data was entered into Microsoft Office Excel and analyzed using statistical package for social sciences (SPSS) windows version 20. Chi-squares (X^2) was used to test differences in retrospective malaria prevalence between years, sexes, ages and seasons. P-values ≤ 0.05 was considered statistical significant and results were presented by tables and graphs.

3.5 Ethical Considerations

This five year data was collected after ethical clearance obtained from Addis Ababa University. After discussing the purpose and method of the study, written permission was sought from the head of Assosa General Hospital medical director.

4. Results

4.1. Annual Trends of Malaria Prevalence in Assosa General Hospital

Within the last five years (2012-2016) a total of 13697 blood films were requested for malaria diagnosis in Assosa General Hospital and 7353 (53.68%) blood samples were microscopically confirmed as malaria cases. There was a fluctuating trend of malaria within the last five years with the maximum 1858(58.63%) microscopically confirmed malaria cases being reported in 2012 and the minimum 942 (46.35%) microscopically confirmed cases of malaria being reported in 2016 (Table 1).

Table 1 Slide-confirmed annual malaria cases and distributions of plasmodium species in Assosa General Hospital, Western Ethiopia

Year	Total Examined	Total Slide Positive	<i>Plasmodium falciparum</i>	<i>Plasmodium vivax</i>	P-value
2012	3169	1858 (58.63%)	723 (38.9%)	1135 (61.1%)	0.0000195
2013	2614	1385 (52.98%)	509 (36.75%)	876 (63.25%)	
2014	3168	1712 (54.04%)	806 (47.08%)	906 (52.92%)	
2015	2714	1456 (53.64%)	778 (53.43%)	678 (46.57%)	
2016	2032	942 (46.35%)	492 (52.23%)	450 (47.77%)	
Total	13697	7353 (53.68%)	3308 (44.98%)	4045 (55.02%)	

As shown in Table 1 *Plasmodium falciparum* and *Plasmodium vivax* are the major causative agents for malaria infection in the study area. Regarding the identification plasmodium species, both species of plasmodium were reported in the last five years with *plasmodium vivax* being the dominant species in the study area. On the whole 4045 (55.02%) and 3308 (44.98%) of the cases were attributed to *P.vivax* and *P. falciparum* monoinfections, respectively (Table 1, Fig 3). The difference was statistically significant ($P < 0.05$). There were higher *P. vivax* monoinfections in

2012 (61.1%) and 2013 (63.25%) than *P. faciparum* (38.95% 36.75%) respectively), and the reverse was observed in 2015 and 2016. This shows that there was a trend shift from *P. vivax* to *P. falciparum* in the study area.

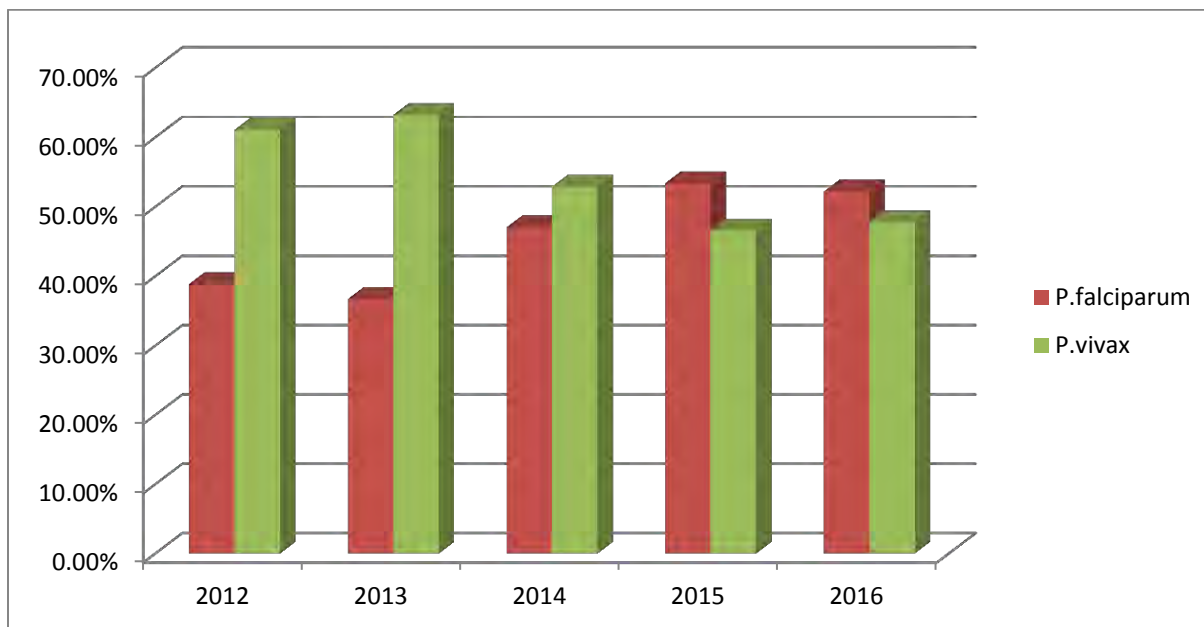


Fig. 4 Distribution of malaria confirmed cases by species and year

4.2. Prevalence of malaria with respect to sex and age groups

In terms of sex, 7237 of the total examined patients were males and 6460 were females. Out of the malaria slide positive individuals, 54.29% were males and 45.71% were females (Table 2). Malaria slide-positives among males were 3992 (55.16%) and among females were 3351(52.03%). The data showed that males were more affected than females. The prevalence of malaria among sex was not statistically significant ($P>0.05$).

Regarding distribution of malaria prevalence by age groups, Out of 7270 total blood films examined in the age group of 15 and above 15 years (≥ 15), 4368(60.08%) were tested positive,

out of 2822 total examined in the age group of 5-14 years 1426 (50.52%) were tested positive and out of 3605 total blood films examined in the age group of 0-4 years 1559 (43.25%) were tested positive. The data showed that the highest malaria prevalence was observed in the age groups of 15 and above 15 years (Table 3). But the prevalence of malaria among age groups was not statistically significant ($P>0.05$).

Table 2 Distribution of malaria confirmed cases by sex

Sex	No of examined	Slide positive number (%)	<i>P. falciparum</i> number (%)	<i>P.vivax</i> number (%)	P-value
Male	7237	3992 (55.16)	1768 (44.29)	2224 (55.71)	0.246
Female	6460	3361 (52.03)	1540 (45.82)	1821 (54.18)	
Total	13697	7353 (53.68)	3308 (44.98)	4045 (55.02)	

Table 3 Distribution of malaria confirmed cases among different age groups

Age	No of examined	Slide positive	<i>P. falciparum</i>	<i>P.vivax</i>	P-value
0-4	3605	1559 (43.25%)	515 (33.03%)	1044 (66.47%)	0.532
5-14	2822	1426 (50.52%)	597 (41.87%)	829 (58.23%)	
≥ 15	7270	4368 (60.08%)	2196 (50.27%)	2172 (49.73%)	
Total	13697	7353 (53.68%)	3308 (44.98%)	4045 (55.02%)	

4.3. Seasonal variation of malaria prevalence in Assosa General Hospital from 2012 to 2016

Seasonal distribution of malaria and infected cases differs in each month and seasons of the year (Table 4). The highest peak of malaria prevalence was observed during September to November (57.16%) shortly after the heavy rain season and the lowest number of malaria cases was observed during the months of March to May (49.18%).

Although the highest number of *P. vivax* and *P. falciparum* was observed during October and the lowest in May.

Table 4 Monthly prevalence of malaria slide confirmed cases in Assosa General Hospital from 2012 to 2016

Month	Total examined	Total positive (%)	<i>P. falciparum</i> (%)	<i>P. vivax</i> (%)
Sep	1425	757 (53.12)	354 (46.76)	403 (53.24)
Oct	1550	932 (60.1)	376 (40.34)	556 (59.66)
Nov	1237	723 (58.45)	303 (41.91)	420 (58.09)
Dec	1324	710 (53.63)	296 (41.69)	414 (58.31)
Jan	1144	597 (52.18)	259 (43.38)	338 (56.62)
Feb	941	460 (48.8)	208 (45.22)	252 (54.78)
March	1027	453 (44.1)	191 (42.16)	262 (57.84)
April	918	478 (52.1)	203 (42.47)	275 (57.53)
May	873	455 (52.24)	260 (57.14)	195 (42.86)
June	968	504 (52.06)	222 (44.05)	282 (55.95)
July	1142	657 (59.1)	303 (46.12)	354 (53.88)
Aug	1148	627 (54.6)	333 (53.11)	294 (46.89)
Total	13697	7353 (53.68)	3308 (44.98)	4045 (55.02)

5. Discussion

In this study, a total of 7353 (53.68%) malaria prevalence among patients were reported in the last five years, period from 2012 to 2016. This was higher than the study conducted Abeshge district, Walga Health Center (Yimer *et al.*, 2015) in which the overall prevalence of malaria was (33.8%). This might be due to variation in sample size, altitude and climate.

My finding also showed that the highest number of malaria slide- positives was in 2012 and then after declining trend continued with the lowest number of cases in 2016. This decreasing trend might be due to a better awareness of the people about malaria and implementation of control strategies.

From the result of the study the predominant plasmodium detected was *P. vivax* (55.02%) followed by *P. falciparum* (44.98%). This result is different from the study conducted in Kola Diba Health center in which *Plasmodium vivax* accounted 75% and *Plasmodium falciparum* accounted 25% (Alemu *et al.*, 2012). But other studies reported that the most prevalent species was *P. falciparum*. The study conducted in Metema Hospital reported that *P. falciparum* accounted 90.7% and *P. vivax* 9% and mixed infection 0.3% (Getachew *et al.*, 2013).

However, this study contradicts with the study conducted similarly, a research conducted in Arsi Negele in which the prevalence of *P. falciparum* and *P. vivax* was 19.8 and 74% respectively and mixed infection was 6.2% (Mengistu and Solomon, 2014).

This finding is concurrent with malaria parasite distribution in Ethiopia which indicates that *Plasmodium falciparum* and *P. vivax* are the two predominant parasites distributed in the country and accounting for 60% and 40% of malaria cases respectively (FMOH, 2012). This

might be due to the differences in the study area, study period, sample size as well as study population in which those studies focused on.

The data showed that males (54.29%) were more infected than females (45.71%) but without any significant statistical difference. This is in line with other studies in Ethiopia. According to the study conducted at Kola Diba Health Center males were more affected than females. The infection rate among males was 52.6% and females were 47.3% (Getachew *et al.*, 2013). The reason why malaria affected more males might be due to the fact that males engaged in activities outside their residence area Migration which make them more prone to infective mosquito bites as compared to female counterparts which are mostly at home and are not exposed counterparts which are mostly at home and are not exposed to malaria areas and protected from such infectious bites.

Regarding the age groups, malaria infection was recorded from all age groups in the study area. However, the rate of infection was high in the age groups ≥ 15 years old followed by 5-14 years old. This might be due to improper usage of bed net. High malaria transmission often overlaps with the planting and harvesting season that increase malaria incidence among working age group and working adults in Agrarian communities.

In the study area, seasonal distribution of malaria infected cases differs in each season of the year. The highest prevalence of malaria cases was observed during spring (September to November) and the lowest number of malaria cases was observed during March to May. This is in agreement with other studies done in Metema Hospital and Kola Diba Health Center in which malaria transmission peaks from September to November (Getachew *et al.*, 2013, Alemu *et al.*, 2012).

Generally, this study showed that during the last five years, there was trend in the decrease of malaria cases observed in Assosa General Hospital. The highest peak was in 2012, there after there was decrease in 2016.

6. Conclusions and Recommendations

6.1. Conclusions

- The overall prevalence of malaria in the study area was 53.68% and the infection by *P. vivax* was higher than *P. falciparum*. There might be misdiagnosis of plasmodium species as monoinfection. Clinical diagnoses of plasmodium species need special attention in the study area.
- Based on the analysis of Socio-demographic factors, males were more prevalent than females. But sex is not statistically significance with malaria prevalence. The patients aged 15 and above 15 (≥ 15) years were more infected than other age groups and children under the age of five (0-4) years were the least infected. The difference in malaria prevalence between the age groups was not statistically significant.
- Even though the malaria morbidity in this hospital showing significant changes positively in 2016. The coming change is not still enough. The clinical data showed that malaria is still a major health problem in the study area.

6.2. Recommendations

In order to minimize the prevalence of malaria in Assosa General Hospital the following recommendations are made based on the findings of the study.

- In order to get a clear picture of the prevalence of malaria and the distribution of the parasite in particular, proper diagnosis methods should be established.
- Both health professionals and people at large should consider environmental management and the community should be mobilized for practice sustainable and integrated vector

control measures including drainage of breeding sites to play a crucial role on preventing the occurrence of further malaria epidemics.

- More attention to malaria control activities must be focused on the residence near to breeding sites and kebeles with high prevalence that might relate to their exposure to mosquito breeding sites.
- To give efficient services and save time, the malaria diagnosing laboratory should establish separately.
- Laboratory diagnosis should be established in all health facilities found in a rural areas, the services provide at this level should be available free of charge.
- All the information regarding to malaria should be registered in a good manner and documented separately.
- Further research on the prevalence of malaria should be conducted to prevent and control of the series consequence of this disease, especially during malaria transmission.

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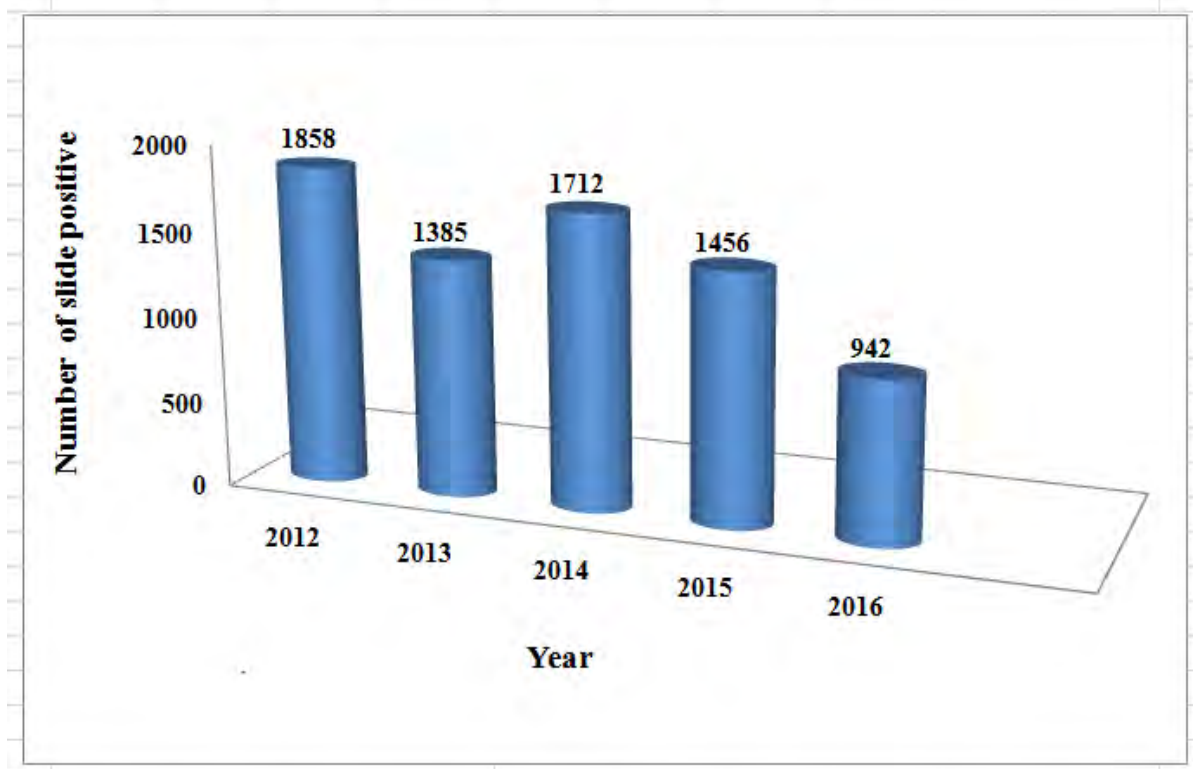
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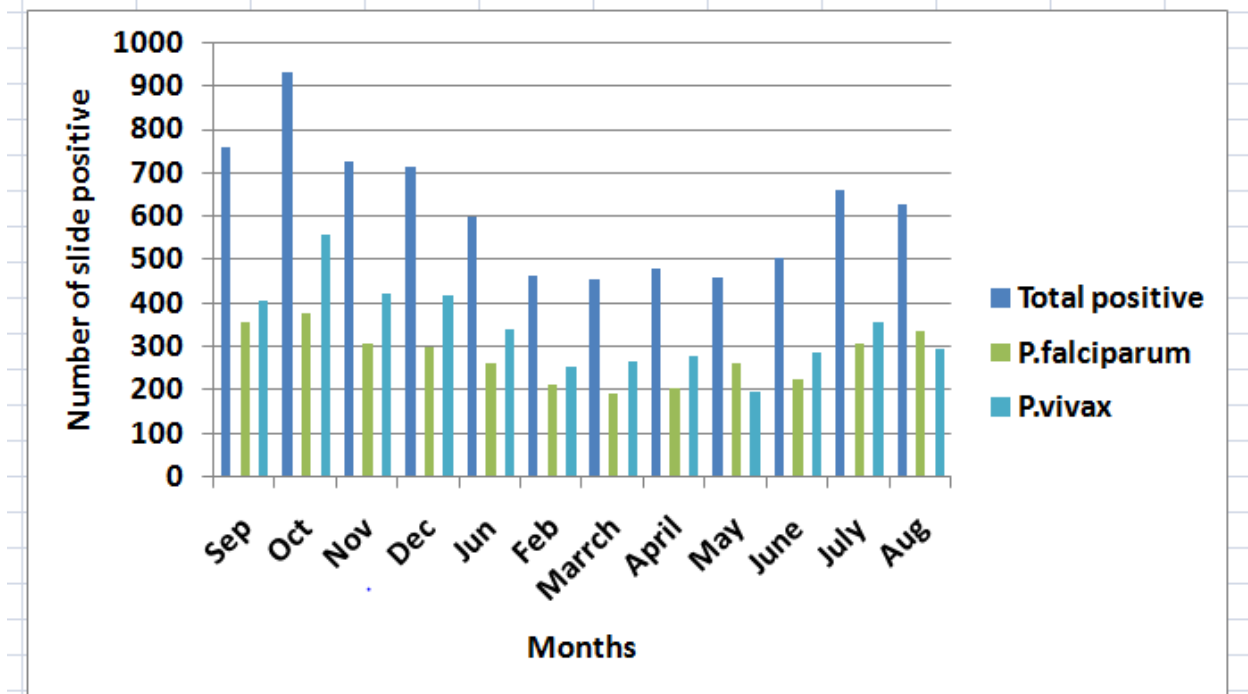
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Appendices

Appendix 1: Yearly profile of malaria positive cases in Assosa General Hospital



Appendix 2: Distribution of malaria confirmed cases by months from 2012-2016



Declaration

I, the undersigned, declare that this Thesis is my original work and has not been presented to any other universities and all sources of information used for the thesis have been fully acknowledged.

Name Tesfaye Meku

Signature _____

Date _____

This MSc thesis has been submitted for examination with my approval as an advisor.

Name Mekuria Lakew (PhD)

Signature _____

Date _____