



ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF ZOOLOGICAL SCIENCES

A FOUR YEAR TREND ANALYSIS OF MALARIA PREVALENCE IN
AYSAITA PRIMARY HOSPITAL, AYSAITA WOREDA, AFAR REGIONAL
STATE, NORTHEAST ETHIOPIA

By

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A thesis Submitted to the School of Graduate Studies of Addis Ababa University in
Partial Fulfillment of the Requirements for the Degree of Master of Science in
Biology

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Feb, 2018

Acknowledgments

I would like to thank Dr.Gurja Belay for spending his precious time and energy in correcting and shaping my final thesis.

I grateful thank my father Ato Belay W/Giorgis and my mother W/o Ambanesh Fekadu for their strong moral support. I would like to extend my thanks to the member of laboratory technicians of Aysaita primary hospital, who helped me in collecting data.

My deepest gratitude also goes to my family members, Elsa Belay, Ato Muluken Belay, Hiwot Belay, Adane Belay, Ato Abebe Ejgu, Ato Sisay Mekonne and Banchialem Amebe for their moral and material support. I would like to extend my deepest gratitude to Ato Biniam Hassen, Ato Ousman Kefyalew and Ato Derara Tefera.

I thank to Mohammed Hanfere school director Ato Ali Ahmed and all staff member for moral and material support.

I am grateful to Addis Ababa University; school of graduate studies for financial support to carryout my research.

Finally I am too pleased to thank GOD for directing, assisting and strengthening me throughout my study.

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List of Acronyms

ACTs	Artemisinin based Combination Therapies
AL	Arthemeter Lumefantrine
AMREF	African Medical and Research Foundation
ANRS	Afar National Regional state
CDC	Center for Disease Control
FMH	Federal Ministry of Health
IRs	In door Residual Spray
ITNs	Insecticide Treated Net
MOH	Ministry of health
MOP	Malaria operational plan
NGO	Non-Governmental Organization
NIAID	National Institute of Allergy and Infectious Diseases
RBC	Red Blood Cells
RBM	Roll Back Malaria
SNNPR	Southern Nations, Nationalities and Peoples Region
SSA	Sub-Saharan Africa
TCC	The Carter Center TM

Abstract

Malaria is sever disease in Ethiopia, 75% Of the land is malarias area and more than 54 million people are vulnerable. The aims of this study was to determine the prevalence of malaria who attended in Aysaita primary hospital for the last four year (2006 -2009E.C) A retrospective study was conducted to determine the prevalence of malaria infection from laboratory registered records in Aysaita primary hospital. All malaria cases reported between 2006-2009E.C. were reviewed and the data finalized using chi-square and ANOVA to analysis the data. During four years a total of 43574 thick and thin Giemsa stained blood films were examined for malaria diagnosis in Aysaita primary hospital and 3,830 (8.7%) microscopically confirmed malaria cases were reported with slightly falling down from 2006 to 2008 E.C and slightly increased in 2009 E.C. Regarding the identified plasmodium species, Plasmodium falciparum and plasmodium vivax accounted for 94.6% and 5.3% of the cases respectively. Malaria was reported in all age groups and both sexes. But ≥ 15 year age group and males were more affected. The prevalence of malaria infection association with sex and age was statistically significance ($p < 0.05$). The apparent fluctuation of malaria trends in the area and the high peak of malaria cases were reported during March with the last four years. Generally slide positive rate of malaria was slightly increased 2009 in study area. Therefore, health planners and administrators should give intensive health intervention and education for the community.

Key word: Plasmodium, Malaria, Ayasita primary hospital, prevalence, Anopheles

1. Introduction

1.1. Back Ground of the Study

Malaria is caused by a protozoan belonging to the genus, *Plasmodium* with five species: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi* infect humans (WHO, 2012). *Plasmodium falciparum* occurs predominantly in sub-Saharan Africa (SSA), which is responsible for the majority of mortality and burden of malaria. *P. vivax* is the second most important species, and its occurrence is particularly prominent in Asia. The *P. malariae* is found in tropical and sub-tropical areas of central and South America, Asia, Africa and South East Asia. *P. ovale* is mostly found in Tropical West Africa. *Plasmodium Knowlesi* is a primate malaria parasite commonly found in Southeast Asia (WHO, 2011).

According to the world health organization, there were 97 countries and territories with ongoing malaria transmission and 7 countries in the prevention of reintroduction phase, making a total of 104 countries and territories in which malaria is presently considered endemic (WHO, 2013). Globally, an estimated 3.3 billion people are at risk of being infected with malaria and developing disease, and 1.2 billion are at high risk to acquire the disease. Some population groups considerably higher risk of contracting malaria, developing severe disease than others. These include infants, children under five years of age, pregnant women with HIV/AIDS as well as non-immune migrant, mobile populations and travelers (WHO, 2015).

The burden is heaviest in the African Region, where an estimated 90% of all malaria deaths occur, and in children aged less than 5 years, which account for 78% of all deaths (WHO, 2014). The parasite burden is also highest in school age children due to low coverage of interventions, and infections may have consequences in school performance and indicate school children as good proxy for transmission in a wide community (Stevenson *et al.*, 2013)

In Ethiopia, malaria was reported to be endemic first and fore most by the Italian and British scientists from the mid-1930s to the late 1950s. In 1953, severe outbreaks that devastated the lives of 7000 people was reported to occur in Dembia plain near Lake Tana and more than 1 million cases were recorded in the recent epidemic year of 1998. In 2003 and 2004, there were

serious malaria epidemics throughout the country, which affected 15 million people in 3 federal regions (WHO-UNICEF, 2003).

Thus, malaria is a major public health problem and it is estimated that about 75% of the land mass of Ethiopia is malarious and 68% of the Ethiopian population, estimated at about 54 million live in malaria risk areas in 2010 (FMH, 2010). *P. falciparum* and *P. vivax* are the most dominant malaria parasites in Ethiopia. They are prevalent in all malarious areas in the country with *P. falciparum* representing about 65% to 75% of the total reported malaria cases, relative frequency varying in time and space within a given geographical range. Prevalence of malaria infection 20.5%, 6.8%, 39.6%, 16% and 6.3% were reported among different study groups from East Shewa (Haji *et al.*, 2016), Sanja (Ligabaw *et al.*, 2014), Kola Diba (Alemu *et al.*, 2012), Dilla (Molla and Ayele, 2015) and Jima town (Tatek, 1994) respectively.

Malaria outbreak was reported in some regions (Beffa *et al.*, 2015). Of the country malaria is seasonal with periodic transmission that leads to the outbreak of an epidemic. In Ethiopia, malaria transmission is largely determined by climate and altitude. Most of the transmission occurs between September and December, after the main rainy season from June to August while the second minor transmission period from April to May, following a short rainy season from February to March, MOH (2009).

Therefore, the purpose of this study was to determine the prevalence of malaria in Ayssita primary hospital records. So it can provide information which predominant species of plasmodium dominating in the study area.

1.2. Objective of the Study

1.2.1. General objective

To identify and determine the prevalence of malaria in Aysaita primary hospital, Aysaita Woreda, Afar Region, Ethiopia.

1.2.2. Specific objective

Specifically the study was intended:-

1. To assess the prevalence of malaria infection for the past four years (2006 – 2009 E.C) in Aysaita primary hospital
2. To identify the Plasmodium species type and determine its prevalence among Aysaita primary hospital patients reported from 2006 - 2009 E.C.
3. To estimate the prevalence of malaria based on age and sex.
4. To assess monthly pattern of malaria infection at Aysaita primary hospital.

1.3. Research question

The following research question was expected to be answered in the course of this study. To this effect, the research questions were presented below:-

1. What is the prevalence of malaria at Aysaita primary Hospital?
2. Which plasmodium species is dominant at Aysaita primary Hospital?
3. Is there any variation in the prevalence of malaria between sex and age group?
4. Which month to do have the highest prevalence of malaria?

2. Literature Review

2.1. Global Epidemiology and Geographic Distribution of Malaria

Malaria, caused by parasites transmitted to humans by mosquitoes, is one of the world's most common and serious tropical diseases. However, on the globe, it extends up to 60° north and 40° south of latitudes. Its distribution in the world is not uniform (Figure 1). Different species of *Plasmodium* are found in different countries (WHO, 2011). The global malaria burden is not evenly distributed with Sub-Saharan Africa accounting for 90% of global malaria cases and a majority of these cases occurring among women and children (Audrey *et al.*, 2008).

Malaria occurs throughout most of the tropical regions of the world. *P. falciparum* predominates in Africa, New Guinea, and Haiti while *P. vivax* is more common in Central America and Africa. The prevalence of these two species is approximately equal in South America, the Indian subcontinent, eastern Asia, and Oceania. *P. malariae* is found in most endemic areas, especially throughout sub-Saharan Africa, but is much less common. *P. ovale* is relatively unusual outside of Africa and, where it is found, comprises <1% of isolates (Nicholas *et al.*, 2008).

Despite the continuous global efforts to fight parasitic infections and the attempts to eliminate the causative organisms, malaria still remains as one of the greatest human killers, causing almost 3 million deaths per year and 300-500 million infections annually (Bero *et al.*, 2009; Tamura *et al.*, 2010). About half of the world's population is living in malaria risk areas, and there were approximately 863,000 deaths in 2008 from an estimated 243 million cases worldwide (WHO, 2009). This is due to the majority of infections in Africa being caused by *P. falciparum*, the most severe and life-threatening form of the human malaria parasite, as well as the most efficient and difficult to control malaria vector, *Anopheles gambiae*, which is the most widespread in the continent (Vangapandu *et al.*, 2007).

Moreover, widespread poverty, lack of infrastructures and resources necessary to mount sustainable interventions against the disease in the continent play a role in the continuing burden of malaria (Teklehaimanot and Mejia, 2008). Most of the deaths due to malaria occur in African children under the age of 5 years, who have little or no immunity to the disease and in every 40

second a child dies of malaria, resulting in a daily loss of more than 2000 young lives worldwide (Tamura *et al.*, 2010). Pregnant women and their unborn children are also at great risk for malaria because the immune response is suppressed in pregnancy and parasitized red blood cells (RBCs) sequestered in the placenta (Vangapandu *et al.*, 2007).

However, recent report declared good news about the remarkable reduction in malaria incidence and mortality rates during the past decade in all regions of the world. Statistically, it was estimated that the number of cases of malaria increased from 233 million in 2000 to 244 million in 2005 but interestingly decreased to 225 million in 2009, and then to 216 million in 2010. There was also a reduction of number of deaths from 985,000 in 2000 to 781,000 in 2009, and then to 655,000 in 2010 (WHO, 2010).

A substantial reduction in malaria transmission has been achieved globally, particularly in endemic countries between 2000 and 2012. Over this period, the malaria mortality rate was reduced by 42% in all age groups and by 48% in children under five years of age. Approximately 3.3 million death were prevented between 2001 and 2012, of which 91% were children under five years of age in Africa. The reduction was mainly associated with scaled up support by international donors, socioeconomic developments, the deployment of artemisinin based combination treatment, wider coverage of long lasting insecticidal nets (LLINs) and indoor residual spraying in malaria's areas (WHO, 2013).

According to the latest estimates from WHO, there were 214 million new cases of malaria worldwide (range 149 –303 million) and an estimated 438 000 malaria deaths (range 236 000 – 635 000) worldwide in 2015. Most of these deaths occurred in the African Region (90%), followed by the South-East Asia Region (7%) and the Eastern Mediterranean Region (2%) (WHO, 2015). Between 2000 and 2015, malaria incidence rates (new malaria cases) fell by 37% globally, and by 42% in Africa. During this same period, malaria mortality rates fell by 60% globally and by 66% in the African Region (WHO, 2015).

According to WHO (2016) report between 2010 and 2015, malaria incidence rates (new malaria cases) fell by 21% globally. During this same period, malaria mortality rates fell by an estimated 29% globally and by 31% in the African Region. Other regions have achieved impressive reductions in their malaria burden. Since 2010, the malaria mortality rate declined by 58% in the

Western Pacific Region, by 46% in the South-East Asia Region, by 37% in the Region of the America and by 6% in the Eastern Mediterranean Region. In 2015, the European Region was malaria-free: all 53 countries in the region reported at least 1 year of zero locally-acquired cases of malaria (WHO, 2016). About 4% of estimated cases globally are due to *P. vivax*, but outside the African continent the proportion of *P. vivax* infections is 41% and 96% estimated due to *Plasmodium falciparum* globally (WHO, 2016).

Populations living in sub-Saharan Africa (SSA) have the highest risk of acquiring malaria. Among 216 million episodes of malaria in 2010, approximately 81%, or 174 million cases, were observed from the African region. There were an estimated 655,000 malaria deaths in 2010, of which 91% were from Africa (WHO, 2011). A person in Africa dies of malaria every 10 seconds (Gerard, 2010). Women and young children are most at risk affects five times as many people as AIDS, leprosy, measles and tuberculosis combined (Betemariam *et al.*, 2002).

In Africa an absolute decrease in the number of deaths from the previous time was observed. This achievement is largely as a the result of a significant scaling-up of malaria prevention and control measures in the last decade, including the widespread use of bed nets, better diagnostics and a wider availability of effective medicines to treat malaria (WHO, 2013).

In Africa, it is estimated that at least USD 12 billion per year is lost directly through illness, treatment and premature death with individual African families spending up to 25% of their income on malaria prevention and control. In some countries with a heavy disease burden, malaria accounts for up to 40 % of public health, up to 50% of inpatient hospital admission, and up to 60% of visits to outpatient health clinics (Dharani *et al.*, 2010).

Overall, malaria constitutes 10% of the continent's disease burden (TCC, 2011). Aggregated losses over time have resulted in substantial differences in GDP between countries with and without malaria, particularly in Africa (Dharani *et al.*, 2010). Furthermore, it also hampers children's schooling and social development through both absenteeism and permanent neurological and other damage associated with severe episodes of the disease, which have important short and long-term social and economic impacts (Teklehaimanot and Mejia, 2008; TCC, 2011). Malaria disease management is therefore an essential part of global health improvement and economic development (Dharani *et al.*, 2010).

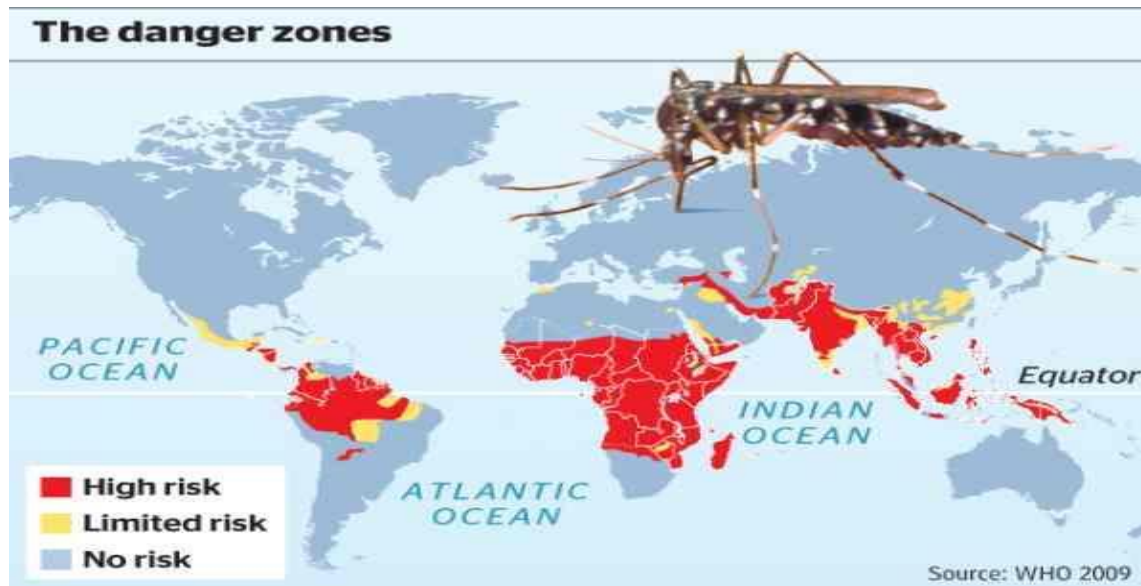


Figure 1. Global distribution of malaria transmission risk. (Source WHO, 2009)

2.2. Epidemiology and Distribution of Malaria in Ethiopia

In Ethiopia, malaria was reported to be endemic first and foremost by the Italian and British scientists from the mid-1930s to the late 1950s. In 1953, severe outbreaks that devastated the lives of 7000 people were reported to occur in Dembia plain near Lake Tana and more than 1 million cases were recorded in the recent epidemic year of 1998. In 2003 and 2004, there were serious malaria epidemics throughout the country, which affected 15 million persons in 3 federal regions (WHO.UNICEF, 2003).

In Ethiopia, malaria is one of the leading causes of morbidity and mortality. Statistically, Ethiopian malaria deaths increased from 15268 in 1980 to a peak of 46918 in 2000, decreasing to 22165 in 2010 and in 2007-2008, malaria was the first cause of outpatient visits, health facility admissions and in-patient deaths, accounting for 12% of all visits and 10% of admissions (TCC, 2011).

In 2015, according to the Ministry of Health, malaria was one of the top ten leading causes of morbidity in all ages and children under age five, accounting for 3.4 and 5.2 percent respectively. The number of new cases of malaria declined from 2.8 million in 1990 to 621345 in 2015.

Malaria caused an estimated 30323 deaths in 1990 and 1561 deaths in 2015, a 94.8% reduction over the 25 years. Age-standardized mortality rate of malaria has declined by 96.5% between 1990 and 2015 with an annual rate of change of 13.4%. Age-standardized malaria incidence rate among all ages and gender declined by 88.7% between 1990 and 2015 (Deribew *et al.*, 2017). Though according to O'Meara *et al* (2010), country-wide surveillance in Ethiopia revealed a 70% decline in malaria morbidity like other areas of sub-Saharan Africa in the past 3-5 years, malaria has been consistently reported as one of the three leading causes of morbidity and mortality over the past years (Otten *et al.*, 2009).

More than two thirds of population lives in malarious area, including the fertile low-land areas that are most suitable for agriculture, and an estimated 51 million people (68% of the population) live in areas at risk of malaria (Mekonnen *et al.*, 2010). Among plasmodium species, *Plasmodium falciparum* and *Plasmodium vivax* are the most dominant malaria parasites in Ethiopia, distributed all over the country and accounting for 60% and 40% of malaria cases, respectively. *Plasmodium malariae* accounts for less than 1% and *Plasmodium ovale* is rarely reported (RBM, 2010).

The distribution of malaria is governed by a large number of factors relating to the parasite, the vector and the host (human). Predominant among these are climatic and environmental factors, particularly those that affect habitat and breeding sites of the Anopheles mosquito vectors such as temperature, precipitation, humidity, presence of stagnant water pools, vegetation, migration, large scale irrigation, urbanization, Anti-malaria drug resistance and human to vector contact etc. (Zacarias and Andersson, 2010).

In Ethiopia, malaria transmission is largely determined by climate and altitude. Most of the transmission occurs between September and December, after the main rainy season from June to August while the second minor transmission period from April to May, following a short rainy season from February to March (MOP, 2009). Five main malaria eco-epidemiological strata are recognized: These are: Malaria free highland areas above 2,500 meter altitude, Arid areas where malaria is only found near semi-permanent water bodies, Epidemic-prone areas in highland fringes between 1,500 – 2,500 meters, Seasonal transmission in lowland areas <1,500 meters, Stable, year round, transmission in the western lowlands and river basin areas. Malaria

transmission in Ethiopia is generally seasonal and highly unstable due to variations in topography and rainfall patterns (Gebreyesus, 2006).

Gebreyesus (2006) states that Dega zone of Ethiopia (altitude above 2,500 meters) with a mean annual temperature of 10-15 degree Celsius is malaria-free. Much of the Woina Dega zone (Altitude 1500 – 2500 meters) is also malaria free, especially the zone in the 2000 – 2500 meters above sea level. Malaria in Ethiopia often occurs below 2000 meters, with short-lived transmission following the rains. However, malaria epidemics have been recorded up to 2400 meters during periods when increased temperature and adequate precipitation are conducive for both vector survival and parasite development within the vector.

The distribution and transmission of malaria in Ethiopia varies from place to place(Figure 2). So the distribution of the malaria in Ethiopia is largely determined by altitude. Altitude affects the pattern of malaria distribution in Ethiopia through its effect on temperature (Betemariam *et al.*, 2002). Risk of malaria is highest in the western lowlands of Oromia, Amhara, Tigray and almost the entire regions of Gambella and Benishangul Gumuz regions. The midlands of Ethiopia between 1000 and 2200 meters attitude experiences seasonal transmission of malaria with sporadic epidemics a very few years. In the eastern lowlands of Ethiopia(Primarily Afar and Somalia), malaria is endemic only along rivers, as this part of the country is largely dry away from rivers. Transmission is limited by the lack of water collections for mosquitoes breeding an low humidity due to low rainfall and sparse vegetation. The central high lands of Ethiopia are free of malaria due to low temperature, which slows the development of the vector parasite(Tsige *et al.*, 2009).

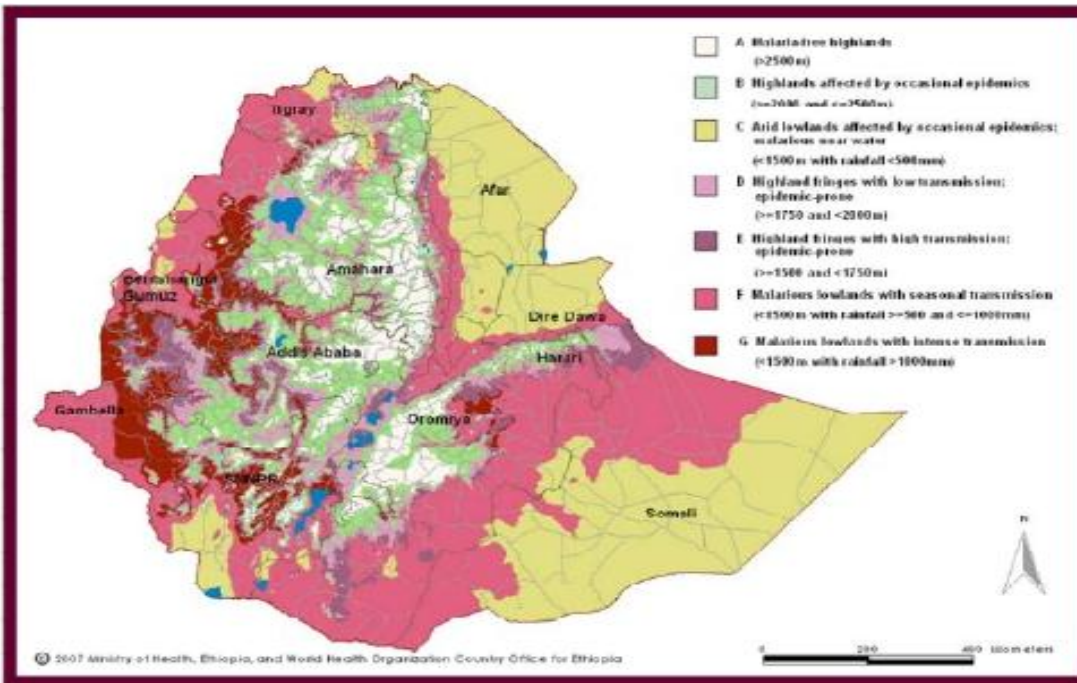


Figure 2 Malaria distribution in Ethiopia (Source: Ayle *et al.*, 2012)

2.3. The Malaria Parasite

Malaria is an ancient disease caused by parasites of the genus *Plasmodium* and transmitted by several species of female anopheline mosquitoes. The term ‘malaria’ originates from mal’aria (Italian) signifying ‘bad air’ or miasmas arising from marshes (Shumbullo, 2013). Malaria is caused by approximately 100 known *Plasmodium* species that infect particular lineages of primates, rodents, bird and reptiles (WHO, 2007). Five distinct *plasmodium* species infect humans: *Plasmodium falciparum*, *P. vivax*, *P. malariae*, *P. knowlesi* and *P. Ovale* cause malaria in humans (WHO, 2011).

Plasmodium falciparum is the most virulent and lethal malaria parasite and 90% of known human deaths are caused by it. *P. vivax* is less deadly but causes a high morbidity. The ability of *P. vivax* and *P. ovale* to remain dormant for months as hypnozoites in the liver hampers current control and future elimination efforts. *Plasmodium malariae* does not form hypnozoites, but it can persist for decades as an asymptomatic blood stage infection (Rahmatullah *et al.*, 2012)

Plasmodium species have different physical shapes, different development process, life spans and different level of severity. They have also different nature of frequency of relapse of the

disease, varied level of effectiveness of anti-malaria drugs, different incubation period and the degree of disability they cause as indicated in table 1 (Morrow,2007).

Table 1. Plasmodium species and their characteristics feature

Species	Intra RBC Schizont	Type of RBC affected	Relapse	Incubation period
<i>Plasmodium vivax</i>	48 hours	Reticulocyte	Yes	10-24 day
<i>Plasmodium ovale</i>	48 hours	Reticulocyte	Yes	10-24 day
<i>Plasmodium malarae</i>	72 hours	Older RBC	NO	18-40 days
<i>Plasmodium falciparum</i>	48 hours	All	No	8-14 days

(Source: Morrow 2007)

The sign and symptom of malaria typically begin of 7-15 days following infection (Gerard, 2010). The symptoms include: fever, chill, headache, shivering, vomiting, back pain, Joints ache, and loss of appetite, Nausea, tiredness, diarrhea and general feeling of discomfort. As the diseases progresses, some patients may develop the classic malaria paroxysm with bouts of illness alternating with symptom free period. The malaria paroxysm comprises three successive stages. The first is a 15 to 60 minutes cold stage characterized by shivering and a feeling of cold. Next comes the 2 to 6 hour hot stage, in which there is fever, sometimes reaching 41⁰c, flushed, dry skin, and often headache, nausea, and vomiting, finally, there is the 2 to 4 hours sweating stage during which the fever drops rapidly and the patient sweats (CDC, 2008).

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, sweating, headaches, vomiting, 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 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, respiratory distress etc.), acute renal failure, severe anemia and metabolic acidosis (Lee *et al.*, 2011)

2.4. The Vectors and Life Cycle of Malaria Parasites

Malaria parasites are transmitted from person to person by female mosquitoes belonging to the genus *Anopheles*. Females require several blood meals before laying eggs, while males feed harmlessly by sucking fruit juices. Females of most species of mosquitoes require a blood meal before the eggs can develop. The malaria vector requires water to complete its life cycle: egg, larva, pupa, and the adult (Jaston, 2004). Species that usually feed on humans are said to be anthropophilic. *Anopheles gambiae* are mainly anthropophilic, endophilic and endophagic. The resting and feeding behavior of malaria vectors is an important consideration in planning control measures (Mike, 2000).

There are about 380 species of *Anopheles mosquitoes* (WHO, 2009). Seventy species can transmit malaria under natural condition, and of these 40 are of major importance's as vectors. Some Anophelines prefer to bite animals and thus either does not normally transmit malaria parasites to humans or do so very. Some others do not live long enough for the parasite to develop in the mosquito, or the parasite does not seem to be able to develop (WHO, 2010).

Malaria is transmitted by more than 30 Anopheline mosquito species in Ethiopia (for example: *Anopheles gambiae*, *Anopheles mosquito*, *Anopheles freeborni*, *Anopheles quadrimaculatus* etc. with diverse breeding and feeding habits, and result in different disease spectra in different population target groups and epidemiological settings (Alonso *et al.*, 2011).

The major malaria vector in Ethiopia is *Anopheles arabiensis* (WHO, 2012). It is widely distributed in the country and is usually vector of epidemic malaria. The second most frequent vector species in the country is *Anopheles pharoensis*. Other less important vectors are *Anopheles funestus* and *Anopheles nilli*, which were in the past important vectors of malaria in limited areas of Ethiopia (RBM, 2010).

The Plasmodium species life cycle involves both female *Anopheline mosquitoes* and human host (figure 3). The parasite has three main phases. These are liver phase, blood phase and mosquito

phase. Malaria is transmitted by mosquito bites in human beings and inoculates sporozoites into the human blood stream, and then the sporozoites travel to the liver. Upon sporozoite replication in the liver, merozoites are released into the blood stream (NIAID, 2011). The merozoites bind to the surface and then enter the Red Blood Cells (RBCs) via a receptor-ligand interaction (CDC, 2004)

The parasite then undergoes growth through the ring and trophozoite stages, finally producing schizonts containing multiple merozoites (erythrocytic cycle). The erythrocytic cycle is the stage responsible for the disease, where all the symptoms and complications take place. It is also the stage when most of the antimalarial drugs (quinolones, antifolates and endo peroxide) take action. Matured schizonts destruct RBCs and release merozoites into the blood stream, which re-invade new RBCs. 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 her next blood meal, 10-14 or more days later, it can again infect a human host. When the mosquito takes her next blood meal, 10-14 or more days later, it can again infect a human host (Lamb *et al.*, 2006).

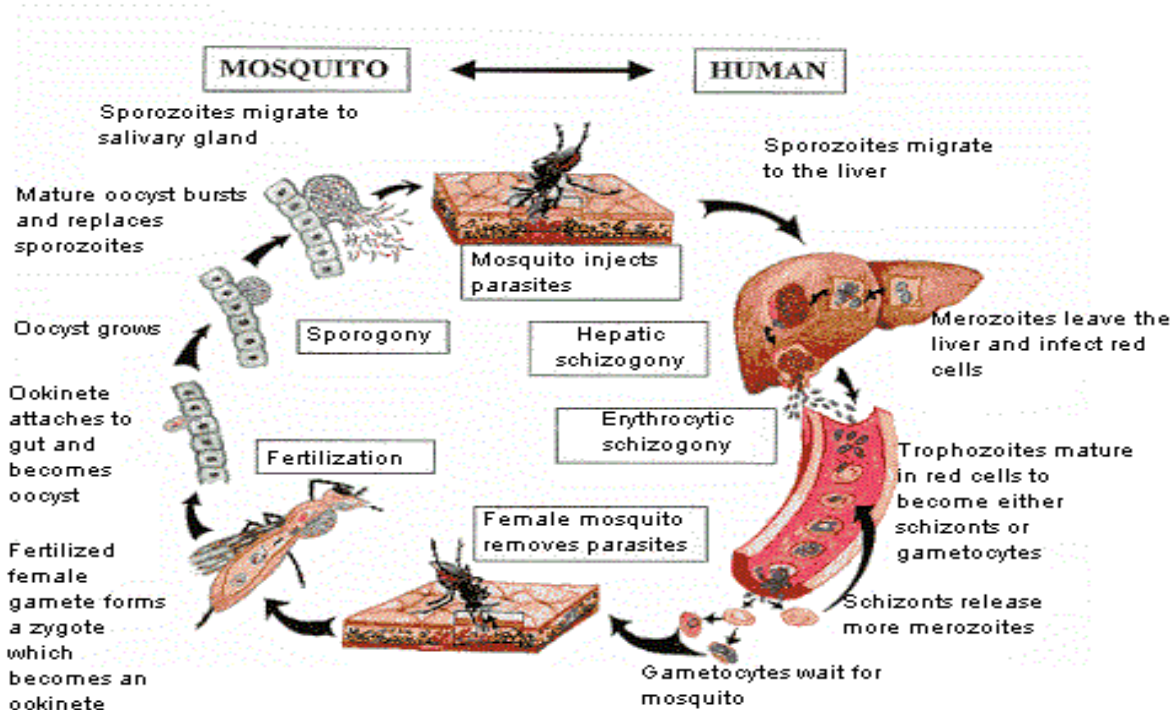


Figure 3. Life cycle of Human malaria parasite (Source: www.pinterest.com)

2.5. Diagnosis of Malaria Parasites Infection and Treatment

Malaria is conventionally diagnosed by microscopic examination of stained blood films using Giemsa, Wright's, or Field's stains (Mekonnen *et al.*, 2010). This method has changed very little since Laveran's original discovery of the malaria parasite, and improvements in staining techniques by Romanowsky in the late 1800s. More than a century later, microscopic detection and identification of Plasmodium species in Giemsa-stained thick blood films (for screening the presenting malaria parasite), and thin blood films (for species' confirmation) remains the gold standard for laboratory diagnosis (Bharti *et al.*, 2007).

From the thick film an experienced microscopist can detect parasite levels (or parasitemia) as few as five parasites/ μ L blood. Diagnosis of species can be difficult because the early trophozoites (ring form) of all four species look similar and it is never possible to diagnose species on the basis of a single ring form; species identification is always based on several trophozoites (Richard *et al.*, 2006). The wide acceptance of this technique by laboratories all

around the world can be attributed to its simplicity low cost, its ability to identify the presence of parasites, the infecting species, and assess parasite density-all parameters useful for the management of malaria (Mekonnen *et al.*, 2010).

Next type of testes are available for diagnosis of malaria is the rapid diagnostic tests (RDTs) offer a useful alternative to microscope in situation where reliable microscopic diagnosis not available.

Malaria RDTs are currently used in some clinical settings and programs. However, before malaria RDTs can be widely adopted, several issues remain to be addressed. The use of this RDT may decrease the amount of times that it takes to determine that patient is infected with malaria. The first rapid diagnostic tests were using plasmodium glutamate dehydrogenase as antigen (PGLUDH). PGLUDH was soon replaced by plasmodium lactose dehydrogenase (PLDH). Depending on which monoclonal anti bodies are used this type of assay can distinguish between different species of human malaria parasites, because of antigenic difference between their PLDH iso-enzymes (Ling *et al.*, 1986).

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).

Third type of test is physical diagnosis (clinical test) that is based on only a history of subjective fever as the indication of to treat for malaria (Redd *et al.*, 2006).

Malaria is an entirely preventable and treatable disease. The type of medication that is used to treat malaria depends on the severity of the disease and likelihood Chloroquine resistance .The drugs available to treat malaria include : Chloroquine, Quinine, Hydroxychloroquine (coartem), Atovaquone (Mepron), Proguanil (solid as a generic), Mefloquine, Clindamycin (Cleocin), Doxycycline, Pyrimethamine /Sulfadoxine (Fansidar) (UNICEF, 2000).

The recommended treatment of severe complicated malaria is intravenous quinine or artemisinin derivatives. Intravenous infusion of quinine should be given slowly over 8 hours to avoid cardiac complications. This should be followed by oral quinine tablets for a total of 7 days once the patient is conscious and can drink. Although treatment may start at the health center, the patient should then be immediately referred to a hospital (UNICEF, 2000).

2.6. Prevention and Control of Malaria

Ethiopia's fight against malaria started more than half a century ago. Initially malaria control began as pilot control project in the 1950s and it was launched as a national eradication campaign in the 60s followed by a control strategy in the 70s (CDC, 2004). Ethiopia developed a five year National strategic plan for malaria prevention, control and Elimination (2011-2015). The strategic plan has set goals to achieve malaria elimination in areas with historically low malaria transmission and near zero malaria deaths in all remaining parts of the country by 2015 (FMH, 2010).

Combating malaria is among the eight Millennium Development Goals. Early diagnosis and effective treatment, Vector control, Easy and universal accessibility to ITNs, Residual periodic spray of dwellings, Environmental management, and continued efforts in epidemic prevention are currently implemented control strategies. Expanded use of information technologies, education, and communication is among the supporting strategies (Sheleme, 2007). Insecticide-treated materials are important in malaria control evidence from several studies show that use of insecticide-treated materials reduced severe malaria cases in children by about 45% and all case mortality by about 20% (Sheleme, 2007).

In recent years, there has been financial support by global donors in order to curb the disease in malaria endemic countries. 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 ultimate goal of worldwide malaria eradication by 2040-2050 (PMI, 2015). The proven malaria intervention tools being extensively used in Ethiopia are: Insecticide treated mosquito nets (ITNs); in door residual spray (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 (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%. In Ethiopia since 2010 the pyrethroid resistance has been confirmed and dichloro Diphenyl-Trichloroethane (DDT) resistance was also common (Balkew *et al.*, 2010). In addition to that, the carbamate resistance has been reported for at least one malaria vector and organo Phosphate resistance has been reported for Ethiopia (Yewhalaw *et al.*, 2011).

Ethiopia has adopted Artemeter Lumefantrine (AL), one form of ACTs as first line treatment policy since 2004 (FMOH, 2004) for uncomplicated *P.falciparum* and for *P.vivax* chloroquine remains 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. But, a system for monitoring adverse reactions to antimalarial has never been in existence. Surveillance for active case detection (ACD) for case investigation and ACD 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 medium treatment failure rate of less than 10% observed.

2.7. The prevalence of malaria

Surveys of malaria indicators conducted in 2007 in Countries with high, stable transmission: Niger, Rwanda and United Republic of Tanzania Zanzibar revealed a parasite prevalence rate of 2.4% in 2842 children fewer than 5 years of age. A community based survey data from two districts indicated parasite prevalence rates of 0.8% (68/8650) overall and 0.4% (9/2123) in children under 5 years of age (Samuel *et al.*, 2008).

The afro-tropical region, which is only 8% of the world's population, bears the heaviest malaria burden, with 200 to 280 million cases, over 90% of which are due to *Plasmodium falciparum* (Eholié, 2009).

According to a study in Pacific Island, malaria was seasonal, the parasite prevalence in the population varying from 21% (60% falciparum, 40% vivax) in the wet season to 11% (15% falciparum, 85% vivax) in the dry season (WHO, 2008).

A study in 13 endemic districts of Bangladesh shows an overall malaria prevalence of 3.97%, the majority of cases (90%) of which was falciparum malaria (Haque *et al.*, 2009).

Nationally, in Ethiopia, *Plasmodium vivax* and *Plasmodium falciparum* comprise 40% and 60% of malaria infections respectively (Jima *et al.*, 2010). A malaria indicator survey, 2007 indicated that parasite prevalence (as measured by microscopy) in Ethiopia and Oromia was 0.7% and 0.3%, respectively (USAID/CDC, 2010). According to this survey 60 out of 7117(1.0%) were positive for Plasmodium infection by microscopy, with 0.7% and 0.3% due to *P. falciparum* and *P. vivax*, respectively. Of the 6775 matched individuals, 40(0.6%) and 5 (0.1%) were positive for *P. falciparum* and *P. vivax*. No individuals tested positive for both *P. falciparum* and *P. vivax*. Prevalence of infection in children was 0.9%. Of 45 positive individuals tested, 37 (87.0%) were children <15 years of age. Overall, 134 (2.0%) surveyed individuals tested positive for Plasmodium infection by RDTs, with 1.8% and 0.2% due to *P. falciparum* and *P.vivax*, respectively(Jima *et al.*, 2010).

According to Afar regional state annual malaria report in 2005/06 showed that among 92,248 patients whose blood films were examined microscopically, 41% were positive for malaria (AMRIFE, 2008).

Study conducted in Oromia and SNNPR regions of Ethiopia showed the overall malaria parasite prevalence of 2.4% (95% CI 1.6–3.5). Prevalence by cluster varied from 0 to 25%, with 55% of the 64 clusters having no positive cases. The malaria parasite prevalence differed markedly between Oromia, 0.9% (95% CI 0.5–1.6) and SNNPR, 5.4% (95% CI 3.4–8.5) regions ($p < 0.001$). The prevalence was highest in the Eastern and North-eastern zones of SNNPR. The malaria species seen most frequently was *P. falciparum*: 69.4% of positive slides had *P. falciparum* and 30.6% had *P. vivax*. No mixed infections of *P. falciparum* and *P. vivax* were observed. The overall ratio of *Falciparum* to *P. vivax* was 2.3; 4.3 in Oromia and 2.1 in SNNPR (Shargie *et al.*, 2008). The study conducted in Metema (Getachew *et al.*, 2013), Kola Diba (Alemu *et al.*, 2012), Butajira (Woyessa *et al.*, 2012) reported. The prevalence of *plasmodium falciparum* 90.7%, 75% and 12% while as *plasmodium vivax* accounted 9%, 25% and 86.5% respectively.

2.8. Malaria status in Afar Region

According to official statistics, the region's population is about 1.5 million; of which 90% are pastoralists and 10% are agro-pastoralists.

The overall health status of the Afar population is poor, with women and children particularly vulnerable to poor health maternal mortality (720/100,000) and under five child mortality (229/1000) are double the national average (WHO, 2010). According to the 2014/2015 regional health Bureau data, there are 4 hospitals, 68 health centers, 251 health posts and 88 health stations in the region that are run by the government. In addition, there are 25 small and medium level privately-owned clinics and only one hospital which is operated by a non-governmental organization. Malaria transmission in the region is generally unstable, with perennial transmission in areas along the Awash River valley. In 2014/2015, there were a total of 289852 cases of all types of malaria (FMOH, 2015).

There were 20,323 under-five and 1605 pregnant women with malaria who were attended to in the outpatient department the same year. Moreover, there were 625 under-fives and 64 pregnant mothers with severe malaria admitted in the region (FMOH, 2008).

The 2014 Ethiopian DHs also showed that among 10,000 children less than 5 years, 18.7% had experienced fever within the previous two weeks (17% in Afar). While fever is a common symptom of malaria on set, 16.6% of those surveyed had received an anti-malaria drug within 48 hours (Yeshiwondim *et al.*, 2011)

3. Materials and Method

3.1. Descriptions of the Study Area

The study was conducted in Aysaita primary hospital, Aysaita woreda which is located in zone one, Afar regional state, Aysaita woreda is located 652 km northeast of Addis Ababa. Based on the projection of 2013 National census conducted by central statistical agency of Ethiopia (CSA), this woreda had a total population of 66,780 of whom 35,572 were males and 31,208 were female. This woreda has altitude and longitude of 11⁰35' N and 41⁰23' E with an elevation of 350 to 473 meter above sea level. Annual mean temperature in the area is greater than 27.5⁰c and annual rain fall range between 500 mm to 1000 mm (BoFED and NPE, 2005)

Administratively it is found in zone one of the regional administration; and this zone comprises eight woreda Aysaita woreda shares boundary with the republic of Djiboti internationally and with Afambo, Dubti and Elidar woreda of zone one in region (Figure 4). It is one of the woreda crossed by Awash River that make some of kebles vulnerable to flood hazared. Aysaita woreda has 11 keble (ANRS, 2010).

In the woreda there are one hospital, one health center and 6 private clinics and 13 Tenakella. The majority of the populations are depending on livestock resource whereas the rest are merchants and government employers.

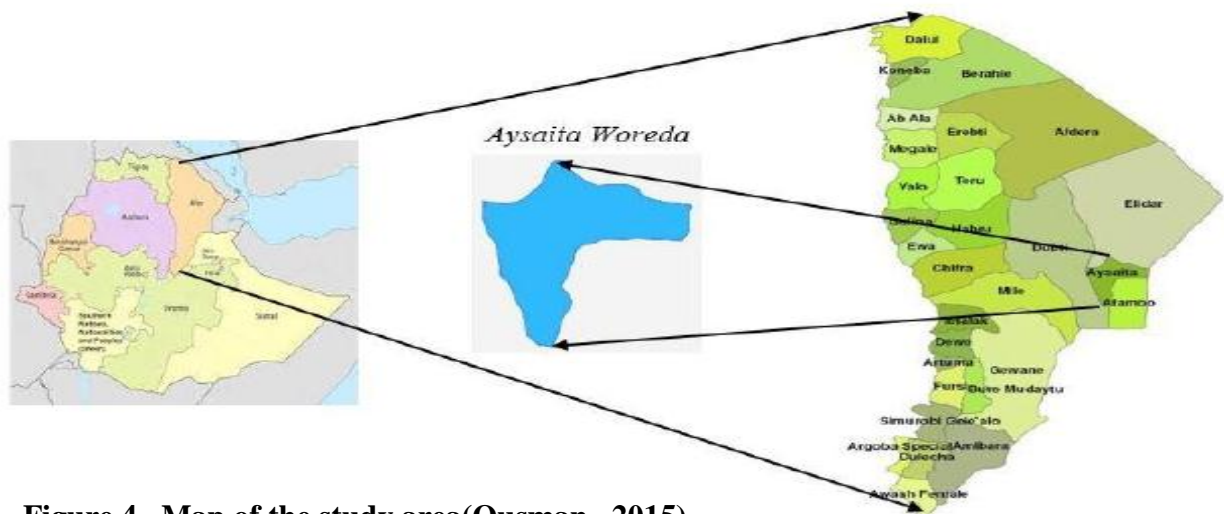


Figure 4 . Map of the study area(Ousman, 2015)

3.2. Research design

A retrospective study was conducted to determine the prevalence of malaria by reviewing blood film malaria report of four year (2006 to 2009 E.C) registered data at Aysaita primary Hospital.

3.3. Data Collection procedures and Sources

In this study, malaria patients medical history document review/archival/ were made from year 2006 to 2009 E.C to obtain the pertinent document for the study to assess the prevalence of malaria diseases in the study area at Aysaita primary hospital during the study period. Laboratory data were collected from patient's medical history registration records.

3.4. Data analysis

Study was employed none parametric test of linearity using Chi-square in order to enhance data accuracies which is to transcribe the availability of significance. Chi-square is used to evaluate uncategorised numeric data to estimate its significance relationship with elaborated issues during the study time. It also used ANOVA for analysis between groups. If the significance level is $\chi^2 > 0.05$ which is data is not fitted to the coefficient like with the data might not be $p < 0.05$ is significantly adequate.

3.5. Ethical consideration

This data was collected after ethical clearance obtained from Addis Ababa University. After discussing the purpose of the study; written permission was sought from the head of Ayssita primary hospital medical director to collect the data.

4. Results

4.1. Annual Prevalence of Malaria

During the study period, a total of 43574 malaria suspected patients give blood films for malaria diagnosis in Aysaita primary hospital of which 3830 (8.7%) blood samples were microscopically confirmed as malaria cases the prevalence of malaria in the hospital registered data showed that variations from year ranging from the highest record of 11.4% in 2009 E.C to that of the lower record of 5.3% in 2008 E.C with the period of four year (2006 - 2009 E.C) ($p=0.000$, $df=1$) as in table 2 below.

Table 2. Annual prevalence of malaria at Aysaita primary hospital

Year	No of blood sample screened			No of positive sample			p. value
	Male	Femal e	Total	Male	Female	Total positive sample	
2006	7066	6883	13949	1037	544	1581 (11.3%)	0.000
2007	5872	5710	11582	443	283	726 (6.3%)	
2008	4605	4210	8815	302	167	496 (5.3%)	
2009	4654	4574	9228	632	422	1054 (11.4%)	
Total	22197	21377	43574	2414 (63.1%)	1416 (36.9%)	3830 (8.7%)	

4.2. Frequency of Plasmodium species

As shown in table 3 the overall prevalence Frequency of plasmodium from slide diagnostic was 3830 of 3608 (94.2%) were *Plasmodium falciparum* and 222 (5.8%) were *Plasmodium vivax*. The frequency of *Plasmodium falciparum* was higher in 2009 and lower in 2008; similarly the frequency of *Plasmodium vivax* was higher in 2006 and lower in 2009. The data also show that the prevalence of *Plasmodium falciparum* and *Plasmodium vivax* as causative agents for malaria infection in study area. There was statistically significance between the prevalence of *plasmodium falciparum* and *plasmodium vivax* (P = 0.000, df = 1)

Table 3. Frequency of plasmodium species at Aysaita primary hospital

Year	<i>Plasmodium falciparum</i>	<i>Plasmodium Vivax</i>	Total	p-value
2006	1451(91.8%)	130 (8.2%)	1581	0.000
2007	699 (96.3%)	27 (3.7%)	726	
2008	439 (93.6%)	30 (6.4%)	469	
2009	1019 (96.7%)	35 (3.3%)	1054	
Total	3608 (94.2%)	222 (5.8%)	3830	

4.3. Prevalence of Malaria in different Age group

Malaria was reported in all age group in the study area but the age group of ≥ 15 were more affected, with prevalence rate of 2333 (60.9%) followed by age group 5-14 year with prevalence rate 863 (22.5%) and the age group of 0-4 affected with prevalence rate 634 (16.6%). Moreover prevalence of malaria infection was statistically associated with age (p= 0.002, df = 1) shown in table 4 below.

Table 4. Prevalence of malaria in different age group in Aysaita primary hospital

Age	Plasmodium falciparum	Plasmodium vivax	Total prevalence	p-value
0-4	586	48	634 (16.6%)	0.002
5-14	817	46	863 (22.5%)	
≥ 15	2205	128	2333 (60.9%)	
Total	3608	222	3830	

4.4. Prevalence of Malaria by sex at Aysaita primary hospital

Out of the total examination patients male 22197 and female 21377, the malaria slide positive male were 2414 (63.1%) and female were 1416 (39.9%).The data showed that males were more affected than female. The prevalence of malaria infection between male and female was statistically significance ($p=0.000$, $df = 1$)as in table 5 below.

Table 5. Prevalence of malaria by sex in Aysaita primary hospital

Sex	Plasmodium falciparum	Plasmodium vivax	Total prevalence	p-value
Male	2281	132	2414 (63.9%)	0.000
Female	1327	90	1416 (39.1%)	
Total	3608	222	3830	

4.5. Monthly Prevalence of Malaria

This study showed malaria was occurred in all month of the year. From below Table 6, Chi-Square Tests of malaria infections, by Month of malaria infections reflected among Aysaita primary hospital, in September *Plasmodium vivax* resulted by 7 (1%) *Plasmodium falciparum* infection resulted by 36 (2%). In October month malaria is spired *Plasmodium vivax* resulted by 5 (0.5%) and *Plasmodium falciparum* infection resulted to 71 (5%).

In Nov *Plasmodium vivax* resulted by 9 (1%), *Plasmodium falciparum* infection resulted by 76 (7%). In December, *Plasmodium vivax* resulted by 10(1.5%) and *Plasmodium falciparum* infection resulted by 179 (20%). In January, *Plasmodium vivax* resulted by 16 (2%) and *Plasmodium falciparum* infection resulted by 319 (26%).

In February, *Plasmodium vivax* resulted by 44 (26.0%) and *Plasmodium falciparum* infection resulted by 829 (31%). In March, *Plasmodium vivax* resulted by 56(40.0%) and *Plasmodium falciparum* infection resulted by 890 (32%).

In April, *Plasmodium vivax* resulted by 21(14%) and *Plasmodium falciparum* infection resulted by 683(32%). In May, *Plasmodium vivax* resulted by 12 (3%) *Plasmodium falciparum* infection resulted by 183(33%). In Jun *Plasmodium vivax* resulted by 24 (13%) and *Plasmodium falciparum* infection resulted by 100 (8%).

In July *Plasmodium vivax* resulted by 9 (1%) and *Plasmodium falciparum* infection resulted by 71 (5%). August *Plasmodium vivax* resulted by by 9(1%) and *Plasmodium falciparum* infection resulted 99 (8%) at 5% significance level by df. Majority of malaria infections are highly consented during February to April month.

Table 6. Monthly prevalence of malaria in Aysaita primary hospital

Month	Total examine	Total positive	Plasmodium falciparum	Plasmodium Vivax	P.Value
Sept	2643	43(1.1%)	36(2)	7(1%)	0.003
Oct	2940	76(2%)	71(5%)	5(0.5%)	
Nov	3027	85(2.2%)	76(7%)	9(1%)	
Dec	3150	189(4.9%)	179(20%)	10(1.5%)	
Jan	4087	407(10.6%)	391(26%)	16(2%)	
Feb	5524	873(22.8%)	829(31%)	44(26%)	
March	5309	946(24.7%)	890(32%)	56(40%)	
April	4264	704(18.7%)	683(32%)	21(14%)	
May	3189	195(5.1%)	183(33%)	12(3%)	
June	3219	124(3.3%)	100(8%)	24(13%)	
July	2575	80(2.1%)	71(5%)	9(1%)	
Aug	3647	108(2.8%)	99(8%)	9(1%)	
Total	43574	3830	3608	222	

4.6. Discussion of the findings

The data showed an overall prevalence of malaria infection was 3830(8.7%) which was lower than study conducted in Kola Diba 39.6 % (Alemu *et al.*, 2012), Dila 16% (Molla and Ayele, 2015), and East shewa 20.5% (Haji *et al* 2016). But it was higher than similar study conducted in Jima (Tatek, 1994 and Bangladesh (Haque *et al.*, 2009) in which over all prevalence of malaria disease accounted were 7% and 3.97% respectively. The difference might be due to altitude difference, climate variability and sample size.

The result also showed declining of malaria prevalence from 2006 - 2008. This decreasing might be due to increase attention to malaria control and prevention activities by different responsibilities. But this declining show increment in 2009 may be climatic change that occurs by the expansion of Eli no and attentions given in the prevention of malaria prevalence decreases in the study area and which might indicate inconsistent intervention measures to reduce the burden of the disease.

Studies showed that malaria using Chi-Square Test of malaria infection among Aysaita primary hospital ; male are more victim than female. In this study, the overall prevalence of malaria in males 2414 (63.1%) was higher than females 1416 (36.9%) this is in line with study conducted in Motta (Tilahun *et al.*, 2016), Metema hospital (Getachew *et al.*, 2013) and Wolayta zone (Deresse *et al.*, 2015) in which the overall prevalence were 57.47%: 42.57%, 57.7%: 42.3% and 50.74:49% respectively.

The reason why malaria affected more males might be due to the fact that male engaged in activities out their residence area to keep agriculture products, livestock and most of the people migrate in to low land area for different work which made them more prone to mosquito bites as compared to female which were limited to their resident area at home and may not be more exposed to anopheles mosquito.

Based on the laboratory diagnosis of plasmodium species distribution of malaria, 3608 (94.2%) were the malaria case of *Plasmodium falciparum* and 222 (5.3%) *Plasmodium vivax*. This indicates *Plasmodium falciparum* to be the dominant species in the study area.

This study coincides with the malaria parasite distribution in Ethiopia which indicates *Plasmodium falciparum* and *Plasmodium vivax* was two predominant parasites distributed all over the nation and accounting for 60% and 40% of malaria cases respectively. However this is also in agreement with another report conducted in Metema (Getachew *et al.*, 2013) and Kola Diba (Alemu *et al.*, 2012), with reported prevalence of *Plasmodium falciparum* 90.7% and 75% respectively, while *Plasmodium vivax* accounted for 9% and 25%, respectively. This study contradicts with a study conducted in Butajira (Woyesa *et al.*, 2012) with *Plasmodium falciparum* 12.4% and *Plasmodium vivax* 86.5%. This may be due to the difference in the study area, study size, study period, sample size as well as study population in which those studies focused on and it might be altitude variation.

In relation to age group malaria was detected in all age groups in the study area. However, the rate of infection was high in the age group ≥ 15 years old followed by 5-14 years old and 0-4 years old. The highest prevalence of malaria in the age group of ≥ 15 (60.9%) in the study area was much higher than the one recorded in Kola Deba (50%) Alemu *et al.*, 2012, however the prevalence in the age group 5-14 years old (22.5%) is slightly higher than the same in Kola Diba (20%) reported by Alemu *et al.*, 2012. The prevalence of malaria in the age group <5 in the study was 16.6% similar to Kola Diba 16.6%. The reason why malaria affected productive age groups might be due to the fact that these age groups spend more time outdoors for farming and to keep their cattle's. Due to these reasons this age group was more exposed to anopheline mosquitoes.

In this study area, malaria was observed in almost every month of the year. The maximum malaria case was observed during the minor transmission period (February, March and April). This study differs from a report in Kola Diba (Alemu *et al.*, 2012) and Motta (Tilahun *et al.*, 2016). It might be large scale irrigation, stagnant water pools and climate variability.

5. Conclusions and Recommendation

5.1. Conclusion

Malaria is the most prevalence disease in the study area. The study shows that a decreased from 2006 to 2008 E.C. But slightly increase in 2009 E.C. The highest prevalence was recorded in 2009 E.C (11.4%). and the lowest prevalence recorded in 2008 E.C (5.3%). Among Plasmodium species, *Plasmodium falciparum* (94.2%) was predominantly affecting people in the study area. Based on the Analysis of sex, males were more infected than female. With malaria prevalence on age, children under the age of five were the least prevalence of all other age groups. In the study area, the most prevalent cases were reported in male age group ≥ 15 . The months of February to April show higher prevalence of malaria in study area.

5.2. Recommendation

Based on the findings of the present study, the following recommendations were made;

- All the information regarding to malaria should be registered in a good manner and documented separately.
- Special attention should be crucial for age group ≥ 15 years since infection rate of malaria was very high in active age categories in the study area.
- Strong attention should be given to *Plasmodium falciparum* because it was the predominant parasitic and highly devastating effect on health and wealth of community in comparing to other malaria parasite in study.
- The Woreda health office could make malaria prevention and control program like, anti-malaria drug provision, bed net distribution and houses praying by prioritizing based on the risk level of areas.
- Further research on the prevalence of malaria should be taken to prevent and control of the series consequence of this disease, especially during malaria transmission.

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Annexes

Annual prevalence of malaria at Aysaita primary hospital

Year	No of blood sample screened			No of positive sample			positive sample	df	p. value
	Male	Female	Total	Male	Female	Total			
2006	7066	6883	13949	1037	544	1581(11.3%)	1	0.000	
2007	5872	5710	11582	443	283	726(6.3%)	1		
2008	4605	4210	8815	302	167	496(5.3%)	1		
2009	4654	4574	9228	632	422	1054(11.4%)	1		
Total	22197	21377	43574	2414(63.1%)	1416(36.9%)	3830(8.7%)			

Frequency of plasmodium species at Aysaita primary hospital

Year	Plasmodium species			p-value
	Pf	Pv	Total	
2006	1451(91.8%)	130(8.2%)	1581	0.000
2007	699(96.3%)	27(3.7%)	726	
2008	439(93.6%)	30(6.4%)	469	
2009	1019(96.7%)	35(3.3%)	1054	
Total	3608(94.2%)	222(5.8%)	3830	

Prevalence of malaria in different age group in Aysaita primary hospital

Age	Plasmodium falciparum	Plasmodium vivax	Total prevalence	df	p-value
0-4	586	48	634 (16.6%)	1	0.002
5-14	817	46	863 (22.5%)	1	
≥ 15	2205	128	2333 (60.9%)	1	
Total	3608	222	3830		

Prevalence of malaria in sex in Aysaita primary hospital

Sex	Plasmodium falciparum	Plasmodium vivax	Total prevalence	df	p-value
Male	2281	132	2414 (63.9%)	1	0.000
Female	1327	90	1416 (39.1%)	1	
Total	3608	222	3830		

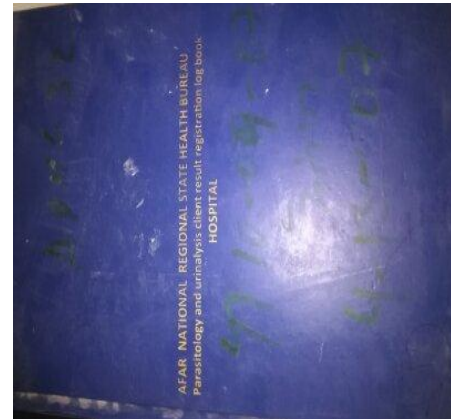
Monthly prevalence of malaria in Aysaita primary hospital

Month	Total positive	Plasmodium falciparum	Plasmodium Vivax	df	P.Value
Sept	43(1.1%)	36 (2%)	7 (1%)	1	0.003
Oct	76(2%)	71 (5%)	5 (0.5%)	1	
Nov	85(2.2%)	76 (7%)	9 (1%)	1	
Dec	189(4.9%)	179 (20%)	10 (1.5%)	1	
Jan	407(10.6%)	319 (26%)	16 (2%)	1	
Feb	873(22.8%)	829 (31%)	44 (26.0%)	1	
March	946(24.7%)	890 (32%)	56 (40.0%)	1	
April	704(18.7%)	683 (32%)	21 (14%)	1	
May	195(5.1%)	183 (33%)	12 (3%)	1	
June	124(3.3%)	100 (8%)	24 (13%)	1	
July	80(2.1%)	71 (5%)	9 (1%)	1	
Aug	108(2.8%)	99 (8%)	9 (1%)	1	
Total	3830	222 (100%)	222 (100%)		

ANOVA -Four years frequency of Plasmdium species

		Sum of Squares	df	Mean Square	F	Sig.
2006	Pv	130.125	1	14.5000	3	.000
	pf	1451.000	1	130.0000	3	
	Total	1581.125	1	72.2500	4	
2007	Pv	27.000	1	29.0000	2	.000
	pf	699.000	1	127.0000	3	
	Total	718.000	1	363.0000	3	
2008	Pv	30.500	1	439.0000	2	.000
	pf	439.000	1	30.0000	3	
	Total	469.500	1	234.5000	2	
2009	Pv	35.000	1	101.0000	1	.000
	pf	1019.000	1	169.0000	2	
	Total	1054.000	1	527.0000	3	

Four years frequency of Plasmodium species									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
2006	36.00	1	14.5000	.	.	.	.	14.50	14.50
	71.00	1	130.0000	.	.	.	.	130.00	130.00
	Total	2	72.2500	81.67083	57.75000	-661.5333	806.0333	14.50	130.00
2007	36.00	1	699.0000	.	.	.	.	699.00	699.00
	71.00	1	27.0000	.	.	.	.	27.00	27.00
	Total	2	363.0000	475.17576	336.00000	-3906.2848	4632.2848	27.00	699.00
2008	36.00	1	439.0000	.	.	.	.	439.00	439.00
	71.00	1	30.0000	.	.	.	.	30.00	30.00
	Total	2	234.5000	289.20667	204.50000	-2363.9189	2832.9189	30.00	439.00
2009	36.00	1	1019.0000	.	.	.	.	1019.00	1019.00
	71.00	1	35.0000	.	.	.	.	35.00	35.00
	Total	2	527.0000	695.79307	492.00000	-5724.4527	6778.4527	35.00	1019.00



Documentation in Ayssita primary hospital

Declaration

I, the undersigned, declare that this Thesis is my original work and all source materials used are duly acknowledged.

Name Biniyam Belay

Signature-----

Date -----

This Thesis has been approved for submission to the department of zoological sciences for public defense.

Name Gurja Belay (PhD)

Signature-----

Date -----